Substantial Progress Yet Significant Opportunity for Improvement in Stroke Care in China

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Background and Purpose—Stroke is a leading cause of death in China. Yet the adherence to guideline-recommended ischemic stroke performance metrics in the past decade has been previously shown to be suboptimal. Since then, several nationwide stroke quality management initiatives have been conducted in China. We sought to determine whether adherence had improved since then.

Methods—Data were obtained from the 2 phases of China National Stroke Registries, which included 131 hospitals (12 173 patients with acute ischemic stroke) in China National Stroke Registries phase 1 from 2007 to 2008 versus 219 hospitals (19 604 patients) in China National Stroke Registries phase 2 from 2012 to 2013. Multiple regression models were developed to evaluate the difference in adherence to performance measure between the 2 study periods.

Results—The overall quality of care has improved over time, as reflected by the higher composite score of 0.76 in 2012 to 2013 versus 0.63 in 2007 to 2008. Nine of 13 individual performance metrics improved. However, there were no significant improvements in the rates of intravenous thrombolytic therapy and anticoagulation for atrial fibrillation. After multivariate analysis, there remained a significant 1.17-fold (95% confidence interval, 1.14–1.21) increase in the odds of delivering evidence-based performance metrics in the more recent time periods versus older data. The performance metrics with the most significantly increased odds included stroke education, dysphagia screening, smoking cessation, and antithrombotics at discharge.

Conclusions—Adherence to stroke performance metrics has increased over time, but significant opportunities remain for further improvement. Continuous stroke quality improvement program should be developed as a national priority in China. **(*Stroke*. 2016;47:2843-2849. DOI: 10.1161/STROKEAHA.116.014143.)**

Key Words: China ■ hospitals ■ quality improvement ■ registries ■ stroke

Stroke remains to be the leading cause of mortality in China and was responsible for ≈1.9 million deaths in 2013.[1] Despite advances in diagnosis and treatments for stroke, adherence to evidence-based stroke care has been suboptimal based on several national studies conducted before 2009.[2,3] Since then, improving the quality of stroke care has become

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a national priority.[4] This interest has led to several quality management initiatives by the China Ministry of Health after 2008 to promote adherence to guideline-recommended performance measures for acute ischemic stroke.[4–8]

We sought to assess the change in the quality of acute ischemic stroke care by comparing the adherence to guideline-recommended performance measures before 2009 with that after the implementation of these initiatives since 2009.

Methods

China National Stroke Registries

The China National Stroke Registry (CNSR) is a national hospital-based, prospective stroke registry.[9] Data collected among 131 hospitals during September 2007 to August 2008 were used as CNSR phase 1 or the baseline for the current study. CNSR phase 2 was launched during June 2012 to January 2013 and consisted of 219 hospitals. Among them, 72 hospitals participated in both CNSR phase 1 and 2, 59 sites only in CNSR phase 1 and 147 hospitals only in phase 2. These 147 hospitals were selected by a Steering Committee using a convenient sampling method from the China National Network of Stroke Research developed by the National Center of Quality Management in Stroke Care including 491 hospitals and matched based on the comparability of the data from the 2007 to 2008 data, including geographic region, teaching status, hospital beds, and annual stroke discharges. The flow chart of the study is shown in Figure 1. The study was approved by the Institutional Review Board of the Beijing Tiantan Hospital.

Case Identification and Data Abstraction

Trained research co-ordinators at each site examined all medical records of stroke patients to identify eligible cases for the registries. Adult inpatients (≥18 years of age) with acute ischemic stroke at admission as evidenced by brain computed tomography or magnetic resonance imaging were included. Informed consent was obtained from patients or legal representatives. All subjects received an evaluation using the National Institutes of Health Stroke Scale within 24 hours of hospital admission. The following variables are extracted from medical documents: patient demographics, onset-to-door time, health insurance schemes[10] (urban basic medical insurance schemes for urban and governmental employees and urban residents, new rural cooperative medical schemes for rural residents, commercial insurance, and self-payment), vascular risk factors, and implementation of performance measures for acute stroke care, final diagnosis, length of stay, modified Rankin scale at discharge, and in-hospital death. Hospital-level information included geographic region (eastern, central, and western areas according to the annual report on health statistics of China[11]), teaching status, hospital bed size, and annual stroke volume. The definitions of the variables were described in the Table I in the online-only Data Supplement.

Quality Measures for Stroke Care and Prevention

A total of 13 guideline-recommended performance metrics were prespecified for this study by the Steering Committee based on the national standards, guidelines' recommendations,[6–8] and Get With The Guidelines-Stroke (GWTG-Stroke),[12] including 6 acute performance measures: (1) intravenous tissue-type plasminogen activator (tPA) in patients who arrive within 2 hours after symptom onset and treated within 3 hours, (2) antithrombotic medication within 48 hours of admission, (3) deep vein thrombosis prophylaxis within 48 hours of admission for nonambulatory patients, (4) dysphagia screening before any oral intake, (5) carotid imaging, (6) assessment or receiving of rehabilitation and 7 performance measures at discharge: (1) antithrombotic medication, (2) anticoagulation for atrial fibrillation, (3) antihypertensive medication for patients with hypertension, (4) medications for lowering low-density lipoprotein ≥100 mg/dL, (5) hypoglycemia medication for diabetes mellitus, (6) smoking cessation, and (7) stroke education (Table II in the online-only Data Supplement).

A composite score was developed and defined as the total number of interventions actually performed among eligible patients divided by the total number of recommended interventions among eligible patients.[12]

Statistical Analyses

Both patient and hospital characteristics were reported as median with interquartile ranges for continuous variable and as frequency and percentage for categorical variables by 2 study period, CNSR phase 1 (2007–2008) and phase 2 (2012–2013). The differences are tested by χ^2 tests for categorical variables and Wilcoxon rank-sum test for continuous variables.

The primary outcomes were the difference in adherence to the guideline-based performance measures between the 2 study periods, as reflected, respectively, by 13 individual measures, the composite score, and the odds of fulfilling care opportunities for eligible performance measures as described in previous research.[13] As for the odds of fulfilling care opportunities, each measure for which a patient was eligible contributed an observation in the analysis, and the outcome was a dichotomized (1: measure met versus 0: measure not met).[13] For example, if a particular patient was eligible for 6 of the 8 performance measures and only received 3 of them, this patient contributed 6 observations to the analysis. Multiple regression models were developed to evaluate the difference in adherence to performance measure between the 2 study periods. These analyses adjusted for patient and hospital characteristics, including age, race, sex, insurance schemes, previous stroke/transient ischemic attack, diabetes mellitus, hypertension, dyslipidemia, coronary heart disease/previous myocardial infarction, atrial fibrillation, ever smoking, stroke severity, hospital geographic region, teaching status, number of hospital beds, and annual stroke discharges. Generalized estimating equations were used to account for within-hospital clustering.

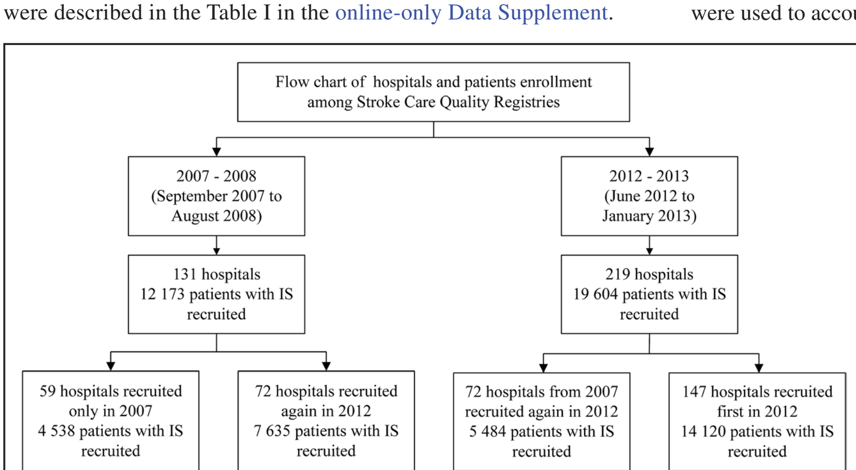

Figure 1. Flow chart of hospitals and patients enrollment among Stroke Care Quality Registries. IS indicates ischemic stroke.

The primary analysis included all hospitals in the CNSR phase 1 and 2. A sensitivity analysis was performed in 72 hospitals participated in both CNSR phase 1 and 2.

All tests are 2-tailed with $P<0.05$ regarded as the level of statistical significance. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Hospital and Patient Characteristics: 2007 to 2008 Versus 2012 to 2013

A total of 278 hospitals were included, among which 72 (25.9%) hospitals participated in both time periods. Proportion of teaching hospitals, regional representation, average hospital bed size, and annual stroke discharge volume were similar between 2007 to 2008 and 2012 to 2013 ($P>0.05$; Table III in the online-only Data Supplement).

A total of 31 777 subjects were included in the analysis: 12 173 from the 131 hospitals in the 2007 to 2008 data set and 19 604 patients from the 219 hospitals in the 2012 to 2013 data set. Patient demographics, medical insurance types, and vascular risk factors are compared in Table 1. Because of large sample size, many of the difference are statistically significant but may not be clinically meaningful. Generally, patients in the 2012 to 2013 data set were slightly younger (median 65 versus 67), were more likely to have new rural cooperative medical schemes insurance (39.5% versus 16.8%), and had less severe stroke (National Institutes of Health Stroke Scale; median 4 versus 5). Similar trend of characteristics above was also observed in patients admitted to 72 hospitals that participated in both CNSR phase 1 and 2 (Table IV in the online-only Data Supplement). As for stroke-related in-hospital outcomes, patients in the 2012 to 2013 data set had a shorter length of stay, better functional outcome at discharge (modified Rankin scale ≤2), and a lower rate of the in-hospital death (all $P<0.001$; Table 1).

Adherence to Performance Measures: 2007 to 2008 Versus 2012 to 2013

Adherence to each individual performance measure and the composite measure during the 2 study periods

Table 1. Patient Characteristics Between 2 Phases of Stroke Care Quality Registries (2007 to 2008 and 2012 to 2013)

	Level	All Participating Hospitals		*P* Value
		2007–2008, n (%)	2012–2013, n (%)	
Demographics				
Age, y	Median (IQR)	67 (57–75)	65 (57–74)	<0.001
Race	Han	11 799 (96.9)	18 980 (96.8)	0.596
	Non-Han	374 (3.1)	624 (3.2)	
Sex	Male	7513 (61.7)	12 437 (63.4)	0.002
	Female	4660 (38.3)	7167 (36.3)	
Insurance scheme	UBMIS	7429 (61.0)	10 021 (51.1)	<0.001
	NRCMS	2039 (16.8)	7747 (39.5)	
	Commercial	397 (3.3)	69 (0.4)	
	Self-payment	2308 (19.0)	1767 (9.0)	
Medical history				
Previous stroke/TIA	Yes	4152 (34.1)	6979 (35.6)	0.007
Diabetes mellitus	Yes	2625 (21.6)	4060 (20.7)	0.069
Hypertension	Yes	7780 (63.9)	12 697 (64.8)	0.121
Dyslipidemia	Yes	1369 (11.2)	2370 (12.1)	0.023
CHD/previous MI	Yes	1764 (14.5)	2655 (13.5)	0.018
Atrial fibrillation	Yes	901 (7.4)	1382 (7.0)	0.237
Ever smoking	Yes	4845 (39.8)	8672 (44.2)	<0.001
Onset-to-door time, h	Median (IQR)	24.0 (9.0–72.0)	22.0 (5.5–53.5)	<0.001
NIHSS at admission	Median (IQR)	5 (2–9)	4 (2–7)	<0.001
In-hospital outcomes				
Length of stay, d	Median (IQR)	14 (11–20)	13 (9–16)	<0.001
mRS ≤2 at discharge	Yes	8190 (67.3)	14 712 (75.0)	<0.001
In-hospital mortality	Yes	496 (4.1)	222 (1.1)	<0.001

CHD indicates coronary heart disease; IQR, interquartile range; MI, myocardial infarction; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale; NRCMS, new rural cooperative medical schemes; TIA, transient ischemic attack; and UBMIS, urban basic medical insurance schemes.

are shown in Figure 2 and Table 2. The composite measure was increased from 0.63 in 2007 to 2008 to 0.76 in 2012 to 2013 ($P<0.001$). After adjusting for patient and hospital characteristics, multilevel model by using generalized estimated equations method analysis showed significant improvements in the composite measure and all 9 individual performance measures (Table 2). There was no statistically significant improvement in intravenous thrombolytics (18.3% versus 14.1%), early antithrombotics (84.6% versus 80.3%), deep vein thrombosis prophylaxis (65.0% versus 59.6%), and anticoagulation for atrial fibrillation (21.0% versus 19.7%), either in the unadjusted or adjusted analysis (Table 2).

Overall, there was 1.17-fold increase in the odds of receiving each performance measure between 2007 to 2008 and 2012 to 2013 after adjusting patients' and hospitals' characteristics. The top 4 performance metrics with the significantly increased odds included stroke education, dysphagia screening, smoking cessation, and antithrombotics at discharge. The increase in the odds of fulfilling care opportunities between 2007 to 2008 and 2012 to 2013 was consistent across all subtypes of hospitals ($P>0.05$ for all comparisons) except geographic region (Western versus Eastern: odds ratio=1.04; 95% confidence interval, 1.00–1.08; $P=0.038$; Table V in the online-only Data Supplement).

Sensitivity analysis of 72 hospitals participating in both phase 1 and 2 also revealed substantial improvements in the composite measure. Nine of the 13 individual performance measures (except for intravenous thrombolysis, early antithrombotics, deep vein thrombosis prophylaxis, and anticoagulation for atrial fibrillation) were improved (Table 2). Multivariate generalized estimated equations analysis revealed a 1.21-fold increase in the odds of receiving each performance measure from 2007 to 2012 (Table V in the online-only Data Supplement).

Discussion

In the current study, we observed a marked improvement in overall adherence to guideline-recommended performance measures after implementing several quality management initiatives nationwide in China. Significant improvements were observed in the composite score and 9 out of 13 individual performance measures in the overall hospitals and in 72 hospitals participating in both CNSR phase 1 and 2.

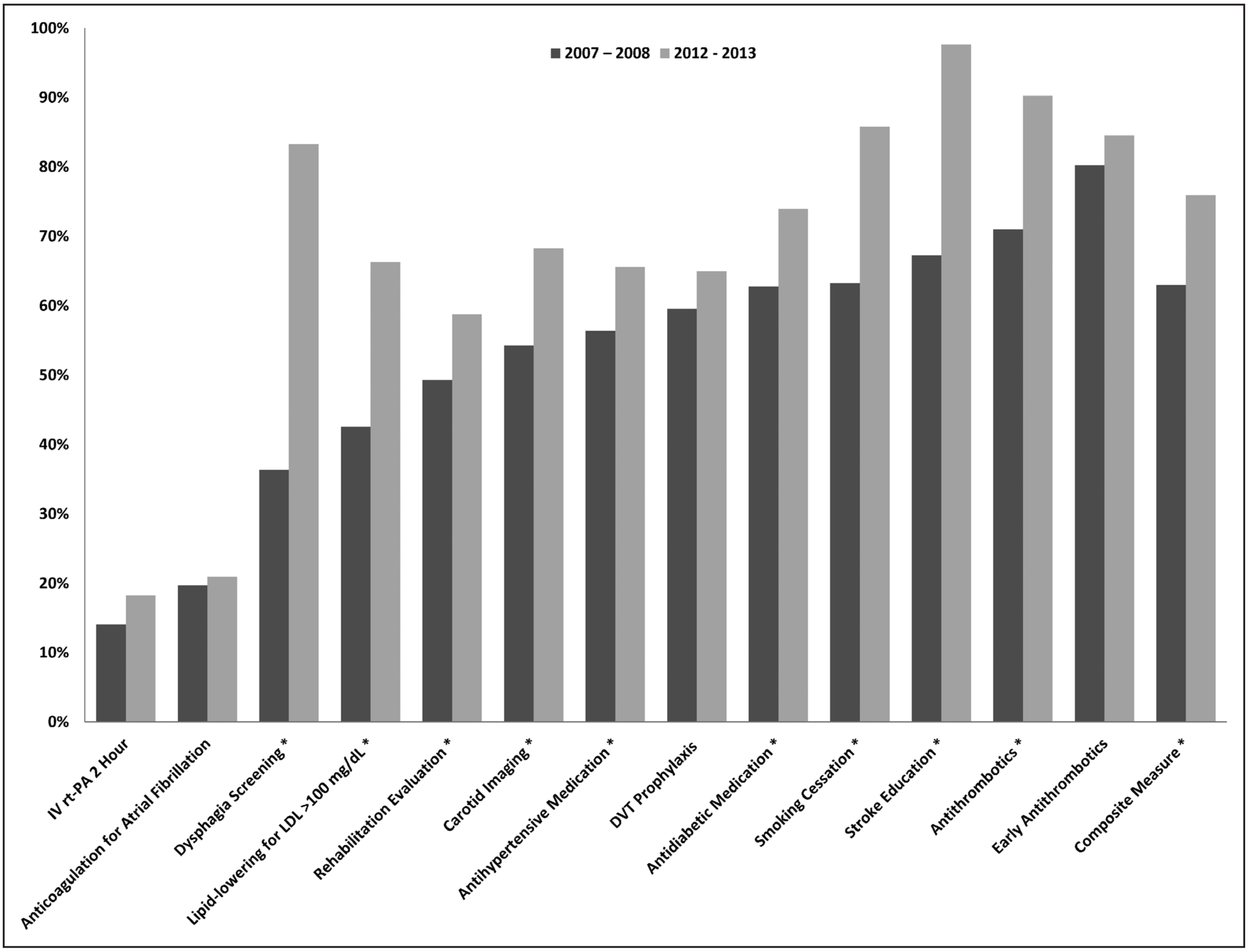

Figure 2. Improvement in the stroke care quality displayed as the composite measure and the percentage of eligible patients who received each guideline-recommended performance metric from 2007 to 2012. DVT indicates deep vein thrombosis; IV tPA, intravenous tissue-type plasminogen activator; and LDL, low-density lipoprotein. *These performance measures and composite score were increased significantly between 2007 to 2008 and 2012 to 2013 ($P<0.05$).

Table 2. Improvement of the Adherence to Performance Measures in Acute Ischemic Stroke Care and Prevention From 2007 to 2012

	All Participating Hospitals				Seventy-Two Hospitals Participating in Both CNSR Phase 1 and 2			
	2007–2008	2012–2013	Unadjusted	Adjusted for Patient and Hospital* Characteristics	2007–2008	2012–2013	Unadjusted	Adjusted for Patient and Hospital* Characteristics
Performance measures	Adherence rate, % (N1/N2)†	Adherence rate, % (N1/N2)	OR (95% CI)	OR (95% CI)	Adherence rate, % (N1/N2)	Adherence rate, % (N1/N2)	OR (95% CI)	OR (95% CI)
Acute performance measures‡								
IV r-tPA 2 h	14.1 (120/1203)	18.3 (243/1326)	1.36 (0.85–2.16)	1.59 (0.99–2.56)	15.1 (102/675)	23.9 (89/373)	1.76 (0.93–3.32)	2.03 (0.99–4.18)
Early antithrombotics	80.3 (9706/12 090)	84.6 (16 149/19 093)	1.34 (0.83–2.16)	1.17 (0.78–1.77)	81.3 (6169/7586)	88.7 (4711/5311)	1.79 (0.94–3.40)	1.55 (0.83–3.00)
DVT prophylaxis	59.6 (2769/4643)	65.0 (3556/5474)	1.25 (0.86–1.81)	1.32 (0.92–1.90)	61.8 (1788/2893)	71.8 (1176/1638)	1.56 (0.81–3.01)	1.54 (0.85–2.79)
Carotid imaging	54.3 (6339/11 677)	68.3 (13 239/19 382)	1.81 (1.31–2.50)	1.81 (1.34–2.46)	55.6 (4092/7354)	70.4 (3809/5409)	1.89 (1.10–3.26)	2.37 (2.17–2.59)
Dysphagia screening	36.4 (4406/12 090)	83.3 (15 360/18 444)	8.68 (5.72–13.1)	7.69 (4.99–11.89)	35.1 (2637/7518)	79.3 (4083/5148)	7.11 (3.45–14.69)	8.35 (7.59–9.20)
Rehabilitation evaluation	49.3 (5757/11 677)	58.8 (18 939–19 382)	1.46 (1.07–1.98)	1.42 (1.07–1.91)	48.1 (3534/7354)	59.8 (3234/5409)	1.60 (1.03–2.49)	1.75 (1.61–1.89)
Discharge performance measures‡								
Antithrombotics	71.0 (8285/11 677)	90.3 (16 021/17 743)	3.80 (2.70–5.36)	2.99 (2.05–4.38)	71.0 (5221/7354)	89.1 (4598/5162)	3.33 (1.84–6.02)	3.21 (2.87–3.60)
Anticoagulation for atrial fibrillation	19.7 (221/1124)	21.0 (332/1578)	1.08 (0.82–1.42)	0.97 (0.70–1.36)	18.3 (121/662)	24.4 (121/495)	1.44 (0.95–2.18)	1.40 (0.89–2.22)
Lipid-lowering drug for LDL >100 mg/dL	42.6 (2402/5634)	66.3 (8475/12 791)	2.64 (1.94–3.58)	2.72 (2.02–3.65)	43.1 (1584/3677)	69.0 (2507/3633)	2.94 (1.88–4.60)	3.05 (2.73–3.40)
Antihypertensive medication	56.4 (4620/8196)	65.6 (9684/14 758)	1.47 (1.19–1.82)	1.40 (1.16–1.69)	56.7 (2899/5114)	70.4 (2833/4025)	1.81 (1.28–2.56)	1.54 (1.40–1.70)
Antidiabetic medication	62.8 (1984/3159)	74.0 (3977/5371)	1.68 (1.25–2.26)	1.57 (1.22–2.01)	61.8 (1215/1965)	78.3 (1177/1504)	2.22 (1.55–3.18)	1.97 (1.66–2.34)
Smoking cessation	63.3 (2973/4694)	85.8 (7379/8600)	3.49 (2.36–5.17)	3.71 (2.68–5.14)	65.2 (1901/2914)	92.2 (2318/2514)	6.30 (3.60–11.01)	5.26 (4.39–6.32)
Stroke education	67.3 (7864/11 677)	97.7 (18 936/19 382)	20.58 (13.30–31.86)	18.78 (12.73–27.72)	66.6 (4900/7354)	98.0 (5299/5409)	24.12 (13.58–42.85)	19.66 (16.13–24.19)
Composite measure§	0.63 (0.43–0.78)	0.76 (0.70–0.89)	1.20 (1.16–1.25)	1.18 (1.14–1.22)	0.63 (0.44–0.78)	0.78 (0.71–0.89)	1.22 (1.16–1.28)	1.20 (1.19–1.21)

CI indicates confidence interval; CNSR, Chinese National Stroke Registry; DVT, deep vein thrombosis; GEE, generalized estimated equations; IV, intravenous; LDL, low-density lipoprotein; OR, odds ratio; and r-tPA, recombinant tissue-type plasminogen activator.

*Adjusted for patient characteristics of age, race, sex, insurance schemes, previous stroke/transient ischemic attack, diabetes mellitus, hypertension, dyslipidemia, coronary heart disease/previous myocardial infarction, atrial fibrillation, ever smoking, and stroke severity, and hospital characteristics of times of participating in the registries, geographic region, teaching status, number of hospital beds, and annual stroke discharges.

†N1 indicates the number of eligible patients receiving the performance measure. N2 represents the number of patients eligible for the performance measure.

‡Change of performance measures were tested by the logistic regression model using GEE accounting for within-hospital clustering.

§Composite measure by the linear regression model using GEE accounting for within-hospital clustering.

The improvement of individual performance measures and the composite score during the 5 years between 2 time periods was apparent even after adjusting for those previous reported patient' and hospital' variables affecting the care quality, such as age, sex, stroke severity, teaching status, and bed capacity.[13,14] Potential factors for this improvement of the quality of care between 2007 to 2008 and 2012 to 2013 were inferred. First, during these 5 years, improving the quality of stroke care became a national priority, and several quality management initiatives of stroke care were implemented nationwide.[4] These main interventions of the quality improvement included the establishment of the National Center of Quality Improvement in Stroke Care, the national guidelines for acute treatment and secondary prevention of stroke, organizational stakeholder and opinion leader meetings, hospital recruitment, collaborative workshops for hospital teams, and hospital tool kits.[4–8] These improvement tools were previously shown to be successful in continuously improving the quality of care in the GWTG-Stroke.[12,13] The sensitivity analysis of the 72 hospitals participating in both of 2 phases implied that the sustained participation in the quality improvement initiatives was associated with the better gains. Additionally, the health insurance coverage was improved over time, which could be an important factor for the significant improvement of stroke care quality.

Despite substantial improvement in stroke care quality over time, gaps in adherence to the guideline-based recommendation and clinical practice still exist, even among the top 3 performance measures of early antithrombotics (84.6% in 2012 CNSR versus 97.04% in 2007 GWTG-Stroke), discharge antithrombotics (90.3% in 2012 CNSR versus 98.88% in 2007 GWTG-Stroke), and lipid-lowering drug for low-density lipoprotein ≥100 mg/dL (66.3% in 2012 CNSR versus 88.29% in 2007 GWTG-Stroke).[13] Furthermore, the adherences to intravenous tPA use (18.3%) and anticoagulation for atrial fibrillation (21.0%) were still lowest in 2012 in China, which were far down from GWTG-Stroke (72.84% and 98.39% separately) in 2007. The potential reasons for the low implementation rate of intravenous tPA included the high cost of the tPA, the low health coverage rate, concern for safety of using intravenous tPA in China.[3] Stroke center certification has been proven to increase the use of thrombolytic therapy.[15] However, it was not developed in China. As for the prescription of warfarin, because of the narrow therapeutic margin and drug or food interactions of warfarin, frequent international normalized ratio testing and dose adjustments are required. In China, insufficiency of a comprehensive community health service makes frequent INR testing difficult. Additionally, physicians are concerned about the safety of using warfarin.[16] New oral anticoagulants are an alternative for warfarin and recommended by guidelines without monitoring INR and increasing the risk of hemorrhage.[17]

Increased compliance with acute stroke care and secondary prevention guideline-recommended performance metrics is associated with favorable outcomes.[18] Patients in the CNSR phase 2 had better functional outcome at discharge than those in CNRS phase 1. The median length of stay was reduced by 1 day. Meanwhile, the in-hospital mortality was decreased from 4.1% to 1.1%, which was consistent with the findings of the previous study among ischemic stroke patients in China from 2.48% to 1.47% from 2007 to 2010.[19] Patients in the 2012 to 2013 data set were younger and had lower National Institutes of Health Stroke Scale scores, which may decrease the risk of in-hospital death.[20] Second, these improvements of in-hospital outcomes may reflect the quality improvement of in-hospital stroke care and potentially contribute to decreases in the cost of care.[21] Additionally, several confounding factors related with in-hospital mortality should be considered, such as that some families of patients who have severe strokes may request to die at home based on previous wishes in China, the improvement in public awareness resulting in more patients arrived early and treated early, or even changes in length of stay. If stroke patients continue to comply with the prevention measures after discharge, a substantial decline in stroke recurrence may also be predicted according to clinical guidelines.[4,6,21] Additionally, given the enormous number of stroke inpatients each year in China, even superficially modestly increased odds of evidence-based health care will convert into enormously more healthcare opportunities to be implemented. These sustained improvements of the quality of care could translate into enormous cost savings in the long term.

Meanwhile, there exist several limitations in this study. First, some of the participating hospitals in 2012 had no baseline data of the quality of care in 2007. The possibility that hospitals in 2012 were simply better all along existed. To reduce this bias, the comparable basic structure characteristics of hospitals between the 2 phases were considered when we selected the potential participating sites in 2012. Improvements in stroke care quality after adjusting for patient- and hospital-level variables were still observed among those 72 returning hospitals, suggesting that the improvements are substantial. The potential reasons that part of the hospitals involved in CNSR phase 1 did not continue through phase 2 included that these quality improvement initiatives required hospitals to invest enough human, material, and funding resources. Second, observed differences of stroke care quality might also reflect the secular trend besides these stroke quality management initiatives themselves. Because stroke care quality was not consecutively recorded among the participating hospitals from 2007 to 2012, this change with time was not analyzed independently as was the case for the GWTG-Stroke.[13] The causal relationship between these initiatives and the improvement of the quality of care could not be established. To prevent these types of bias, a cluster-randomized trial of a targeted multifaceted intervention to bridge the evidence-based gap in the management of acute ischemic stroke in China is ongoing.[22] Additionally, the healthcare delivery varies widely in China, and hospitals voluntarily participating in the CNSRs and network may be interested in the stroke care quality improvement, so the observed findings may not represent the quality of care nationwide.

As the aging process of China's population structure is accelerating, the burden of stroke becomes increasingly heavy. Although improvement of stroke care quality is observed in this study, significant opportunities exist for further improvement. Continuous quality improvement of stroke care should be developed as a sustained priority in China. Efforts that increase the input of the financial and human resources to the stroke care, implement targeted initiatives for improvement of stroke care across the country, develop certification of stroke center, and strengthen physician and public knowledge may contribute to further improvements of the quality of care in China.

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Disclosures

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