

**Original Article**

# Stroke Type, Time to Care, and EWS as Predictors of Patient Outcomes: A Case-Control Study



Ika Subekti Wulandari<sup>1</sup>, Anis Laela Megasari<sup>1</sup>

<sup>1</sup> Department of Nurse Anesthesia, Vocational School, Sebelas Maret University, Surakarta, Central Java, Indonesia

**ARTICLE INFO****Article History**

Submit : May 3, 2025

Accepted : June 22, 2025

Published : July 8, 2025

**Correspondence**

Anis Laela Megasari;  
2Department of Nurse  
Anesthesia, Vocational School,  
Sebelas Maret University,  
Surakarta, Indonesia.

**Email:**

anislaelamegasari@gmail.com

**Citation:**

Megasari, A. L. ., & Wulandari, I. S. (2025). Stroke Type, Time to Care, and EWS as Predictors of Patient Outcomes: A Case-Control Study. *Journal of Applied Nursing and Health*, 7(2), 252–262. <https://doi.org/10.55018/janh.v7i2.313>

**ABSTRACT**

**Background:** Stroke management requires speed in identification and action to improve stroke outcomes. Unfortunately, the identification of strokes is still slow. This study aims to determine the factors that influence the development of stroke patients.

**Methods:** This study used a case-control design with a retrospective approach. This case-control study adheres to the STROBE reporting guidelines. Purposive sampling was applied with a sample size of 37 respondents. The variables studied were the type of stroke, the Early Warning Score (EWS), the time to seek health services, and the outcome of stroke patients. The Glasgow Outcome Scale Extended (GOSE) measures the effects on stroke patients. Spearman and Sommers's test analyzed data to determine the relationship between two variables, and the multiple regression test was used for multivariate analysis.

**Results:** The results showed that the majority of stroke types were Non-Hemorrhagic Strokes (86.5%), the majority of EWS scores fell into the deficient category (51.4%), and the majority of the time spent seeking health services was less than 2 hours (94.6%). There is a significant relationship between the type of stroke (p-value 0.02), EWS score (p-value 0.01), and the time to seek health services and stroke outcome (p-value 0.03). Multivariate analysis revealed that the type of stroke, time to seek health services, and EWS scores were simultaneously or collectively associated with stroke patient outcomes (F count = 5.269 > F table = 2.88, with a coefficient of determination of 32.4%). This research showed that the type of stroke, time to seek health services, and the EWS score can be used as predictors of the outcome level of stroke patients.

**Conclusion:** These findings highlight the importance of integrating Early Warning Score (EWS) into hospital protocols to support early recognition and timely response for stroke patients, potentially improving patient outcomes

**Keywords:** Early Warning Score; Elderly; Outcome Stroke; Time to seek health services; Type of stroke.

**Implications for Practice:**

- Providing targeted education about stroke symptoms, the importance of timely healthcare access, and the use of Early Warning Scores (EWS) can improve awareness and reduce delays in seeking medical assistance.
- The systematic implementation of the Early Warning Score in stroke management protocols can support the early detection of critical conditions and facilitate timely medical interventions.
- Strengthening public health initiatives to emphasize the urgency of immediate action during stroke symptoms can help reduce preventable delays and improve patient outcomes.

## Introduction

Stroke is the second leading cause of death worldwide after ischemic heart disease and the third leading cause of disability worldwide (Pu et al., 2023). According to the WHO, in 2018, around 7.75 million people died from strokes that occurred in the world. The Centers for Disease Control in 2020 reported that one person dies every four minutes from a stroke in the United States (Song et al., 2025). According to the Indonesian Health Ministry, the highest prevalence of stroke in Indonesia is in East Kalimantan Province (14, 7%), and the lowest is in Papua Province (4.1%). The prevalence of stroke in South Sumatra Province is 10%. Indonesia has the second highest stroke burden after Mongolia, with 3,382.2/per 100,000 people based on DALYs (disability-adjusted life year) (Fitri et al., 2023).

Stroke is a time-sensitive disease that requires speed in identification and action to improve patient outcomes. Stroke is treatable, but time is critical. Therefore, time is crucial to effective stroke management. It has been previously reported that the average human brain loses approximately 1.9 million neurons per minute during a stroke episode. Additionally, the extent of brain cell loss can vary depending on the severity of the stroke and the individual's underlying health condition (Sun & Wang, 2023). Recognizing the onset of stroke symptoms is important so the condition does not worsen. The sooner medical treatment is started, the better the chances of limiting brain cell loss and reducing the long-term impact of the stroke (Alitonang, 2020; Saceleanu et al., 2023).

Stroke remains one of the leading causes of mortality and long-term disability worldwide. Prompt recognition and early intervention are crucial for minimizing brain damage and enhancing patient

outcomes. The concept of "time is brain" emphasizes that every minute of delay in stroke management can result in the loss of millions of neurons, underscoring the critical need for timely assessment and treatment. Some signs of a stroke onset include sudden weakness or numbness on one side of the body, severe headache, difficulty speaking, or vision problems (Liu & Gu, 2023). If any of these symptoms occur, it is essential to call emergency services immediately or visit the nearest hospital. Remember, time is of the essence in stroke management. Everything related to stroke management is very sensitive to time. Since every minute delay in action against stroke would result in the loss of 13.8 billion synapses, a one-hour delay would be equivalent to 3.6 years of brain aging, and prompt action could greatly increase the chances of a successful recovery and minimize potential brain damage (Hussain & Park, 2021; Laili et al., 2023; Widayati et al., 2024).

Most patients present to the hospital more than 24 hours after their stroke (Nagao et al., 2020). The cause of this condition is due to a lack of knowledge about the symptoms of stroke onset. This lack of knowledge will lead to an inability to recognize the symptoms of a stroke, misinterpret the visible signs, and assume that the symptoms are not severe, hoping that they will disappear. As a result, they may not immediately call Emergency Medical Services or take them to the emergency department. A lack of knowledge regarding stroke risk factors and early warning signs can result in delayed recognition of stroke as a critical emergency condition. This often leads to a postponement in seeking medical help or arriving at the hospital promptly (Risitano & Toni, 2020).

In addition to time management, the emergency scoring system is essential to stroke management (Herpich & Rincon,

2020). An Early Warning Score (EWS) is a tool or instrument used to detect physiological changes experienced by patients, such as vital signs and the patient's level of consciousness, during hospitalization. The EWS assessment, which includes checking blood pressure, pulse, respiratory rate, and oxygen supplementation, as well as patient awareness, is carried out periodically by nurses in the inpatient room to detect changes in the patient's condition early. The EWS value determines the action to be taken and documented in the patient's medical record, based on the applicable operational procedure (Langkjaer et al., 2023). Stroke represents a life-threatening neurological emergency, where delayed recognition and intervention are strongly associated with increased morbidity and mortality. In low-resource hospital settings, the absence of advanced diagnostic facilities and specialized stroke teams necessitates the use of simple, rapid, and standardized assessment tools such as the Early Warning Score (EWS). Identification of key predictors, including stroke type, EWS, and time to initial health service contact, can facilitate more effective triage processes and early clinical decision-making, thereby contributing to improved patient outcomes in resource-constrained environments.

Stroke attacks often cause sufferers to experience motor disabilities (Hartati et al., 2025; Murphy & Werring, 2020). Generally, stroke survivors who survive show different outcomes according to their disability, such as paralysis or weakness of limbs, sensory disturbances, language disorders, memory disorders, and emotional disorders (Ali et al., 2020). The highest risk of recurrent stroke generally occurs in the first year (even in the first weeks and months). After one year, the risk is reduced by 5% annually. After a stroke, the possibility of heart disease is 5-10%/year. The condition following this attack or outcome necessitates preventive action to

prevent the situation from worsening (Lin et al., 2021). This study aims to determine the factors associated with the outcome of stroke patients.

## Methods

### Study Design

This study used a quantitative design with a retrospective case-control approach to analyze the types of strokes, early warning score, and time to seek health services.

### Participants

The population in this study consisted of all stroke patients, 59 individuals treated at the hospital in 2024. The sampling technique employed was purposive sampling, involving 37 respondents who met the criteria of having been out of the hospital for a minimum of 3 months and a maximum of 12 months. The variables studied included the type of stroke, the EWS score, and the time the patient arrived at the hospital with the attack. Moreover, it was also the type of stroke time to seek health services, and the Early Warning Score was analyzed from medical records that measured seven domains: respiration rate, oxygen saturation, use of supplemental oxygen, temperature, systolic blood pressure, heart rate, and level of consciousness (Figure 1).

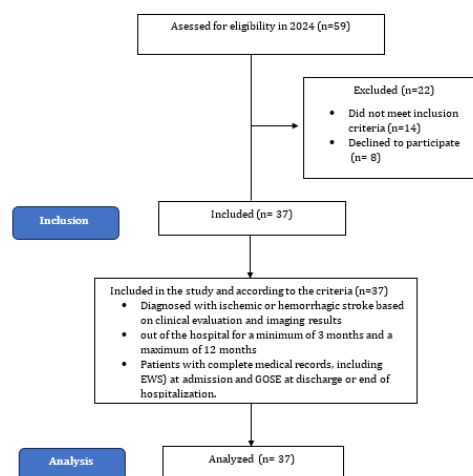


Figure 1. STROBE flowchart

## Instruments

The Early Warning Score (EWS) was used to assess physiological deterioration based on vital signs, including respiratory rate, oxygen saturation, temperature, blood pressure, pulse rate, and level of consciousness. Stroke outcome was measured using the standard Glasgow Outcome Scale Extended (GOSE) questionnaire, which assesses seven domains: consciousness, function in the home, outside the home, work/study, social and leisure activities, family and friendship, and symptoms (Nelson et al., 2022). This questionnaire has been tested for validity and reliability by previous research and shows a Cronbach's alpha value of 0.69 (Shukla et al., 2023).

## Data Collection

Data collection on respondent characteristics, such as age and gender, was conducted by recording information from patient medical records. Data on stroke type, Early Warning System (EWS) score, and time of arrival at the health facility were also obtained from completely documented medical records. Furthermore, patient outcomes were measured using the GOSE questionnaire, which covers seven domains of function, namely awareness, function at home, function outside the home, work or study, social and recreational activities, family relationships, and symptoms. Cases with incomplete or missing medical records were excluded from the final analysis. Data completeness was assessed before inclusion, and only medical records with fully documented Early Warning Score (EWS) and Glasgow Outcome Scale Extended (GOSE) results were retained. Data collection was conducted retrospectively from January to March 2025, using patient records from stroke admissions occurring between January 2024 and December 2024. The Early Warning Score (EWS) was assessed by attending nurses upon the patient's arrival

in the emergency department as part of standard triage procedures. All EWS data were recorded at admission, before the definitive diagnosis or initiation of treatment. The Glasgow Outcome Scale Extended (GOSE) was assessed by physicians during follow-up visits or through structured interviews conducted between 3 and 12 months after hospital discharge, reflecting the patient's long-term functional recovery. This delayed outcome measurement allowed for a more accurate evaluation of post-stroke recovery across physical, cognitive, and social domains. Data collection was conducted using a quantitative approach to ensure accuracy and consistency, and to comply with research ethics procedures by maintaining the confidentiality of data and respondent identities.

## Data Analysis

Data were analyzed using univariate, bivariate, and multivariate analysis. Univariate analysis was presented as a frequency distribution, along with the minimum, maximum, mean, median, and standard deviation. Bivariate analysis was performed using the Spearman and Somers tests, and multivariate analysis was conducted with multiple regression tests.

## Ethical Considerations

This study was approved by the Research Ethics Committee (No. 025/UKH.L.02/EC/IX/2024). Before collecting data, each respondent had signed an informed consent form and was informed about their voluntary participation, that their identities would be kept anonymous, and that no personally identifiable information would be collected to ensure confidentiality. The data are permanently deleted after collection is completed.

## Results

**Table 1** summarizes the demographic and clinical characteristics of the 37 stroke patients included in this study. The majority of respondents were male (62.2%), with an average age of 61 years (SD  $\pm$  9.775), ranging from 41 to 81 years. Most participants experienced non-hemorrhagic strokes (86.5%), while only a small proportion had hemorrhagic strokes (13.5%). Early Warning Score (EWS) assessments at admission revealed that over half of the respondents had a very low score (51.4%), followed by a low score (43.2%) and a moderate score (5.4%); none presented with a high EWS. Nearly all patients (94.6%) sought medical care within 2 hours of stroke onset, indicating timely access to healthcare services. Regarding clinical outcomes based on the Glasgow Outcome Scale Extended (GOSE), the vast majority (91.9%) were categorized as having good functional outcomes (GOSE  $\geq$  7), while only 8.1% had poor functional outcomes (GOSE  $\leq$  7).

**Table 1.** Respondent Characteristics and Clinical Variables (n = 37)

Variable	Category	Frequency (n)	Percentage (%)
<b>Gender</b>	Male	23	62.2
	Female	14	37.8
<b>Age (years)</b>	Mean $\pm$ SD	—	61 $\pm$ 9.775
	Range (min-max)	—	41 - 81
<b>Stroke Type</b>	Non-Hemorrhagic	32	86.5
	Hemorrhagic	5	13.5
<b>EWS Score</b>	0 (Very Low)	19	51.4
	1-4 (Low)	16	43.2
	5-6 (Moderate)	2	5.4
	$\geq$ 7 (High)	0	0
<b>Time to Seek Care</b>	$\leq$ 2 hours	35	94.6
	> 2 hours	2	5.4
<b>GOSE Outcome</b>	Good Function ( $\geq$ 7)	34	91.9
	Poor Function ( $\leq$ 7)	3	8.1

**Table 2** presents the results of bivariate and multivariate analyses examining the relationship between stroke-related variables and patient outcomes. A weak positive correlation was observed between stroke type and functional outcome ( $r = 0.251$ ,  $p = 0.02$ ), suggesting that non-hemorrhagic strokes were more frequently associated with better recovery. Time to seek care was also significantly associated with stroke outcomes ( $r = 0.343$ ,  $p = 0.03$ ), indicating that faster access to healthcare was linked to improved functional status. Notably, the Early Warning Score (EWS) showed a moderate positive correlation with stroke outcomes ( $r = 0.456$ ,  $p = 0.03$ ), implying that lower EWS values were more predictive of favorable outcomes. The multivariate regression analysis confirmed that time to seek care, stroke type, and EWS collectively accounted for 32.4% of the variance in stroke outcomes ( $R^2 = 0.324$ ,  $F = 5.269$ ,  $p = 0.03$ ), emphasizing their combined predictive value in clinical prognosis.

**Table 2.** Correlation and Regression Analysis of Predictors with Stroke Outcome

Variable	Correlation Coefficient (r)	P-value	R Square	F Count
Stroke Type	0.251	0.02	—	—
Time to Seek Care	0.343	0.03	0.324	5.269
EWS Score	0.456	0.03	—	—

## Discussion

The results of the analysis show that stroke type, time to seek health services, and Early Warning Score (EWS) simultaneously influence stroke patient outcomes. These findings align with previous evidence, which confirms that accurate diagnosis of stroke type, timely treatment, and clinical risk assessment via the EWS score are crucial factors in determining the success of treatment for stroke patients (Kim et al., 2025). Ischemic and hemorrhagic strokes require different

treatments. So delays in deciding the type of stroke can impact the effectiveness of therapy. In addition, research by Potisopha (2021) shows that every 15 minutes of delay in stroke treatment can significantly reduce the chances of recovery of neurological function, emphasizing the importance of seeking health services promptly. The combination of Early Warning Score (EWS) and time to seek health services provides a clinically relevant framework for early triage decision-making in stroke cases. EWS enables rapid physiological assessment upon hospital arrival, while the timing of patient presentation reflects the urgency and efficiency of prehospital response. Together, these indicators offer a more comprehensive picture of stroke severity and prognosis, supporting the timely identification of high-risk patients and allocation of critical interventions. Integrating both parameters into emergency protocols may improve functional outcomes, particularly in settings with limited resources specialized for stroke care.

On the other hand, the EWS score serves as an early prediction tool, helping medical personnel identify stroke patients who are at high risk of experiencing complications (Alhmoud et al., 2021). Research by Zambrano (2025) revealed that a high EWS score correlates with increased mortality and morbidity in stroke patients, especially if not followed by timely intervention. This evidence demonstrates that the EWS score serves not only as a clinical indicator but also facilitates rapid decision-making to determine treatment priorities (Zambrano et al., 2025). Therefore, the findings from this analysis strengthen the argument that successful management of stroke patients requires an integrated approach that combines accurate diagnosis, timely response, and effective clinical risk assessment.

Atherosclerosis can cause problems in the heart and blood vessels that supply the heart muscle. Elderly patients have stroke risk factors, the greater the chance for stroke, and if exposed to the part of the brain that plays a role in the speech muscles and nerves, the greater the likelihood of suffering from dysarthria (George, 2020). Men have a habit of smoking or unhealthy living habits, such as eating fatty foods, that can cause atherosclerosis in blood vessels. Atherosclerosis can result in the blockage of blood flow, leading to embolism, thrombus, or systemic hypoperfusion. It causes ischemia in the brain, leading to a stroke. Ischemia in the brain causes damage to the pons or medulla oblongata, resulting in dysarthria (slurred or garbled speech) (Lechner et al., 2020). The incidence of non-hemorrhagic stroke can cause disability for patients who survive. One of them is the inability to self-care due to weakness in the extremities and decreased mobility, which can hinder the fulfillment of activities of daily living. Activities of daily living are those that a person performs in fulfilling their needs (Dyfani & Lahdji, 2023).

One of the essential keys to reducing mortality and minimizing brain damage caused by stroke is to provide prompt and appropriate treatment (Hollist et al., 2021). If stroke treatment is given more than the golden hour, the neurological damage experienced by stroke patients will be permanent (Randhawa et al., 2022). The most recommended time for stroke patients is 3-4,5 hours, called the golden hour. A study that was conducted at the Kupang Hospital showed that the time the patient arrived at the hospital was >3 hours, with a percentage of 56.7%, and the average neurological damage of stroke patients was 70%, thus showing that prehospital treatment is essential to minimize neurological damage that occurs. Meanwhile, based on research, the average onset of stroke symptoms until stroke patients arrive at the hospital brought by

their families is 177.67 minutes (2 hours 58 minutes), with the fastest arrival time of 15 minutes and late arrival, which is 420 minutes (7 hours) ([Di Lorenzo et al., 2021](#)).

Factors used to determine outcomes in head injury patients include age, GCS, pupillary reactions, CT scan images (especially the Marshall classification), and the patient's vital signs, such as hypoxia and hypotension ([Eric Nyam et al., 2025](#)). Various neuropsychiatric symptoms associated with head trauma include cognitive impairment, mood disorders, anxiety, psychosis, and behavioural problems. This can interfere with rehabilitation programs, the ability to return to work, and social relationships. GOSE is widely accepted as the standard for assessing outcomes in head injury. The effect of a head injury patient is the result of a dynamic, time-dependent process ([Wilson et al., 2021](#)). Most head injury patients are recovering well or are moderately disabled. The 6-month GOSE score was obtained in >87% of 447 cases. Sixty percent of patients recovered well, and 26% experienced moderate disability. Approximately 7% of patients experienced severe disability and combined vegetative cases and died,  $\pm$  7% of the total. 38% of patients recovered well within three months of the accident, only 4% were symptom-free, and 31% could return to work. The strength of the relationship between the Early Warning Score and the Outcome of Stroke Patients in this result has a correlation coefficient value of 0.456, so it has a moderate relationship strength with a positive relationship direction because the better the early warning score, the better the GOS value. EWS focuses more on detecting emergencies before they occur, allowing life-threatening conditions to be handled quickly or even avoided through earlier treatment, thereby improving the resulting outcome ([Šakić Trogrlić et al., 2022](#)). An Early Warning Score is a physiological scoring system generally used

in medical-surgical units to identify patients at risk of an emergency before it occurs. The EWS scoring is accompanied by an action algorithm based on the scoring results from the patient assessment. Therefore, a rapid assessment system is crucial for detecting the onset of a crisis in stroke patients. The finding that stroke type, Early Warning Score (EWS), and time to seek health services are significantly associated with patient outcomes has important clinical implications. Incorporating these variables into stroke assessment protocols can improve risk stratification and guide timely interventions. In clinical settings, particularly where resources are limited, these predictors can help healthcare providers identify high-risk patients early, prioritize care, and optimize treatment pathways to improve functional recovery and reduce complications.

These findings highlight the importance of integrating Early Warning Score (EWS) monitoring and timely care-seeking behavior into standardized stroke management pathways. Given the predictive value of EWS in identifying patients at risk of poor outcomes, there is a strong rationale for national health authorities, such as the Ministry of Health (MOH), to mandate the implementation of routine EWS monitoring across all stroke centers. Such policy integration may strengthen early triage, improve patient outcomes, and ensure consistent clinical responses, particularly in low-resource hospital settings.

### Relevance to Clinical Practice

Integrating EWS with timely care-seeking behavior supports early triage, risk stratification, and prioritization of stroke patients, especially in resource-limited settings. Hospitals may benefit from piloting the use of EWS in emergency departments by embedding it in initial stroke screening and training triage nurses in its application. Such initiatives can improve workflow

efficiency, treatment timeliness, and recovery outcomes. These findings also suggest that national health authorities, such as the Ministry of Health, should consider mandating EWS monitoring across stroke centers to standardize early responses and promote equitable care.

The stroke triage workflow in emergency settings begins with a rapid assessment by a triage nurse using standardized tools (e.g., FAST), which involves recording the symptom onset time and calculating the Early Warning Score (EWS). Patients are then stratified based on EWS ( $\geq 5$ ) and time from symptom onset ( $\leq 3$  hours); those meeting both criteria are prioritized for immediate neurological evaluation and CT imaging. Within 25–45 minutes, the stroke team conducts imaging to determine the type of stroke and guides treatment decisions. Interventions are initiated within 60 minutes of arrival, and all cases are documented for continuous quality review and process improvement.

To enhance clinical utility, a visual tool such as a stroke-EWS flowchart or a triage scoring matrix can support fast decision-making in emergency settings. A stroke-EWS flowchart outlines step-by-step actions based on EWS values and time from symptom onset, guiding whether to prioritize imaging, alert the stroke team, or initiate interventions. A scoring matrix, on the other hand, cross-tabulates EWS levels with time-to-door intervals to stratify patients by urgency, allowing clinicians to identify those at high risk quickly.

## Conclusion

This research introduces a novel approach by integrating stroke type, Early Warning Score (EWS), and time to seek health services as combined predictors of patient outcomes. These elements are often studied independently in prior literature. Unlike earlier studies that focused solely on clinical severity or imaging results, this

study emphasizes practical, real-time triage tools (such as EWS) and the timeliness of care as key factors that can be applied even in low-resource emergency settings. The findings support a scalable triage framework that can guide early decision-making and hospital workflow, particularly in facilities with limited access to advanced stroke diagnostics and imaging capabilities. Results support further validation of the Early Warning Score (EWS) as a routine predictor in stroke care, highlighting its potential to guide early triage decisions and improve patient outcomes, especially in settings with limited resources. These findings underscore the importance of regional health authorities adopting EWS as part of mandatory stroke triage protocols in all emergency departments, particularly in district hospitals. Implementing EWS through training programs, integration into electronic health records, and inclusion in regional stroke referral guidelines can support faster decision-making, better resource allocation, and more consistent care for stroke patients across healthcare facilities.

## Funding

A grant from Sebelas Maret University funded this research.

## CrediT Authorship Contributions Statement

Ika Subekti Wulandari<sup>1</sup>: Conceptualization, Methodology, Supervision, Writing - Original Draft

Anis Laela Megasari: Software, Validation, Formal Analysis, Writing - Review & Editing

## Conflicts Of Interest

There is no conflict of interest.

## Acknowledgments

The researcher would like to thank the Research Institutions and Community

University Karya Husada, with number No. 025/UKH.L.02/EC/IX/2024.

## References

- Alhmoud, B., Bonnici, T., Patel, R., Melley, D., Williams, B., & Banerjee, A. (2021). Performance of universal early warning scores in different patient subgroups and clinical settings: a systematic review. *BMJ Open*, *11*(4), e045849.
- Ali, J. S., Ramadan, R. M. E., & Aboushady, R. M. N. (2020). *Stroke Rehabilitation Strategies to Enhance Activities of Daily Living*. LAP LAMBERT Academic Publishing.
- Alitonang, W. M. (2020). Analysis Of Application Of Discharge Planning In Hypertension Patients On Patient Satisfaction Level. *Journal of Applied Nursing and Health*, *2*(1), 16–21. <https://doi.org/10.55018/janh.v2i1.8>
- Di Lorenzo, R., Saqqur, M., Buletko, A. B., Handshoe, L. S., Mulpur, B., Hardman, J., Donohue, M., Wisco, D., Uchino, K., & Hussain, M. S. (2021). IV tPA given in the golden hour for emergent large vessel occlusion stroke improves recanalization rates and clinical outcomes. *Journal of the Neurological Sciences*, *428*, 117580.
- Dyfani, A. G., & Lahdji, A. (2023). The Effect Of Perceived Benefit And Perceived Barrier On Activity Of Daily Living In Non-Hemorrhagic Stroke Post Patients. *Proceedings of the International Conference of Community Health and Medical Sciences*, *1*(1), 182–189.
- Eric Nyam, T.-T., Tu, K.-C., Kuo, Y.-H., Wang, C.-C., Liu, C.-F., Liao, J.-C., & Kuo, C.-L. (2025). Age and pupil size: key predictors of mortality in traumatic brain injury patients with GCS 3. *Frontiers in Neurology*, *16*, 1536421.
- Fitri, A., Saputra, M., Malem, R., & Ulfa, N. (2023). The Relationship Of The Role Of Posyandu Cadres On The Quality Of Life Of Elderly Stroke Suffers In The Working Area Of The Meurah Mulia Community Health Center North Aceh. *International Conference on Education, Science, Technology and Health (ICONESTH)*, 1390–1398.
- George, M. G. (2020). Risk factors for ischemic stroke in younger adults: a focused update. *Stroke*, *51*(3), 729–735.
- Hartati, S., Kamesworo, & Elviani, Y. (2025). Effectiveness of Acupressure Therapy in Reducing Blood Pressure Among Older Adults with Hypertension. *International Journal of Health Concord*, *1*(1), 33–40. <https://doi.org/https://ihc.candle.or.id/index.php/ihc/article/view/10>
- Herpich, F., & Rincon, F. (2020). Management of acute ischemic stroke. *Critical Care Medicine*, *48*(11), 1654–1663.
- Hollist, M., Au, K., Morgan, L., Shetty, P. A., Rane, R., Hollist, A., Amaniampong, A., & Kirmani, B. F. (2021). Pediatric stroke: overview and recent updates. *Aging and Disease*, *12*(4), 1043.
- Hussain, I., & Park, S. J. (2021). Big-ECG: Cardiographic predictive cyber-physical system for stroke management. *IEEE Access*, *9*, 123146–123164.
- Kim, C., Lee, J. J., Sohn, J.-H., Kim, J.-H., Won, D.-O., & Lee, S.-H. (2025). Comparison of early warning scoring systems for predicting stroke occurrence among hospitalized patients: A study using smart clinical data warehouse. *PloS One*, *20*(1), e0316068.
- Laili, N., Heni, S., & Tanoto, W. (2023). Optimalisasi Program Edukasi Pencegahan Stroke ‘Cerdik’ pada Penderita Hipertensi: Optimizing the “Smart” Stroke Prevention Education Program for Hypertension Sufferers. *Jurnal Abdi Kesehatan Dan Kedokteran*,

- 2(2 SE-Articles), 154–167.  
<https://doi.org/10.55018/jakk.v2i2.40>
- Langkjaer, C. S., Bundgaard, K., Bunkenborg, G., Nielsen, P. B., Iversen, K. K., Bestle, M. H., & Bove, D. G. (2023). How nurses use National Early Warning Score and Individual Early Warning Score to support their patient risk assessment practice: A fieldwork study. *Journal of Advanced Nursing*, 79(2), 789–797.
- Lechner, K., von Schacky, C., McKenzie, A. L., Worm, N., Nixdorff, U., Lechner, B., Kränkel, N., Halle, M., Krauss, R. M., & Scherr, J. (2020). Lifestyle factors and high-risk atherosclerosis: Pathways and mechanisms beyond traditional risk factors. *European Journal of Preventive Cardiology*, 27(4), 394–406.
- Lin, B., Zhang, Z., Mei, Y., Wang, C., Xu, H., Liu, L., & Wang, W. (2021). Cumulative risk of stroke recurrence over the last 10 years: a systematic review and meta-analysis. *Neurological Sciences*, 42, 61–71.
- Liu, Y., & Gu, Y. (2023). Case report: A case of abrupt stroke as the first symptom of neurobrucellosis. *Frontiers in Neurology*, 14, 1066042.
- Murphy, S. J. X., & Werring, D. J. (2020). Stroke: causes and clinical features. *Medicine*, 48(9), 561–566.
- Nagao, Y., Nakajima, M., Inatomi, Y., Ito, Y., Kouzaki, Y., Wada, K., Yonehara, T., Terasaki, T., Hashimoto, Y., & Ando, Y. (2020). Pre-hospital delay in patients with acute ischemic stroke in a multicenter stroke registry: K-PLUS. *Journal of Stroke and Cerebrovascular Diseases*, 29(11), 105284.
- Nelson, L. D., Magnus, B. E., Temkin, N. R., Dikmen, S., Manley, G. T., & Balsis, S. (2022). How do scores on the Functional Status Examination (FSE) correspond to scores on the Glasgow Outcome Scale-Extended (GOSE)? *Neurotrauma Reports*, 3(1), 122–128.
- Pu, L., Wang, L., Zhang, R., Zhao, T., Jiang, Y., & Han, L. (2023). Projected global trends in ischemic stroke incidence, deaths and disability-adjusted life years from 2020 to 2030. *Stroke*, 54(5), 1330–1339.
- Randhawa, A. S., Pariona-Vargas, F., Starkman, S., Sanossian, N., Liebeskind, D. S., Avila, G., Stratton, S., Gornbein, J., Sharma, L., & Restrepo-Jimenez, L. (2022). Beyond the golden hour: Treating acute stroke in the platinum 30 minutes. *Stroke*, 53(8), 2426–2434.
- Risitano, A., & Toni, D. (2020). Time is brain: timing of revascularization of brain arteries in stroke. *European Heart Journal Supplements*, 22(Supplement\_L), L155–L159.
- Saceleanu, V. M., Toader, C., Ples, H., Covache-Busuioc, R.-A., Costin, H. P., Bratu, B.-G., Dumitrascu, D.-I., Bordeianu, A., Corlatescu, A. D., & Ciurea, A. V. (2023). Integrative approaches in acute ischemic stroke: from symptom recognition to future innovations. *Biomedicines*, 11(10), 2617.
- Šakić Trogrlić, R., van den Homberg, M., Budimir, M., McQuistan, C., Sneddon, A., & Golding, B. (2022). Early warning systems and their role in disaster risk reduction. In *Towards the “perfect” weather warning: bridging disciplinary gaps through partnership and communication* (pp. 11–46). Springer International Publishing Cham.
- Šakić, D., Thombre, B. D., Baby, P., Palaninathan, J., Subramanian, S., Prathyusha, P. V., & Bhagavatula, I. D. (2023). Validity of Glasgow outcome scale-extended (GOSE) mobile application for assessment of outcome in traumatic brain injury patients. *Brain Injury*, 37(10), 1215–1219.
- Song, Y., Chen, J., Zhang, Y., & Zhang, Q. (2025). Prevalence and Risk Factors of Stroke in Patients with Nonvalvular Atrial Fibrillation: A Case-Control Study. *World Neurosurgery*, 195,

123652.

Sun, B., & Wang, Z. (2023). A Short Review on Advances in Early Diagnosis and Treatment of Ischemic Stroke. *Galen Medical Journal*, 12, 1.

Widayati, D., Rachmania, D., & Safitri, N. (2024). Increasing the Comfort of Hypertension Sufferers Through Effleurage Back Massage. *Journal of Applied Nursing and Health*, 6(1), 193–202.

<https://doi.org/10.55018/janh.v6i1.194>

Wilson, L., Boase, K., Nelson, L. D., Temkin, N. R., Giacino, J. T., Markowitz, A. J., Maas, A., Menon, D. K., Teasdale, G., & Manley, G. T. (2021). A manual for the glasgow outcome scale-extended interview. *Journal of Neurotrauma*, 38(17), 2435–2446.

Zambrano, J. J., Thadi, P., & Alberto, N. (2025). Evaluating the Role of the Modified Early Warning Score in Predicting Neurological Deterioration and Mortality in Acute Stroke (P4-13.004). *Neurology*, 104(7\_Supplement\_1), 4452.