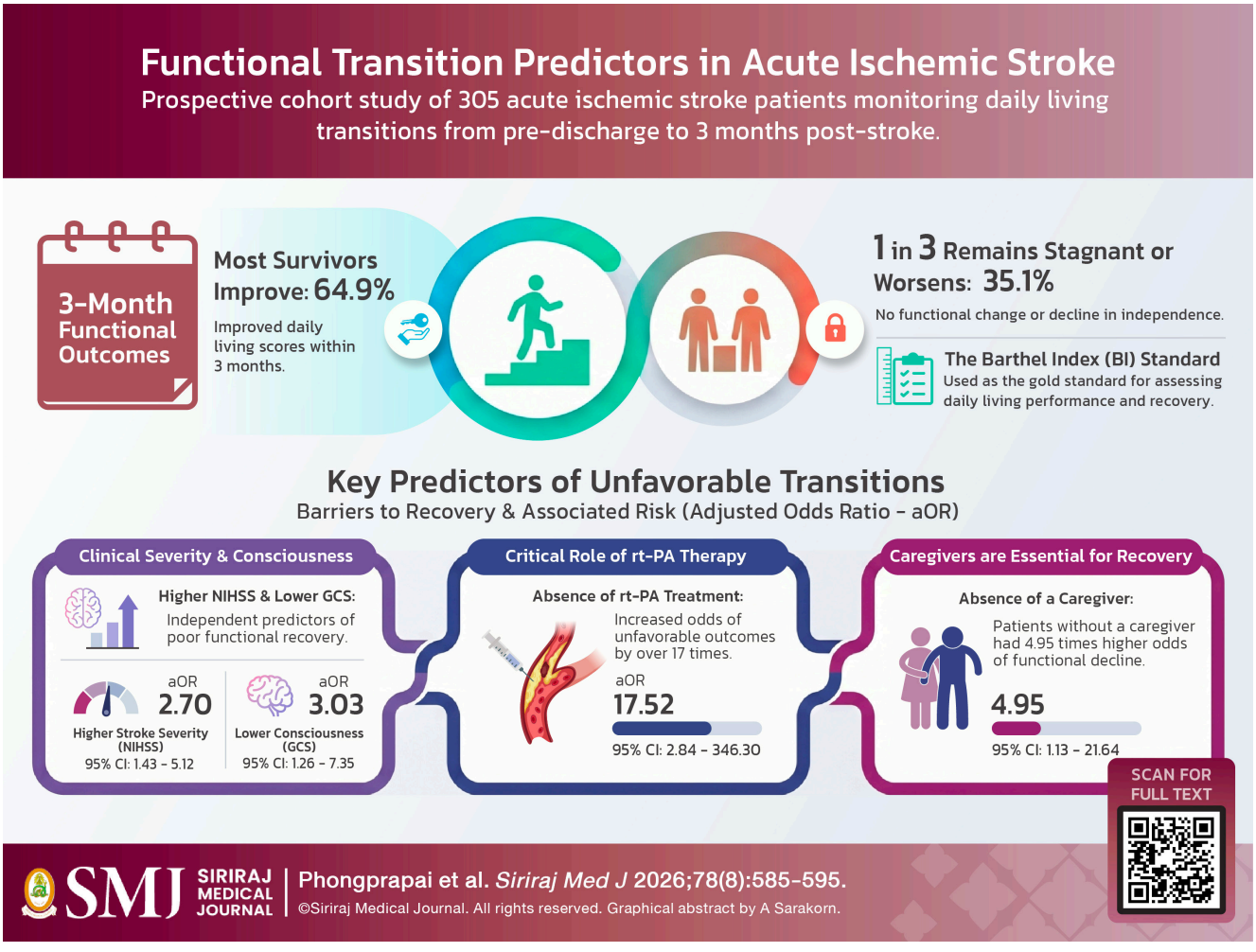
Prognostic Factors for Changes in Activities of Daily Living After Acute Ischemic Stroke

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ABSTRACT

Objective: Disability in activities of daily living (ADL) is one of the most common sequelae of ischemic stroke. The factors that govern the course of functional recovery in this group of patients need to be identified to inform clinical management. The objective of this study was to explore the prognostic factors of ADL for the functional outcome of patients with acute ischemic stroke at 3-month follow-up.

Materials and Methods: A prospective cohort study in patients with acute ischemic stroke was performed. Prognostic factors were obtained from patient records. The Barthel index (BI) was used to evaluate functional status both before discharge and at a 3-month follow-up. Correlates of worsening or unchanged ADL were calculated using multivariable ordinal logistic regression.

Results: A total of 305 patients were enrolled (mean age, 65 years; male, 55.4%). At 3 months, ADL improved in 64.9% of patients, remained unchanged in 28.2%, and worsened in 6.9%. Several independent prognostic factors for worse or unchanged ADL at 3 months were identified and included: higher NIHSS (aOR = 2.70, 95% CI: 1.43–5.12), lower GCS (aOR = 3.03, 95% CI: 1.26–7.35), absence of thrombolytic therapy with rt-PA (aOR =17.52, 95% CI:2.84-346.30), and absence of a caregiver (aOR =4.95, 95% CI, 1.13–21.64).

Conclusions: Stroke severity (NIHSS, GCS) and acute intervention (rt-PA), as well as social support (caregivers), are important determinants of functional evolution in ischemic stroke patients. These results support the need for early risk stratification and optimized post-discharge support to enhance long-term rehabilitation outcomes.

Keywords: Ischemic stroke; activities of daily living; prognostic factors; caregivers; functional recovery (Siriraj Med J 2026;78(8):585-595)

INTRODUCTION

Ischemic stroke is a leading cause of long-term disability worldwide. Survivors frequently experience persistent neurologic deficits, including motor weakness, sensory loss, and bulbar dysfunction, all of which substantially affect Activities of Daily Living (ADL).[1] Functional independence is therefore a central outcome in stroke management and rehabilitation. The Barthel Index (BI) is widely recognized as the global gold standard for assessing ADL performance, demonstrating excellent reliability (ICC 0.94) and discriminating ability (AUC 0.82) in stroke populations.[3-5]

Preliminary data from Naresuan University Hospital indicate considerable heterogeneity in post-stroke recovery trajectories. Although most patients demonstrate improvement within the first-year after stroke, approximately 16% experience no functional improvement or functional deterioration. Identifying prognostic factors that cause these unfavorable outcomes is therefore important for proper clinical approach.

Existing literature have identified advanced age and baseline stroke severity as strong predictors of functional outcomes. However, other potential predictors, such as TIA history, certain comorbidities, and infarct volume, have shown inconsistent associations across studies.[5-13] A notable limitation of many prior investigations is the reliance on single-time-point ADL assessments.[5,9,12] Cross-sectional evaluations do not adequately capture the dynamic nature of functional recovery or decline. Without longitudinal comparison across time points, the classification of patients as "worsening" may be imprecise.

To address this limitation, the present study employed a two-point ADL assessment and categorized functional trajectories into three ordinal levels: improved, unchanged, or worsened. Using a proportional odds model to analyze these ordinal transitions allows for a strong insight into the factors that either protect against or contribute to functional decline. This knowledge is important for designing tailored rehabilitation interventions and optimizing long-term prognostic accuracy for stroke patients.

The objective of this study is to identify the prognosis factors associated with worsening ADL levels in patients following their first episode of acute ischemic stroke, specifically changes in BI scores from discharge to 3-month follow-up.

MATERIALS AND METHODS

This cohort study was conducted at a tertiary care academic medical center. The study protocol was approved by Institutional Review Board (COA No. P3-0120/2564). Data were collected from August 2021 to July 2022.

Participants and recruitment

Patients aged ≥18 years with first-ever acute ischemic stroke were eligible for inclusion. The diagnosis of ischemic stroke was established based on clinical neurological examination and confirmed by neuroimaging (CT or MRI). Patients were excluded if they: (1) had other coexisting brain lesions, such as a brain tumor; (2) died during the 3-month follow-up period; or (3) resided outside the hospital's primary service area, precluding follow-up assessment.

Sample size calculation

The sample size was estimated for each potential prognostic factor relative to the three-category ordinal outcome (improved, unchanged, or worsened ADL). Calculations were performed using R statistical software. The largest estimated required sample size among all potential factors was selected to ensure sufficient statistical power for multivariable proportional odds modeling. A total of 305 eligible patients were included in the final analysis (Fig 1).

Data collection and prognostic factors

Potential prognostic factors were identified through an extensive literature review and extracted from the hospital's electronic database. Baseline and clinical data were collected upon patient admission:

- Baseline Characteristics: Recorded variables included age (categorized as < 60 or ≥ 60 years), gender, presence of a primary caregiver, and Body Mass Index (BMI), which was classified according to Asian criteria: categorized into low (< 18.5 kg/m^2), normal (18.5–22.9 kg/m^2), and high (≥ 23 kg/m^2) according to Asian criteria.
- Clinical and Biochemical Profiles: Data included thrombolytic therapy (rt-PA) administration, NIHSS score (≤ 5 vs. > 5), Glasgow Coma Scale (GCS) (≤ 12 vs. ≥ 13), and time from onset to hospital arrival (early ≤ 4.5 hours vs. late > 4.5 hours). Biochemical markers analyzed were serum albumin (< 3.5 vs. ≥ 3.5 g/dL) and hemoglobin (≤ 12 vs. > 12 g/dL).
- Comorbidities: Pre-existing conditions, including hypertension, hyperlipidemia, and diabetes mellitus, were recorded as binary variables (Yes/No).

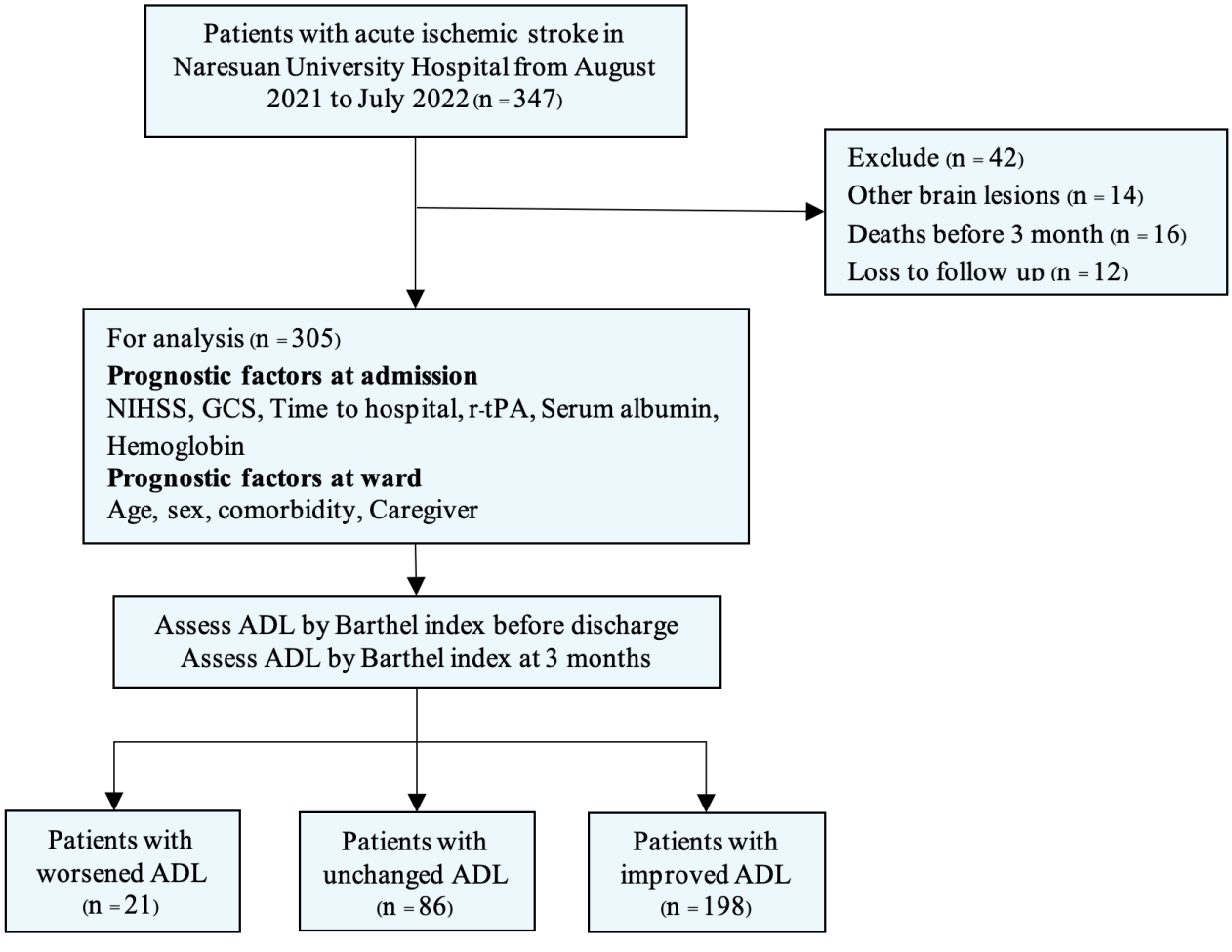


Fig 1. Study flow diagram of patients with acute ischemic stroke in Naresuan University Hospital from August 2021 to July 2022.

Outcome measurement

The main endpoint was the change in Activities of Daily Living (ADL), assessed using the Barthel Index (BI). The BI evaluates 10 domains, functional items with total scores ranging from 0 to 100, where higher scores indicate greater independence. Assessments were performed at two time points: (1) prior to hospital discharge and (2) at 3 months post-stroke. Functional trajectory was determined by calculating the difference between the 3-month score and the pre-discharge score, categorized into three levels:

1. Improved ADL: A positive change in BI score (> 0).

2. Unchanged ADL: No change in BI score (0).

3. Worsened ADL: A negative change in BI score (< 0).

Statistical analysis

Data distribution was evaluated using the Shapiro-Wilk test and visual inspection of histograms. Continuous variables were summarized as mean ± standard deviation (SD) for normally distributed data or median with interquartile range (IQR) for non-normal distributions. Categorical variables were expressed as frequencies and percentages. Baseline characteristics across the three ADL trajectory groups (improved, unchanged, and worsened) were compared using One-way ANOVA for continuous variables and the Exact Probability Test (or Fisher's Exact Test) for categorical variables.

A proportional odds model (ordinal logistic regression) was utilized to identify potential prognostic factors of ADL transitions. The parallel lines assumption was verified using the Brant test to ensure that the relationship between each variable and the odds of a higher outcome remained consistent across ordinal cut-points.

In the multivariable model, a backward elimination approach was used. Variables with p-value < 0.20 in the univariate analysis were initially entered into the model, while a p-value < 0.05 was required for retention in the final model. Results were presented as adjusted odds ratios (aOR) with 95% confidence intervals (CI); the model estimated the odds of an unfavorable functional trajectory (worsened or unchanged ADL) compared to the improved ADL reference group. All statistical analyses were performed using R Studio (Version 4.2.0), two-tailed p-values < 0.05 were considered statistically significant.

RESULTS

Participant flow and baseline characteristics

A total of 305 patients with first-ever episode of acute ischemic stroke were enrolled in the study. At 3-month follow-up, 198 patients (65.0%) demonstrated improved ADL, 86 (28.2%) had no change, and 21 (6.8%) experienced worsening ADL based on changes in BI scores.

Baseline characteristics according to ADL trajectory are shown in Table 1. Patients in the worsened ADL group were significantly older (mean age, 71.6 ± 9.3 years) than those in the improved ADL group (64.8 ±13.9 years). This cohort also exhibited higher initial stroke severity (NIHSS: 12.9 ± 9.1 VS 4.4 ± 4.7) and lower levels of consciousness (GCS: 13.1 ± 2.6 vs GCS:14.6 ± 1).

Lower serum albumin levels were more frequently observed among patients with worsened ADL (16.1%) compared with those with improved ADL (5.0%). No statistically significant differences among groups in terms of gender, BMI, and time to hospital arrival (Table 1).

Prognostic factors for ADL change

Univariable ordinal logistic regression identified high NIHSS, low GCS, lack of rt-PA treatment, and the absence of a caregiver as significant predictors of less favorable ADL outcomes (worsened or unchanged ADL status) (Table 2).

In the multivariable proportional odds model, high NIHSS (aOR = 2.70; 95% CI: 1.43–5.12) and low GCS (aOR = 3.03; 95% CI: 1.26–7.35) were identified as independent prognostic factors for functional outcomes. The absence of rt-PA treatment was associated with the highest odds of unfavorable ADL outcomes (aOR = 17.52; 95% CI: 2.84–346.30), while the absence of a caregiver was also significantly associated with higher odds of worsened or unchanged ADL (aOR = 4.95; 95% CI: 1.13–21.64).

Among the comorbidities, the presence of diabetes mellitus was significantly associated with higher odds of functional worsening in the adjusted model (aOR = 1.96; 95% CI: 1.01–3.70). Other factors, including age, gender, and BMI, did not reach statistical significance in the final multivariable model (Table 2).

Sensitivity analysis

Subgroups with small sample sizes: patients who received rt-PA (n = 15) and those without a caregiver (n = 8). Across alternative models, elevated NIHSS and reduced GCS at admission consistently remained significant predictors of unfavorable ADL outcomes (Table 3). In the most conservative model (Model 3), which excluded both rt-PA and caregiver variables, high NIHSS (aOR = 2.24; 95% CI:1.21–4.16) and low GCS (aOR = 2.00; 95% CI:1.06–4.92) remained independently

TABLE 1. Stroke-Related predictors according to ADL change categorizations.

Characteristics	Worsened ADL		Unchanged ADL		Improved ADL		P value
Age (years) (n, %)							
<60	2	2.2	32	34.4	59	63.4	0.037[b]
≥60	19	9.0	54	25.5	139	65.5	
Mean ± SD	71.6 ± 9.3		63.2 ± 14.1		64.8 ± 13.9		0.011[a]
Gender (n, %)							
Female	9	6.6	46	33.8	81	59.6	0.150[b]
Male	12	7.1	40	23.7	117	69.2	
BMI (kg/m²) (n, %)							
Low	5	18.5	5	18.5	15	63.0	0.200[b]
Normal	5	5.3	29	30.5	61	64.2	
High	11	6.0	52	28.6	119	65.4	
Mean ± SD	22.0 ± 4.1		24.5 ± 4.4		24.2 ± 4.3		0.364[a]
Having Caregiver (n, %)							
Yes	21	7.1	79	26.6	197	66.3	0.002[b]
No	0	0.0	7	87.5	1	12.5	
Clinical profiles							
Time to hospital (hr) (n, %)							
Early	12	9.5	32	25.4	82	65.1	0.274[b]
Late	9	5.0	54	30.2	116	64.8	
Mean ± SD	11.3 ± 16.3		14.9 ± 19.1		15.9 ± 21.8		0.774[a]
Glasgow coma scale (n, %)							
High	12	4.5	76	28.5	179	67.0	< 0.001[b]
Low	9	23.7	10	26.3	19	50.0	
Mean ± SD	13.1 ± 2.6		14.4 ± 1.4		14.6 ± 1.07		< 0.001[a]
NIHSS (n, %)							
Low	6	2.0	64	28.0	150	70.0	< 0.001[b]
High	17	16.3	30	28.8	57	54.9	
Mean ± SD	12.9 ± 9.1		4.5 ± 5.0		4.4 ± 4.7		0.004[a]

TABLE 1. Stroke-Related predictors according to ADL change categorizations. (Continued)

Characteristics	Worsened ADL		Unchanged ADL		Improved ADL		P value
Receiving rt-PA (n, %)							
Yes	0		0		1		6.7[b]
No	21		7.3		85		29.3[b]
Biochemical Profiles							
Hemoglobin (g/dL) (n, %)							
Normal	11	5.4	58	28.6	134	66.0	0.368[b]
Low	10	9.9	28	27.7	63	62.4	
Mean ± SD	11.7 ± 2.8		12.4 ± 1.9		12.7 ± 1.8		0.011[a]
Albumin (g/dL) (n, %)							
Normal	10	5.0	54	26.7	138	68.3	0.024[b]
Low	10	16.1	15	24.2	37	59.7	
Mean ± SD	3.5 ± 0.7	4.9 ± 8.8	3.8 ± 0.47	0.221a			
Comorbidity							
Hypertension (n, %)							
Yes	16	7.4	55	25.6	144	67.0	0.286[b]
No	5	5.6	31	34.1	54	60.3	
Dyslipidemia (n, %)							
Yes	10	5.5	50	27.6	121	66.9	0.457[b]
No	11	8.9	36	29.0	77	62.1	
Diabetic mellitus (n, %)							
Yes	7	6.7	33	31.7	64	61.6	0.617[b]
No	14	7.0	53	26.3	134	66.7	

[a]P-value was calculated using One-way ANOVA for continuous variables.

[b]P-value was calculated using the Fisher's exact test for categorical variables.

TABLE 2. Associations of prognostic factors according to ADL change categorizations by ordinal logistic regression (Worse ADL vs Unchanged ADL or Improve ADL).

Prognostic factors	Univariable ORs (95%CI)	Multivariable ORs (95%CI)
Baseline characters		
Age (years)		
<60	Ref	Ref
≥ 60	1.01 (0.62 – 1.68)	1.09 (0.59 – 2.68)
Gender		
Male	Ref	Ref
Female	1.45 (0.91 – 2.32)	1.69 (0.95 – 3.02)
BMI (km/m^2)		
Normal	Ref	Ref
Low	1.30 (0.52 – 3.14)	1.46 (0.50 – 3.98)
High	0.96 (0.58 – 1.61)	1.11 (0.59 – 3.09)
Having caregiver		
Yes	Ref	Ref
No	4.17 (1.27 – 13.7)	4.95 (1.13 – 21.64)
Clinical profiles		
Time to hospital (hr)		
Early	Ref	Ref
Late	0.94 (0.59 – 1.51)	0.87 (0.45 – 1.43)
Glasgow Coma Scale		
High	Ref	Ref
Low	2.65 (1.32 – 5.29)	3.03 (1.26 – 7.35)
NIHSS		
Low	Ref	Ref
High	2.27 (1.39 – 3.69)	2.70 (1.43 – 5.12)
Receiving rt-PA		
Yes	Ref	Ref
No	8.14 (1.61 – 148.75)	17.52 (2.84 – 346.30)
Biochemical Profiles		
Hemoglobin (mg/dL)		
Normal	Ref	Ref
Low	1.23 (0.75 – 2.01)	0.77 (0.40 – 1.44)
Albumin (mg/dL)		
Normal	Ref	Ref
Low	1.66 (0.92 – 2.97)	1.42 (0.71 – 2.42)
Comorbidity		
Hypertension		
Yes	Ref	Ref
No	0.83 (0.78 – 2.13)	0.76 (0.40 – 1.45)
Dyslipidemia		
Yes	Ref	Ref
No	1.28 (0.51 – 1.35)	1.18 (0.63 – 2.17)
Diabetes mellitus		
Yes	Ref	Ref
No	1.00 (0.79 – 1.26)	1.96 (1.01-3.70)

TABLE 3. Sensitivity analysis, associations of prognostic factors according to ADL change.

Prognostic factors	Multivariable ORs (95%CI)		
	Model 1	Model 2	Model 3
Age (years)			
<60	Ref	Ref	Ref
≥ 60	1.15 (0.62 – 2.18)	0.99 (0.53 – 1.86)	1.63 (0.89 – 3.01)
Gender			
Male	Ref	Ref	Ref
Female	1.79 (1.01 – 3.21)	1.65 (0.92 – 2.97)	1.65 (0.93 – 2.93)
BMI (km/m^2)			
Normal	Ref	Ref	Ref
Low	1.28 (0.42 – 3.04)	1.40 (0.55 – 3.90)	1.41 (0.45 – 3.99)
High	1.01 (0.55 – 1.67)	1.31 (0.69 – 3.29)	1.30 (0.71 – 3.43)
Having caregiver			
Yes	Ref		
No	4.94 (1.31 – 21.50)		
Time to hospital (hr)			
Early	Ref	Ref	Ref
Late	0.80 (0.45 – 1.43)	0.93 (0.52 – 1.66)	1.05 (0.59 – 1.89)
Glasgow Coma Scale			
High	Ref	Ref	Ref
Low	2.79 (1.14 – 6.84)	2.59 (1.10 – 6.15)	2.00 (1.06 – 4.92)
NIHSS			
Low	Ref	Ref	Ref
High	2.71 (1.43 – 5.14)	2.73 (1.43 – 5.21)	2.24 (1.21 – 4.16)
Receiving rt-PA			
Yes		Ref	
No		17.22 (2.75 – 343.21)	
Hemoglobin (mg/dL)			
> 12	Ref	Ref	Ref
≤ 12	0.72 (0.37 – 1.36)	0.77 (0.39 – 1.48)	0.69 (0.35 – 1.32)
Albumin (mg/dL)			
Normal	Ref	Ref	Ref
Low	1.48 (0.74 – 2.90)	1.52 (0.76 – 2.96)	2.04 (0.86 – 3.93)
Hypertension			
No	Ref	Ref	Ref
Yes	1.31 (0.70 – 2.44)	1.36 (0.72 – 2.54)	1.30 (0.68 – 2.47)
Dyslipidemia			
No	Ref	Ref	Ref
Yes	0.89 (0.45 – 1.77)	0.86 (0.43 – 1.72)	0.86 (0.44 – 1.70)
Diabetes mellitus			
No	Ref	Ref	Ref
Yes	0.52 (0.28 – 0.97)	0.46 (0.25 – 0.86)	0.74 (0.41 – 1.36)

Model 1; All prognostic factors but excluding rt-PA
Model 2; All prognostic factors but excluding caregiver
Model 3; All prognostic factors but excluding rt-PA and/or caregiver OR, odds ratio; CI, confidence interval

associated with worsened or unchanged ADL. In contrast, the association between absence of diabetes mellitus and functional outcome was no longer statistically significant in Model 3 (aOR = 0.74; 95% CI: 0.41–1.36) (Table 3).

DISCUSSION

Main findings

This study identified high NIHSS score, impaired level of consciousness (GCS), absence of thrombolytic therapy (rt-PA), and absence of a caregiver as significant predictive factors of unfavorable functional trajectory (worsened or unchanged ADL) at three months following first-ever acute ischemic stroke. Patients presenting with these characteristics at admission had significantly higher odds of functional deterioration or lack of improvement compared with those who demonstrated functional recovery. Sensitivity analyses confirmed the robustness of NIHSS and GCS as prognostic indicators, even after exclusion of small subgroups.

Interpretation and clinical relevance

The findings of this study highlight the central role of neurological severity and metabolic status in determining functional outcomes after ischemic stroke. Both NIHSS and GCS reflect the extent of neurological impairment at presentation. Patients presenting with high NIHSS and low GCS scores likely have larger infarcted brain volumes, resulting in extensive areas of neuronal death and irreversible damage to the ischemic penumbra.[15-17] Such profound damage significantly hinders neuronal recovery, making functional deterioration or stagnation more likely. Clinically, these factors can serve as early warning signs for healthcare providers to identify patients at higher risk who may require more intensive monitoring and rehabilitation.

In addition to acute neurologic disturbances, the metabolic status of the patients was a significant factor in functional changes. Although absence of diabetes mellitus was related to lower odds of functional deterioration, this finding should be interpreted cautiously. In contrast to the consistent predictive value of NIHSS and GCS, the association between diabetes status and functional outcomes demonstrated less stability and appeared less robust than the primary neurological predictors (NIHSS and GCS). Specifically, this association did not persist in the sensitivity analysis (Model 3: aOR 0.74, 95% CI 0.41–1.36). The 95% confidence interval of the association approached the null value (0.99), and the lack of detailed information regarding glycemic control or disease duration does not allow us to make a definitive physiological inference. The observed association may reflect the broader concept that a lower comorbidity burden is associated with better recovery.[18] For instance, common post-stroke complications in the Thai population, such as dysphagia, have been identified as critical factors requiring standardized management to prevent further functional decline.[13] However, further investigation incorporating more granular metabolic data is warranted.

Regarding therapeutic intervention, the role of rt-PA is critical in reducing thrombus burden and restoring blood flow to salvageable brain tissue. Consistent with established evidence[19], patients who did not receive rt-PA in this study demonstrated a higher likelihood of worsened ADL compared to those who did. However, it should be noted that the number of patients receiving rt-PA was relatively small (n=15), resulting in wide confidence intervals. While this factor is statistically significant, the precision of the estimated effect size is limited by this small subgroup size.

The social environment, particularly caregiver support, emerged as another critical factor in stroke recovery. Caregivers contribute substantially to rehabilitation adherence, complication prevention, mobility assistance, and nutrition support during post-discharge recovery.[14,20] This is consistent with an integrative review of Thai stroke patients, which emphasizes that structured support and interventions to enhance medication adherence are vital for long-term clinical outcomes.[23] Nevertheless, the interpretation of caregiver-related findings requires caution. The limited number of patients without a caregiver (n=8) led to wide confidence intervals, indicating that although the absence of a caregiver is a significant predictor, the precision of the effect size remains limited. Additionally, patients may be more likely to require caregiver involvement, potentially introducing reverse causality.

Comparison with previous studies

The prognostic significance of NIHSS identified in this study is consistent with prior investigations demonstrating that stroke severity is a primary determinant of functional recovery.[5,6,9,12] NIHSS serves as a reliable proxy for stroke severity and infarct volume, which are known predictors of neuronal damage.[16] Recent data from another Thai university hospital further confirm that initial NIHSS and age are robust predictors of functional outcomes in acute ischemic stroke patients.[12] Although direct infarct volume measurement was unavailable in the present study, the use of NIHSS provided a clinically practical and validated severity indicator.

The influence of impaired consciousness on functional transitions was also demonstrated in our cohort. The direction and strength of the association between a low

GCS and poor ADL outcomes is consistent with previous studies that utilized the Modified Rankin Scale (MRS) as the primary endpoint.[5,8] This indicates that a diminished level of consciousness at admission is a key predictor of functional status at discharge, regardless of whether outcomes are quantified using the Barthel Index or the mRS.

Regarding thrombolytic therapy, there is strong evidence supporting the beneficial effects of rt-PA on post-stroke recovery. Our results remain consistent with previously reported randomized trials. Despite a longer follow-up duration in our study and the fact that the majority of our subjects were not given thrombolysis, we found that the absence of rt-PA treatment conferred significantly greater odds of unfavorable functional outcomes.[12,13] The low rate of thrombolytic therapy observed in our study might reflect systemic challenges in prehospital management and transport efficiency, which remain significant barriers to timely stroke care in Thailand.[24] Furthermore, our results concerning the role of caregivers align with systematic reviews identifying social support as a crucial factor in predicting changes in ADL.[9,14] While previous literature has explored several prognostic factors, discrepancies between our findings and other studies[5-7] may be due to differences in study design and variations in healthcare systems, rehabilitation access, and sociocultural context within Thailand.

Strengths and limitations

A major strength of this study is its prospective design and the utilization of a two-point ADL assessment to evaluate functional trajectory rather than a single static outcome measure. This approach allows for more nuanced evaluation of recovery patterns over time.

However, several limitations warrant consideration. First, the small number of patients who received rt-PA and the high prevalence of caregiver support within the cohort resulted in wide confidence intervals, potentially affecting the precision of their estimated effects. Second, the lack of quantitative neuroimaging data, particularly infarct volumes, and the use of restricted categorizations for comorbidities may have limited our ability to identify more granular prognostic relationships. Finally, as a single-center study conducted at a tertiary hospital in Thailand, the generalizability of our findings to other healthcare settings should be approached with caution.

Future research should prioritize multi-center studies to augment the sample size of specific clinical subgroups. Integrating direct neuroimaging biomarkers, such as infarct volume, and a more detailed assessment of comorbidity management would improve the understanding of prognostic relationships. Additionally, characterizing ADL trajectories using more sensitive functional scales or percentile-based analyses may provide a more comprehensive overview of the recovery course following an ischemic stroke.

CONCLUSION

Higher NIHSS scores and impaired level of consciousness at admission are the most important predictors of functional dependence in patients following their first episode of acute ischemic stroke. Furthermore, the absence of thrombolytic therapy and lack of caregiver support serve as imprecisely estimated associations for unfavorable ADL outcomes at three months. These results underscore the critical necessity of early risk stratification and the implementation of social support systems to optimize long-term functional recovery and clinical outcomes for stroke survivors.

Data Availability Statement

The datasets (including primary and secondary data) generated and analyzed during the current study are not publicly available due to patient privacy concerns and ethical restrictions. However, de-identified data can be provided upon reasonable request to the corresponding author. Acknowledgement

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DECLARATIONS

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Conflict of Interest

All authors declare no conflict of interest.

Registration Number of Clinical Trial

This article is not a clinical trial.

Author Contributions

Conceptualization and methodology, W.P, T.C., and N.S. ; Investigation, W.P., T.C. ; Formal analysis, W.P., T.C; Visualization and writing – original draft, W.P., N.S. ; Writing – review and editing W.P., N.S. ; Supervision, N.S. All authors have read and agreed to the final version of the manuscript.

Use of Artificial Intelligence

During the preparation of this work, the author(s)

used Gemini Pro and Chat GPT 5 to improve the linguistic clarity, grammatical accuracy, and structural organization of the manuscript. After using this service, the author(s) thoroughly reviewed, verified, and edited the content as needed to ensure scientific accuracy and take full responsibility for the content of the publication.

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