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Original article

IMPLEMENTATION AND TEMPORAL VARIABILITY OF GUIDELINE-RECOMMENDED ACUTE STROKE CARE AT A TERTIARY UNIVERSITY CENTER: A RES-Q REGISTRY ANALYSIS

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Abstract

Introduction: Although guideline-recommended performance indicators for acute stroke care are well established, their consistent implementation in routine clinical practice over time remains challenging. Registry-based analyses allow evaluation not only of performance levels, but also of temporal variability and system-level performance.

Aim: To evaluate the implementation and temporal variability of guideline-recommended acute stroke care indicators and early discharge outcomes over one year using RES-Q registry data from a tertiary university hospital.

Material and methods: A retrospective analysis of prospectively collected RES-Q registry data was performed for all consecutive stroke patients admitted at the Department for Urgent Neurology at the University Clinic for Neurology between 1 January and 31 December 2025. Demographic characteristics, admission severity, imaging performance, acute treatment metrics, in-hospital care indicators, and discharge management were analyzed descriptively using quarterly aggregated data.

Results: A total of 179 stroke patients were included. Neuroimaging was performed in 100% of cases throughout the study period. Intravenous thrombolysis rates varied between 7% and 43%, while endovascular treatment was performed in up to 20% of patients in selected quarters. Median door-to-needle times ranged from 48 to 180 minutes, demonstrating marked temporal variability. Adherence to discharge care indicators was high, including swallowing screening (90–100%), anticoagulation in patients with atrial fibrillation (92–100%), and antithrombotic therapy in non-AF patients (82–100%). Median discharge modified Rankin Scale scores ranged from 4.0 to 5.0.

Conclusion: Continuous registry-based monitoring is essential to identify system-level fluctuations and to support sustainable improvements in stroke care delivery.

Keywords: stroke, RES-Q registry, performance indicators, thrombolysis, stroke systems of care

Introduction

Timely and evidence-based management of acute stroke is essential for improving patient outcomes. International guidelines define key performance indicators across the entire stroke care pathway, including rapid neuroimaging, timely reperfusion therapies, organized in-hospital care, and appropriate secondary prevention at discharge[1,2]. Achieving consistent implementation of these indicators in routine clinical practice, however, remains challenging even in specialized stroke centers[3].

Stroke quality registries provide an opportunity to move beyond static assessments of care quality and to explore longitudinal patterns, temporal variability, and system-level performance in real-world settings[4]. The Registry of Stroke Care Quality (RES-Q) is an international quality improvement initiative designed to monitor adherence to evidence-based stroke care indicators across diverse healthcare systems[5]. Registry-based analyses from tertiary university hospitals are particularly valuable for identifying organizational strengths, temporal fluctuations, and areas requiring targeted improvement[6].

The present study aimed to evaluate the implementation and temporal variability of guideline-recommended acute stroke care indicators over one year using RES-Q registry data from a tertiary university hospital, with additional assessment of early discharge outcomes.

Material and methods

Study design and setting

This was a retrospective observational study based on prospectively collected data from the RES-Q registry. All consecutive patients admitted with acute stroke to the University Clinic for Neurology, Department for Urgent Neurology, a tertiary referral and comprehensive stroke center, between 1 January and 31 December 2025 were included.

Data source

Data were extracted from the RES-Q hospital dashboard and summarized quarterly. The registry captures standardized information on demographics, stroke severity, imaging, acute treatment, in-hospital care, and discharge management.

Study population

Adult patients admitted with ischemic stroke, intracerebral hemorrhage, or subarachnoid hemorrhage during the study period were included. Analyses were conducted using aggregated quarterly data.

Quality indicators and outcomes

The following domains were evaluated:

- Admission characteristics: admission NIHSS, pre-stroke modified Rankin Scale (mRS), onset-to-door time
- Imaging and diagnosis: performance of neuroimaging, door-to-imaging time, detection of vascular occlusion
- Acute treatment: rates of intravenous thrombolysis, endovascular treatment, combined therapy, door-to-needle and door-to-groin times
- In-hospital care: swallowing screening, temperature and glucose management
- Discharge care: antithrombotic therapy, anticoagulation in atrial fibrillation, carotid artery imaging
- Early outcomes: discharge NIHSS, discharge mRS, length of hospital stay

Statistical analysis

Data are presented descriptively as medians and percentages. Quarterly trends were examined to explore temporal variability in performance indicators. No inferential statistical testing was performed, in line with the registry-based quality assessment design.

Ethical considerations

The RES-Q registry operates in accordance with applicable data protection regulations. The study was conducted as a quality improvement analysis using anonymized registry data.

Results

Patient characteristics

A total of 179 stroke patients were included (Table 1). Quarterly patient numbers ranged from 28 to 79. Median admission NIHSS decreased from 14 in the first quarter to 10 in the fourth quarter. Pre-stroke functional impairment (mRS ≥3) was present in up to 16% of patients in selected quarters.

Table 1. Baseline characteristics of stroke patients admitted in 2025

Characteristic	Q1 (n=79)	Q2 (n=28)	Q3 (n=35)	Q4 (n=37)
NIHSS on admission, median	14.0	13.0	11.0	10.0
In-hospital stroke, %	3	0	3	3
EMS pre-notification, %	7	0	17	0
Onset-to-door time, min, median	240	153	130	168
Pre-stroke mRS 1–2, %	32	7	9	5
Pre-stroke mRS ≥3, %	14	0	6	16

NIHSS-National Institutes of Health Stroke Scale; mRS – modified Rankin Scale.

Imaging and diagnostic performance

Neuroimaging was performed in 100% of patients throughout the year. Median door-to-imaging time ranged from 20 to 26 minutes. Vascular occlusion was detected in 50–100% of cases across quarters (Table 2).

Table 2. Imaging and diagnostic performance indicators

Indicator	Q1	Q2	Q3	Q4
Neuroimaging performed, %	100	100	100	100
Door-to-imaging time, min, median	26	20	20	22
Vascular occlusion detected, %	100	67	50	100

Acute ischemic stroke treatment

Rates of intravenous thrombolysis showed marked variability, ranging from 7% to 43%. Median door-to-needle times ranged from 48 to 180 minutes. Endovascular treatment was performed in up to 20% of patients in selected quarters (Table 3). These findings indicate substantial temporal variability in reperfusion treatment metrics.

Table 3. Acute ischemic stroke treatment metrics

Indicator	Q1	Q2	Q3	Q4
Intravenous thrombolysis only, %	29	35	43	7
Mechanical thrombectomy only, %	0	15	7	11
IV thrombolysis + thrombectomy, %	1	5	0	4
Any reperfusion therapy, %	30	55	50	21
Door-to-needle time, min, median	53	87	48	180
Door-to-groin time, min, median	194	93	30	235

In-hospital care and discharge management

Swallowing screening was performed in 90-100% of patients. Secondary prevention measures at discharge demonstrated high adherence to guideline recommendations, including anticoagulation in patients with atrial fibrillation (92-100%) and antithrombotic therapy in non-AF patients (82–100%). Carotid artery imaging was performed in 42-83% of cases (Table 4).

Table 4. In-hospital care and discharge quality indicators

Indicator	Q1	Q2	Q3	Q4
Swallowing screening performed, %	100	100	90	100
Anticoagulation at discharge (AF+), %	92	100	100	100
Antithrombotic therapy at discharge (AF−), %	100	82	100	100
Carotid artery imaging performed, %	65	83	77	42

AF – atrial fibrillation

Early outcomes

Median discharge mRS ranged from 4.0 to 5.0, and median discharge NIHSS ranged from 4.0 to 8.0. Median length of hospital stay ranged from 11 to 14 days (Table 5).

Table 5. Early outcomes at hospital discharge

Outcome	Q1	Q2	Q3	Q4
Discharge mRS, median	5.0	4.5	4.0	5.0
Discharge NIHSS, median	6.0	4.0	8.0	4.5
Length of hospital stay, days, median	12	14	12	12

Discharge mRS reflects early functional status

Discussion

In this registry-based analysis, we evaluated the implementation and temporal variability of guideline-recommended acute stroke care indicators over a one-year period at a tertiary university hospital. The findings demonstrate that high adherence to several structural and discharge indicators was achievable; however, meaningful variability in reperfusion treatment rates and treatment times was observed across quarters.

Rapid neuroimaging was consistently achieved in all patients, with median door-to-imaging times within guideline-recommended targets. Early imaging is a cornerstone of modern stroke systems of care and directly influences eligibility for reperfusion therapies[1,2]. Universal imaging performance in our cohort reflects a well-established diagnostic pathway and structured emergency stroke activation protocol.

Intravenous thrombolysis rates varied between 7% and 43% during the study period. Such variability has been described in other real-world registry studies and may reflect seasonal differences in patient presentation, fluctuations in referral patterns, changes in case mix severity, and system-level pressures[7,8]. Similarly, door-to-needle times ranged from 48 to 180 minutes across quarters. While the lower values fall within international recommendations (<60 minutes)[1], the higher values underscore the operational complexity of stroke care delivery and the need for continuous process optimization.

Endovascular treatment rates in selected quarters were consistent with comprehensive stroke center profiles reported in European registries[6,9]. However, procedural timing metrics also demonstrated variability. Door-to-groin times are influenced by multiple factors, including imaging protocols, anesthesiology availability, interventional team activation, and logistical coordination[10]. Registry-driven monitoring of these metrics is essential to identify bottlenecks and implement targeted improvements.

Discharge care indicators demonstrated high adherence, particularly in antithrombotic therapy and anticoagulation for atrial fibrillation.

Secondary prevention measures are strongly associated with reduced recurrent stroke risk and are key performance indicators in international quality frameworks[2,11]. The high rates observed in this cohort suggest robust integration of guideline-recommended discharge pathways into routine clinical practice.

Early functional outcomes at discharge reflected moderate to severe disability, consistent with the relatively high baseline NIHSS scores and the tertiary referral profile of the institution. It is important to emphasize that discharge mRS reflects early in-hospital status and cannot substitute for long-term functional outcome assessment[12]. Nevertheless, discharge status remains a useful indicator of early care trajectory and rehabilitation needs.

An important contribution of this study lies in highlighting temporal variability rather than static performance levels. Variability across quarters likely reflects dynamic system pressures, including workforce availability, referral load, and fluctuating case severity. Similar patterns have been described in studies evaluating the so-called "weekend effect" and off-hour variability in stroke care delivery[13,14]. Continuous registry-based monitoring allows identification of such fluctuations and supports institutional resilience through data-informed quality improvement initiatives.

Taken together, these findings support the value of structured stroke registries as tools not only for benchmarking but also for evaluating implementation consistency over time. In tertiary centers, where patient complexity is high and referral pathways dynamic, sustained registry engagement is essential for maintaining high standards of care[4,5].

Limitations

An earlier institutional analysis addressed selected acute stroke care metrics during the first half of 2025, whereas the present study extended the evaluation to a full-year, registry-based analysis with a specific focus on temporal variability and discharge care indicators.

This study has several limitations. It is a single-center analysis and therefore not intended for national benchmarking. The use of quarterly aggregated dashboard data limits the possibility for detailed patient-level statistical analyses. In addition, long-term outcomes beyond hospital discharge were not available.

Conclusion

This RES-Q registry analysis demonstrates that implementation of guideline-recommended acute stroke care at a tertiary university hospital is achievable but subject to meaningful temporal variability. Continuous registry-driven monitoring is essential for identifying system-level fluctuations and supporting sustainable improvements in stroke care delivery.

Conflict of interest statement. None declared.

References

1. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, *et al*. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/ American Stroke Association. *Stroke* 2019; 50(12): e344-e418. doi: 10.1161/STR. 0000000000000211.
2. Berge E, Whiteley W, Audebert H, De Marchis GM, Fonseca AC, Padiglioni C, *et al*. European Stroke Organisation (ESO) guidelines on intravenous thrombolysis for acute ischaemic stroke. *Eur Stroke J* 2021; 6(1): I-LXII. doi: 10.1177/2396987321989865.

3. Meretoja A, Strbian D, Mustanoja S, Tatlisumak T, Lindsberg PJ, Kaste M. Reducing in-hospital delay to 20 minutes in stroke thrombolysis. *Neurology* 2012; 79(4): 306-313. doi: 10.1212/WNL.0b013e31825d6011.
4. Heuschmann PU, Biegler MK, Busse O, Elsner S, Grau A, Hasenbein U, *et al*. Development and implementation of evidence-based indicators for measuring quality of acute stroke care: the Quality Indicator Board of the German Stroke Registers Study Group (ADSR). Stroke 2006; 37(10): 2573-2578. doi: 10.1161/01.STR.0000241086.92084.c0.
5. Simsic S, Varecha M, Grecu A, Jankujova M, Mikulik R. A new DICOM database implementation for the collection of registry-based stroke care data, as part of the Registry of Stroke Care Quality (RES-Q). InINTERNATIONAL JOURNAL OF STROKE 2020 Nov 1 (Vol. 15, No. 1_ SUPPL, pp. 165-166).
6. Wiedmann S, Norrving B, Nowe T, Abilleira S, Asplund K, Dennis M, *et al*. Variations in quality indicators of acute stroke care in 6 European countries: the European Implementation Score (EIS) Collaboration. *Stroke* 2012; 43(2): 458-463. doi: 10.1161/STROKEAHA.111.628396.
7. Strong B, Lisabeth LD, Reeves M. Sex differences in IV thrombolysis treatment for acute ischemic stroke: a systematic review and meta-analysis. *Neurology* 2020; 95(1): e11-e22. doi: 10.1212/WNL.0000000000009733.
8. Kamal N, Holodinsky JK, Stephenson C, Kashayp D, Demchuk AM, Hill MD, *et al*. Improving door-to-needle times for acute ischemic stroke: effect of rapid patient registration, moving directly to computed tomography, and giving alteplase at the computed tomography scanner. *Circulation Cardiovas Qual Outcomes* 2017; 10(1): e003242. doi: 10.1161/CIRCOUTCOMES.116.003242.
9. Aguiar de Sousa D, von Martial R, Abilleira S, Gattringer T, Kobayashi A, Gallofré M, *et al*. Access to and delivery of acute ischaemic stroke treatments: a survey of national scientific societies and stroke experts in 44 European countries. *Eur Stroke J* 2019; 4(1): 13-28. doi: 10.1177/2396987318786023.
10. Saver JL, Goyal M, Van der Lugt AA, Menon BK, Majoie CB, Dippel DW, *et al*. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: a meta-analysis. *JAMA* 2016; 316(12): 1279-1288. doi: 10.1001/jama.2016.13647.
11. Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, Ezekowitz MD, *et al*. Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2014; 45(7): 2160-2236. doi: 10.1161/STR.0000000000000024.
12. Banks JL, Marotta CA. Outcomes validity and reliability of the modified Rankin scale: implications for stroke clinical trials: a literature review and synthesis. *Stroke* 2007; 38(3): 1091-1096. https://doi.org/10.1161/01.STR.0000258355.23810.c6.
13. Tripathi A, Santos D, Daniel D, Dhamoon MS. Patterns and outcomes of weekend admission for acute ischemic stroke. *J Stroke Cerebrovasc Dis* 2023; 32(9): 107250. doi: 10.1016/j.jstrokecerebrovasdis.2023.107250.
14. Sorita A, Ahmed A, Starr SR, Thompson KM, Reed DA, Dabrh AM, *et al*. Off-hour presentation and outcomes in patients with acute ischemic stroke: a systematic review and meta-analysis. *Eur J Intern Med* 2014; 25(4): 394-400. doi: 10.1016/j.ejim.2014.03.012.