Use of Emergency Medical Services and Timely Treatment Among Ischemic Stroke

Findings From the China Stroke Center Alliance

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Background and Purpose—Emergency medical services (EMSs) are critical for early treatment of patients with ischemic stroke, yet data on EMS utilization and its association with timely treatment in China are still limited.

Methods—We examined data from the Chinese Stroke Center Alliance for patients with ischemic stroke from June 2015 to June 2018. Absolute standardized difference was used for covariates' balance assessments. We used multivariable logistic models with the generalized estimating equations to account for intrahospital clustering in identifying demographic and clinical factors associated with EMS use as well as in evaluating the association of EMS use with timely treatment.

Results—Of the 560 447 patients with ischemic stroke analyzed, only 69 841 (12.5%) were transported by EMS. Multivariable-adjusted results indicated that those with younger age, lower levels of education, less insurance coverage, lower income, lower stroke severity, hypertension, diabetes mellitus, and peripheral vascular disease were less likely to use EMS. However, a history of cardiovascular diseases was associated with increased EMS usage. Compared with self-transport, EMS transport was associated with significantly shorter onset-to-door time, door-to-needle time (if prenotification was sent), earlier arrival (adjusted odds ratio [95% CIs] were 2.07 [1.95–2.20] for onset-to-door time ≤2 hours, 2.32 [2.18–2.47] for onset-to-door time ≤3.5 hours), and more rapid treatment (2.96 [2.88–3.05] for IV-tPA [intravenous recombinant tissue-type plasminogen activator] in eligible patients, 1.70 [1.62–1.77] for treatment with IV-tPA by 3 hours if onset-to-door time ≤2 hours, and 1.76 [1.70–1.83] for treatment with IV-tPA by 4.5 hours if onset-to-door time ≤3.5 hours).

Conclusions—Although EMS transportation is associated with substantial reductions in prehospital delay and improved likelihood of early arrival and timely treatment, rate of utilization is currently low among Chinese patients with ischemic stroke. Developing an efficient EMS system and promoting culture-adapted education efforts are necessary for improving EMS activation. **(*Stroke*. 2019;50:1013-1016. DOI: 10.1161/STROKEAHA.118.024232.)**

Key Words: China ■ emergency medical services ■ prehospital delay ■ stroke ■ thrombolytic therapy

Stroke is the leading cause of death in China.[1] Over 70% of prevalent strokes in China are ischemic,[2] for which thrombolytic therapy is the most effective evidence-based treatment.[3] However, prehospital or in-hospital delay may preclude the use of thrombolytics and weaken the treatment effect. Previous studies in high-income countries indicated that emergency medical service (EMS) utilization was independently associated with shorter prehospital delay and more rapid treatment.[4–6] Although several studies reported on EMS utilization in China, they were limited to 1 province or several cities and lacked timely treatment measures.[7,8] A national program aimed at bridging gaps between guideline recommendations and clinical practices named the Chinese Stroke Center Alliance was sponsored and launched in 2015.[9] In this study, we address the urgent need to use this national-level data to describe the pattern of EMS utilization, identify associated

Received October 10, 2018; final revision received January 30, 2019; accepted February 12, 2019.

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The online-only Data Supplement is available with this article at https://www.ahajournals.org/doi/suppl/10.1161/STROKEAHA.118.024232.

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factors with EMS activation, and assess the association between EMS utilization and timeliness of arrival and treatment.

Methods

The data that support the findings of this study are available from the corresponding author upon request.

Details of Chinese Stroke Center Alliance program have been previously reported elsewhere.[9] All participating hospitals received research approval to collect data without requiring individual patient informed consent under the common rule or a waiver of authorization and exemption from their institutional review board. Study population (Figure I in the online-only Data Supplement), study variables, and definitions are described in the Methods in the online-only Data Supplement. Given the extensive data set, comparison using $P<0.05$ indicates statistical significance but may not have any clinical significance. Therefore, baseline characteristics were compared using absolute standardized differences with absolute standardized difference ≥10 considered to be clinically significant.[10] We used generalized estimating equations logistic regression modeling with adjustment for within-hospital clustering in both unadjusted and adjusted models. Sensitivity analyses among cases with documented-only or with mode-imputed National Institutes of Health Stroke Scale scores were conducted to determine whether findings are different from primary results.

Results

Among the 560 447 patients with ischemic stroke from 1955 hospitals (Table I in the online-only Data Supplement), only 69 841 (12.5%) were EMS transported. No regional discrepancies were found (Figure II in the online-only Data Supplement). Compared with EMS-transported patients, self-transported patients were younger, had lower monthly income, milder stroke severity, and were less likely to have a history of cardiovascular diseases such as atrial fibrillation/flutter, coronary heart disease/myocardial infarction and heart failure (Table II in the online-only Data Supplement).

All covariates other than gender and carotid stenosis were statistically significantly associated with EMS usage. Strong predictors of EMS usage were cardiovascular diseases, such as atrial fibrillation/flutter, heart failure, coronary heart disease/myocardial infarction, and dyslipidemia. Lower stroke severity was the most substantial barrier to EMS use. Other factors associated with less EMS activation were shown in Figure 1. Similar findings were obtained in sensitivity analyses (Table III in the online-only Data Supplement).

EMS-transported patients experienced significantly shorter prehospital delay than self-transported patients. However, we did not observe superiority of EMS transportation in the door-to-needle time measure (Table). Nevertheless, if prehospital notification had been sent, there would be fewer minutes of in-hospital delay (61 [40–91] versus 65 [45–95]; $P=0.0001$). The proportion of patients with an onset-to-door

Variables	Unadjusted OR (95% CI)	Results P Value	Adjusted OR (95% CI)	Results* P Value
Age (Ref: ≥65)				
<45	0.83 (0.80–0.87)	<.0001	0.94 (0.90–0.99)	0.0124
45–64	0.76 (0.75–0.77)	<.0001	0.88 (0.86–0.89)	<.0001
Women vs. men	1.10 (1.09–1.12)	<.0001	1.01 (0.99–1.03)	0.1909
Education (Ref: College)				
High school	0.93 (0.89–0.97)	0.0007	0.95 (0.91–1.00)	0.032
Below elementary	0.94 (0.90–0.99)	0.0094	0.89 (0.85–0.94)	<.0001
Unclear	0.67 (0.64–0.70)	<.0001	0.75 (0.71–0.79)	<.0001
Insurance (Ref: UEMIS)				
URMIS	0.91(0.89–0.93)	<.0001	0.90 (0.88–0.92)	<.0001
NRCMS	0.89 (0.87–0.90)	<.0001	0.90 (0.88–0.92)	<.0001
Self–payment	0.98 (0.94–1.01)	0.1324	1.01 (0.97–1.04)	0.766
Others	0.79 (0.75–0.82)	<.0001	0.80 (0.77–0.84)	<.0001
Income (Ref:≥5001)				
≤1000	0.86(0.83–0.90)	<.0001	0.91 (0.88–0.95)	<.0001
1001–5000	0.83(0.79–0.86)	<.0001	0.88 (0.84–0.92)	<.0001
Unclear	0.63 (0.61–0.66)	<.0001	0.77 (0.74–0.80)	<.0001
NIHSS at admission (Ref: ≥15)				
Not documented	0.21 (0.20–0.22)	<.0001	0.25 (0.24–0.26)	<.0001
0–4	0.16 (0.15–0.16)	<.0001	0.18 (0.18–0.19)	<.0001
5–14	0.36 (0.35–0.37)	<.0001	0.40 (0.39–0.41)	<.0001
Atrial fib/flutter	2.86 (2.78–2.93)	<.0001	1.97 (1.91–2.03)	<.0001
Stroke/TIA	1.05 (1.03–1.07)	<.0001	0.95 (0.93–0.96)	<.0001
Carotid stenosis	1.19 (1.11–1.27)	<.0001	1.03 (0.96–1.10)	0.408
CHD/MI	1.50 (1.46–1.53)	<.0001	1.23 (1.20–1.26)	<.0001
Heart failure	2.60 (2.45–2.76)	<.0001	1.30 (1.22–1.39)	<.0001
Hypertension	0.98 (0.96–0.99)	0.0075	0.97 (0.95–0.98)	<.0001
Diabetes mellitus	0.94 (0.92–0.96)	<.0001	0.93 (0.91–0.95)	<.0001
Dyslipidemia	1.19 (1.16–1.22)	<.0001	1.15 (1.12–1.19)	<.0001
PVD	1.08 (1.02–1.15)	0.006	0.86 (0.81–0.92)	<.0001

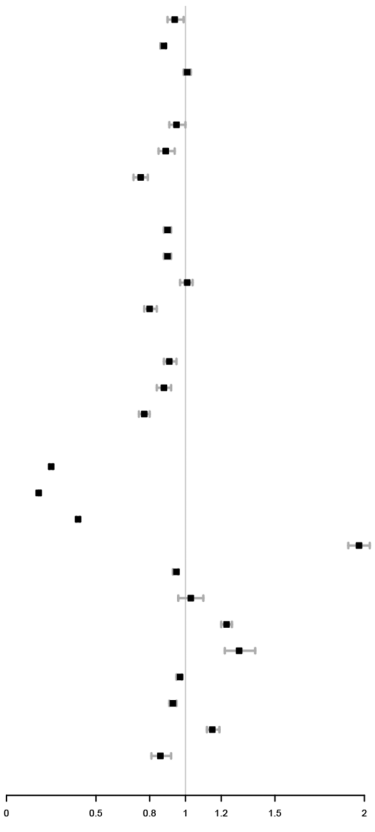

Figure 1. Factors associated with emergency medical service (EMS) usage. *Adjusted for age, gender, education, insurance, family monthly income per capita, National Institutes of Health Stroke Scale (NIHSS) at admission, history of coronary heart disease (CHD)/myocardial infarction (MI), atrial fib/flutter, stroke/transient ischemic attack (TIA), heart failure, hypertension, carotid stenosis, diabetes mellitus, dyslipidemia, and peripheral vascular disease (PVD) when it is appropriate. NRCMS indicates new rural cooperative medical scheme; UEMIS, urban employ medical insurance scheme; and URMIS, urban residents medical insurance scheme.

Table. Timeline Comparison Between Self-Transport and EMS Transport

Timeline Measure	Eligible Patients	Median (IQR), min		*P*
		Self-Transport	EMS Transport	
Onset-to-door time	514 140	1300 (243–3099)	271 (109–1379)	<0.0001
Door-to-needle time*	24 542	62 (40–94)	62 (40–93)	0.6994
Onset-to-needle time*	24 542	171 (127–220)	169 (125–215)	0.0002

EMS indicates emergency medical services; and IQR, interquartile range.

*Nine hundred sixty-nine patients with undocumented needle time were excluded from 25 510 IV-tPA (intravenous recombinant tissue-type plasminogen activator) patients from this analysis.

time ≤2 hours among EMS-transported patients was almost 2-fold that of self-transported patients (30.2% versus 15.1%, *P*<0.0001). The adjusted results indicated that compared with self-transported patients, EMS transportation was associated with a 2.07-fold (95% CI, 1.95–2.20) or 2.32-fold (95% CI, 2.18–2.47) higher likelihood of onset-to-door time ≤2 hours or onset-to-door time ≤3.5 hours, respectively. EMS-transported patients were nearly 3× (adjusted odds ratio, 2.96; 95% CI, 2.88–3.05) more likely to receive IV-tPA (intravenous recombinant tissue-type plasminogen activator). Similar results were found in treatment with IV-tPA within 3 hours among eligible patients with onset-to-door time ≤2 hours (adjusted odds ratio, 1.70; 95% CI, 1.62–1.77) or treatment with IV-tPA within 4.5 hours among eligible patients with onset-to-door time ≤3.5 hours (adjusted odds ratio, 1.76; 95% CI, 1.70–1.83) (Figure 2). Sensitivity analyses yielded similar results (Tables IV and V in the online-only Data Supplement).

Discussion

EMS is strongly recommended for timely arrival and rapid treatment of patients with stroke in the recent guidelines from the American Heart Association and American Stroke Association.[11] However, <13% of patients with ischemic stroke were transported to the hospital by EMS in our study, which was much lower than 59.6% in the DASH II Study (The Second Delay in Accessing Stroke Healthcare) or 63.7% in the Get With The Guidelines-Stroke program.[4,12]

We identified several factors associated with decreased use of EMS, including lower stroke severity, younger age, and lower educational attainment. However, the underlying reason for these characteristics' association with lower EMS utilization cannot be determined by our data at this time. A possible explanation may be the lack of accessibility to EMS or lack of awareness of the need for urgent stroke treatment. Developing a more efficient EMS system and promoting culture-adapted stroke education programs, such as Stroke 1-2-0, on timely recognition of stroke and awareness of the importance of EMS activation are needed to address these disparities.[13,14]

Our study has some limitations. This observational study is based on hospitals' voluntary enrollment and does not have an elaborately designed sampling frame. However, the large sample size and the generalized estimating equations model help improve the robustness and generalizability of the study. We do not have data on distance traveled from symptom onset to the hospital so we could not assess the relationship between distance and prehospital delay. However, other studies have shown that EMS transportation is associated with

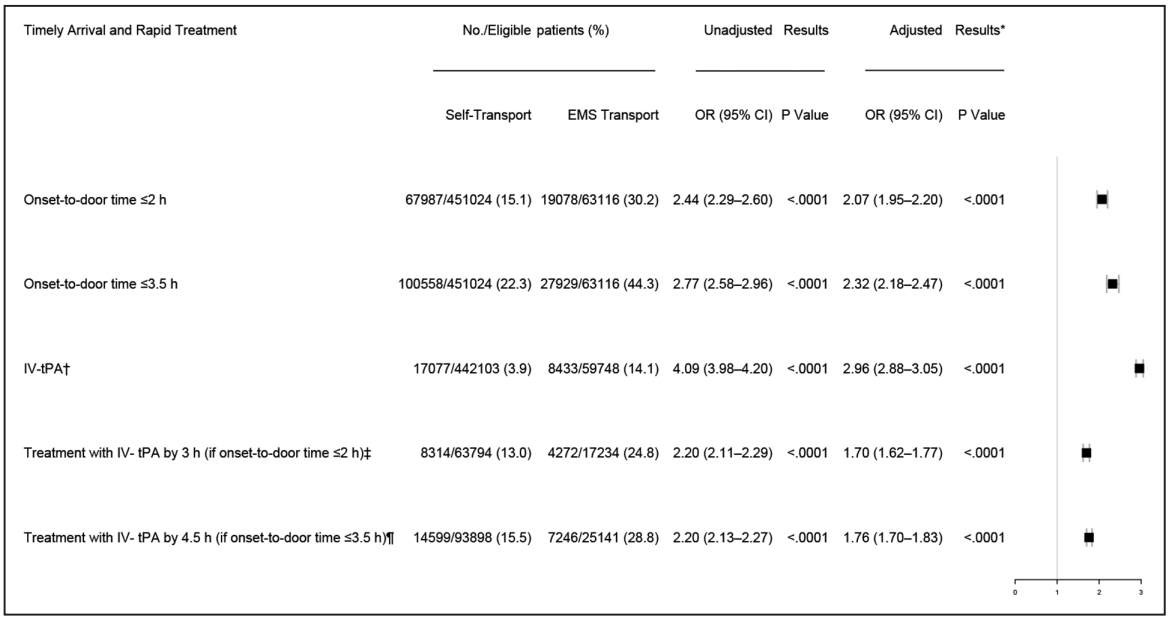

Figure 2. Association between emergency medical service (EMS) and Timely Arrival and Rapid Treatment. *Adjusted for age, gender, National Institutes of Health Stroke Scale (NIHSS) at admission, history of atrial fib/flutter, stroke or transient ischemic attack, heart failure, carotid stenosis, coronary heart disease or myocardial infarction, hypertension, diabetes mellitus, dyslipidemia, and peripheral vascular disease. †Patients (12 289; 8921 by self-transport and 3368 by EMS transport) with contraindications to IV-tPA (intravenous recombinant tissue-type plasminogen activator) within the time window were excluded from this analysis. ‡Patients (6037; 4193 by self-transport and 1844 by EMS transport) with contraindications to IV-tPA within the time window were excluded from this analysis. ¶Patients (9448; 6660 by self-transport and 2788 by EMS transport) with contraindications to IV-tPA within the time window were excluded from this analysis. OR indicates odds ratio.

shorter prehospital delay regardless of geographic distance.[6] Finally, undocumented National Institutes of Health Stroke Scale scores, symptoms or arrival time data may introduce selection bias. To address this issue, Tables VI and VII in the online-only Data Supplement comparing characteristics were provided and results showed comparable covariates. Results from the sensitivity analysis also confirmed the robustness of our primary analysis.

Conclusions

Our study showed that only 1 in 8 patients with ischemic stroke was EMS transported to the hospital, a proportion that is much lower than that of high-income countries. EMS usage is associated with shorter prehospital delay and a higher likelihood of timely treatment. To improve EMS activation, more emphasis should be placed on developing an efficient EMS system and promoting culture-adapted stroke education programs.

Acknowledgments

We thank all participating centers in the Chinese Stroke Center Alliance program for their hard work in data collection.

Sources of Funding

This work was supported by grants from National Key R&D Program of China (2017YFC1310901, 2016YFC0901001, 2016YFC0901002), National Natural Science Foundation of China (81600999).

Disclosures

None.

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