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**TREATMENT OUTCOMES AND ASSOCIATED FACTORS
IN PATIENTS WITH ACUTE MINOR ISCHEMIC STROKE**

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ABSTRACT OF THE DISSERTATION

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2. Nguyen Dung Tien, Mai Ton Duy, Viet Dao Phuong, Ha Tran Hung Marco Fabus, Melanie Fleming, Tran Cong Minh. Early neurological deterioration in patients with minor stroke: A single-center study conducted in Vietnam. *PLOS One* | <https://doi.org/10.1371/journal.pone.0323700> May 19, 2025:1-13.
3. Nguyen Dung Tien, Mai Ton Duy, Viet Dao Phuong, Ha Tran Hung, Tran Cong Minh, Nguyen Xuan Huan. ProfessoEarly neurological deterioration in minor stroke caused by small artery occlusion: Incidence, risk factors and treatment impact. *Journal of Stroke and Cerebrovascular Diseases* 34 (2025) 108331: 1-7.
4. Mai Duy Ton, Ha Tran Hung, Nguyen Tien Dung. Clinical and paraclinical characteristics and treatment outcomes of patients with minor stroke admitted within the first 4.5 hours. 2025. *JMR* 196 E17 (11) – 2025.

INTRODUCTION

1. Rationale of the Study

The concept of minor ischemic stroke has received increasing attention since the 2010s, with an NIHSS threshold of ≤ 5 widely used to identify patients who present with subtle deficits yet remain at high risk for early recurrence and unfavorable outcomes. International studies show that 30–40% of these patients may have poor functional outcomes, and early recurrence rates may reach 8–20% without optimal management. Meanwhile, treatment recommendations for reperfusion therapy in minor stroke remain heterogeneous; the roles of intravenous thrombolysis, mechanical thrombectomy, and dual antiplatelet therapy (DAPT) continue to be investigated. Early neurological deterioration (END) is a strong predictor of poor outcomes, but recognizing and preventing END remains challenging.

In Vietnam, minor ischemic stroke has not been well studied. Because symptoms are often subtle, patients frequently present late, miss the window for reperfusion therapy, and face elevated risks of END and long-term disability. Some domestic studies have addressed treatment-related factors, but differences in population definitions and small sample sizes limit generalizability. Therefore, a large-scale study using standardized criteria and comprehensive assessment is needed to provide evidence relevant to clinical practice in Vietnam.

Accordingly, we conducted the study entitled **“Treatment Outcomes and Associated Factors in Patients with Acute Minor Ischemic Stroke”** with three objectives:

1. *To describe the clinical and paraclinical characteristics of patients with acute minor ischemic stroke at the Stroke Center of Bach Mai Hospital.*
2. *To evaluate treatment outcomes in patients with acute minor ischemic stroke.*
3. *To analyze factors associated with treatment outcomes in patients with acute minor ischemic stroke.*

2. New Contributions of the Dissertation

This dissertation is the first study in Vietnam to systematically characterize clinical features, neuroimaging findings, and vascular pathology in a large cohort of patients with acute minor ischemic stroke ($n = 932$). The mean patient age was 64.3 years; males predominated. Non-NIHSS symptoms were infrequent, with dizziness being the most common. Major vascular risk factors included hypertension, diabetes mellitus, smoking, and obesity. The most common etiological subtype according to TOAST was small-vessel occlusion (53.2%). Neuroimaging frequently showed lesions in the corona radiata, putamen, and internal capsule, with intracranial stenosis/occlusion rates of 8.0% and 12.5%, and extracranial carotid stenosis/occlusion rates of 3.1% and 2.0%, respectively.

The dissertation provides important evidence on treatment outcomes in minor stroke, demonstrating an END rate of 10.6% and a 90-day unfavorable outcome rate (mRS 2–6) of 11.2%, with the highest rates observed in large-vessel occlusion subgroups. These findings emphasize that minor ischemic stroke is not necessarily a benign condition.

The study also identifies independent prognostic factors associated with END and unfavorable 90-day outcomes (mRS 2–6) among patients with non-cardioembolic acute minor ischemic stroke. Predictors of END included baseline NIHSS score, systolic blood pressure, internal capsule and corona radiata involvement, hemorrhagic transformation, intracranial arterial occlusion, intravenous thrombolysis, and dual antiplatelet therapy. Predictors of 90-day mRS 2–6 included baseline NIHSS, END, hemorrhagic

transformation, intracranial occlusion, intravenous thrombolysis, and dual antiplatelet therapy. These findings deepen understanding of disease progression and help guide treatment and monitoring strategies for this patient group in Vietnam.

3. Structure of the Dissertation

The dissertation consists of 165 pages, including: Introduction (2 pages), Literature Review (31 pages), Methods (28 pages), Results (54 pages), Discussion (57 pages), Conclusion (2 pages), and Recommendations (1 page). It contains 24 tables and 37 figures, with 163 references.

The PhD candidate has published four peer-reviewed articles related to this dissertation, including one study protocol in an international journal, two original research articles in international journals, and one article in the English Edition of the Journal of Medical Research.

CHAPTER 1 LITERATURE REVIEW

1.1. Definitions

1.1.1. Ischemic Stroke

Ischemic stroke is defined as a focal neurological deficit lasting more than 24 hours caused by ischemic injury to a localized region of the brain, spinal cord, or retina. According to the Vietnamese Ministry of Health's Guidelines for the Diagnosis and Management of Stroke, ischemic stroke is a condition in which blood flow to a specific area of the brain is suddenly interrupted, resulting in corresponding neurological dysfunction.

1.1.2. Minor Ischemic Stroke

Minor stroke, understood as minor ischemic stroke, has been described since the early 2010s and is primarily defined by the severity of neurological deficits measured by the NIHSS, rather than by infarct size on CT/MRI. Initially, Urs Fischer proposed a strict definition (no individual NIHSS item >1 and total NIHSS ≤ 3). Subsequently, most authors have adopted NIHSS ≤ 5 as the threshold for defining minor stroke. Dhamoon classified stroke severity into mild, moderate, and severe according to NIHSS ≤ 5 , 6–13, and ≥ 14 , respectively. Major trials such as IST-3, PRISMS, and studies by Tai Hwan Park and Guillaume Turc also used NIHSS ≤ 5 to define minor ischemic stroke.

In 2021, Xiong, analyzing 472,352 patients, demonstrated comparable outcomes, mortality, recurrence, and myocardial infarction rates between NIHSS ≤ 3 and ≤ 5 groups, thereby supporting the use of NIHSS ≤ 5 in clinical research. Minor ischemic stroke accounts for a substantial proportion of cases in clinical practice: approximately 54.6% in the Northern Manhattan cohort, around 50% in Northern Kentucky, and roughly 30% of the nearly 3 million annual ischemic strokes in China.

The risk of recurrence after minor ischemic stroke is considerable without proper secondary prevention: 8–12% within the first 7 days, 11–15% within the first month, and 10–20% within 3 months. Therefore, developing appropriate treatment strategies for patients with minor ischemic stroke is crucial to reducing disability and preventing recurrent stroke.

1.1.3. Disabling Neurological Deficits

Ischemic stroke with disabling neurological deficits is defined as a stroke in which the neurological impairment, if not improved, would prevent the patient from performing basic activities of daily living (e.g., bathing/dressing, ambulation, toileting, and eating) or returning to work as usual. The assessment of whether a deficit is disabling depends on

the clinical judgment of the treating physician following direct evaluation and discussion with the patient and family. For example, a patient who works as a trumpeter presenting with facial droop would have a deficit that clearly prevents a return to their profession if it does not improve. Similarly, aphasia in a professional singer constitutes a disabling deficit, as it impedes the patient's ability to resume their previous occupation.

1.2. Risk Factors

According to current guidelines of the American Stroke Association, stroke risk factors are classified as follows:

1.2.1. Non-modifiable Risk Factors

a) Age: Age is the strongest and most consistently proven risk factor. Stroke incidence doubles with each decade after age 55.

b) Sex: Women aged 45–54 may have a higher incidence of stroke compared with men of the same age group. This difference may partly result from suboptimal management of stroke risk factors in women.

c) Genetics: An increased incidence of stroke within certain families has long been recognized. A well-established genetic variant is the MTHFR 677T allele, considered a hereditary risk factor for stroke and suggesting a causal association between elevated homocysteine levels and stroke.

d) Race/Ethnicity: There is substantial racial and ethnic variation in the incidence of TIA and stroke-related mortality. Stroke incidence is significantly higher in rural populations compared with urban populations.

1.2.2. Modifiable Risk Factors

- a) Diabetes mellitus
- b) Hypertension
- c) Atrial fibrillation/Atrial flutter
- d) Overweight/Obesity
- e) Hypercholesterolemia
- f) Cigarette or tobacco smoking
- g) Excessive alcohol consumption
- h) History of ischemic stroke/TIA
- i) Peripheral artery disease
- j) Coronary artery disease/Myocardial infarction
- k) Heart failure

1.3. Clinical Features

1.3.1. Clinical Presentation

The clinical manifestations of minor ischemic stroke depend on the vascular territory involved and correspond to deficits arising from dysfunction of specific neural pathways. Symptoms are often mild and easily overlooked, such as subtle facial droop, dizziness, ataxia, dysarthria, nystagmus, hemisensory changes, or mild focal weakness affecting an arm, leg, or one side of the body. Symptoms may gradually worsen or deteriorate in a stepwise pattern.

Clinical features of acute minor ischemic stroke are typically categorized by anterior circulation (carotid artery, anterior cerebral artery, middle cerebral artery) and posterior circulation (vertebral artery, posterior cerebral artery, basilar artery).

The NIHSS is a valuable tool for assessing stroke severity at presentation and predicting functional outcomes. Minor ischemic stroke is clinically characterized using NIHSS criteria, with NIHSS ≤ 5 commonly accepted as the diagnostic threshold.

1.3.2. Neuroimaging

a. Brain and Vascular CT Imaging

Early CT signs within the first 24 hours after stroke include loss of gray–white differentiation in the lentiform nucleus and/or caudate head, decreased attenuation of the insular cortex (insular ribbon sign), and hyperdensity of the middle cerebral artery (MCA) or basilar artery.

CT angiography allows evaluation of large-vessel pathology, including:

- Intracranial atherosclerotic stenosis $\geq 50\%$ corresponding to the infarcted territory.
- Intracranial arterial dissection, such as distal internal carotid artery (ICA) or V4 vertebral artery dissection.
- Large-vessel occlusion, including ICA terminus (T or L configuration), MCA M1 occlusion, tandem lesions (concomitant ICA + M1 occlusion), or M2 occlusions (common trunk, superior or inferior division).
- Moyamoya-like vascular changes.

b. Brain and Vascular MRI

MRI detects ischemic lesions earlier and with higher sensitivity than CT. Acute infarction typically appears as hyperintensity on DWI with corresponding ADC reduction. FLAIR imaging can be used as a surrogate “tissue clock” in cases with unknown onset time to determine eligibility for thrombolysis.

TOF-MRA identifies stenosis or occlusion, helping determine the location and severity of vascular lesions.

1.3.3. Other Paraclinical Tests

a) Electrocardiography is recommended (Class I) to detect atrial fibrillation, atrial flutter, and other arrhythmias.

b) Echocardiography helps detect cardiac sources of embolism, including mitral stenosis (mild, moderate, severe), rheumatic valvular disease, mechanical valves, myocardial infarction, and intracardiac thrombus. The American Stroke Association recommends echocardiography as Class IIa for determining stroke etiology.

c) Carotid ultrasound identifies large-artery atherosclerosis, carotid stenosis, or dissection. It is recommended as Class Ia for etiological evaluation in ischemic stroke.

d) Blood tests include capillary glucose, venous glucose, HbA1c, lipid profile (cholesterol, LDL-C, HDL-C, triglycerides), urea, creatinine, liver enzymes, and hypercoagulability workup (protein C, protein S, systemic disorders, etc.).

1.4. TOAST Classification

The TOAST system categorizes ischemic stroke into five etiological subtypes:

(1) Large-artery atherosclerosis: Diagnosed when stenosis $\geq 50\%$ or complete occlusion is present in major arteries supplying the infarct territory, as confirmed by ultrasound, CTA, or MRA.

(2) Cardioembolism: Embolic stroke due to atrial fibrillation, myocardial infarction, valvular heart disease, dilated cardiomyopathy, etc. These infarcts are typically large, prone to hemorrhagic transformation, and may involve multiple vascular territories.

(3) Small-vessel occlusion: Characterized clinically by lacunar syndromes without cortical signs; lesion size is usually <1.5 cm in the deep subcortical or brainstem regions, and may be undetectable on CT/MRI. Cardioembolism and $\geq 50\%$ large-artery stenosis must be excluded.

(4) Other determined etiologies: Includes non-atherosclerotic vasculopathies (e.g., vasculitis, dissection), hypercoagulable states, and hematologic disorders. Diagnosis requires specialized testing and vascular imaging, after excluding cardiac and large-artery causes.

(5) Undetermined etiology: Accounts for about one-third of cases, including those with no identifiable cause despite complete workup or those with multiple potential etiologies that cannot be clearly distinguished.

1.5. Treatment

1.5.1. Reperfusion Therapy

Guidelines for reperfusion therapy in minor ischemic stroke remain inconsistent due to limited evidence. According to AHA/ASA 2019:

- Patients presenting within 3 hours with disabling deficits may receive intravenous thrombolysis (Class Ib).
- In the 3–4.5-hour window, the recommendation is weaker (Class IIb).
- In non-disabling minor stroke, thrombolysis within 0–4.5 hours has not demonstrated benefit.

ESO 2021 strongly recommends alteplase for disabling deficits but not for non-disabling minor stroke unless large-vessel occlusion is present, where most experts still favor treatment.

Regarding mechanical thrombectomy, AHA/ASA 2019 states that patients with NIHSS ≤ 5 and ICA or proximal M1 occlusion within 6 hours *may be considered* for thrombectomy (Class IIb). Similarly, thrombectomy may be considered for distal anterior circulation occlusions or posterior circulation occlusions (vertebrobasilar).

There is currently no evidence-based recommendation for mechanical thrombectomy in the extended 6–24 hour window for minor ischemic stroke. Overall, reperfusion therapy primarily relies on carefully selected use of intravenous alteplase.

1.5.2. Secondary Stroke Prevention

a. Antithrombotic Strategy

Effective secondary prevention requires accurate identification of stroke mechanism. For non-cardioembolic minor stroke, evidence from CHANCE and POINT demonstrates that early dual antiplatelet therapy (aspirin + clopidogrel), initiated within 12–24 hours and continued for 21–90 days, significantly reduces recurrence and is strongly recommended (AHA 2021, Class IA). Aspirin + ticagrelor may be used for 30 days in NIHSS ≤ 5 , though with higher bleeding risk (Class IIb). After 90 days, ESO recommends switching to single antiplatelet therapy.

For cardioembolic stroke, anticoagulation is the standard of care: DOACs for non-valvular atrial fibrillation and vitamin K antagonists for rheumatic mitral stenosis (moderate–severe) or mechanical valves.

b. Combination Therapy

LDL-cholesterol should be reduced to <1.8 mmol/L (or <1.4 mmol/L in the presence of carotid/intracranial stenosis) with high-intensity statins; ezetimibe may be added if targets are unmet after 6 weeks. Blood pressure should be maintained $<130/80$ mmHg with combination therapy. Diabetes management targets HbA1c $<7\%$, adjusted for age, duration, and comorbidities. Lifestyle modification includes increased physical activity, weight control, and abstinence from smoking and alcohol.

1.6. Current Evidence in Vietnam and Worldwide

Multiple large studies demonstrate that minor ischemic stroke is not a benign condition. Urs Fischer reported that 23.5% of minor stroke patients had mRS 2–5 and 1.3% died. Dae-Hyun Kim found 38% had poor outcomes. Romano reported that 37% had mRS ≥ 2 at day 90, identifying age, sex, smoking, atrial fibrillation, prior stroke, and baseline NIHSS as major predictors.

END occurs in 5–40% of minor stroke patients and is strongly associated with poor outcomes. Sam Min Sung reported an END rate of 10.6%, with unfavorable outcomes (mRS ≥ 2) in 78.2% of END patients compared with 19.8% without END; associated factors included higher NIHSS, hemorrhagic transformation, and large-vessel stenosis/occlusion (OR 2.0–2.56).

Among patients with large-vessel occlusion, Pierre Seners reported END in 13.2% and demonstrated that END substantially increased the risk of poor 90-day outcomes (OR 7.37). A predictive score was proposed based on occlusion site and clot length, with END risks increasing progressively at 3%, 7%, 20%, and 35%. These findings highlight the importance of early identification and prevention of END in minor ischemic stroke.

CHAPTER 2 STUDY SUBJECTS AND METHODS

2.1. Study Subjects

2.1.1. Inclusion Criteria

- Patients aged ≥ 18 years.
- Patients diagnosed with ischemic stroke based on clinical features and neuroimaging according to the American Stroke Association. A diagnosis of ischemic stroke was established when ≥ 1 of the following criteria was met (Criterion 1 mandatory):
 - (1) Clinical criterion: sudden onset of focal neurological deficits lasting >24 hours, or transient symptoms with evidence of ischemia on MRI;
 - (2) Neuroimaging criterion: radiological evidence of infarction on CT or MRI (hypodensity on CT, or DWI hyperintensity with corresponding ADC reduction on MRI); and
 - (3) Exclusion criterion: exclusion of intracranial hemorrhage and non-vascular causes.
 - Admission within 24 hours from the last known well time.
 - NIHSS ≤ 5 at admission to the Stroke Center, Bach Mai Hospital, with a score of 0 on the level of consciousness items (1a, 1b, 1c) of the NIHSS.

2.1.2. Exclusion Criteria

- Pre-stroke mRS ≥ 2 .
- Pregnancy or breastfeeding.
- Coexisting intracranial conditions: traumatic brain injury, intracerebral hemorrhage, subarachnoid hemorrhage, brain tumors.
- Incomplete medical records.

2.2. Study Setting and Duration

- Setting: Stroke Center, Bach Mai Hospital.
- Study period: Patient enrollment from September 2023 to September 2025.

2.3. Study Design

- The study was designed as an observational, analytical, longitudinal cohort study.

2.4. Sample Size and Sampling Method

Sample Size:

The sample size was estimated using the formula for determining a single population proportion:

Using $p = 0.38$ (proportion of unfavorable 90-day outcomes in the study by Dae-Hyun Kim), precision $d = 0.09$, and confidence level 95%, the minimum required sample size was $N = 774$.

Given that the Stroke Center receives approximately 1,000 minor stroke cases annually and anticipating 20% loss due to incomplete data or follow-up, the required sample size was determined to be 929 patients.

Sampling Method:

All eligible patients who met the inclusion criteria and had no exclusion criteria during the study period were consecutively included.

2.5. Study Variables and Endpoints

a. Primary Clinical Outcome:

- Unfavorable outcome at day 90 defined as mRS 2–6.
- Favorable outcome at day 90 defined as mRS 0–1.

b. Secondary Clinical Outcome:

- Early neurological deterioration (END): defined as an increase of ≥ 2 points in NIHSS within the first 72 hours.

2.6. Statistical Analysis

Data were analyzed as follows: quantitative variables were presented as medians (IQR) or means $\pm$ SD; qualitative variables as frequencies and percentages. Group comparisons used the Student's t-test, Mann–Whitney U test, Chi-square test, or Fisher's exact test as appropriate.

Univariate and multivariable logistic regression analyses were performed to identify factors associated with outcomes. Variables were entered into multivariable models when $p < 0.20$ in univariate analysis or had established clinical relevance, ensuring at least 10 events per variable to avoid overfitting.

Multivariable models were built using the Enter method. Multicollinearity was assessed using VIF (< 5). Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test and classification accuracy.

2.7. Ethical Considerations

The study was reviewed and approved by the Institutional Review Board (IRB) of Bach Mai Hospital under Decision No. 4837/BM-HĐĐĐ dated November 24, 2023. Ethical approval was also granted by the Institutional Review Board in Biomedical Research of Hanoi Medical University under Certification No. NCS2024/GCN-HMUIRB dated May 15, 2024.

CHAPTER 3 RESEARCH RESULTS

3.1. Clinical and Paraclinical Characteristics of Patients With Acute Minor Ischemic Stroke at the Bach Mai Stroke Center

3.1.1. Clinical Characteristics

3.1.1.1 Sex Distribution

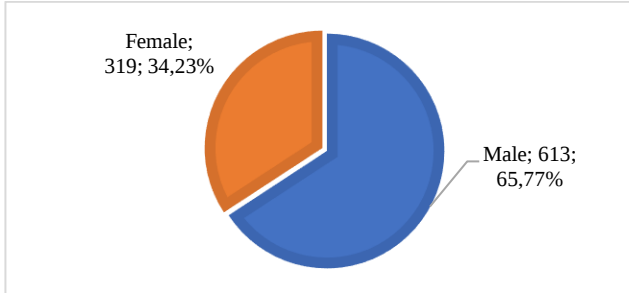


Figure 3.1. Sex Distribution in the Study Population

Comment: Male patients accounted for the majority of the study population, representing 65.77%.

3.1.1.2 General Clinical Characteristics

Table 3.1. General Characteristics of the Study Population

Characteristics	Total N = 932 (100%)
Age, mean $\pm$ SD	64.27 $\pm$ 12.13
Systolic blood pressure at admission, mmHg (mean $\pm$ SD)	152.63 $\pm$ 23.39
Diastolic blood pressure at admission, mmHg (mean $\pm$ SD)	87.94 $\pm$ 13.73
Systolic blood pressure $\geq$ 150 mmHg at admission, n (%)	496 (53.2%)
Diastolic blood pressure $\geq$ 90 mmHg at admission, n (%)	469 (50.3%)
BMI, kg/m ² (mean $\pm$ SD)	22.9 $\pm$ 2.36

Comment: Both systolic and diastolic blood pressures at admission were above the threshold for hypertension.

3.1.1.4 NIHSS Score at Admission

Table 3.2. NIHSS Score at Admission by Sex

	Total N = 932 (100%)
NIHSS at admission, median (IQR)	3 (2–4)

Comment: The median NIHSS score for the entire cohort was 3.

3.1.1.6 Onset-to-Hospital Arrival Time

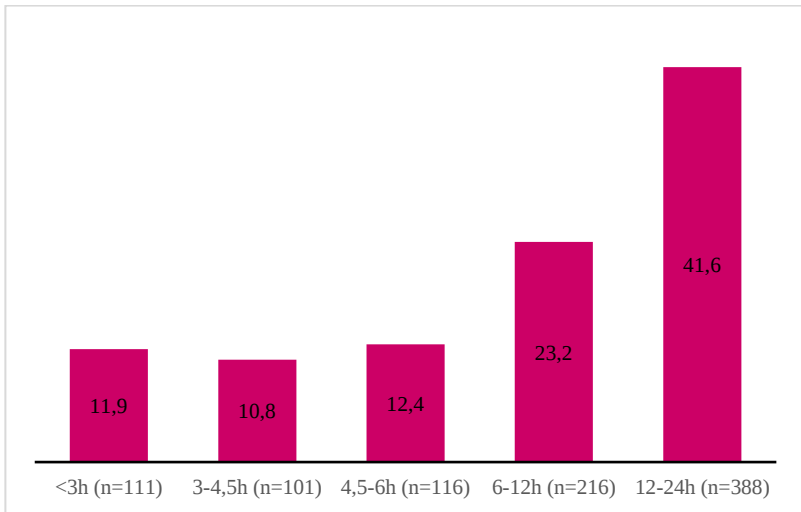


Figure 3.2. Distribution of Onset-to-Hospital Arrival Time

Comment: The highest proportion of patients presented within the 12–24 hour time window. The proportion of patients arriving within the golden time window (first 4.5 hours from onset) was 22.7% in the study population.

3.1.1.7 Vascular Risk Factors in the Study Population

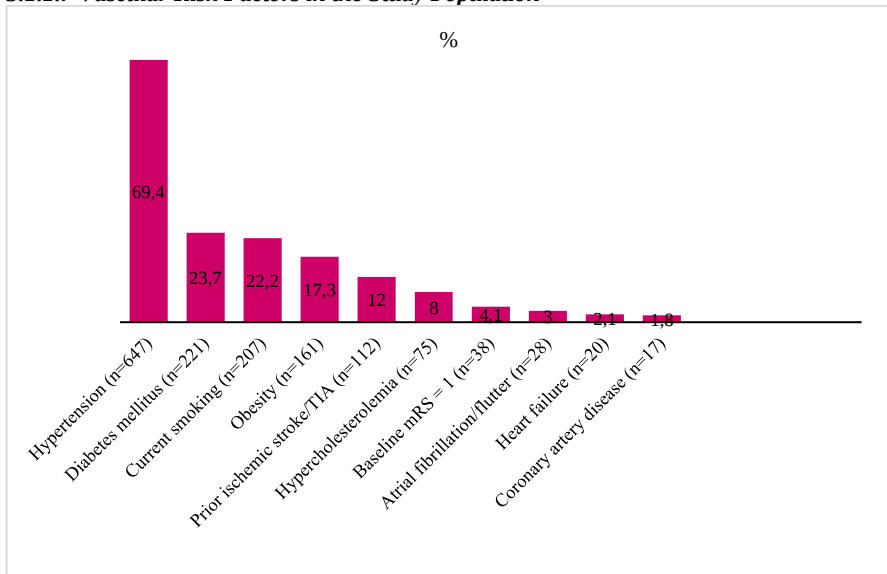


Figure 3.3. Vascular Risk Factors

Comment: Hypertension was the most common risk factor. The least frequent risk factors were coronary artery disease and heart failure.

3.1.2.4 TOAST Classification

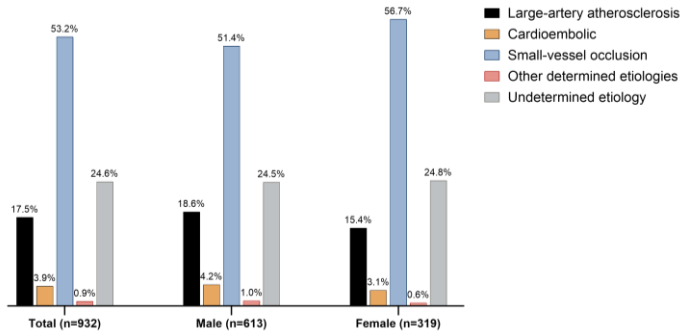


Figure 3.4. TOAST Classification in the Study Population

Comment: Small-vessel occlusion was the most common etiology in the cohort. “Other determined etiology” accounted for the smallest proportion. Undetermined etiology represented approximately 24.57% of the population.

Table 3.3. Distribution of Infarct Locations in the Study Population

Infarct Location	Total N = 823 (100%)
Thalamus	105 (12.8%)
Internal capsule	103 (12.5%)
Caudate nucleus	42 (5.1%)
Putamen	211 (25.6%)
Insular cortex	35 (4.3%)
Corona radiata	246 (29.9%)
Corpus callosum	3 (0.4%)
Temporal lobe	91 (11.1%)
Frontal lobe	65 (7.9%)
Parietal lobe	43 (5.2%)
Occipital lobe	73 (8.9%)
Brainstem	135 (16.4%)
Cerebellum	56 (6.8%)

Comment: The most frequent infarct location was the corona radiata (29.9%), followed by the putamen (25.6%).

3.1.2.6 Characteristics of Hemorrhagic Transformation in the Study Population

Table 3.4 Distribution of Hemorrhagic Transformation

	Total N=932 (100%)
Hemorrhagic Transformation n (%)	7 (0,75)
HI 1	4 (0,43)
HI 2	1 (0,1)
PH1	1 (0,1)
PH2	1 (0,1)
sICH	1 (0,1)

Comment: The overall rate of hemorrhagic transformation in the study population was low (0.5%). There was no statistically significant difference between males and females across all grades of hemorrhagic transformation.

3.1.2.7 Extracranial Carotid Artery Stenosis/Occlusion

Table 3.5. Characteristics of Extracranial Carotid Artery Stenosis and Occlusion

	Total N=823 (100%)	Male N=545 (66.2%)	Female N=278 (33.8%)	p
Stenosis 50–99%, n (%)	29 (3.1)	22 (3.6)	7 (2.2)	0.321
Occlusion, n (%)	19 (2.0)	19 (3.1)	0 (0%)	<0.001

Comment: The prevalence of extracranial carotid stenosis did not differ significantly between males and females ($p = 0.321$). However, extracranial carotid occlusion was more frequent in males (3.1%) than in females (0%), with a statistically significant difference ($p < 0.001$).

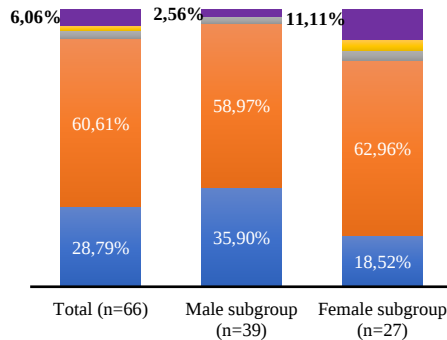


Figure 3.6. Frequency of Intracranial Arterial Stenosis in the Study Population

Comment: The most frequent intracranial stenosis site was the middle cerebral artery, followed by the intracranial internal carotid artery, in both males and females. The least frequent site was the posterior cerebral artery.

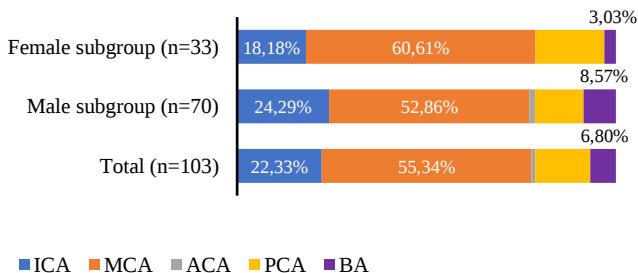


Figure 3.7. Distribution of Intracranial Arterial Occlusion Sites in the Study

Comment: The most frequent site of intracranial occlusion was the middle cerebral artery in both males and females. The least frequent site was the anterior cerebral artery, also consistent across both sexes.

3.2 Treatment Outcomes in Acute Minor Ischemic Stroke

3.2.1 Functional Outcome (mRS)

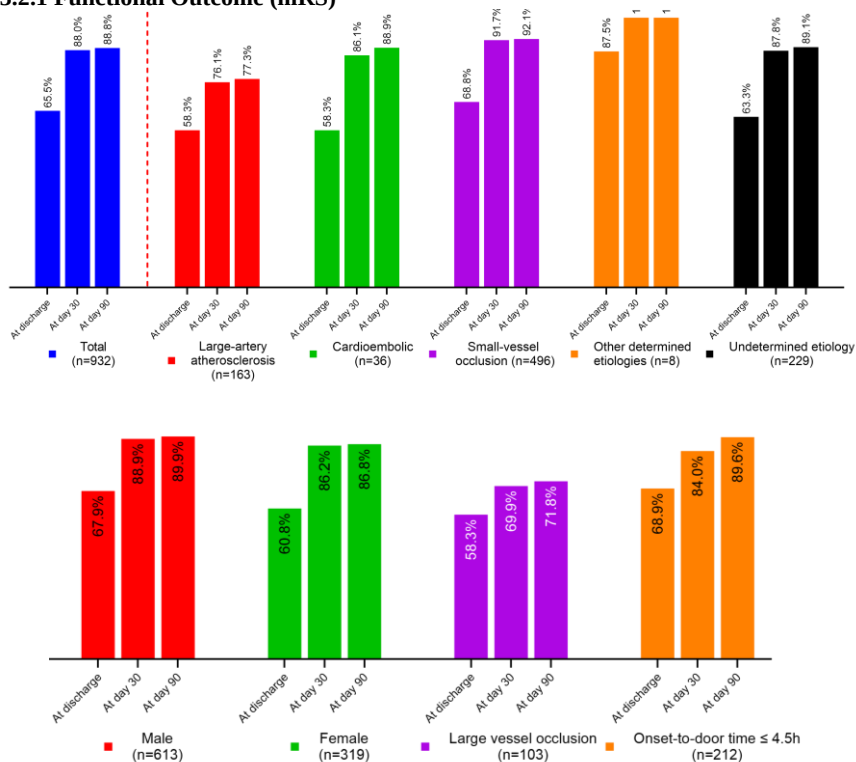


Figure 3.8. Favorable Functional Outcome (mRS 0–1) in the Overall Population and Subgroups

Comment: The subgroup with the highest rate of favorable outcome (mRS 0–1) at day 90 was the small-vessel occlusion group (92.1%). The lowest rate was observed in the minor stroke group with large-vessel occlusion (73.0%).

3.2.2 Early Neurological Deterioration

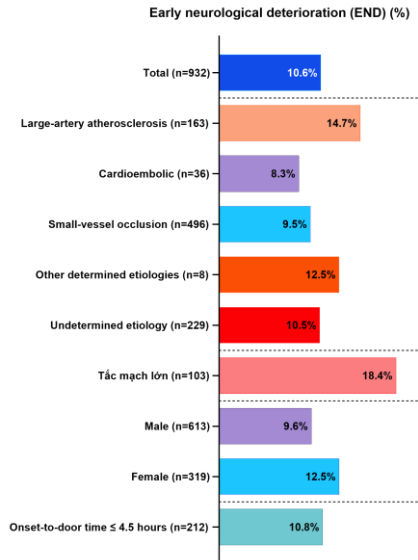


Figure 3.9. Rate of Early Neurological Deterioration in the Study Population

Comment: The small-vessel occlusion group had the lowest rate of early neurological deterioration (9.5%), whereas the highest rate was observed in the minor stroke group with large-vessel occlusion (18.4%).

3.3. Analysis of Factors Associated With Treatment Outcomes in Acute Minor Ischemic Stroke

3.3.1 Overall Population

3.3.1.1 Functional Recovery

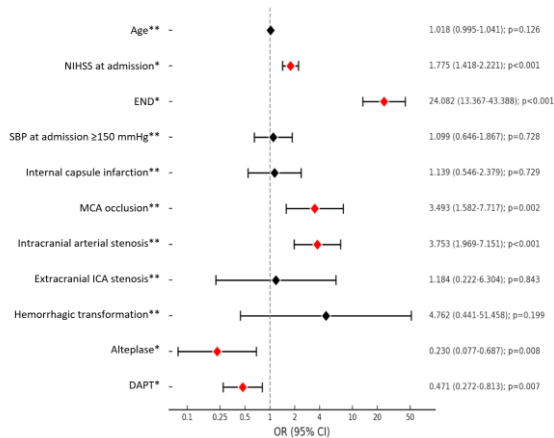


Figure 3.10. Predictors of poor functional outcome (mrs 2–6) at day 90 in non-cardioembolic acute minor ischemic stroke

* Adjusted for variables in Model 1: baseline NIHSS score, early neurological deterioration, corresponding intracranial arterial occlusion, and treatment strategy (dual antiplatelet therapy, intravenous thrombolysis, and single antiplatelet therapy).

Model 1 identified five independent predictors of poor functional outcome (mRS 2–6 at day 90), all with high statistical significance ($p < 0.001$).

Model performance: The ROC curve demonstrated strong discriminatory ability, with an area under the curve (AUC) of 0.873 (95% CI 0.832–0.914; $p < 0.001$), indicating good classification accuracy for predicting poor 90-day outcomes.

Table 3.6. Prognostic score for 90-day poor functional outcome (mrs 2–6) in non-cardioembolic acute minor ischemic stroke

Risk Factor	B Coefficient	Proposed Score	Adjusted Score
NIHSS (per 1-point increase)	0.574	1	1
Early neurological deterioration	3.181	6	6
Corresponding intracranial arterial occlusion	1.322	2	2
Treatment strategy			
– Intravenous thrombolysis	–1.469	–3	0
– Dual antiplatelet therapy	–0.754	–1	2
– Single antiplatelet therapy	0	0	3

Total score: 0–16 points

Table 3.7. Risk stratification for predicting poor functional outcome

Total Score	Risk Category	Rate of Poor Outcome (mRS 2–6)
0–5	Low risk	3.2%
6–10	Intermediate risk	21.8%
11–16	High risk	70.2%

3.3.1.2 Early Neurological Deterioration

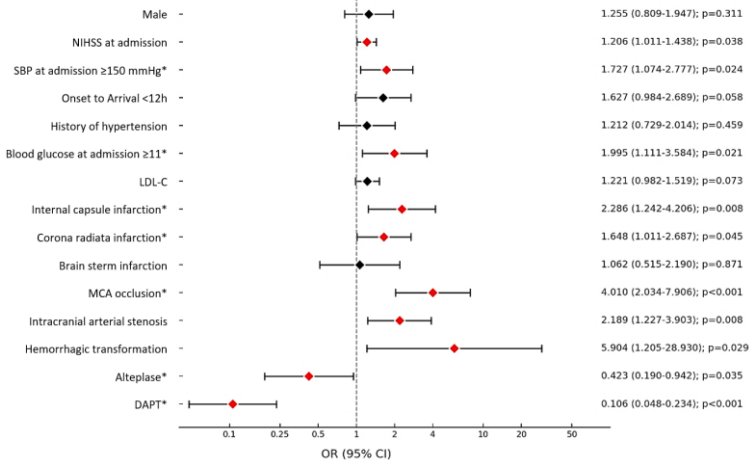


Figure 3.10. Predictors of early neurological deterioration in non-cardioembolic acute minor ischemic stroke

*: Adjusted for covariates (Model 2): systolic blood pressure at admission >150 mmHg, capillary blood glucose >11 mmol/L at admission, internal capsule infarction, corona radiata infarction, middle cerebral artery occlusion, dual antiplatelet therapy, and single antiplatelet therapy.

Model 2 demonstrated good predictive performance for early neurological deterioration (END), with an area under the ROC curve of 0.753 (95% CI 0.704–0.811; $p < 0.001$) in patients with non-cardioembolic acute minor ischemic stroke. Based on Model 2, we developed the following prognostic scoring system for END:

Table 3.8. Prognostic score for early neurological deterioration in non-cardioembolic acute minor ischemic stroke

<i>Predictive Factor</i>	<i>B Coefficient</i>	<i>Proposed Score</i>	<i>Adjusted Score</i>
Systolic blood pressure ≥ 150 mmHg at admission	0.546	+1	+1
Capillary blood glucose ≥ 11 mmol/L at admission	0.691	+1	+1
Internal capsule infarction	0.827	+2	+2
Corona radiata infarction	0.500	+1	+1
Middle cerebral artery occlusion	1.389	+3	+3
Treatment strategy			
– Dual antiplatelet therapy	–2.243	–4	0
– Intravenous thrombolysis	–0.861	–2	+2
– Single antiplatelet therapy	0	0	+4

Total score: 0–12 points

We stratified risk according to the scoring system as follows:

Table 3.9. Risk stratification score for early neurological deterioration in non-cardioembolic acute minor ischemic stroke

<i>Total score</i>	<i>Risk category</i>	<i>Early neurological deterioration rate</i>
0–2	Low risk	5.0%
3–5	Intermediate risk	19.0%
6–12	High risk	50.0%

When applying the above risk stratification thresholds, the observed rates of early neurological deterioration were 5.0%, 19.0%, and 50.0% in the low-, intermediate-, and high-risk groups, respectively. The differences between risk groups were statistically significant (Chi-square, $p < 0.001$), and a test for trend showed a progressive increase in END risk with higher risk scores (p -trend < 0.001).

3.3.2. Minor Ischemic Stroke Due to Small-Vessel Occlusion

3.3.2.1 Functional Recovery

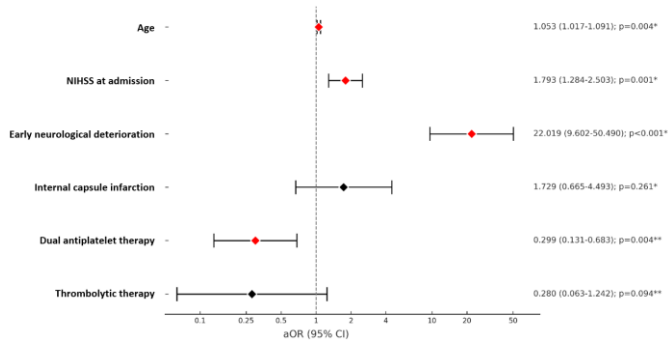


Figure 3.11. Predictors of poor functional outcome (mRS 2–6) at day 90 in minor ischemic stroke due to small-vessel occlusion

Comment: Multivariable analysis showed that age, baseline NIHSS, early neurological deterioration, and dual antiplatelet therapy were independent predictors of 90-day poor functional outcome (mRS 2–6) in minor ischemic stroke due to small-vessel occlusion.

3.3.2.2 Early Neurological Deterioration

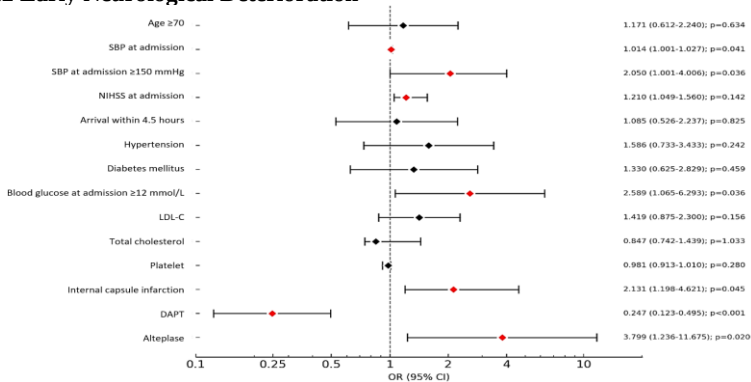


Figure 3.12. Predictors of early neurological deterioration in minor ischemic stroke due to small-vessel occlusion

Comment: Predictors of early neurological deterioration in this group included systolic blood pressure, NIHSS score, blood glucose, internal capsule infarction, and treatment strategy.

3.3.3. Minor Ischemic Stroke Due to Large-Artery Atherosclerosis

3.3.3.1 Functional Recovery

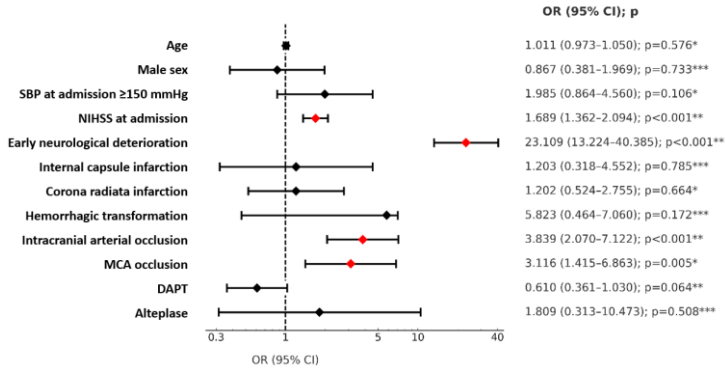


Figure 3.13. Predictors of poor functional outcome (mrs 2–6) at day 90 in minor ischemic stroke due to large-artery atherosclerosis

The prediction model for poor 90-day functional outcome (mRS 2–6) in minor ischemic stroke due to large-artery atherosclerosis showed excellent discrimination, with an area under the ROC curve of 0.867 (95% CI 0.828–0.907; $p < 0.001$).

3.3.3.2 Early Neurological Deterioration

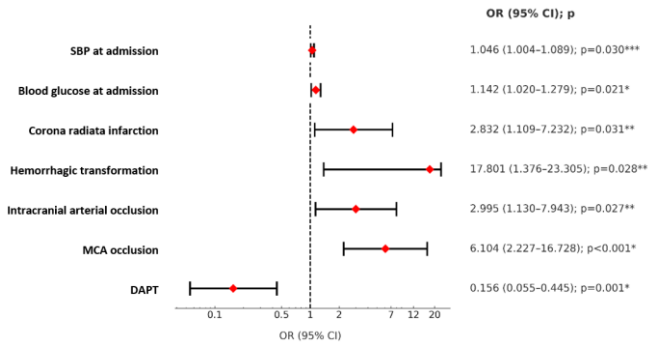


Figure 3.14. Predictors of early neurological deterioration in minor ischemic stroke due to large-artery atherosclerosis

Comment: Predictors of END in minor ischemic stroke due to large-artery atherosclerosis included systolic blood pressure, capillary blood glucose, corona radiata infarction, hemorrhagic transformation, corresponding intracranial or MCA occlusion, and dual antiplatelet therapy (protective effect).

3.3.4. Minor Ischemic Stroke With Large-Vessel Occlusion

3.3.4.1 Functional Recovery

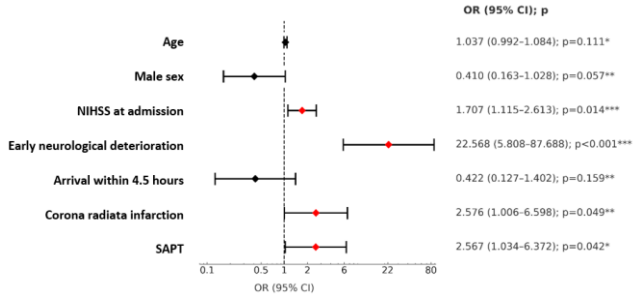


Figure 3.15. Predictors of poor functional outcome (mrs 2–6) at day 90 in minor ischemic stroke with large-vessel occlusion

Comment: Predictors of 90-day poor functional outcome (mRS 2–6) in minor ischemic stroke with LVO included baseline NIHSS, early neurological deterioration, corona radiata infarction, and single antiplatelet therapy.

3.3.4.2 Early Neurological Deterioration

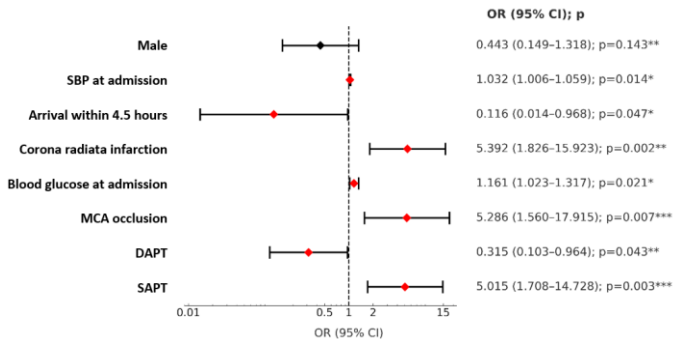


Figure 3.16. Predictors of early neurological deterioration in minor ischemic stroke with large-vessel occlusion

Comment: Predictors of END in minor ischemic stroke with LVO included systolic blood pressure, presentation ≤ 4.5 hours, corona radiata infarction, hyperglycemia, corresponding MCA occlusion, and antiplatelet regimen (DAPT protective; SAPT associated with higher risk)

3.3.5. Non-cardioembolic Acute Minor Ischemic Stroke Patients Presenting Within 4.5 Hours

Table 3.10. Effect of Treatment Modalities on Early Neurological Deterioration

	OR (KTC 95%), p	aOR (KTC 95%), p*
DAPT vs SAPT	0.032 (0.004-0.274) 0,002	0,033 (0,004-0,289) 0,002
rtPA vs SAPT	3,095 (1,042-9,196) 0,042	4,053 (0,791-20,779) 0,093
rtPA vs DAPT	3,333 (2,759-7,860) <0,001	6,114 (3,084-10,274) <0,001

*: *Adjusted using a propensity score.*

Comment: After adjustment for baseline characteristics, DAPT markedly reduced the risk of early neurological deterioration compared with SAPT and alteplase, while no significant difference was observed between SAPT and alteplase.

Table 3.11. Effect of Treatment Modalities on 90-Day Functional Outcome (mRS 2–6)

	OR (KTC 95%), p	aOR (KTC 95%), p*
DAPT vs SAPT	0,142 (0,043–0,464), 0,001	0,167 (0,049–0,574) 0,005
rtPA vs SAPT	1,057 (0,335–3,338) 0,924	1,110 (0,212–5,805) 0,902
rtPA vs DAPT	7,467 (2,188–25,485) 0,001	2,645 (0,435–16,087) 0,291

*: *Adjusted using a propensity score.*

Comment: DAPT reduced the risk of poor functional outcome (mRS 2–6) compared with SAPT. Alteplase did not differ significantly from either DAPT or SAPT.

CHAPTER 4 DISCUSSION

4.1. Clinical and paraclinical characteristics of patients with acute minor ischemic stroke at the Stroke Center, Bach Mai Hospital

4.1.1. Age and Sex

In our study, males accounted for the majority of patients (65.8%), similar to many studies on minor ischemic stroke such as Kim (70.2%), Ju (67.1%), Boulenoir (73%), and Sung (67.5%). Other studies reported a more balanced sex distribution, such as Wang (48.7% male) and Heitkamp (51% male), reflecting population differences. The mean age in our cohort (64.27 years) is also consistent with most international studies, in which the mean age typically ranges from 63 to 65 years (Wang, Ju, Nedeltchev, Sung, Boulenoir). These data confirm that our study population accurately reflects the epidemiological profile of patients with minor ischemic stroke.

4.1.2. Baseline NIHSS

The median baseline NIHSS score in our cohort was 3 (IQR 2–4), comparable to large studies such as Seners, TEMPO-2, Ton, Chen, and Wang. The distribution of NIHSS scores in these studies also shows that low NIHSS (0–3) accounts for the highest proportion, representing a characteristic feature of minor ischemic stroke populations.

Sex-stratified analysis in our study showed that only leg weakness differed significantly between males and females; there were no major differences in disabling deficits or dominant hemisphere involvement. However, studies such as MaRISS, PRISMS, and Seners have demonstrated that even mild deficits are associated with a risk of poor outcomes, underscoring the importance of early assessment and treatment.

4.1.3. Time from onset to hospital arrival

In our study, only 22.7% of patients with minor ischemic stroke arrived at the hospital within the first 4.5 hours, while 41.6% presented between 12 and 24 hours, reflecting substantial prehospital delays. These findings are consistent with the multicenter study by Mai Duy Ton (2023), in which only about one-third of patients arrived within 6 hours. Delayed presentation is largely related to limited public awareness and an underdeveloped prehospital emergency system.

Compared with international data, the rate of early hospital arrival in Vietnam remains much lower than in the CHANCE and POINT trials, although the proportion

arriving within 12 hours in our study is relatively acceptable. Late arrival substantially reduces opportunities for reperfusion therapies, including intravenous thrombolysis and mechanical thrombectomy.

4.1.4. Vascular risk factors

In our study, hypertension was the most prevalent risk factor (69.4%), consistent with major trials such as CHANCE, MaRISS, CNSR, and GSR-ET (59–75%), highlighting its prominent role in minor stroke epidemiology. Diabetes mellitus was present in 23.7%, similar to international reports (20–27%). Atrial fibrillation/flutter accounted for only 3.9%, much lower than in MaRISS, TEMPO-2, or GSR-ET, reflecting population differences. The smoking rate (22.2%) was in the mid-range compared with other studies (16–43%) and differed markedly between males and females.

Overall, our population exhibits risk factor patterns broadly comparable to those in large international studies, while still reflecting specific characteristics of the Vietnamese context.

4.1.5. TOAST classification

In our study, small-vessel occlusion was the most frequent TOAST subtype (53.2%), higher than in other studies such as ATAMIS, Xie, and Mai Duy Ton. Large-artery atherosclerosis accounted for 17.5%, cardioembolism for only 3.9%, and undetermined etiology for 24.6%.

International comparisons show considerable variation across populations: Xie reported a high proportion of atherosclerosis (36.8%), whereas ATAMIS had a very high rate of undetermined etiology (61%). Conversely, Rashid found a predominance of cardioembolism (44.6%). These differences highlight the epidemiological diversity between cohorts and emphasize the importance of understanding local etiologic patterns in managing minor ischemic stroke.

4.1.6. Brain and vascular imaging

In our study, most patients with minor ischemic stroke (59.9%) had a single lesion, consistent with focal ischemia. The most common lesion locations were the corona radiata (29.9%), putamen (25.6%), brainstem (16.4%), thalamus, and internal capsule, reflecting typical involvement of deep perforator branches of the middle cerebral artery. Evidence from Kim, Rosso, and Kawano indicates that even small deep lesions can be associated with unfavorable outcomes, particularly when involving the deep MCA territory.

Intracranial stenosis/occlusion was present in 20.5% of patients (8.0% stenosis, 12.5% occlusion), with MCA being the most frequently affected artery. Although this rate is lower than in some Vietnamese studies, intracranial stenosis/occlusion remains clinically relevant as an independent predictor of poor outcome and END. The rate of hemorrhagic transformation was very low (0.8%), comparable to or lower than that reported by Kim, MaRISS, and TEMPO-2. Despite its low frequency, hemorrhagic transformation warrants attention because it can be associated with END in selected cases.

For extracranial carotid arteries, stenosis $\geq 50\%$ accounted for 3.1% and occlusion for 2.0%, notably all carotid occlusions occurred in males. This difference may relate to higher smoking rates and atherosclerotic burden in men, consistent with domestic data. Studies by Sung and Xie also found that $\geq 50\%$ stenosis/occlusion (intracranial or extracranial) is an important predictor of END.

In summary, the neuroimaging characteristics of our minor stroke cohort demonstrate that: (1) lacunar-type lesions predominate; (2) intracranial vascular

abnormalities are more common than extracranial lesions; and (3) hemorrhagic complications are rare, but stenosis/occlusion has major prognostic implications for clinical course and functional outcome.

4.2. Treatment outcomes in patients with acute minor ischemic stroke

4.2.1. Overall population

The rate of END in our study was 10.6%, similar to several other studies, although reported END rates overall vary widely (2–26%) because of differences in definitions and population characteristics. END has been shown to be strongly associated with poor functional outcomes and long-term mortality, emphasizing the need for close monitoring and individualized management.

Functional outcomes in our cohort were generally favorable: 88.9% achieved mRS 0–1 at day 90, and mortality was only 1.1%, comparable to large studies such as ARAMIS and MaRISS. However, outcomes differed by etiology: small-vessel occlusion had the best prognosis, whereas large-vessel occlusion had the poorest outcomes, consistent with the higher END risk in LVO. Studies by Sykora and Xu also show that treatment efficacy depends on stroke mechanism, reinforcing the role of etiologic stratification and individualized treatment strategies in minor ischemic stroke.

4.2.2. Minor ischemic stroke due to small-vessel occlusion

In the small-vessel occlusion subgroup, the END rate in our study was 9.5%, lower than in many international studies (2–47%), likely due to differences in definitions and study populations. Observational evidence suggests that dual antiplatelet therapy significantly reduces END and improves mRS outcomes, consistent with our results and studies by Kimura, Nishi, and Cui.

Functional outcomes in the small-vessel occlusion group were excellent, with 92.1% achieving mRS 0–1; however, END dramatically reduced the likelihood of recovery (55.3% vs. 96.0%). Across multiple studies, END consistently emerges as a strong predictor of poor outcomes (adjusted OR 5–12).

From a pathophysiological perspective, END in lacunar infarction may be related to progressive occlusion of multiple perforator branches or the so-called “capsular warning syndrome.” Overall, END in minor stroke due to small-vessel occlusion is not uncommon and carries major prognostic weight, supporting the need for close monitoring and early optimization of therapy.

4.2.3. Minor ischemic stroke due to large-artery atherosclerosis

In the large-artery atherosclerosis subgroup, the END rate in our cohort was 14.7%, comparable to international studies (11–22%), and END occurred more frequently in patients receiving single antiplatelet therapy than in those on DAPT. This subgroup had the poorest 90-day functional outcomes, with mRS 0–1 in only 77.3% of patients, and a marked decline among those with END (20.8% vs. 87.8%).

Trials such as CHANCE, POINT, ARAMIS, and studies by Sykora indicate that DAPT is safe, reduces END, and is non-inferior to alteplase in terms of functional outcomes, with a lower bleeding risk. Several studies (Xu, Cui, Zhang) demonstrate that DAPT yields better outcomes even in patients with large-artery atherosclerosis. These findings suggest that DAPT is an optimal strategy for minor stroke due to large-artery atherosclerosis to limit END and enhance functional recovery.

4.2.4. Minor ischemic stroke with large-vessel occlusion

In minor stroke with LVO, the risk of END is particularly high; our study recorded an END rate of 18.4%, while other studies have reported rates from 13% to nearly 50%.

END markedly worsens functional outcomes, with mRS 0–1 at day 90 in only 71.8% of our cohort and even lower in some other populations.

Studies by Seners, Boulenoir, and Gwak show that “rescue” thrombectomy in LVO patients who develop END significantly improves mRS compared with conservative management. This raises a crucial question: should thrombectomy be performed routinely in minor LVO (NIHSS ≤ 5), or reserved for patients who develop END? Two ongoing randomized trials, ENDO-LOW and MOSTE, are expected to provide definitive evidence on optimal treatment strategies in this special subgroup.

4.2.5. Minor ischemic stroke without cardioembolism, presenting within 4.5 hours

In our study, 21.6% of patients with minor ischemic stroke presented within 4.5 hours, similar to multicenter Vietnamese data. In this early-arrival subgroup, DAPT was used most frequently (65.7%), far exceeding alteplase (17.9%) and single antiplatelet therapy (16.4%), in line with strong evidence from THALES, CHANCE, and POINT.

Current guidelines recommend thrombolysis only for minor stroke with disabling deficits, whereas non-disabling cases are preferentially treated with DAPT for at least 21 days. In our early-arrival subgroup, DAPT yielded the best outcomes, with a 90-day poor outcome rate (mRS 2–6) of only 1.5%, significantly lower than with alteplase (13.9%) or single therapy (12.5%).

4.3. Factors associated with treatment outcomes in patients with acute minor ischemic stroke

4.3.1. Overall population

In the non-cardioembolic minor stroke population, END occurred in 10.8% of patients, lower than in some international studies owing to differences in definitions and sample sizes. Predictors of END included baseline NIHSS, systolic blood pressure, admission glucose, internal capsule infarction, intracranial occlusion, hemorrhagic transformation, and single antiplatelet therapy; in contrast, DAPT and rtPA reduced END risk. Our END prediction model (ROC = 0.753) showed good risk stratification and formed the basis for a clinically applicable risk score.

Regarding functional outcomes, the 90-day mRS 2–6 rate was 11.2%. Predictors of poor outcome included baseline NIHSS, END, intracranial occlusion, and treatment strategy (single antiplatelet therapy being inferior to DAPT or thrombolysis). These findings are consistent with studies by Nedeltchev, Lingyun Wu, Romano, and Mai Duy Ton. Our prognostic model for 90-day mRS 2–6 (ROC = 0.873) demonstrated strong predictive performance; we proposed a risk score for future individualized treatment.

4.3.2. Minor Ischemic Stroke due to Small-Vessel Occlusion

In the small-vessel occlusion subgroup, predictors of END included higher baseline NIHSS, systolic blood pressure, hyperglycemia, internal capsule infarction, and treatment strategy. DAPT substantially reduced END risk, whereas elevated glucose and internal capsule involvement increased it. DAPT also reduced poor functional outcomes (mRS 2–6), consistent with findings from Kimura, Nishi, ARAMIS, and international meta-analyses.

END was the strongest predictor of poor outcomes (OR >20), alongside older age and higher baseline NIHSS. DAPT emerged as a key protective factor, significantly lowering the risk of poor mRS compared with single therapy.

Intravenous thrombolysis was associated with improved outcomes in univariate analysis but lost significance after adjustment, similar to findings by Vynckier and Pan. Overall, these results reinforce the role of DAPT and rigorous blood pressure and glucose control in preventing deterioration and improving outcomes in lacunar minor stroke.

4.3.3. Minor ischemic stroke due to large-artery atherosclerosis

In the large-artery atherosclerosis subgroup (17.5%), the END rate was 14.7%, and END was the strongest predictor of poor outcome (mRS 2–6), with adjusted OR >23. Predictors of END included systolic blood pressure, hyperglycemia, corona radiata/internal capsule infarction, hemorrhagic transformation, intracranial or MCA occlusion; DAPT significantly lowered END risk.

Poor 90-day outcome (22.1%) was associated with higher baseline NIHSS, END, and intracranial occlusion, consistent with the extensive vascular burden and worse prognosis in LAA. Large-vessel occlusion, particularly MCA occlusion, markedly increased the risk of poor mRS at 90 days. DAPT showed a trend toward better outcomes than single therapy, emphasizing its importance in this subgroup.

4.3.4. Minor ischemic stroke with large-vessel occlusion

In the LVO subgroup (17.5%), END predictors included systolic blood pressure, hyperglycemia, corona radiata infarction, MCA/intracranial occlusion, and treatment strategy. DAPT reduced END risk, whereas single antiplatelet therapy increased it. END remained the strongest predictor of poor outcome (adjusted OR >22), consistent with studies by Seners, Gwak, and Heitkamp.

Unlike ARAMIS, our study found DAPT to be more effective than alteplase in reducing END, possibly due to differences in END definitions and patient selection. Prognostic models based on perfusion imaging or biomarkers (such as pNfL) have been proposed by other authors but are difficult to implement widely in Vietnam. In our outcome analyses, baseline NIHSS, END, corona radiata infarction, and single therapy increased the risk of poor mRS, while thrombolysis was more beneficial than single antiplatelet therapy in minor LVO.

4.3.5. Minor ischemic stroke without cardioembolism, presenting within 4.5 hours

In the early-arrival subgroup (within 4.5 hours), patients treated with alteplase usually had more severe deficits at baseline (higher NIHSS, dominant hemisphere or brainstem involvement). After adjustment, DAPT provided the greatest reduction in END risk, outperforming both single therapy and alteplase, while alteplase did not show superiority over single antiplatelet therapy.

Large studies (ARAMIS, Sykora, Viana, Zhang, etc.) indicate that DAPT is non-inferior and sometimes superior to alteplase in terms of END and functional recovery in minor stroke. Synthesizing the evidence, IV thrombolysis does not clearly improve the proportion of good mRS, whereas DAPT consistently yields better END and 90-day outcomes.

CONCLUSIONS

We conducted the study “Treatment Outcomes and Associated Factors in Patients with Acute Minor Ischemic Stroke” with an actual sample size of 932 patients and obtained the following conclusions according to the study objectives:

1. Description of clinical and paraclinical characteristics in patients with acute minor ischemic stroke at the Stroke Center, Bach Mai Hospital

1.1. Clinical characteristics

- Mean age in the cohort was 64.27 ± 12.13 years. Males accounted for 65.8%.
- Non-NIHSS clinical symptoms were present in 70/932 patients (7.51%), with dizziness being the most common (65/932; 6.97%).
- Median NIHSS (IQR) in the cohort was 3 (2–4).
- The proportion of patients admitted within the first 4.5 hours was 22.7%.

- The most frequent stroke risk factors were: hypertension (69.4%), diabetes mellitus (23.7%), smoking (22.2%), obesity (17.3%), and prior ischemic stroke/TIA (12.0%).

- TOAST etiologic distribution: small-vessel occlusion was the most common (53.2%), followed by large-artery atherosclerosis (17.5%).

1.2. Paraclinical characteristics

- Atrial fibrillation was present in 3.9% of patients. Moderate-to-severe mitral stenosis was observed in 0.8%.

- The most common infarct locations were the corona radiata (29.9%), putamen (25.6%), brainstem (16.4%), thalamus (12.8%), internal capsule (12.5%), and temporal lobe (11.1%).

- Hemorrhagic transformation occurred in 7/932 patients (0.8%).

- For extracranial carotid arteries, stenosis 50–99% accounted for 3.1%, and occlusion for 2.0%.

- Intracranial arterial findings:

- o Stenosis 50–99% occurred in 8.0%, most frequently in the MCA (4.6%) and intracranial ICA (2.3%).

- o Occlusion was present in 12.5%, most commonly in the MCA (6.9%) and intracranial ICA (2.6%).

2. Treatment outcomes in patients with acute minor ischemic stroke

- The overall END rate was 10.6%; by subgroup: 9.5% in small-vessel occlusion, 14.7% in large-artery atherosclerosis, 18.4% in large-vessel occlusion, 10.45% in early-arrival (≤ 4.5 hours), 12.5% in females, and 9.6% in males.

- The rate of poor functional outcome (mRS 2–6) at day 90 in the overall cohort was 11.2%; by subgroup: 7.9% in small-vessel occlusion, 22.7% in large-artery atherosclerosis, 28.16% in large-vessel occlusion, 10.4% in early-arrival (≤ 4.5 hours), 13.2% in females, and 10.1% in males.

3. Analysis of factors associated with treatment outcomes in patients with acute minor ischemic stroke

In the non-cardioembolic minor stroke population, factors associated with treatment outcomes included:

- For early neurological deterioration (END): baseline NIHSS, systolic blood pressure, internal capsule and corona radiata infarction, hemorrhagic transformation, intracranial occlusion, intravenous thrombolysis, and dual antiplatelet therapy.

- For poor functional outcome (mRS 2–6) at day 90: baseline NIHSS, END, hemorrhagic transformation, corresponding intracranial occlusion, intravenous thrombolysis, and dual antiplatelet therapy.

RECOMMENDATIONS

In clinical practice, early risk stratification for END and poor functional outcomes in patients with minor ischemic stroke is essential for selecting appropriate treatment strategies in the absence of clear reperfusion guidelines. We propose the use of two prognostic scores developed in this study to support systematic risk assessment. These scores should be validated in future clinical trials before widespread implementation in routine practice.