https://doi.org/10.59459/1859-1655/JMM.1107

ASSESSMENT OF THE QUALITY OF CARE AND TREATMENT FOR ACUTE STROKE PATIENTS IN THE FIRST QUARTER OF 2026 AT THANH HOA GENERAL HOSPITAL

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ABSTRACT

Objective: *To evaluate the quality indicators of acute stroke care and treatment during the first quarter of 2026 at Thanh Hoa General Hospital.*

Methods: *A retrospective cross-sectional study was conducted to evaluate the quality management of acute stroke care and treatment at the Department of Neurology and Stroke, Thanh Hoa General Hospital, from January 1 to March 31, 2026. Secondary data obtained from the RES-Q stroke quality registry were used to describe quality indicators and compare them with national RES-Q Vietnam data.*

Results: *A total of 413 patients with acute stroke were admitted during the study period. Male patients accounted for 58.1%, with a median age of 69 years. Hypertension was the most prevalent vascular risk factor (79.2%). Most patients arrived at the hospital by private transportation (94.3%), whereas only 0.3% were transported by emergency medical services from the scene. Among patients with acute ischemic stroke, 17.2% received intravenous thrombolysis and 18.3% underwent mechanical thrombectomy. Median workflow metrics were as follows: door-to-imaging time, 15 minutes (interquartile range [IQR], 10-19); door-to-needle time, 36 minutes; door-to-groin puncture time, 42 minutes for direct admissions and 49 minutes for transferred patients; and door-to-reperfusion time, 93 minutes. These workflow metrics compared favorably with the corresponding benchmark data from the RES-Q Vietnam registry. The primary reason for not receiving intravenous thrombolysis was delayed hospital arrival (61.2%). Functional independence at discharge, defined as a modified Rankin Scale (mRS) score ≤2, was achieved in 59.2% of patients. The in-hospital mortality rate was 5.2%, and post-discharge follow-up appointments were scheduled for 98.5% of patients.*

Conclusion: *Quality indicators of acute stroke care and management at Thanh Hoa General Hospital showed favorable overall performance, particularly in diagnostic workflow and reperfusion therapy metrics. The major limitations were observed in the prehospital phase, including a high rate of delayed hospital presentation and low utilization of emergency medical services from the scene.*

Keywords: acute stroke, RES-Q, intravenous thrombolysis, mechanical thrombectomy, quality of stroke care.

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Received: 12/5/2026; scientific review: 5/2026; accepted: 28/5/2026

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1. INTRODUCTION

Stroke is the second leading cause of mortality and the leading cause of long-term disability worldwide. The burden of stroke has continued to increase substantially over recent decades. According to estimates from the Global Burden of Disease 2019 study, approximately 12.2 million new stroke cases occur annually, with more than 101 million individuals living with stroke-related disability. Moreover, stroke remains a leading cause of disability-adjusted life years (DALYs) globally [3]. Accumulating evidence has demonstrated that stroke outcomes are closely associated with both time to treatment and the quality of initial management. Reperfusion therapies achieve optimal effectiveness only when administered within an appropriate therapeutic time window. Therefore, the evaluation and improvement of quality indicators in acute stroke care represent a critical priority [5].

The Registry of Stroke Care Quality (RES-Q) is an international standardized stroke registry implemented across multiple countries to collect, monitor, and benchmark quality indicators of stroke care and treatment. In Vietnam, the number of healthcare institutions participating in the RES-Q registry has progressively increased.

The nationwide implementation of this registry has facilitated the collection and standardization of stroke care quality indicators and supported quality assessment and interhospital benchmarking across healthcare facilities [5]. Thanh Hoa General Hospital is among the participating centers in the RES-Q Vietnam registry, with a large volume of stroke patients. Comprehensive analysis of stroke care quality indicators at each healthcare institution is of substantial practical importance, as it reflects the current status of local clinical practice while also providing a scientific foundation for future large-scale quality improvement interventions in acute stroke care.

Accordingly, this study was conducted to evaluate the quality indicators of acute stroke care and management at Thanh Hoa General Hospital based on RES-Q registry data from the first quarter of 2026.

2. SUBJECTS AND METHODS

2.1. Subjects

All patients with acute stroke admitted to the Department of Neurology and Stroke, Thanh Hoa General Hospital, who were recorded in the hospital's RES-Q registry during the first quarter of 2026 were included in the study.

- Eligibility criteria: Patients diagnosed with acute stroke or stroke-related conditions according to the RES-Q registry definitions were eligible for inclusion, including acute ischemic stroke (AIS), intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), transient ischemic attack (TIA), cerebral venous thrombosis (CVT), and stroke mimics.

- Exclusion criteria: Patients with incomplete data for key study variables, duplicate records, or missing essential information in the RES-Q registry were excluded from the analysis.

2.2. Methods

- Study design: A retrospective cross-sectional study using secondary data obtained from the RES-Q registry at Thanh Hoa General Hospital and benchmark data from the RES-Q Vietnam registry.

- Study population and sampling method: All eligible patients recorded in the RES-Q registry at Thanh Hoa General Hospital during the first quarter of 2026 were consecutively included, comprising 413 patients collected between 00:00 on January 1, 2026 and 24:00 on March 31, 2026. Benchmark data were extracted from the RES-Q Vietnam registry during the same study period.

- Study variables and outcome measures:

+ Patient characteristics: age, sex, and stroke onset circumstances (in-hospital stroke or wake-up stroke).

+ Cardiovascular and stroke risk factors: hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, heart failure, smoking, prior stroke, and coronary artery disease/myocardial infarction (CAD/MI).

+ Prehospital treatment: antihypertensive agents, antidiabetic medications, anticoagulants, and statins.

+ Emergency department evaluation: transport to hospital by emergency medical services (EMS), private transportation, or interhospital transfer; prenotification by referring hospitals; and symptom onset-to-door time.

+ Initial assessment and acute treatment: initial receiving department and first-day admission ward/unit.

+ Clinical and paraclinical characteristics: neurological deficit severity assessed using the National Institutes of Health Stroke Scale (NIHSS); coagulation testing including the international normalized ratio (INR); neuroimaging modalities including CT, CT/CTA, CT/CTA/CTP, MRI, and MRI/MRA; and door-to-imaging (DTI) time, defined as the interval from hospital arrival to completion of diagnostic imaging.

+ Reperfusion therapy characteristics in patients with Acute ischemic stroke (AIS): rate of vessel occlusion identified on CTA/MRA and rates of intravenous thrombolysis and mechanical thrombectomy; door-to-needle time (DTN), defined as the interval from hospital arrival to initiation of intravenous thrombolysis; door-to-groin puncture time in directly admitted patients (DTGpa) and transferred patients (DTGsa); door-to-reperfusion time (DTR); and door-in-door-out time (DIDO), defined as the interval from arrival at the primary hospital to transfer for reperfusion therapy.

+ Post-discharge follow-up: rates of patients with and without scheduled follow-up appointments after discharge.

+ Clinical outcomes: assessed using the modified Rankin Scale (mRS), ranging from 0 to 6 points.

- Statistical analysis: Statistical analyses were performed using descriptive statistical methods. Continuous variables are presented as median and interquartile range (IQR), whereas categorical variables are presented as percentages.

- Ethical considerations: This study used anonymized secondary data obtained from the RES-Q registry, involved no intervention in the

treatment process, and was conducted in accordance with ethical principles for biomedical research.

3. RESULTS

Among the 413 cases recorded in the RES-Q registry, acute ischemic stroke was the most common subtype, accounting for 344 cases (83.3%), followed by intracerebral hemorrhage with 41 cases (9.9%), subarachnoid hemorrhage with 16 cases (3.9%), transient ischemic attack with 8 cases (1.9%), and other neurological conditions with 4 cases (1.0%).

- Baseline characteristics, vascular risk factors, and prehospital presentation of patients with acute stroke at Thanh Hoa General Hospital (study cohort, n = 413) compared with the RES-Q Vietnam registry cohort (n = 8,846) during the first quarter of 2026:

Table 1. Baseline characteristics, vascular risk factors, and prehospital presentation of patients with acute stroke.

Indicator Category	Indicator	Study Cohort (n = 413)	RES-Q Vietnam (n = 8,846)
Baseline characteristics	Median age	69 years	66 years
	Male sex	58.1	58.3
	Female sex	41.9	41.7
	In-hospital stroke	1.5	1.2
	Wake-up stroke	5.3	5.3
Cardiovascular and stroke risk factors	Hypertension	79.2	52.8
	Diabetes mellitus	19.3	23.6
	Dyslipidemia	10.4	12.9
	Atrial fibrillation	3.8	5.7
	Heart failure	2.9	4.1
	Smoking	7.6	9.8
	Prior stroke	6.7	10.8
	Coronary artery disease/myocardial infarction	5.2	6.9
Prehospital treatment	Antihypertensive agents	91.8	66.7
	Antidiabetic medications	18.0	21.5
	Antiplatelet therapy	1.2	9.3
	Anticoagulant therapy	3.9	3.2
	Statins	14.8	14.8
Prehospital presentation	Arrival via EMS from the scene	0.3	10.5
	Arrival by private transportation	94.3	79.2
	Interhospital transfer	3.9	6.0
	EMS prenotification	11.0	11.0
	Median onset-to-door time	111 minutes	319 minutes

Patients with acute stroke at Thanh Hoa General Hospital had a median age of 69 years, and 58.1% were male. Hypertension was the most prevalent vascular risk factor (79.2%). Most patients arrived at the hospital by private transportation (94.3%), whereas utilization of emergency medical services (EMS) was extremely low (0.3%). The median symptom onset-to-door time was 111 minutes, which was shorter than that reported in the RES-Q Vietnam registry data (319 minutes).

- Initial assessment, neuroimaging evaluation, and reperfusion therapy in patients with acute stroke at Thanh Hoa General Hospital (study cohort: n = 413) compared with RES-Q Vietnam registry data (n = 8,846) during the first quarter of 2026. Reperfusion therapy metrics, including intravenous thrombolysis and mechanical thrombectomy, were analyzed separately in patients with acute ischemic stroke eligible for reperfusion treatment to ensure comparability of denominators between the study cohort (n = 344), the RES-Q Vietnam registry cohort (n = 6,282), and previous studies.

Table 2. Initial assessment, neuroimaging evaluation, and reperfusion therapy in patients with acute stroke.

Indicator Group	Indicator	Study Cohort	RES-Q Vietnam
Initial admission and early management*	First admission department: Emergency Department	94.6	94.6
	First admission department: Imaging Department	0	1.3
	Admitting department: Neurology	68.8	68.8
	First-day stay in ICU/Stroke Unit	100	80.4
	First-day stay in regular ward	0	19.6
Clinical assessment*	NIHSS assessment performed	100%	100%
	Median NIHSS score	8	5
	Pre-stroke mRS 0	80.7	75.8
	Pre-stroke mRS 1	7.4	10.1
Laboratory testing*	Laboratory-based INR testing performed	95.5	68.0
	INR testing not performed	2.3	28.7
Neuroimaging*	Brain imaging performed	100	98.6
	No imaging performed	0	0.27
	Non-contrast CT	36.3	29.2
	CT/CTA	28.2	53.4
	CT/CTA/CTP	1.2	1.2
	MRI	17.3	17.3
	MRI/MRA	0	17.3
	Median door-to-imaging time	15 minutes (IQR, 10-19 minutes)	19 minutes
Reperfusion therapy**	Proportion of AIS patients receiving IV thrombolysis	17.15	16.33
	Median door-to-needle time	36 minutes	35 minutes
	No thrombolysis due to arrival outside therapeutic window	61.2%	65.3%
	Proportion of AIS patients with vessel occlusion on CTA/MRA	34.8	34.8
	Proportion of AIS patients undergoing mechanical thrombectomy	18.31	11.37
	Door-to-groin puncture time (primary admission)	42 minutes	69 minutes
	Door-to-groin puncture time (secondary admission)	49 minutes	78 minutes
	Door-to-reperfusion time	93 minutes	120 minutes
	Door-in-door-out time for transfer for reperfusion therapy	Not recorded	92 minutes
Post-discharge follow-up*	Scheduled outpatient follow-up after discharge	98.5	Not available
	No scheduled follow-up after discharge	1.5	Not available
* n (study cohort) = 413; n (RES-Q Vietnam registry) = 8,846 ** n (study cohort AIS population) = 344; n (RES-Q Vietnam data) = 6,282			

The majority of patients were initially admitted through the Emergency Department (94.6%), and all patients received care in the Stroke Unit/Intensive Care Unit during the first day of hospitalization. NIHSS assessment and brain imaging were performed in 100% of cases. Stroke subtypes and related conditions recorded in the RES-Q system included acute ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, transient ischemic attack, and other related conditions according to the registry classification. The median door-to-imaging time was 15 minutes (IQR: 10-19 minutes).

Among the 413 patients enrolled in the study, quality-of-care and reperfusion therapy metrics were evaluated in the subgroup of 344 patients with acute ischemic stroke. Overall, these indicators were consistent with the quality benchmarks of the RES-Q registry. The intravenous thrombolysis rate at Thanh Hoa General Hospital was 17.2%, with a median door-to-needle time of 36 minutes. Mechanical thrombectomy was performed in 18.3% of patients, with median door-to-groin puncture times of 42 minutes among directly admitted patients and 49 minutes among transferred patients. The median door-to-reperfusion time was 93 minutes, which was shorter than that reported in the RES-Q Vietnam dataset. Delayed hospital arrival was the primary reason for exclusion from intravenous thrombolysis (61.2%). The proportion of patients scheduled for outpatient follow-up after discharge was 98.5%, suggesting the hospital's emphasis on continuity of care and post-stroke management.

Table 3. Clinical outcomes at discharge according to the modified rankin scale (mRS)

Indicator Group	Indicator	Study Cohort (n = 413)	RES-Q Vietnam (n = 8,846)
Functional outcome at discharge	mRS 0-2	59.2	51.0
	mRS >2	35.6	42.8
In-hospital mortality	mRS = 6	5.2	6.2

Evaluation of clinical outcomes at discharge showed that the proportion of patients achieving functional independence (mRS 0-2) was 59.2%, compared with the RES-Q Vietnam dataset (51.0%). In contrast, the proportions of patients with functional dependence (mRS >2) and in-hospital mortality were 35.6% and 5.2%, respectively, both lower than those reported in the RES-Q Vietnam dataset (42.8% and 6.2%, respectively).

4. DISCUSSION

This study included 413 patients with acute stroke in the RES-Q registry at Thanh Hoa General Hospital during the first three months of 2026, including all stroke subtypes and related conditions classified within the registry system. Of these, 344 patients with acute ischemic stroke were included in the analysis of quality-of-care and reperfusion therapy metrics. The age and sex distribution of the study population was comparable to that of the RES-Q Vietnam dataset, with similar proportions of male patients (58.1% vs. 58.3%) and female patients (41.9% vs. 41.7%), suggesting good representativeness of the study cohort. The median age of 69 years was consistent with the epidemiological characteristics of stroke reported in Vietnam and other Asian countries [8]. Compared with the study conducted at Soc Trang General Hospital involving 318 patients, the number of stroke patients recorded at Thanh Hoa General Hospital was higher despite a shorter study period, reflecting the large patient volume and the hospital's central role in the provincial stroke care system [2]. Furthermore, the Thanh Hoa dataset encompassed the full spectrum of stroke subtypes, whereas the Soc Trang study primarily focused on ischemic stroke, providing a broader representation of real-world stroke care practice.

Regarding vascular risk factors, hypertension was the most prevalent comorbidity (79.2% vs. 52.8%), consistent with its well-established central role in stroke pathogenesis as demonstrated in the INTERSTROKE study [9]. Other risk factors were observed at lower rates compared with the RES-Q Vietnam dataset, including diabetes mellitus (19.3% vs. 23.6%), prior stroke (6.7% vs. 10.8%), and dyslipidemia (10.4% vs. 12.9%). Lower proportions were also noted for atrial fibrillation (3.8% vs. 5.7%), heart failure (2.9% vs. 4.1%), smoking (7.6% vs. 9.8%), and coronary artery disease (5.2% vs. 6.9%). The rate of preventive medication use prior to hospital admission remained low, reflecting suboptimal community-based risk factor management, consistent with findings from the PURE study [10]. These findings indicate that prehospital risk factor control remains a critical component in reducing the burden of stroke, even as the quality of in-hospital stroke care continues to improve.

In-hospital workflow metrics demonstrated favorable performance, with a 100% rate of NIHSS assessment, near-universal brain imaging, and a short door-to-imaging time (IQR, 10-19 minutes), indicating that the processes for acute stroke triage and diagnostic evaluation were well standardized. These findings are comparable to those reported by other high-performing stroke centers in Vietnam [1]. However, the major limitation remained at the prehospital stage, where utilization of emergency medical services (EMS) was extremely low (0.3%), while the vast majority of patients arrived at the hospital by private transport (94.3%). This reduced the likelihood of receiving treatment within the therapeutic time window [1], [11]. In addition, the absence of EMS prenotification limited early activation of the stroke team. Therefore, despite

favorable in-hospital performance metrics, prehospital system delays continued to significantly affect the overall effectiveness of acute stroke care.

In this study, reperfusion therapy metrics were analyzed in the subgroup of 344 patients with acute ischemic stroke who met treatment eligibility criteria according to the RES-Q registry standards. The intravenous thrombolysis rate reached 17.2%, comparable to the RES-Q Vietnam dataset (16.33%) and higher than that reported at Soc Trang General Hospital (14.8-15.0%) [2], indicating improved access to reperfusion therapy at our institution. The median door-to-needle time was 36 minutes, comparable to the 35 minutes reported in the RES-Q Vietnam dataset and within recommended guideline targets [12], reflecting the efficiency of in-hospital stroke workflows. The rate of mechanical thrombectomy was 18.3%, exceeding both the RES-Q Vietnam data (11.37%) and the rate reported at Soc Trang General Hospital (1.3%) [2]. Median door-to-groin puncture times were 42 minutes for directly admitted patients and 49 minutes for transferred patients, both shorter than the corresponding times in the RES-Q Vietnam dataset (69 and 78 minutes, respectively). Similarly, the median door-to-reperfusion time was 93 minutes, compared with 120 minutes in the RES-Q Vietnam dataset, reflecting efficient endovascular treatment workflows and more rapid achievement of reperfusion. Discharge outcomes were also favorable, with a functional independence rate (mRS 0-2) of 59.2%, compared with 51.0% in the RES-Q Vietnam dataset, while the in-hospital mortality rate was lower (5.2% vs. 6.2%). These findings suggest that optimization of in-hospital stroke care processes may substantially improve treatment outcomes, particularly in the context of low EMS utilization. Nevertheless, the proportion of patients with functional dependence (mRS >2) remained relatively high at 35.6%, reflecting a persistent burden of post-stroke disability. This suggests that improvements in in-hospital care alone may not fully compensate for prehospital limitations, particularly delayed hospital arrival and low EMS utilization. Therefore, in addition to maintaining efficient in-hospital workflows, strategies aimed at improving public awareness of stroke symptoms and strengthening prehospital emergency systems remain essential for further improving stroke outcomes.

Although in-hospital treatment metrics were favorable, the majority of patients remained ineligible for intravenous thrombolysis because of delayed hospital arrival, primarily due to presentation outside the therapeutic time window (61.2% at Thanh Hoa General Hospital vs. 65.3% in the RES-Q Vietnam dataset). These findings are consistent with data reported from Soc Trang General Hospital, where the onset-to-admission time was markedly prolonged (1,488.56 ± 1,666.37 minutes), limiting access to reperfusion therapy [2]. This suggests that the major barrier remains at the prehospital stage, where improvements in in-hospital stroke care have not yet been accompanied by corresponding changes in community health-seeking behavior and prehospital emergency system performance. Experience from Thong Nhat Hospital has demonstrated that strengthening EMS coordination, developing regional referral networks, and enhancing public stroke awareness campaigns may improve reperfusion therapy rates [1]. In Thanh Hoa, strategies aimed at improving public awareness of stroke symptoms, increasing EMS utilization, and implementing prenotification and rapid transfer protocols-particularly for patients with suspected large vessel occlusion-should be prioritized. The near-universal rate of scheduled outpatient follow-up after discharge represents a notable strength of the current stroke care system. However, additional post-discharge indicators, including actual outpatient follow-up attendance, control of vascular risk factors (blood pressure, LDL-C, and HbA1c), adherence to secondary preventive medications, rehabilitation participation, and hospital readmission rates, should be incorporated to enable a more comprehensive evaluation of the stroke care continuum.

This study has several limitations. First, because aggregated data from the RES-Q registry were used, patient-level analyses could not be performed, limiting the ability to identify factors associated with clinical outcomes. Second, the RES-Q Vietnam dataset may not fully represent the entire stroke care system in Vietnam; therefore, comparisons in this study should be interpreted descriptively. In addition, because the study relied on aggregated data from the RES-Q Vietnam registry, detailed information regarding the number of participating centers, hospital types, and geographic distribution of institutions within the registry system was not available. This limitation should be considered when interpreting and comparing the reference data. Furthermore, the study period was limited to the first three months of 2026 and may not fully reflect longer-term trends in stroke care performance. Although discharge outcomes, including modified Rankin Scale (mRS) scores and in-hospital mortality, were recorded, post-discharge follow-up data were unavailable. Consequently, long-term functional outcomes-particularly at standard follow-up time points such as 90 days after stroke-as well as the risk of stroke recurrence could not be evaluated. In addition, the study did not provide

a detailed distribution of stroke subtypes within the overall study population, while reperfusion therapy metrics were analyzed specifically in the subgroup of 344 patients with acute ischemic stroke who met treatment eligibility criteria according to RES-Q standards. Finally, this was a single-center study, and multivariable analyses were not performed to identify independent factors associated with clinical outcomes. Therefore, the observed associations should be interpreted as descriptive rather than causal. Nevertheless, given the large sample size and the use of standardized data from the RES-Q registry, this study still provides valuable real-world evidence regarding the effectiveness of stroke care organization at the provincial hospital level. Furthermore, the findings may serve as a foundation for future in-depth analytical studies and quality improvement interventions.

These findings suggest that although in-hospital treatment capacity has improved substantially, optimization of the entire stroke care continuum-particularly reducing the time from symptom onset to hospital arrival and strengthening prehospital emergency systems-remains a key determinant of treatment effectiveness and clinical outcomes. In this context, improving prehospital factors should not merely be regarded as a supportive strategy, but rather as a potentially decisive component in enhancing the overall quality of stroke care at the health system level.

5. CONCLUSION

Acute stroke care at Thanh Hoa General Hospital demonstrated favorable performance across several key quality indicators, particularly in patient triage, diagnostic workflow, reperfusion therapy, and in-hospital management. Door-to-imaging and door-to-needle times were short, while the rates of intravenous thrombolysis and mechanical thrombectomy compared favorably with the RES-Q Vietnam reference data. Functional outcomes at discharge were also favorable, with a relatively high proportion of patients achieving functional independence. However, major limitations remained in the prehospital phase, where utilization of emergency medical services was extremely low and most patients arrived at the hospital beyond the therapeutic time window, resulting in a high proportion of patients who did not receive reperfusion therapy.

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