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In-Hospital Versus Out-of-Hospital Stroke Onset Comparison of Process Metrics in a Community Primary Stroke Center

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Abstract

Objective: To examine in-hospital stroke onset metrics and outcomes, quality of care, and mortality compared with out-of-hospital stroke in a single community-based primary stroke center.

Patients and Methods: Medical records of in-hospital stroke onset were compared with out-of-hospital stroke onset alert data between January 1, 2013 and December 31, 2019. Time-sensitive stroke process metric data were collected for each incident stroke alert. The primary focus of interest was the time-sensitive stroke quality metrics. Secondary focus pertained to thrombolysis treatment or complications, and mortality. Descriptive and univariable statistical analyses were applied. Kruskal-Wallis and χ^2 tests were used to compare median values and categorical data between prespecified groups. The statistical significance was set at α=0.05.

Results: The out-of-hospital group reported a more favorable response to time-sensitive stroke process metrics than the in-hospital group, as measured by median stroke team response time (15.0 vs 26.0 minutes; $P\leq.0001$) and median head computed tomography scan completion time (12.0 vs 41.0 minutes; $P=.0001$). There was no difference in the stroke alert time between the 2 groups (14.0 vs 8.0 minutes; $P=.089$). Longer hospital length of stay (4 vs 3 days; $P=.004$) and increased hospital mortality (19.3% vs 7.4%; $P=.0032$) were observed for the in-hospital group.

Conclusions: The key findings in this study were that time-sensitive stroke process metrics and stroke outcome measures were superior for the out-of-hospital groups compared with the in-hospital groups. Focusing on improving time-sensitive stroke process metrics may improve outcomes in the in-hospital stroke cohort.

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Among hospitalized patients admitted with diagnosis other than stroke, for 2%-17% an acute stroke complicates their hospitalization.[1-5] In 2005, an American Stroke Association Task Force published a seminal article that paved the way for organized and structured care of patients with acute stroke.[6] Research emphasis and protocol development have largely been devoted to out-of-hospital stroke (OHS) care, but in-hospital stroke (IHS) care processes and protocol development are swiftly catching up.[7-10]

Timely management of patients suspected of having a stroke is crucial to the outcome. Fast triaging and clinical, radiologic, and laboratory assessments performed early can lead to a successful immediate intervention. Consequently, the American Heart Association or American Stroke Association launched a target stroke initiative in 2010, with recommendations of a door-to-needle (DTN) response time of less than 60 minutes for at least 50% of patients[11] and in 2019, the ambitious goal of a DTN of 60 minutes for 85% of patients, 45 minutes in 75% of patients, and 30 minutes in 50% or more of patients presenting with acute ischemic stroke and receiving thrombolysis therapy.[12]

In-hospital stroke vs OHS comparisons of demographic characteristics, hospital

characteristics, immediate treatment with thrombolysis therapy, and mortality have found to favor OHS cohorts in multiple studies.[13-15] The IHS onset protocol, different from the OHS protocol was established in 2013, in our hospital. Stroke alert activation protocol in our emergency department (ED) (OHS) comprise a designated stroke team (on-call neurologist, laboratory medicine technologist for blood draw, an ED provider responsible for alert activation, an ED registered nurse [RN] caring for the patient, and a rapid response RN), an established clinical pathway for rapid response or assessment with set time criteria, and notification of the computed tomography (CT) staff. For the IHS protocol, alert activation is initiated by the bedside RN or any clinical staff member who observed a change in the patient's baseline function, the rapid response RN, and the hospital internal medicine provider are designated as first responders. On-call neurologists are designated as second responders. Ordering of standard laboratory studies (prothrombin time and glucose) and CT head are also part of the protocol. Strict time criteria for response were not specified or monitored as the OHS protocol. In 2018, Mayo Enterprise Telestroke Service assumed the primary role of responding to OHS acute stroke alerts virtually for patients with stroke symptom onset of 24 hours or less before presentation. The IHS and OHS onset comparison of key process metrics that may influence the success or failure of acute stroke intervention is understudied.

Objective

The primary aim of this study was to perform comparative analysis of time-sensitive stroke process metrics between IHS and OHS and to compare OHS pretelemedicine and post-telemedicine responses to stroke alerts in a single community-based Joint Commission-certified primary stroke center. Additional analysis of demographic characteristics and clinical, radiologic, and laboratory factors between IHS and OHS and pretelemedicine and post-telemedicine eras were performed.

METHODS

Ethics approval was obtained from the Mayo Clinic institutional review board, and the need for patient informed consent was waived (IRB 19-002465).

Mayo Clinic Health System Eau Claire is a community-based, Joint Commission-certified primary stroke center. Eau Claire is a city of 69,441 people in West-Central Wisconsin. Racial makeup was 87.7% White, 5.7% Asian, 3.1% Latino or Hispanic, 1.4% African American, and 0.2% Native Americans, according to the population estimate for July 1, 2021(V2021).[16] The hospital is part of the Mayo Clinic health system. It is located near downtown, with a bed capacity of 204 licensed for 304. The stroke program is run by the neuroscience department in close collaboration with the emergency and radiology departments. The program is supported by the Mayo Clinic comprehensive stroke center in Rochester, Minnesota, and Mayo Enterprise Telestroke Network.

We performed a retrospective analysis of all patients for whom an IHS stroke alert occurred during admission to our hospital between January 1, 2013, and December 31, 2019. This comprised 12.4% (192 of the 1551) of all stroke cases. First, 370 OHS patients were selected based on similar characteristics to our IHS cohort patients for comparative analysis. Detailed description of IHS and OHS cohort identification has previously been published.[7]

Data were independently abstracted by 3 physicians (2 neurologists and 1 hospitalist) into a standard form. Variables collected included demographic characteristics and clinical, radiologic, and laboratory data for each incident for IHS and OHS groups. The demographic characteristic data included age, sex, and dates of admission and discharge. Classic stroke risk factors were abstracted. Stroke ascertainment was performed by review of the neurologist's consulting notes and results of brain-imaging studies (magnetic resonance imaging [MRI] and CT scan). A clinical diagnosis of stroke by the neurologist without supportive radiologic evidence was also predetermined to be acceptable. Cerebrovascular events were classified as transient ischemic attacks, ischemic strokes, intracerebral hemorrhages, subarachnoid hemorrhages, and subdural hemorrhages. Ischemic stroke subtypes were classified according to atherothrombosis or large-vessel

disease (A), small-vessel disease (S), cardiac pathology (C), others (O), and dissection (D) classification (ASCOD classification). An additional classification of embolic stroke of unknown source was added, defined as nonlacunar ischemic infarct measuring >2.0 cm on MRI diffusion-weighted imaging or >1.5 cm on MRI flair imaging and without flow limiting proximal arterial stenosis or cardioembolic source.[17] Stroke risk factors were deemed to be present if documented in the electronic medical record at any time before or at the index admission. Acceptable laboratory variables were those obtained during immediate hospitalization, except for lipid profile, for which values obtained within 30 days of index admission were included.

Discharge diagnoses were grouped under the headings: stroke (ischemic stroke), transient ischemic attack (transient ischemic attack), hemorrhagic stroke (intracerebral hemorrhage, subdural hemorrhage, and subarachnoid hemorrhage), stroke mimics (migraines, seizures, transient global amnesia, paresthesia, and vertigo or peripheral vestibular dysfunction), encephalopathy and psychiatry, (all psychiatric diagnoses). For patients with an ischemic stroke diagnosis, the following additional data were collected: thrombolysis therapy administration, contraindications for those that did not receive treatment, and post thrombolysis complications for those that received treatment.

The primary outcomes of interest considered include door-to-stroke alert activation (OHS), symptom recognition to stroke alert activation (IHS), alert activation to stroke team response time (OHS and IHS), order time to CT head, prothrombin completion, platelet completion, and glucose completion times, DTN time (OHS), and symptom recognition to needle time (IHS). Secondary outcomes of interest include appropriate stroke investigations performed (CT head, computer tomogram angiography [CTA] head and neck, MRI head, magnetic resonance angiography head and neck, carotid ultrasonography, prothrombin time assay, platelet assay, glucose assay, and lipid profile), National Institute of Health Stroke Scale [NIHSS], hospital length of stay, hospital mortality, endovascular thrombectomy consideration, thrombolysis therapy administration, thrombolysis therapy complications and contraindications, and stroke subtypes. Comparisons between overall IHS and overall OHS and OHS pretelemedicine and post-telemedicine eras were analyzed. For accurate ascertainment, death was defined as a patient dying in the hospital before discharge.

Statistical Analyses

All data for this study were captured retrospectively from the electronic medical record. Categorical variables are presented as counts and percentages. Statistical testing of categorical variables was reported with χ^2 tests. Continuous variables are presented as mean ± SD and median (interquartile range). Statistical testing of continuous variables across 2 or more categories was reported with Kruskal-Wallis tests. Multivariable linear regression models were used to adjust for imbalanced baseline covariates. A Bonferroni correction was applied to time-sensitive stroke process metrics, and P value of $\leq$.05 are highlighted as statistically significant throughout. The data analysis for this paper was generated using SAS or STAT software, version 9.4 of the SAS System for Windows. The SAS and all other SAS Institute Inc product or service names are registered trademarks or trademarks of SAS Institute Inc.

RESULTS

During the study period of January 1, 2013, and December 31, 2019, we identified all 192 IHS alert activations and selected 370 OHS controls for comparative analysis. Mean age was 71.0±14.95 years and 71.8±15.06 years, and 49.5% and 48.1% were female for IHS and OHS groups, respectively. The OHS group had more favorable response to time-sensitive stroke metrics as measured by faster median stroke team response time from activation for OHS and IHS (15.0 vs 26.0 minutes; $P\leq$.0012), median-order to prothrombin assay completion time for both IHS and OHS (20.0 vs 22.0 minutes; P=.18, and median-order to platelet assay completion time for both IHS and OHS (12.0 vs 14.5 minutes; P=.0024) compared with the IHS group. The median door to noncontrast head

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TABLE 1. Comparison of Demographic Characteristics and Time Sensitive Stroke Process Metrics Between IHS and OHS

	HIS n=192	OHS n=370	*P*
Age y, mean ± SD	71.0±14.95	71.8±15.06	.06
Sex, n (%)			.08
Female	95 (49.5)	178 (48.1)	
Male	97 (50.5)	192 (51.9)	

Stroke process metrics, n (%)							
	IHS			OHS			
	n	Median (range)	Mean ± SD	n	Median (range)	Mean ± SD	Bonferroni *P*
PTCT (min)	111	22.0 (16.0-34.0)	29.0±20.6	344	20.0 (16.0-26.0)	22.8±12.4	.18
PLCT (min)	118	14.5 (9.0-25.0)	37.0± 135.8	358	12.0 (8.0-18.0)	14.7±11.2	.002
NCCTH-CT (min)	171	41.0 (26.0-67.0)	68.3±115.3	362	12.0 (8.0-19.0)	16.5±19.5	.001
GCT (min)	126	30.0 (13.0-42.0)	43.8±128.1	360	29.0 (18.0-35.0)	27.1±14.8	.99
SAAT	164	8.0 (1.0-27.0)	28.8±61.9	361	14.0 (0.0-55.0)	66.0±157.0	.99
STRT	179	26.0 (10.0-55.0)	54.2±103.1	331	15.0 (6.0-29.0)	21.3±25.1	.001

Abbreviations: GCT, glucose completion time; NCCTH-CT, noncontrast CT head completion time; PLCT, platelet completion time; PTCT, prothrombin completion time; SAAT, stroke alert activation time; STRT, stroke team response time.

CT completion time for OHS and symptom recognition to CT completion time for IHS (12.0 vs 41.0 minutes; $P \leq .0012$) The median door-to-stroke alert (OHS) and symptom recognition to stroke alert (IHS) were comparable (14.0 vs 8.0 minutes; $P=.99$).There was no difference in the above time-sensitive metrics when we compared ischemic stroke only between the IHS and OHS (excluding stroke mimics) groups. In addition, in multivariable linear regression models to control for imbalanced baseline covariates, time-sensitive stroke process metrics significant above retain statistical significance after a Bonferroni correction. Second, we examined the same time-sensitive stroke process metrics for the pretelemedicine and post-telemedicine eras for OHS only. We found faster median door-to-stroke alert time (3.0 vs 35.0 minutes; $P \leq .0001$), median stroke team response time (9.0 vs 24.5 minutes; $P \leq .0001$), median door-to-head CT completion time (9.0 vs 15.5 minutes), median-order to prothrombin assay completion time (16.0 vs 22.0 minutes; $P \leq .0001$) and median-order to platelet assay completion time (8.0 vs 14.0 minutes; $P \leq .0001$) for pre-telemedicine era compared with post-telemedicine era group. However, there were no differences in the frequency of thrombolysis administration and endovascular thrombectomy consideration between the 2 groups. (Tables 1, 2, and 3; Figure A and B).

A summary of the clinical characteristics between IHS and OHS groups is shown in Table 3. The IHS cohort reported a higher proportion of history of cardiovascular risk factors (coronary heart disease and coronary heart failure) and lower proportions of previous stroke compared with the OHS group. The IHS group reported a higher frequency of stroke mimics (40.1% vs 16.8%; $P \leq .0001$), but a higher proportion of patients in the OHS group were discharged home (51.1% vs 29.1%; $P \leq .0001$). The IHS group was more likely to be disabled at baseline before their incident stroke compared with the OHS group, as shown by modified Rankin scale of 4 (14.6% vs 7.0%; $P \leq .0001$). More patients in the OHS group compared with the IHS group underwent appropriate radiologic and laboratory testing during their hospitalization, noncontrast head CT scan (98.1% vs 89.1%; *P*.0001), head CTA (38.8% vs 16.1%; $P \leq .0001$), neck CTA (24.6% vs 8.9%; $P \leq .0001$), brain MRI (56.8% vs 45.3%; $P=.0100$), prothrombin

TABLE 2. Comparison of Demographic Characteristics and Time Sensitive Stroke Process Metrics Between Pretelemedicine and Post-telemedicine Era in OHS Group

	Pretelestroke Era n=166	Post-telestroke Era n=204	*P*
Age (y), mean ± SD	70.2±15.36	73.0±14.73	.07
Sex, n (%)			.09
Female	88 (53.0)	90 (44.1)	
Male	78 (47.0)	114 (55.9)	
Stroke process metrics, n (%)			
TPA given	28 (33.7)	36 (33.6)	.10
EVT consideration	6 (7.2)	16 (15.0)	.10

	Pretelemedicine era			Posttelemedicine era			
	n	Median (range)	Mean ± SD	n	Median (range)	Mean ± SD	*P*
PTCT (min)	81	16.0 (5.0-52.0)	18.8±8.1	100	22.0 (6.0-166.0)	25.3±17.4	<.0001
PLCT (min)	83	8.0 (1.0-44.0)	11.6±8.3	103	14.0 (1.0-61.0)	17.3±11.4	<.0001
NCCTH-CT (min)	83	9.0 (4.0-27.0)	10.6±5.6	106	15.5 (3.0-222.0)	19.4±23.3	<.0001
GCT (min)	83	27.0 (1.0-70.0)	27.1±13.3	104	28.5 (3.0-77.0)	26.0±15.6	.73
DTN	28	51.5 (12.0-115.0)	53.2±23.1	36	57.5 (21.0-115.0)	59.5±21.2	.17

Abbreviations: GCT, glucose completion time; TPA, tissue plasminogen activator; EVT, endovascular thrombectomy; PTCT, prothrombin completion time; PLCT, platelet completion time; NCCTH-CT, noncontrast CT head completion time

time assay (93.0% vs 57.8%; $P \leq .0001$), glucose assay (97.6% vs 65.1%; $P \leq .0001$), platelet assay (96.8% vs 61.5%; $P \leq .0001$), and lipid profile (61.4% vs 48.4%; $P = .0034$).

We examined whether there was a difference in outcome between IHS and OHS cohorts for ischemic stroke only (Table 4). We found no difference in NIHSS and DTN for thrombolysis treatment between the groups. A higher proportion of IHS cohort reported laboratory contraindication to thrombolysis therapy compared with OHS group (12.5% vs 3.7%; $P \leq .0001$), whereas almost one third of OHS group did not have a documented reason for thrombolysis contraindication (33.2% vs 8.0%; $P \leq .0001$). Hospital mortality, however, was higher for IHS group compared with OHS group (19.3% vs 7.4%; $P = .0032$). The proportion of patients that received thrombolysis therapy (33.7% vs 8.0%; $P < .0001$) and transferred to a higher level of care for endovascular thrombectomy consideration (11.6% vs 3.4%; $P = .03$) was higher for the OHS group compared with the IHS group.

DISCUSSION

The OHS cohort reported a more favorable response to time-sensitive stroke process metrics of median door-to-CT completion (OHS), symptom recognition to CT completion (IHS), median stroke team response time from alert, and median-order-to-key laboratories (platelet and prothrombin assays) completion times (OHS and IHS) compared with IHS cohorts. Differences between our OHS and IHS stroke protocols may account for this, but there are other potential contributing factors. Less experienced staff in acute stroke processes in the IHS group compared with the OHS group, wider range of IHS staff activating stroke alert, complex IHS patients with underlying medical conditions and symptoms difficult to distinguish from acute stroke, and a higher ratio of patients to RNs in the IHS group.

We determined that the door-to-stroke alert and CT completion time (OHS) is comparable with symptom recognition to stroke alert and CT completion time (IHS) when examined from the perspective of effectiveness of the established stroke process comparison for the 2 cohorts. Our findings were similar to those of De Marchi Assuncao et al[18] recent case control cohorts of code stroke response times for CT completion times between OHS and IHS groups. Although some studies that examined completion times used

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TABLE 3. Comparison of Clinical Characteristics Between IHS and OHS

	IHS (n=192)	OHS (n=370)	P
Stroke risk factors, n (%)			
Hypertension	136 (70.8)	262 (70.8)	.10
Diabetes Mellitus	73 (38.0)	122 (33.0)	.23
Dyslipidemia	126 (65.3)	218 (59.2)	.14
CAD	70 (36.5	219 (22.2)	.0003
CHF	58 (30.2)	53 (14.3)	.0001
Afib/Aflutter	62 (32.3)	107 (28.9)	.41
PVD	27 (14.1)	35 (9.5)	.10
OSA	39 (20.3)	57 (15.4)	.14
Prior stroke	41 (21.5)	116 (31.4)	.01
Smoker	22 (11.5)	54 (14.6)	.30
Discharge diagnosis, n (%)			<.0001
ICH	10 (5.2)	19 (5.1)	
Stroke mimics	77 (40.1)	62 (16.8)	
Ischemic stroke	88 (45.8)	190 (51.4)	
SDH	1 (0.5)	4 (1.1)	
TIA	10 (5.2)	33 (8.9)	
Seizure	0 (0,0)	1 (0.3)	
Encephalopathy	0 (0.0)	29 (7.8)	
Discharge location, n (%)			<.0001
Home	52 (28.1)	179 (51.1)	
Hospice	34 (18.4)	21 (6.0)	
Rehab	8 (4.3)	19 (5.4)	
SNF	91 (49.7)	131 (37.4)	
Missing data	7	20	
Prestroke mRS, n (%)			<.0001
0	49 (25.5)	188 (50.8)	
1	34 (17.7)	55 (14.9)	
2	42 (21.9)	45 (12.2)	
3	39 (20.3)	54 (14.6)	
4	28 (14.6)	26 (7.0)	
5	0 (0.0)		
Radiology tests done for stroke activation, n (%)			
NC Head CT	171 (89.1)	363 (98.1)	<.0001
CTA Head	31 (16.1)	143 (38.8)	<.0001
CTA Neck	17 (8.9)	91 (24.6)	<.0001
MRI Head	87 (45.3)	210 (56.8)	<.0001
MRA Head	7 (3.6)	10 (2.7)	.54
MRA Neck	2 (1.0)	10 (2.7)	.20
CUS	62 (32.3)	150 (40.5)	.06
Laboratory tests done for stroke activation, n (%)			
Prothrombin time	111 (57.8)	344 (93.0)	<.0001
Glucose	125 (65.1)	361 (97.6)	<.0001
Platelet	118 (61.5)	358 (98.6)	<.0001
Lipid profile	93 (48.4)	227 (61.4)	.003

Continued on next column

TABLE 3. Continued

Abbreviations: Afib, atrial fibrillation; CAD, coronary artery disease; CHF, congestive heart failure; CTA, computer tomogram angiography; CUS, carotid ultrasound; ICH, intracerebral hemorrhage; MRA, magnetic resonance angiogram; MRI: magnetic resonance imaging; NC Head CT, Noncontrast head computer tomography; OSA, obstructive sleep apnea; PVD; peripheral vascular disease; SDH, subdural hematoma; TIA, transient ischemic attack; SNF, skilled nursing facility

door-to-laboratory completion time frame,[18] we chose to use order-to-key laboratory completion times to allow for a uniform comparison of the effectiveness of our established stroke care processes between IHS and OHS groups.

Although the same time-sensitive stroke process metrics favored pretelemedicine (in-person stroke team) era compared with post-telemedicine (virtual telestroke team) era for the OHS cohort, there was no statistically significant difference in the DTN time, frequency of thrombolysis administration, and endovascular thrombectomy considerations for the 2 groups. In a study comparing stroke outcomes of hub and spoke hospital telestroke program, similar findings of frequency of thrombolysis administration were observed.[19] This paradox of delayed stroke alert activation and stroke team response time for telestroke teams compared with in-person stroke teams, but with similar DTN and thrombolysis frequencies can be explained by differences between the 2 workflows. It is not uncommon for telestroke alert activation to be intentionally delayed by personnel at the originating site until such a time that the patient has already been evaluated by the emergency physician, has transferred to and from the CT scanner, and radiological and laboratory data are available for interpretation. The delay in activation and response time for the virtual telestroke team is most likely mitigated by the telestroke team's more rapid assessment and

decision-making, which results in similar DTN and frequency of thrombolysis administration.

Pertaining to stroke outcome, although there was no difference between the NIHSS and DTN for thrombolysis for patients with a final diagnosis of ischemic stroke for OHS and IHS groups, hospital mortality and prestroke functional disability were higher for the IHS group. The proportion of patients treated with thrombolysis therapy, transferred to a higher level of care for endovascular thrombectomy consideration, or discharged home favored the OHS cohort. These findings are in keeping with multiple previous studies.[7,11-13]

Limitations

Our study has some limitations. Multiple variables reported missing data points because of absent or incomplete documentation. For patients with missing time-sensitive stroke process metrics, we did not include those patients in this study. This may have introduced biased results and reduced statistical power. Although the study's primary focus was on time-sensitive stroke process metrics on stroke alert activation, exclusion of potentially misdiagnosed strokes, estimated to occur in approximately 14% of stroke patients who presented to ED, may have introduced a selection bias in the comparative analysis.[20] The association between time-sensitive stroke process metrics and outcomes, such as hospital mortality and hospital length of stay, in the IHS cohort may be cofounded by higher baseline comorbidities, a higher risk of hospital complications, lower eligibility, and a higher number of contraindications for intravenous thrombolysis therapy and thrombectomy in the IHS cohort. Manual abstraction of time-

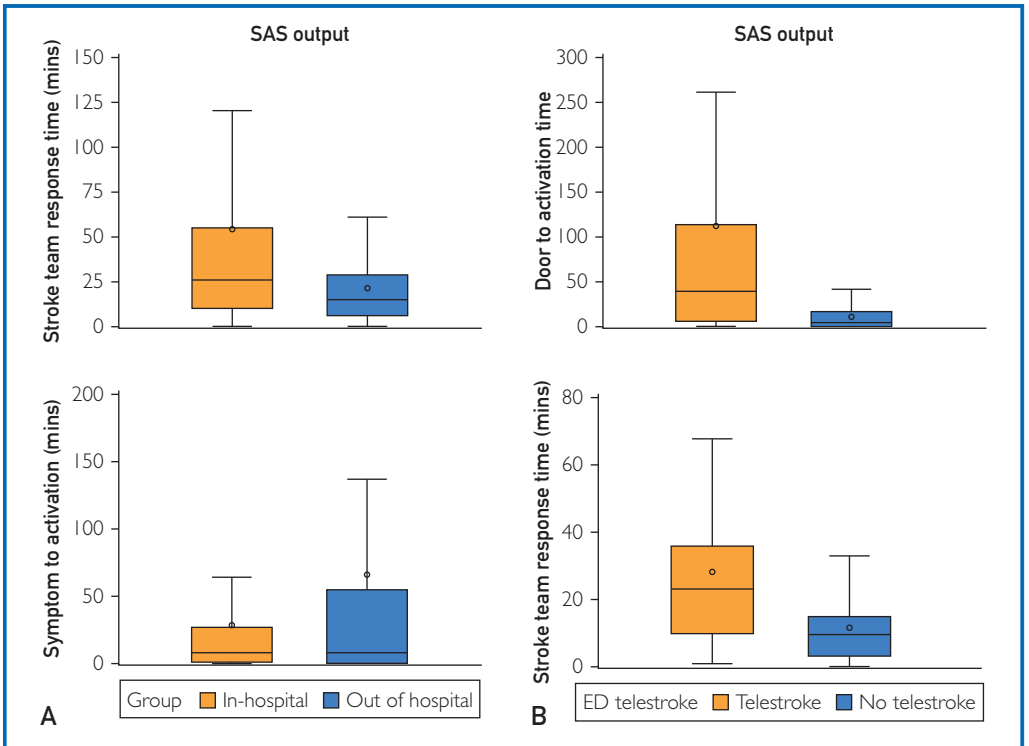

FIGURE. A, Box and whisker plot comparing stroke alert and stroke team response time between IHS and OHS. B, Box and whisker plot comparing door-to-stroke alert and stroke team response time between pretelemedicine and post-telemedicine era for OHS. ED, emergency department; HIS, in-hospital stroke; OHS, out-of-hospital stroke.

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TABLE 4. Interventions, Clinical Characteristics, and Outcomes: IHS Versus OHS for Ischemic Stroke Only

	IHS			OHS			
	n	Median (IQR)	Mean ± SD	n	Median (IQR)	Mean ± SD	*P*
NIHSS	72	7.0 (2.5-14.0)	9.0±7.68	199	5.0 (2.0-12.0)	8.0±7.76	.20
HLOS (days)	109	4.0 (3.0-8.0)	6.5±7.95	224	3.0 (2.0-5.0)	3.8± 3.37	.0001
DTN (min)	7	96.0 (34.0-149.0	91.1±55.98	64	55.0 (44.5-67.5)	56.7±22.06	.22
DAT (mins)	90	92.0 (25.0-338.0)	235.2 (340.16)	243	12.0 (0.0-59.0)	74.1±176.14	<.0001
STRT (mins)	105	28.0 (10.0-80.0)	69.8 (129.87)	230	15.0 (6.0-30.0)	21.4±25.06	<.0001
CTCT (mins)	99	18.0 (11.0-30.0)	22.3 (20.25)	243	12.0 (8.0-20.0)	15.8±17.07	<.0001
PTCT (mins)	72	22.0 (16.5-34.0)	28.6 (19.19)	234	20.0 (16.0-27.0)	22.9±13.68	.03
GCT (mins)	83	30.0 (13.0-41.0)	49.0 (156.63)	241	28.0 (17.0-35.0)	26.6±14.22	.15
PCT (mins)	78	16.5 (10.0-28.0)	46.3 (166.17)	240	12.0 (8.0-18.0)	14.5±9.82	.0002
			IHS n (%)			OHS n (%)	*P*
Hospital mortality			22(20.2)			20 (8.1)	.001
TPA given			7(8.0)			64 (33.7)	<.0001
EVT consideration			3 (3.4)			22 (11.6)	.03
TPA complications							.84
Major			0 (0.0)			1 (1.6)	
Minor			0 (0.0)			2 (3.1)	
No complication			7 (100.0)			61 (95.3)	
TPA contraindications							<.0001
CT contraindication			6 (6.8)			14 (7.4)	
Laboratory contraindication			11 (12.5)			7 (3.7)	
Late presentation			34 (38.6)			62 (32.6)	
Medication			5 (5.7)			4 (2.1)	
Patient refusal			2 (2.3)			8 (4.2)	
Others			23 (26.1)			32 (16.8)	
No documentation			7(8.0)			63 (33.2)	
Missing data			6			23	
Stroke subtypes							.03
Cardioembolic			40 (45.5)			52 (27.4)	
Dissection			1 (1.1)			1 (0.5)	
ESUS			16 (18.2)			34 (17.9)	
LVO			8 (9.1)			35 (18.4)	
SVD			17 (19,3)			58 (30.5)	
Other			6 (6.8)			10 (5.3)	

Abbreviations: CTCT, CT completion time; DAT, door-to-activation time; DTN, door-to-needle; ESUS, embolic stroke of undetermined source; EVT, endovascular thrombectomy; GCT, glucose assay completion time; HLOS, hospital length of stay; LVO, large-vessel occlusion; NIHSS, National institute of health stroke scale; PCT, platelet assay completion time; PTCT, prothrombin time assay completion time; STRT, stroke team response time; TPA, tissue plasminogen activator

sensitive stroke process metrics is as accurate as the original documentation, and automated abstraction methods may be superior. However, the heterogeneous nature of these stroke metrics makes automated abstraction a huge challenge. Moreover, our patient population from historical data, primarily comprises Caucasians with small percentages of other races, such as Black, Asians and Latinos. This therefore limits the generalization of our findings to communities with more diverse population.

CONCLUSION

In-hospital stroke management is delayed at all levels of recognition, alerts, assessments, CT imaging, and laboratory assessments. The IHS group reported a higher number of comorbidities and complexities, higher cardiovascular risk burden, lower eligibility, and higher number of contraindications to intravenous thrombolysis therapy, and higher mortality rate. Focusing on improving time-sensitive stroke process metrics in IHS cohorts, despite some of the potential cofounders previously mentioned, may lead to an improvement in outcome. Consideration could be given to encouraging early notification of telestroke alerts for OHS and introducing extended telestroke coverage for IHS.

POTENTIAL COMPETING INTERESTS

The authors report no competing interests.

Abbreviations and Acronyms: **CT,** computed tomography; **CTA,** computer tomogram angiography; **DTN,** door-to-needle; **HIS,** in-hospital stroke; **MRI,** magnetic resonance imaging; **NIHSS,** National Institute of Health Stroke Scale; **OHS,** out-of-hospital stroke; **RN,** registered Nurse; **SD,** standard deviation

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