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A comparison of in-hospital stroke and community-onset stroke outcomes after endovascular thrombectomy at a tertiary level hospital in Taiwan

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Abstract

Background: While acute-phase thrombectomy is a recognized treatment for main cerebral artery occlusion, variability exists in outcomes for in-hospital stroke and community-onset stroke patients undergoing endovascular thrombectomy. This study investigates the prognostic differences between in-hospital stroke and community-onset stroke patients in an Asian context, with a focus on the impact of patient transfer processes on treatment outcomes. *Methods:* Data were collected from in-hospital stroke patients who underwent endovascular thrombectomy in a tertiary medical center between January 2017 and December 2020. Propensity score matching with a ratio of 1:4 was performed to compare in-hospital stroke and community-onset stroke patients based on sex, age, NIHSS, and occluded vessel location. *Results:* The study included 20 in-hospital stroke and 80 community-onset stroke patients, with no significant difference in successful recanalization rates, complications, mortality rates, and NIHSS and mRS scores between the groups. The community-onset stroke group had longer times to treatment, particularly among transferred patients. A high proportion of in-hospital stroke patients had undergone surgery before their stroke, and a greater incidence of heart failure was noted in this group. *Conclusion:* Despite pre-stroke surgical treatments and a higher rate of heart failure in in-hospital stroke patients, prompt endovascular thrombectomy resulted in comparable outcomes to community-onset stroke patients. The study underscores the importance of reducing treatment times, especially for transferred patients, to improve stroke care efficacy.

Keywords: Endovascular thrombectomy, ischemic stroke, in-hospital, neurological outcome, time metric

INTRODUCTION

Acute-phase thrombectomy has been established as a safe and effective treatment for main cerebral artery occlusion since 2015, as evidenced by multiple clinical trials.[1-5] However, recent data present variable prognostic outcomes for patients with in-hospital stroke (IHS) and community-onset stroke (COS) undergoing endovascular thrombectomy (EST).[6,7] These discrepancies may stem from differences in patient characteristics, the promptness of stroke identification, and transfer processes. Recognizing the dearth of such studies in Asian populations, this study aims to delineate the prognostic disparities between IHS and COS patients treated with EST, exploring the contributing factors and examining the critical role of patient transfer in treatment efficacy.

METHODS

Data collection

This study involved a retrospective analysis of

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IHS patients treated with EST at a high-capacity tertiary care facility (over 2000 beds) from January 2017 to December 2020. The stroke team collected comprehensive data, including demographics, medical history, initial NIH Stroke Scale scores, temporal metrics, and neurological outcomes post-EST—such as complication rates, mortality, NIHSS scores at 24 hours and at discharge, and 90-day mRS scores. COS cases referred to our center were also incorporated into the study. We conducted a propensity score-matched analysis to equitably compare the two cohorts, focusing on variables like gender, age, use of intravenous tPA, baseline NIHSS, and occlusion site. Our protocol, sanctioned by the institutional review board (IRB No. CMUH112-REC3-062), ensured that patients presenting with stroke symptoms were promptly evaluated and managed in line with established guidelines. The decision to administer thrombolytic therapy was made by the on-duty neurologist, while a skilled neuroradiologist performed thrombectomy following the American Heart Association's protocols. EST eligibility criteria included confirmed large artery occlusion and evidence of substantial ischemic penumbra on CT perfusion imaging for anterior circulation strokes. Importantly, all interventions were contingent upon informed consent, with patients fully briefed on the potential risks and advantages of the procedure.

Outcome Assessment

Reperfusion was assessed using the modified Thrombolysis in Cerebral Infarction (mTICI) scale, with successful reperfusion defined as mTICI 2b or 3. Symptomatic intracerebral hemorrhage (SICH) after EST is defined as any ICH that occurs within 24 hours of EST and an increase in the NIHSS score of 4 or more points. Any new ICH that does not meet the definition of SICH was classified as asymptomatic ICH. Mortality rate during hospitalization was also compared between groups. NIHSS was used to assess neurological deficits 24 hours after onset and on the day of discharge. A favorable functional outcome was defined as an mRS of ≤ 2 in 90 days after stroke onset.

Statistical analysis

To scrutinize the outcomes between IHS and COS subjects, we applied a propensity score matching at a 1:4 ratio, evaluating five key factors: gender, age, the site of large vessel occlusion, administration of intravenous tPA, and initial NIHSS scores. We encapsulated the baseline data of participants, presenting continuous variables as means with standard deviations for those following a normal distribution, and categorical variables as counts and percentages. The time to treatment was articulated through medians and interquartile ranges. We assessed differences in continuous data using either the two-sample t-test or the Mann–Whitney U test, depending on their distribution, and utilized the chi-square test for categorical data comparisons. All analyses were processed using SAS software, version 9.4, with a p-value threshold of 0.05 or less to establish statistical relevance.

RESULTS

Demographic data

Baseline patient demographics are shown in Table 1. A total of 20 patients with IHS and 80 patients with COS were enrolled in the study. The average age of patients was about 65 years old, and there was a higher proportion of men compared to women. Most of the medical history variables showed no significant difference between the two groups, except for heart failure. The median presentation NIHSS score in the study was around 19. Anterior circulation occlusion was observed in 75% of the IHS group and 71.25% of the COS group. Neither group received intravenous tPA.

Time metrics

The time required for procedures is presented in Table 2-1. The COS group exhibited longer door-to-image time, door-to-angiography room time, and door-to-groin puncture time, with a significant difference (P-value = 0.017, 0.011, 0.015, respectively). Further analysis of the COS group, divided into patients transferred from other hospitals and those not transferred, revealed significant delays in time indicators for the transferred patients, as shown in Table 2-2.

Outcomes

Neurological outcomes are provided in Table 3. Successful recanalization (defined as mTICI 2b/3) showed no significant difference between the two groups. There were no statistically significant differences in terms of complications (including SICH and asymptomatic ICH) and mortality rates. In the IHS group, the median NIHSS at 24 hours was 12, while in the COS group, it was 14. The median NIHSS at discharge was 9 and

Table 1: Baseline patient demographics

Characteristics	IHS (N=20)	COS (N=80)	p-value
Age, mean±SD	64.10±13.38	65.81±11.48	0.750
Sex, Male, n (%)	15 (75.00)	62 (77.50)	0.774
Medical history			
Prior stroke n (%)	2 (10.00)	21 (26.25)	0.148
HTN, n (%)	17 (85.00)	73 (91.25)	0.413
DM, n (%)	8 (40.00)	40 (50.00)	0.423
Hyperlipidemia, n (%)	8 (40.00)	50 (62.50)	0.068
Af, n (%)	7 (35.00)	38 (47.50)	0.314
HF, n (%)	10 (50.00)	7 (8.75)	<0.001
CAD, n (%)	7 (35.00)	17 (21.25)	0.243
Uremia, n (%)	2 (10.00)	1 (1.25)	0.101
Active tumor, n (%)	4 (20.00)	6 (7.50)	0.109
Inactive tumor, n (%)	1 (5.00)	7 (8.75)	1.000
Alcohol, n (%)	5 (25.00)	7 (8.75)	0.060
Smoking, n (%)	11 (55.00)	37 (46.25)	0.483
NIHSS on presentation, mean (range)	19 (8-29)	19 (8-34)	0.962
IVT, n (%)	0 (0)	0 (0)	0.315
Location site			0.793
Basilar artery, n (%)	5 (25.00)	23 (28.75)	
Proximal ICA, n (%)	1 (5.00)	7 (8.75)	
Distal ICA, n (%)	5 (25.00)	7 (8.75)	
MCA, n (%)	10 (50.00)	30 (37.50)	

SD: Standard deviation, IQR: Interquartile range, HTN: Hypertension, DM: Diabetes mellitus, Af: Atrial fibrillation, HF: Heart failure, CAD: Coronary artery disease, NIHSS: National Institute of Health Stroke Scale, IVT: Intravenous thrombolysis, ICA: Internal carotid artery, MCA: Middle cerebral artery

11 respectively. No significant differences were observed in 24-hour and discharged NIHSS. The statistics for both groups were also equivalent in terms of 90-day mRS ≤ 2.

Additional data on IHS patients are presented in Table 4, including age, sex, department, admission diagnosis, relevant comorbidities, operations performed during this hospitalization and TOAST classification. In this study, 65% of the patients underwent surgery before the occurrence of stroke and cardioembolism accounted for 30% of strokes.

Figure 1 demonstrated functional outcome at 3 months evaluated by whole spectrum mRS between patients with IHS and COS.

DISCUSSION

This study revealed that patients receiving EST treatment did not have worse neurological prognosis in the IHS group compared to the COS

Table 2-1: Time metrics between IHS and COS group

Onset to procedure	IHS (N=20)	COS (N=80)	p-value
CT perfusion (min), median (IQR)	75 (49-158)	198 (81-319)	0.017
Angioroom (min), median (IQR)	205 (135-298)	310 (229-460)	0.011
Groin puncture (min), median (IQR)	221 (162-311)	322(245-480)	0.015

CT: Computed tomography, IQR: interquartile range

Table 2-2: Time metrics between transfer and non-transfer subgroups

Onset to procedure	Non-Transferral (N=40)	Transferral (N=40)	p-value
CT perfusion (min), median (IQR)	138 (54-207)	266 (139-466)	<0.001
Angioroom (min), median (IQR)	245 (171-x338)	414 (290-604)	<0.001
Groin puncture (min), median (IQR)	259 (184-356)	428 (306-615)	<0.001

CT: Computed tomography, IQR: interquartile range

group. While the efficacy of EST in acute cerebral artery occlusion is well-documented, our research uncovers the nuanced outcomes within Taiwanese healthcare settings, an area less explored in global research. Due to Taiwan's government-funded healthcare insurance, coverage for part of the equipment costs for EST began in 2016, and from 2018, the insurance started to cover the procedural and assessment fees for EST. With the support of the national insurance, more physicians were willing to engage in thrombectomy procedures, which likely resulted in an increase in the number of physicians performing this procedure during the later period of our study. There were no significant differences in age, sex, NIHSS on presentation, occluded location, and medical history between the two groups, except for a significantly higher rate of heart failure in the IHS group, which has also been observed in other studies.[8-11] Previous studies have showed the prognosis of patients with IHS was worse than that of patients with COS before EST became prevalent.[12,13] This trend has been observed in many studies even after EST gradually became a standard treatment.[6,14,15] Possible reasons for this observation include the fact that patients experiencing IHS may have more severe symptoms at the time of stroke onset compared to patients with COS.[16] This difference can be attributed to various causes and mechanisms, such as massive watershed infarcts and hemodynamic abnormalities, as well as hypercoagulable states caused by surgery or other medical conditions, can lead to multiple strokes.[17,18] Despite that, other studies have shown that when acute stroke protocols are tailored for IHS, the prognosis of patients with in-hospital stroke who receive EST is not worse than that of COS.[7,19]

Regarding time metrics, including onset-to-image time, onset-to-angiography room time, and onset-to-groin puncture time, the COS group had significantly longer durations compared to the IHS group. After the inclusion of EST in health insurance coverage, we established a standardized process for stroke activation. This encompasses enhanced training for inpatient units to identify stroke incidents effectively. Our integrated stroke process includes identifying suspected stroke patients in the wards, while simultaneously conducting telephone consultations with neurologists, neuroradiologists and contacting the CT scan department to prioritize scans for such patients. Additionally, we have regular quality supervision meetings to review and further improve the process. Nevertheless, our subgroup analysis of the COS group found a significant time delay specifically among patients transferred from other hospitals. This suggests that the referral process may be the primary cause of the delay. It is crucial to improve inter-hospital referral processes

Table 3: Baseline patient demographics

Characteristics	IHS (N=20)	COS (N=80)	p-value
mTICI2b and 3, n (%)	20 (100.0)	71 (88.75)	0.197
Complication			
SICH, n (%)	1 (5.00)	3 (3.75)	1.000
Non-SICH, n (%)	6 (30.00)	36 (45.00)	0.224
Mortality rate, n (%)	2 (10.00)	8 (10.00)	1.000
NIHSS, mean (range)			
24-hour	12(0-38)	14(0-36)	0.275
Discharged	9(0-28)	11(0-34)	0.256
90-day mRS, mean±SD	2.83±1.79	3.57±1.81	0.148

mTICI: modified Thrombolysis in Cerebral Infarction, SICH: Symptomatic intracerebral hemorrhage, ICH: Intracerebral hemorrhage

Table 4: Additional data on in-hospital-stroke patients

Patient	Age	Sex	Department	Admission diagnosis	Comorbidities	Operation	TOAST
1	63	F	OBGYN	Pelvic tumor	Inactive breast cancer	Yes	4
2	68	M	Cardiology	Heart failure	CAD, Af		2
3	62	M	Cardiology	Heart failure	VHD, Af	Yes	2
4	71	M	Genitourinary	Bladder cancer	HTN, DM, Af	Yes	4
5	55	M	Cardiology	NSTEMI			1
6	67	M	Neurosurgery	SAH	HTN, DM		1
7	82	M	Cardiology	STEMI	Af	Yes	2
8	79	F	Cardiology	NSTEMI	HTN, DM	Yes	1
9	51	M	Cardiovascular Surgery	Abdominal aortic thrombosis	DM, CAD	Yes	4
10	55	M	Cardiology	Heart failure	HTN	Yes	1
11	77	M	Metabolic	HHS	HTN, DM, CAD		1
12	76	M	Neurosurgery	Pituitary tumor	HTN	Yes	1
13	80	M	Colorectal Surgery	Rectal cancer	CAD	Yes	4
14	62	F	Medical ICU	Acute pyelonephritis	HTN, DM		5
15	42	F	Nephrology	Peritonitis	ESRD, HF	Yes	4
16	80	M	Cardiology	Heart failure	CAD, Af	Yes	2
17	55	M	Cardiology	Heart failure	Af		2
18	48	F	Chest Medicine	Hydropneumothorax	HTN	Yes	5
19	37	M	Cardiology	Heart failure		Yes	2
20	63	F	Metabolic	HHS	Inactive breast cancer		5

TOAST: 1. Large-artery atherosclerosis, 2. Cardioembolism, 3.Small-vessel occlusion, 4. Stroke of other determined etiology, and 5. Stroke of undetermined etiology; NSTEMI: Non-ST-elevation myocardial infarction; STEMI: ST-elevation myocardial infarction; SAH: Subarachnoid hemorrhage; HHS: Hyperosmolar hyperglycemic state; CAD: Coronary artery disease. VHD: Valvular heart disease; HTN: Hypertension; DM: Diabetes mellitus; Af: Atrial fibrillation; ESRD: End stage renal disease

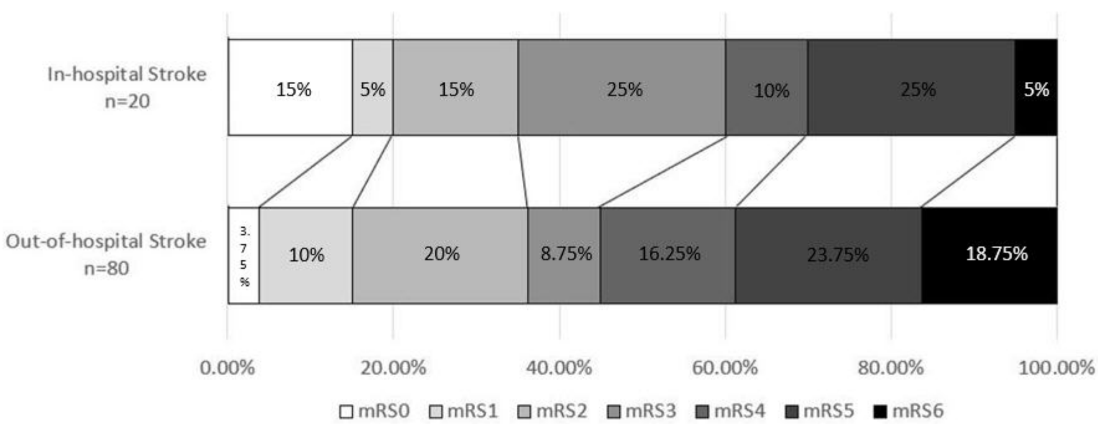

Figure 1. Functional outcome at 3 months evaluated by whole spectrum mRS between patients with IHS and COS

to reduce time delays. This issue can be addressed from various perspectives, such as employing communication tools to facilitate information exchange between hospitals, expediting patient assessment after transfer, and accelerating subsequent time metrics.[20,21] Flying EST teams to remote areas can also help overcome the challenge of limited access to acute stroke care, leading to better outcomes for patients.[22] Moreover, reducing unnecessary referrals is an important hurdle to overcome. Emergency medical technicians (EMTs) can choose to transport suspected stroke patients directly to hospitals capable of performing EST, rather than the nearest hospital. Multiple studies have shown that this approach effectively improves outcomes.[23,24] Enhancing the ability of EMTs to identify suitable EST candidates on site is a major challenge. One study has suggested that audio-video connections between EMTs, neurologists, and local emergency department providers can facilitate the recommendation of appropriate hospitals for transfer and expedite treatment time after transfer.[25] However, further research is needed to confirm these findings.

In our study, there were no significant statistical differences in successful recanalization rate, complications, mortality rate, 24-hour NIHSS, discharged NIHSS and 90-day mRS between the two groups. We observed that a high proportion of IHS patients had received surgical treatment prior to their stroke, and IHS patients also presented with a higher incidence of heart failure. These factors may potentially offset the impact of the longer time taken to administer EST in patients with COS. Similar results have been reported in other studies.[26,27] It is important to consider both time indicators and patient suitability when selecting candidates for EST treatment. Further research is needed to determine the factors that may influence EST prognosis.

Limitations of this study should be acknowledged. First, it was a retrospective, single-center design and our small study groups, making it challenging to draw definitive conclusions regarding the overall effectiveness of EST in both the HIS and COS groups. Additionally, changes in the National Health Insurance system in Taiwan related to EST payment and the impact of the COVID-19 pandemic during the study period may have indirectly influenced the selection of candidates. Lastly, it is worth noting that our hospital implemented additional stroke education and training in the latter part of the study, which may have resulted in shorter treatment times for IHS patients.

In conclusion, even though a substantial number of patients with IHS had surgical interventions prior to their stroke event and exhibited a greater prevalence of heart failure relative to COS patients, timely administration of EST led to equivalent prognostic outcomes in the IHS cohort. Similarities were observed in metrics such as successful recanalization rates, the incidence of complications, mortality figures, and measures including the NIHSS scores at 24 hours post-stroke, at discharge, and the 90-day mRS. Nevertheless, the need to reduce the groin puncture times, especially for patients requiring transfer, is a critical challenge that warrants further attention.

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DISCLOSURES

Data availability: The data supporting the results of the study are available by contacting the corresponding author.

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Conflicts of interest: None

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