Cureus
Part of SPRINGER NATURE

Open Access Original Article

Clinical Profile, Subtypes, and Predictors of Outcomes of Acute Ischemic Stroke: A Tertiary Care Hospital-Based Study From Northeast India

Hemanga Dhing [1], Marami Das [2], Bhawesh Kumar [2], Munindra Goswami [2]

1. Neurology, All India Institute of Medical Sciences, Guwahati, IND 2. Neurology, Gauhati Medical College and Hospital, Guwahati, IND

Corresponding author: Hemanga Dhing, gmchemanga@gmail.com

Review began 09/12/2026
Review ended 11/06/2026
Published 11/16/2026

© **Copyright** 2026
Dhing et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.119796

Abstract

Background and objective: Stroke is one of the leading causes of morbidity and mortality among adults. Few studies from Northeast India have examined the etiology, risk factors, and predictors of stroke outcomes. This study aimed to identify the risk factors, stroke subtypes, and outcomes, as well as predictors of stroke outcomes.

Materials and methods: This was a prospective, observational, hospital-based study conducted at a tertiary care center. Patients aged >18 years with ischemic stroke and confirmed cerebral infarction were recruited from April 2019 to December 2023. Etiological classification was performed according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification. An unfavorable outcome was defined as a modified Rankin Scale (mRS) score of >3 at three months. The primary aim was to investigate the risk factors, stroke subtypes, and outcomes. The secondary aim was to identify predictors of stroke outcomes.

Results: The study included 139 patients with a mean age of 57.12 ± 13.9 years. Hypertension (100 (72%) patients) and diabetes (58 (42%) patients) were the most common risk factors. Hemiparesis was the most common presenting symptom, occurring in 125 (90.79%) patients. Large artery atherosclerosis (LAA) was the most common stroke etiology. A total of 69 (49%) patients had an unfavorable functional outcome (mRS score >3) at three months. Age (odds ratio (OR) 2.6, 95% CI 0.19-1.76; p = 0.01), stroke etiology (LAA; OR 1.35, 95% CI 0.04-0.5; p = 0.02), severe stroke at onset (National Institutes of Health Stroke Scale (NIHSS) score of 16-42; OR 4.7, 95% CI 0.12-2.9; p = 0.03), and white matter hyperintensities on imaging (OR 3.01, 95% CI 0.32-1.87; p = 0.01) were independent predictors of unfavorable outcomes.

Conclusions: Our study found that LAA was a more common stroke etiology than reported in other studies from India. A substantial proportion of patients had unfavorable functional outcomes at three months. In addition to stroke etiology and conventional risk factors, other factors, such as small vessel disease, were significantly associated with stroke outcomes, highlighting the need for preventive efforts.

Categories: Neurology
Keywords: ischemic stroke, large artery atherosclerosis, predictors of outcome, small vessel disease, stroke outcome

Introduction

The current World Health Organization definition of stroke is “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin” [1]. Stroke encompasses a collection of clinical syndromes resulting from cerebral ischemia or intracranial hemorrhage, with highly variable manifestations. In Western countries, stroke ranks as the third leading cause of morbidity and mortality [2].

There are limited studies on ischemic stroke in India. Kaul et al. investigated the etiology of stroke in southern India [3]. The Indo-US Collaborative Stroke Project, a multicenter, hospital-based study conducted at five high-volume academic tertiary care hospitals, examined the risk factors, etiology, and factors associated with ischemic stroke outcomes in India [4]. However, no dedicated studies have focused on ischemic stroke in the northeastern region of India.

The population of Northeast India differs from that of other Indian states in terms of demographics, ancestry, and dietary habits. Indigenous populations in the region share closer ancestral, genetic, and phenotypic ties with East and Southeast Asian populations than with those of mainland India [5]. Many communities exhibit distinct physical characteristics shaped by historical migrations from the north and east, distinguishing them from the predominantly Indo-Aryan and Dravidian populations in other parts of the country. Dietary habits also differ, with greater reliance on meat and fermented foods and lower consumption of dairy products, such as paneer and ghee [6].

Given these regional differences, the present study was conducted at a tertiary care center in Northeast India. The primary aim was to investigate the risk factors, stroke subtypes according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification, and stroke outcomes. The secondary aim was to identify predictors of stroke outcomes.

Materials And Methods

This prospective, observational study was conducted at the Department of Neurology, Gauhati Medical College and Hospital, Guwahati, Assam, from April 2019 to the end of December 2023. The Institutional Ethics Committee of Gauhati Medical College and Hospital approved the study (approval number: MC/190/2007/Pt-11/MAR-19/23), and informed consent was obtained from all patients.

Patients presenting with ischemic stroke within seven days of symptom onset were consecutively enrolled. Patients who had received reperfusion therapy, those with recurrent stroke, and those with preexisting disability were excluded. Patients with hemorrhagic transformation on imaging were included.

Patient demographics, risk factors, and clinical features were recorded. Routine laboratory investigations, including complete blood count, renal function tests, liver function tests, thyroid profile, and fasting lipid profile, were performed for each patient. Thrombophilia screening and immunological investigations (antinuclear antibodies, anti-DNA antibodies, and antiphospholipid antibodies) were also performed when clinically indicated.

Brain imaging (CT or MRI) and vascular imaging of the neck (CT angiography, MR angiography, or Doppler ultrasonography) were performed in all patients. Carotid duplex ultrasonography was performed as the initial investigation to evaluate the extracranial carotid arteries. Confirmatory imaging with CT angiography or MR angiography was performed when the results were equivocal. All patients underwent MR angiography for intracranial vascular imaging. The North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria were used to calculate the percentage of large-vessel stenosis [7]. Significant vascular stenosis was defined as stenosis of ⩾50% or occlusion of an intracranial or extracranial vessel.

ECG, two-dimensional echocardiography, and 24-hour Holter monitoring were performed to identify potential cardioembolic sources. Prolonged cardiac monitoring was not performed. Transesophageal echocardiography was performed when clinically indicated.

White matter hyperintensities were assessed on fluid-attenuated inversion recovery MRI sequences by two neurologists in consultation with the institutional radiologist. Etiological classification was performed according to the TOAST criteria [8]. The etiological categories included large artery atherosclerosis (LAA), small-vessel disease, cardioembolism, other determined etiologies, and undetermined causes.

LAA was defined as stenosis (⩾50%) or occlusion of a major cerebral artery or its branch due to atherosclerosis, potentially resulting in artery-to-artery embolism or large infarcts (>1.5 cm). Cardioembolic stroke was defined as stroke resulting from emboli originating in the heart, such as those associated with atrial fibrillation, recent myocardial infarction, or mechanical heart valves. Small-vessel occlusion (lacunar stroke) was defined as occlusion of a small penetrating artery, typically resulting in infarcts <1.5 cm in subcortical structures in patients with longstanding vascular risk factors, such as hypertension. Stroke due to less common mechanisms, including noninflammatory vasculopathies, genetic disorders, hematologic or hypercoagulable states, and arterial dissections, was classified as stroke of other determined etiology. Stroke of undetermined etiology was assigned when a thorough evaluation failed to identify a cause (cryptogenic stroke), when more than one potential mechanism was identified, or when the diagnostic workup was incomplete.

All patients were followed up at three months. Clinical status, recovery parameters, and risk factor control were assessed during follow-up. The modified Rankin Scale (mRS) score was assessed in all patients at three months. Assessments were preferably conducted face-to-face at the hospital by two neurologists independently. For patients unable to attend the three-month follow-up visit, the mRS score was assessed by telephone. The assessors were also members of the treating team. An unfavorable outcome was defined as an mRS score >3 at three months [9].

Statistical analysis

Data analysis was performed using SPSS Statistics 31.0 (IBM Corp. Released 2025. IBM SPSS Statistics for Windows, Version 31.0. Armonk, NY). A p-value of <0.05 was considered statistically significant. Baseline clinical characteristics, risk factors, stroke subtypes, and imaging findings were compared using Student's unpaired t-test for parametric continuous variables and Fisher's exact test or the chi-square test for categorical variables.

The dependent variable was dichotomized into good outcomes (mRS score ⩽3) and unfavorable outcomes (mRS score >3). To control for potential confounding factors, variables showing a significant association

with the outcome ($p < 0.05$) were included in the binary logistic regression model. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to quantify the strength of the associations.

McFadden's R^2 was 0.18, indicating the explanatory performance of the model. Multicollinearity among the independent variables was evaluated using variance inflation factors, with a reported value of 1.02 [10].

All consecutive patients who met the inclusion criteria were included in the study. The study had an adequate sample size, with 69 patients experiencing unfavorable outcomes, to identify predictors of functional outcomes. The events-per-variable ratio was six [11].

Results

Baseline characteristics

Table *1* summarizes the baseline characteristics of the patients. The mean age was 57.12 ± 13.9 years, and most patients were male (79 (57%)). Hypertension (100 (72%) patients) and diabetes (58 (42%) patients) were the most common risk factors. A history of stroke or transient ischemic attack was reported in 18 (13.82%) patients. At presentation, 16 (11%) patients had severe stroke (National Institutes of Health Stroke Scale (NIHSS) score of 16-42). White matter hyperintensities were present on imaging in 79 (56.8%) patients.

Baseline characteristics		No. of patients (%)
Age (years)		57.12 ± 13.9
Male		79 (57%)
Female		60 (43%)
Hypertension		100 (72%)
Diabetes		58 (42%)
Dyslipidemia		23 (17%)
Smoking		42 (30%)
CAD		19 (13.7%)
Atrial fibrillation		12 (8.6%)
Severe left ventricular dysfunction		3 (2.1%)
P/H/O TIA		18 (13%)
Severe stroke (NIHSS 16-42)		16 (11.5%)
White matter changes present		79 (56.8%)
Stroke subtype	LAA	69 (49.5%)
	SV	28 (20%)
	CE	14 (10%)
	ODE	5 (3.5%)
	UN	23 (17%)

TABLE 1: Baseline characteristics and stroke subtype of patients with number of patients presented as N (%)

CAD: coronary artery disease, TIA: transient ischemic attack, NIHSS: National Institute of Health stroke scale, LAA: large artery atherosclerosis, SV: small vessel disease, CE: cardioembolic, ODE: other determined causes, UN: undetermined causes

Stroke subtype

According to the TOAST classification, LAA was the most common stroke etiology, accounting for 69 (49.5%) patients, followed by small-vessel disease and cardioembolic stroke, which accounted for 28 (20%) and 14 (10%) patients, respectively. The etiology remained undetermined in 23 (17%) patients.

Clinical features of patients

Table 2 summarizes the clinical features of the study patients. Hemiparesis was the most common clinical feature, occurring in 125 (89.9%) patients, followed by headache and dysphagia, which were present in 75 (54%) and 71 (51%) patients, respectively. Seizures occurred in 13 (9.4%) patients.

Clinical features	No. of patients
Altered sensorium	29 (20.1%)
Dizziness	37 (26.6%)
Headache	75 (54%)
Vomiting	14 (10.1%)
Hemiparesis	125 (89.9%)
Quadriparesis	2 (1.5%)
Facial weakness	69 (49.5%)
Seizure	13 (9.4%)
Dysphagia	71 (51.1%)
Ataxia	17 (12.2%)
Dysarthia	69 (49.6%)
Aphasia	27 (19.4%)
Gaze palsy	14 (10.1%)
Visual field defect	18 (12.9%)
Sensory loss	36 (25.9%)
Hemineglect	18 (12.9%)
Visuospatial defect	12 (8.6%)
Memory loss	12 (8.6%)
Apraxia	14 (10.1%)
Anosognosia	6 (4.3%)
Visual agnosia	1 (0.7%)
Hemichorea	4 (2.9%)

TABLE 2: Clinical features of the patients

Factors predicting the unfavorable functional outcome (mRS score >3) of ischemic stroke at three months

A total of 69 (49%) patients had an unfavorable functional outcome (mRS score >3) at the three-month follow-up. Among the patients with LAA, 49 (71%) had an unfavorable outcome.

In the univariable analysis, age >60 years, diabetes, stroke subtype (LAA), severe stroke at onset (NIHSS score 16-42), and white matter hyperintensities on imaging were significantly associated with unfavorable outcomes (Table 3).

Factors	Bad outcome (mRS >3)	Chi-square (X2) value	p-value
Age ≥60	45 (60%)	6.9	<0.05*
Gender (male)	39 (49.3%)	0.03	0.8
Hypertension	51 (51%)	0.26	0.6
Diabetes	36 (62%)	6.15	<0.05*
Dyslipidemia	12 (52%)	0.07	0.7
Smoking	23 (55%)	0.6	0.4
CAD	9 (47%)	0.04	0.8
Atrial fibrillation	8 (66%)	4.35	0.1
Stroke subtype (LAA)	49 (71%)	35.8	<0.05*
Severe stroke (NIHSS 16-42)	13 (81%)	7.2	<0.05*
White matter changes present	50 (63.2%)	13.6	<0.05*

TABLE 3: Univariate analysis of predictors of stroke outcome (according to mRS)

* A p-value of <0.05 is considered statistically significant.

CAD: coronary artery disease, LAA: large artery atherosclerosis, NIHSS: National Institute of Health Stroke Scale

Binary logistic regression analysis showed that age (OR 2.6, 95% CI 0.19-1.76; p = 0.01), stroke etiology (LAA; OR 1.35, 95% CI 0.04-0.5; p = 0.02), severe stroke at onset (NIHSS score 16-42; OR 4.7, 95% CI 0.12-2.9; p = 0.03), and white matter hyperintensities on imaging (OR 3.01, 95% CI 0.32-1.87; p = 0.01) were independent predictors of unfavorable outcomes at the three-month follow-up (Table *4*).

Factors	p-value	OR	CI
Age (≥60)	0.01*	2.6	0.19-1.76
Diabetes	0.12	1.8	-0.17-1.3
Stroke subtype (LAA)	0.02*	1.35	0.04-0.5
Severe stroke (NIHSS 16-42)	0.03*	4.7	0.12-2.9
White matter hyperintensity	<0.01*	3.01	0.32-1.87

TABLE 4: Binary logistic regression analysis of predictors of unfavorable functional outcome

* A p-value of <0.5 is considered statistically significant.

NIHSS: National Institutes of Health Stroke Scale, LAA: Large artery atherosclerosis, OR: odds ratio

Discussion

To our knowledge, this is the first prospective, observational study to investigate the clinical profile, stroke subtypes, and predictors of outcomes in patients with acute ischemic stroke in Northeast India. According to the TOAST classification, LAA was the most common etiology, accounting for 49.5% of cases. Previous studies from India, including the Hyderabad study [3] and the Indo-US Collaborative Stroke Project [4], as well as several studies from East Asia [12], have also identified LAA as the most common stroke subtype. The higher proportion of LAA in our study compared with that reported in the Indo-US Collaborative Stroke Project may be related to inadequate control of vascular risk factors.

In the present study, almost half (49%) of the patients had unfavorable functional outcomes (mRS score >3) at three months, consistent with findings from other studies [13,14]. The Indo-US Collaborative Stroke

Project also reported comparable outcomes [4].

Age is a nonmodifiable predictor of stroke outcomes. Recovery tends to be poorer with increasing age, irrespective of stroke subtype [15-17]. Cerebral atherosclerosis, which progresses with age, is also strongly associated with stroke etiology [18]. Consistent with previous studies, our findings demonstrated that age was significantly associated with stroke outcomes, irrespective of stroke subtype [15-17].

LAA is not only the most common subtype of ischemic stroke but is also associated with a higher risk of stroke recurrence and unfavorable outcomes than other stroke mechanisms [4,19,20]. Consistent with these findings, LAA was associated with unfavorable outcomes in our study. Stroke severity, as measured by the NIHSS, was another important predictor of stroke outcomes. Severe stroke, defined as an NIHSS score ⩾16, has been associated with poor functional recovery at three months [4,21,22]. Similarly, our study found that severe stroke at baseline (NIHSS score ⩾16) was a strong predictor of unfavorable outcomes.

Although not all previous studies have examined the role of small-vessel changes in stroke outcomes, some have reported that patients with coexisting cerebral small vessel disease have poorer functional recovery [23,24]. Recovery after stroke depends on the integrity of widespread neural networks and their ability to compensate for damage and reorganize neural connections to adapt to reduced functional capacity [25,26]. Disruption of these neural networks may contribute to poor functional recovery in patients with white matter disease. Similarly, our study found that the presence of small-vessel disease on imaging was independently associated with unfavorable functional recovery.

Strength of the study

To our knowledge, this is the first study from this region to investigate stroke etiology, risk factors, and predictors of unfavorable outcomes. Other strengths of the study include its prospective, observational design, three-month functional follow-up of all patients, use of the TOAST classification, and assessment of clinical and imaging factors associated with stroke outcomes.

Limitation of the study

Our study also had several limitations. First, factors such as depression, cognitive decline, and coexisting neurological disorders, which may affect neurorehabilitation and functional recovery, were not assessed. Second, as this was a single-center study conducted at a tertiary care hospital, the findings may not be generalizable to other settings. Referral bias also cannot be ruled out given the hospital-based nature of the study. Other limitations include the modest sample size, limited duration of cardiac monitoring, lack of standardized grading of white matter hyperintensities, and dichotomization of age and NIHSS scores. Furthermore, stroke subtypes were classified according to the TOAST criteria, which have their own limitations [27].

Conclusions

This study highlights several similarities between our findings and those of other studies conducted in India and other developing countries. Our findings indicate that LAA is a major etiology of stroke in this region. In addition to conventional risk factors and stroke etiology, other factors, such as cerebral small vessel disease, were independently associated with functional outcomes, highlighting the need for preventive strategies targeting these factors.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Hemanga Dhing, Marami Das, Bhawesh Kumar, Munindra Goswami

Acquisition, analysis, or interpretation of data: Hemanga Dhing, Marami Das, Bhawesh Kumar, Munindra Goswami

Drafting of the manuscript: Hemanga Dhing, Marami Das, Bhawesh Kumar, Munindra Goswami

Critical review of the manuscript for important intellectual content: Hemanga Dhing, Marami Das, Bhawesh Kumar, Munindra Goswami

Supervision: Hemanga Dhing, Marami Das, Bhawesh Kumar, Munindra Goswami

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee of Gauhati Medical College and Hospital issued approval MC/190/2007/Pt-11/MAR-19/23. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T: Cerebrovascular disease in the community: results of a WHO collaborative study. Bull World Health Organ. 1980, 58:113-30.
2. Bath P: Acute stroke. Textbook of Clinical Trials. Machin D, Day S, Green S (ed): Wiley, Hoboken (NJ); 2006. 179-80. 10.1002/9780470010167.ch13
3. Kaul S, Alladi S, Jabeen SA, Bandaru VC, Ankem U, Mekala S, Naik GS: Intracranial atherosclerosis is the most common stroke subtype: ten-year data from Hyderabad Stroke Registry (India). Ann Indian Acad Neurol. 2018, 21:209-13. 10.4103/aian.AIAN_86_18
4. Sylaja PN, Pandian JD, Kaul S, et al.: Ischemic stroke profile, risk factors, and outcomes in India: the Indo-US collaborative stroke project. Stroke. 2018, 49:219-22. 10.1161/STROKEAHA.117.018700
5. Riamei J: Ethnic diversity and politics of inclusion: tribes in North East India . J Dev Policy Pract. 2023, 8:93-109. 10.1177/24551333221110737
6. De B, Kashyap R, Lalnunpuii E, et al.: Food habits and lifestyle of ethnic groups from North-East India - a comparative study. Acta Sci Pharm Sci. 2025, 9:58-73.
7. Barnett HJ, Taylor DW, Haynes RB, et al.: Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. N Engl J Med. 1991, 325:445-53. 10.1056/NEJM199108153250701
8. Adams HP Jr, Bendixen BH, Kappelle LJ, Biller J, Love BB, Gordon DL, Marsh EE 3rd: Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. Stroke. 1993, 24:35-41. 10.1161/01.str.24.1.35
9. Wilson JT, Hareendran A, Grant M, Baird T, Schulz UG, Muir KW, Bone I: Improving the assessment of outcomes in stroke: use of a structured interview to assign grades on the modified Rankin Scale. Stroke. 2002, 33:2243-6. 10.1161/01.str.0000027437.22450.bd
10. Hosmer DW, Lemeshow S, Sturdivant RX: The multiple logistic regression model . Applied Logistic Regression. Hosmer DW, Lemeshow S, Sturdivant RX (ed): Wiley, Hoboken (NJ); 2013. 10.1002/9781118548387.ch2
11. Vittinghoff E, McCulloch CE: Relaxing the rule of ten events per variable in logistic and Cox regression . Am J Epidemiol. 2007, 165:710-8. 10.1093/aje/kwk052
12. Tsai CF, Thomas B, Sudlow CL: Epidemiology of stroke and its subtypes in Chinese vs white populations: a systematic review. Neurology. 2013, 81:264-72. 10.1212/WNL.0b013e31829bfde3
13. Sennfält S, Pihlsgård M, Norrving B, Ullberg T, Petersson J: Ischemic stroke patients with prestroke dependency: characteristics and long-term prognosis. Acta Neurol Scand. 2021, 143:78-88. 10.1111/ane.13328
14. Jalali N, Sadeghi Hokmabadi E, Ghoreishi A, et al.: Outcome predictors in anterior and posterior ischemic strokes: a study based on the Iranian SITS registry. Sci Rep. 2023, 13:1231. 10.1038/s41598-023-28465-8
15. Wei W, Li S, San F, Zhang S, Shen Q, Guo J, Zhang L: Retrospective analysis of prognosis and risk factors of patients with stroke by TOAST. Medicine (Baltimore). 2018, 97:0412. 10.1097/MD.0000000000010412
16. Soriano-Tárraga C, Giralt-Steinhauer E, Mola-Caminal M, et al.: Biological age is a predictor of mortality in ischemic stroke. Sci Rep. 2018, 8:4148. 10.1038/s41598-018-22579-0
17. Ohira T, Shahar E, Chambless LE, Rosamond WD, Mosley TH Jr, Folsom AR: Risk factors for ischemic stroke subtypes: the atherosclerosis risk in communities study. Stroke. 2006, 37:2493-8. 10.1161/01.STR.0000239694.19359.88
18. Scheen AJ: From atherosclerosis to atherothrombosis : from a silent chronic pathology to an acute critical event. Rev Med Liege. 2018, 73:224-8.
19. Starostka-Tatar A, Łabuz-Roszak B, Skrzypek M, Lasek-Bal A, Gąsior M, Gierlotka M: Characteristics of hospitalizations due to acute stroke in the Silesian Province, Poland, between 2009 and 2015. Neurol Neurochir Pol. 2018, 52:252-62. 10.1016/j.pjnns.2017.11.010
20. Lange MC, Ribas G, Scavasine V, et al.: Stroke recurrence in the different subtypes of ischemic stroke. The importance of the intracranial disease. Arq Neuropsiquiatr. 2018, 76:649-53. 10.1590/0004-282X20180095
21. Adams HP Jr, Davis PH, Leira EC, et al.: Baseline NIH Stroke Scale score strongly predicts outcome after stroke: a report of the Trial of Org 10172 in Acute Stroke Treatment (TOAST). Neurology. 1999, 53:126-31. 10.1212/wnl.53.1.126
22. Turcato G, Cervellin G, Cappellari M, et al.: Early function decline after ischemic stroke can be predicted by a nomogram based on age, use of thrombolysis, RDW and NIHSS score at admission. J Thromb Thrombolysis. 2017, 43:394-400. 10.1007/s11239-016-1456-y
23. Hong S, Giese AK, Schirmer MD, et al.: Excessive white matter hyperintensity increases susceptibility to poor functional outcomes after acute ischemic stroke. Front Neurol. 2021, 12:700616. 10.3389/fneur.2021.700616
24. Zerna C, Yu AY, Modi J, Patel SK, Coulter JI, Smith EE, Coutts SB: Association of white matter hyperintensities with short-term outcomes in patients with minor cerebrovascular events. Stroke. 2018, 49:919-23. 10.1161/STROKEAHA.117.017429
25. Carmichael ST: Plasticity of cortical projections after stroke . Neuroscientist. 2003, 9:64-75.

10.1177/1073858402239592

26. Di Filippo M, Tozzi A, Costa C, Belcastro V, Tantucci M, Picconi B, Calabresi P: Plasticity and repair in the post-ischemic brain. Neuropharmacology. 2008, 55:353-62. 10.1016/j.neuropharm.2008.01.012
27. Marnane M, Duggan CA, Sheehan OC, et al.: Stroke subtype classification to mechanism-specific and undetermined categories by TOAST, A-S-C-O, and causative classification system: direct comparison in the North Dublin population stroke study. Stroke. 2010, 41:1579-86. 10.1161/STROKEAHA.109.575373