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ORIGINAL ARTICLE

Stroke

Development of Quality Indicators of Stroke Centers and Feasibility of Their Measurement Using a Nationwide Insurance Claims Database in Japan
— J-ASPECT Study —

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Background: We aimed to develop quality indicators (QIs) related to primary and comprehensive stroke care and examine the feasibility of their measurement using the existing Diagnosis Procedure Combination (DPC) database.

Methods and Results: We conducted a systematic review of domestic and international studies using the modified Delphi method. Feasibility of measuring the QI adherence rates was examined using a DPC-based nationwide stroke database (396,350 patients admitted during 2013–2015 to 558 hospitals participating in the J-ASPECT study). Associations between adherence rates of these QIs and hospital characteristics were analyzed using hierarchical logistic regression analysis. We developed 17 and 12 measures as QIs for primary and comprehensive stroke care, respectively. We found that measurement of the adherence rates of the developed QIs using the existing DPC database was feasible for the 6 QIs (primary stroke care: early and discharge antithrombotic drugs, mean 54.6% and 58.7%; discharge anticoagulation for atrial fibrillation, 64.4%; discharge antihypertensive agents, 51.7%; comprehensive stroke care: fasudil hydrochloride or ozagrel sodium for vasospasm prevention, 86.9%; death complications of diagnostic neuroangiography, 0.4%). We found wide inter-hospital variation in QI adherence rates based on hospital characteristics.

Conclusions: We developed QIs for primary and comprehensive stroke care. The DPC database may allow efficient data collection at low cost and decreased burden to evaluate the developed QIs.

Key Words: Cerebrovascular disease; Performance measure; Quality and outcomes; Quality indicator; Stroke

In Japan, stroke is the 3rd leading cause of death and a leading cause of long-term disability. Recently, the quality of acute stroke care has received increasing attention worldwide. In the USA, several healthcare organizations have undertaken initiatives related to measuring and improving the quality of acute stroke care. In 2000, the American College of Cardiology/American Heart Association (ACC/AHA) published a report on the quality indicator (QI) of care for cardiovascular disease and stroke patients.[1] The Brain Attack Coalition published guidelines for

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certification of primary stroke centers (PSCs)[2] and comprehensive stroke centers (CSCs),[3] which includes structural and educational requirements. Both PSCs and CSCs were developed to provide optimal implementation of intravenous recombinant tissue plasminogen activator (rt-PA) infusions and more intensive stroke care that includes endovascular and neurosurgical treatments. The Joint Commission began developing performance measures for the certification of PSCs[4] and CSCs[5] in 2003 and 2011, respectively.

In the USA, the Get With the Guidelines (GWTG)–Stroke was developed as a national stroke quality improvement initiative to enhance adherence to evidence-based guidelines. Implementation of GWTG–Stroke was simultaneously associated with sustained and substantial absolute percentage improvements in acute stroke care.[6] Similar efforts to develop performance measures to promote the quality of acute stroke care have been reported in several other countries, including Canada,[7] the UK,[8] Germany,[9] Sweden,[10] and Denmark (**Supplementary Table 1**).[11] However, there is no consensus on the methodology used to measure the performance of acute stroke care related to PSCs and CSCs at a national level in a cost-effective manner.

The J-ASPECT study is the first nationwide survey of the real-world setting of acute stroke and neurosurgical practices using data obtained from Diagnosis Procedure Combination (DPC)-based payment systems in Japan. The J-ASPECT study group launched the Close The Gap–Stroke (CTGS) initiative, a nationwide quality improvement initiative in Japan to develop QIs for both PSCs and CSCs, considering the unique aspects of stroke care in Japan, and to continuously measure their adherence rates. In addition, we sought to determine the feasibility of measuring adherence rates for the developed QIs in a cost-effective manner, using the DPC data collected by the J-ASPECT study.

Methods

Procedures and Definitions of QIs for PSCs and CSCs

A standardized process for developing QIs was initiated by the research committee in 2015. They aimed to develop QIs for PSCs and CSCs that reflected basic (e.g., rt-PA therapy for acute ischemic stroke) and advanced (e.g., endovascular therapy for acute ischemic stroke or surgical treatment of hemorrhagic stroke) stroke care. Our method for developing these QIs was adapted from the RAND-University of California, Los Angeles Appropriateness Method (modified Delphi method).[12] This method involved the preparation of candidate QIs and a summarization of supporting evidence, followed by examination by a group of experts to determine whether these QIs had clinical validity and feasibility.

For the candidate QIs for PSCs, we performed systematic reviews of domestic and international studies. The search strategy identified articles published from 1990 to 2014 in MEDLINE. Key search terms included "Cerebrovascular Disorders" AND "Quality Indicators, Health Care" OR "Management Audit" OR "Process Assessment (Health Care)". In addition, we referred to the Japanese guidelines for stroke care[13] and existing QIs from other countries[4,7–11] for the selection of QI candidates.

As for the candidate QIs for CSCs, we focused on the core metrics of the Joint Commission,[14] and further selected candidates from the Class I Recommendations in the 2015 updated AHA/ASA guidelines for acute ischemic stroke regarding endovascular treatment.[15] We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[16]

We invited a multidisciplinary panel of 17 experts in the field of methodological QI development, acute stroke care, neurosurgery, neurology, endovascular surgery, and rehabilitation to assess the validity of the candidate indicators using the modified Delphi method. The QIs that received high ratings after a detailed face-to-face discussion remained in the final set (**Supplementary Table 2**).

Measurement of the Defined QIs Using the Nationwide DPC Database

As the initial step of this initiative, we sought to determine the feasibility of measuring the adherence rates of the developed QIs using the existing DPC database in the J-ASPECT Study to reduce the burden on hospitals. Of the 1,369 certified training institutions of the Japan Neurosurgical Society and the Japan Stroke Society, 558 hospitals responded to the DPC survey. Enrollment in the J-ASPECT study has increased progressively from January 2010 (**Figure 1**). The J-ASPECT study group has analyzed the DPC database to gain new clinical insights, an approach

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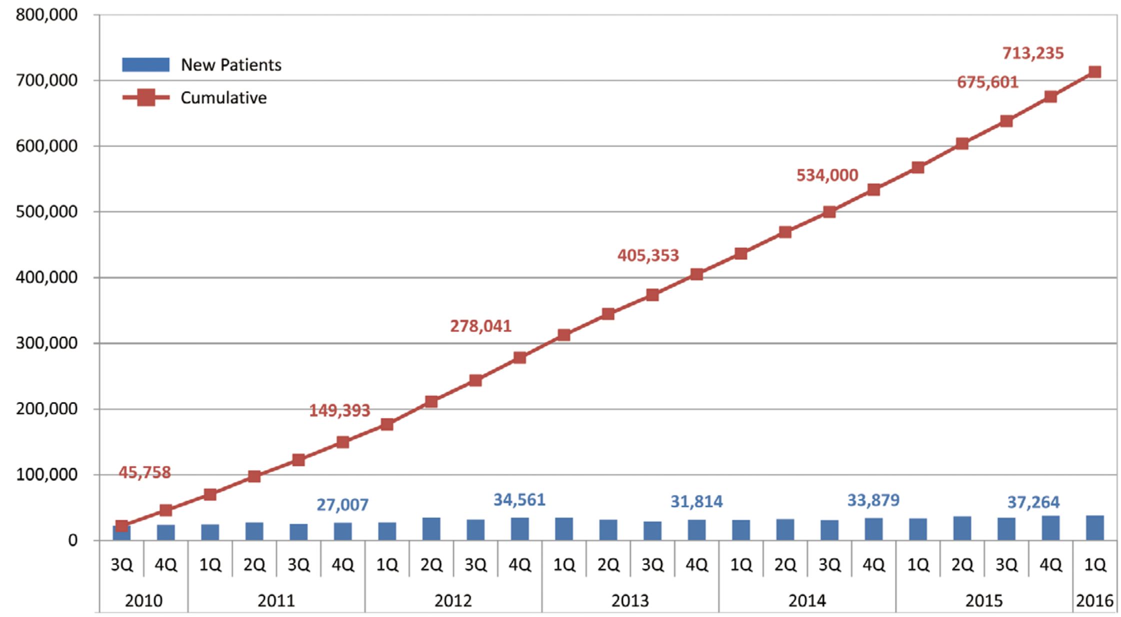

Figure 1. Enrollment in the J-ASPECT study. Quarterly and cumulative enrollment from April 2010 to August 2015.

we applied again for this cross-sectional survey. Details of the J-ASPECT study are reported elsewhere.[17] Briefly, the DPC is a mixed-case patient classification system that was launched in 2002 by the Japanese Ministry of Health, Labor and Welfare and linked to hospitals' financing system. The DPC database includes data on all patients admitted to participating hospitals, including each patient's profile (age, sex and level of consciousness at admission according to the Japan Coma Scale), principal diagnoses, comorbidities on admission, and complications after admission (coded by the International Classification of Diseases and Injuries, 10th revision); procedures including surgeries, medications, and devices used during hospitalization; length of stay; discharge status; and medical expenses. We used the DPC data generated during routine clinical practice in the J-ASPECT study as in other nationwide studies using DPC data.[18–20] To maximize the accuracy of the DPC data in the mixed-case patient classification system, at least one responsible physician (e.g., physicians in charge or residents) were required to record the information with respect to diagnoses and therapies on each patient's medical chart.[18] In the 2014 institutional survey of the J-ASPECT study, the mean numbers of board-certified physicians were 4, 3, 2, and 1 for the Japan Neurosurgical Society, the Japan Stroke Society, the Japanese Board of Neurology, and the Japanese Society for Neuroendovascular Therapy, respectively (unpublished observation). Responsible physicians in each hospital were not specifically recruited for the J-ASPECT study. The high validity of diagnoses and procedures has been reported by previous studies.[18,19,21] The adherence rates in each institution were classified as high (≥75%), intermediate (75–50%), or low (<50%) for descriptive purposes.[22,23] Further, associations between adherence rates and hospital characteristics (no. of annual hospital discharge and beds, academic status (university vs. non-university hospital), and CSC capability (CSC score)) were analyzed using hierarchical logistic regression analysis adjusted for age, sex, and severity (Japan Coma Scale score). The CSC score is the hospital's capability as a CSC; that is, total number of fulfilled recommended items for certification of CSC by the Brain Attack Coalition.[17]

Ethics Statement

This study was approved by the Kyushu University Institutional Review Board, which waived the requirement for informed consent from the participants.

Statistical Analysis

All continuous variables are presented as mean±SD or median (interquartile range; IQR) for variables with a skewed distribution. Analysis of variance was used to compare the means across multiple groups. Non-continuous and categorical variables are presented as frequencies or percentages, and were compared using the χ^2 test. We also examined the yearly QI compliance rates using the Cochran-Armitage trend test. The Bonferroni method was used to adjust the P-values in multiple testing, where appropriate. Hierarchical logistic regression analysis was used to investigate the associations of hospital characteristics (no. of stroke discharges [≥301 or not], no. of beds [≥300 or not], hospital type [academic or not], and CSC score [per 1-unit increase]) with QIs (PSC8, PSC9, PSC10, PSC12, and CSC12), adjusted for sex, age, and level of consciousness on admission according to the Japan Coma Scale. $P<0.05$ was considered to be statistically significant. The analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA) and STATA 14 (Stata Corp, College Station, TX, USA).

Results

QIs for PSCs

After the PUBMED database was screened, a total of 440 abstracts related to basic care of ischemic and hemorrhagic stroke or transient ischemic attacks (TIA) were identified (**Supplementary Figure**). In addition, 7 records for basic stroke care were identified from the guidelines of Japan and other countries.[4,7–11] Of these, 184 publications were analyzed in detail, 29 articles were selected on the basis of evidence of their relevance (Supplementary References), and 19 potential indicators were selected as candidate QIs for PSCs. Finally, 17 QIs were selected after discussion by the expert panel (**Table 1**).

Table 1. Quality Indicators Selected for the Close the Gap-Stroke Program

Indicator	Target population (denominator)	Treated patients (numerator)	Variable statement
QIs for primary stroke care			
1. NIHSS documentation	Patients with ischemic stroke Exclusion: <18 years of age	NIHSS score documented at the time of the initial admission note	
2. CT/MRI within 25 min of arrival	Patients with ischemic stroke arriving within 3.5 h of symptom onset Exclusion: <18 years of age	CT/MRI performed within 25 min of arrival	
3. CT/MRI within 24 h of arrival	Patients with any type of stroke Exclusion: <18 years of age	CT/MRI performed within 24 h of arrival	
4. Extracranial carotid artery evaluation	Patients with ischemic stroke/TIA Exclusion: <18 years of age, death during hospital stay	Extracranial carotid artery evaluated by carotid ultrasonography or angiography (CTA or MRA or DSA)	
5. Stroke Unit	Patients with any type of stroke Exclusion: <18 years of age	Treatment in Stroke Unit	
6. Intravenous thrombolysis administration	Patients with ischemic stroke arriving within 3.5 h of symptom onset Exclusion: <18 years of age	Intravenous thrombolysis performed	
7. Intravenous thrombolysis within 1 h of arrival	Patients with ischemic stroke who were administered intravenous thrombolysis Exclusion: <18 years of age	Intravenous thrombolysis performed within 1 h of arrival	
8. Antiplatelet within 48 h of onset	Patients with ischemic stroke/TIA Exclusion: <18 years of age, expired within 48 h after the hospital stay	Antiplatelet therapy within 48 h of stroke onset	
9. Discharge on antiplatelet medication	Ischemic stroke/TIA patients Exclusion: patients with atrial fibrillation, <18 years of age, death during hospital stay	Antiplatelet medication prescribed at discharge	
10. Discharge on anticoagulation for AF	Ischemic stroke/TIA patients with atrial fibrillation Exclusion: <18 years of age, expired during the hospital stay	Anticoagulation prescribed at discharge	
11. Discharge on statin medication	Ischemic stroke/TIA patients with LDL ≥120 mg/dL Exclusion: <18 years of age, death during hospital stay	Statin prescribed at discharge	
12. Discharge on antihypertensive medication	Any type of stroke patient with hypertension Exclusion: <18 years of age, death during hospital stay	Antihypertensive agents prescribed at discharge	
13. DVT prophylaxis	Patients with any type of stroke Exclusion: <18 years of age, death within 2 days after hospital stay	Foot-pumping for DVT performed within 2 days of arrival	
14. Dysphagia screening	Patients with any type of stroke Exclusion: <18 years of age, death within 2 days after hospital stay	Dysphagia screening performed during hospital stay	
15. Rehabilitation	Patients with any type of stroke Exclusion: <18 years of age, death during hospital stay	Physiotherapy or occupational therapy performed within 2 days of arrival	
16. Smoking cessation	Patients with any type of stroke Exclusion: <18 years of age, death during hospital stay	Smoking cessation advice or counseling given during hospital stay	
17. Stroke education*	Patients with any type of stroke Exclusion: <18 years of age, death during hospital stay	Stroke education given during hospital stay	

(**Table 1** continued the next page.)

Indicator	Target population (denominator)	Treated patients (numerator)	Variable statement
QIs for comprehensive stroke care			
1. Median time to multimodal CT or MR brain and vascular imaging	Patients with ischemic stroke arriving within 6 h of the time that they were last known to be at baseline Exclusion: <18 years of age		Median time from arrival to start of multimodal CT or MR brain and vascular imaging (MRI/MRA or CT/CTA)
2. Received endovascular recanalization properly	Patients with ischemic stroke who are appropriate candidates for endovascular recanalization† Exclusion: <18 years of age	Endovascular recanalization procedure performed	
3. Intravenous thrombolysis before endovascular recanalization	Patients with ischemic stroke who underwent endovascular recanalization procedure (arrived within 3.5 h of symptom onset) Exclusion: <18 years of age	Intravenous thrombolysis performed	
4. TICI grade 2b or 3 after endovascular recanalization	Patients with ischemic stroke who underwent endovascular recanalization procedure Exclusion: <18 years of age	Endovascular recanalization procedure performed with post-reperfusion TICI grade 2b or 3	
5. Median time of DTP	Patients with ischemic stroke who underwent endovascular recanalization procedure Exclusion: <18 years of age		Median time from door to puncture for patients who underwent the endovascular recanalization procedure
6. Symptomatic intracranial hemorrhage after thrombolytic or endovascular therapy	Patients with ischemic stroke who underwent endovascular recanalization or intravenous thrombolysis Exclusion: <18 years of age	Symptomatic intracranial hemorrhage developed within 36 h after thrombolytic or endovascular therapy	
7. 90-day mRS score documentation after thrombolytic or endovascular therapy	Patients with ischemic stroke who underwent thrombolytic or endovascular therapy Exclusion: <18 years of age, death during hospital stay	90-day mRS score documented	
8. Initial severity measure documentation	Patients with SAH or ICH Exclusion: <18 years of age	Initial severity measures documented	
9. SAH intervention within 72 h of onset	Patients with SAH who arrived within 48 h of onset Exclusion: <18 years of age, death within 2 days after onset	Coiling or clipping procedure started within 72 h of onset	
10. Fasudil hydrochloride or ozagrel sodium administration for vasospasm	Patients with SAH who underwent the coiling or clipping procedure Exclusion: <18 years of age, death within 2 days after onset	Fasudil hydrochloride or ozagrel sodium administrated	
11. PT-INR reversal for warfarin-associated ICH	Patients with warfarin-associated ICH and an elevated PT-INR (INR 1.4) Exclusion: <18 years of age	PT-INR reversal with a procoagulant preparation	
12. Complication of diagnostic neuroangiography	Patients with any type of stroke Exclusion: <18 years of age, patients who underwent endovascular recanalization procedure	Stroke or death within 24 h of diagnostic neuroangiography	

*Information about activation of emergency medical system, follow-up after discharge, medications prescribed at discharge, risk factors for stroke and warning signs and symptoms of stroke. †Patients who meet all the following criteria: pre-stroke mRS score 0–1, acute ischemic stroke receiving intravenous r-tPA within 4.5 h of onset according to guidelines from professional medical societies, causative occlusion of the ICA or proximal MCA (M1), NIHSS score ≥6, ASPECTS ≥6, treatment can be initiated (groin puncture) within 6 h of symptom onset. AF, atrial fibrillation; CT, computed tomography; CTA, computed tomography angiography; DSA, digital subtraction angiography; DTP, door to puncture; DVT, deep vein thrombosis; ICH, intracerebral hemorrhage; INR, international normalized ratio; LDL, low-density lipoprotein; MRA, magnetic resonance angiography; MRI, magnetic resonance imaging; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; TIA, transient ischemic attacks; SAH, subarachnoid hemorrhage; TICI, Thrombolysis in Cerebral Infarction.

The QI domains comprised documentation of the initial severity measure (Indicator 1), diagnosis (Indicator 2–4), coordination of care (Indicator 5), acute medication (Indicators 6–8), initiation of secondary prevention for recurrent stroke (Indicators 9–12), prevention of complications (e.g., aspiration pneumonia, venous thromboembolism) (Indicators 13, 14), rehabilitation (Indicator 15), and patient education (Indicators 16, 17).

QIs for CSCs

For the CSCs, 14 potential indicators were selected and finally, 12 QIs were selected (**Table 1**). The QI domains

Table 2. Characteristics of Patients From the J-ASPECT Study Discharged Between 2013 and 2015

	Overall cohort (n=396,350)	Ischemic stroke/TIA (n=266,475)	Intracerebral hemorrhage (n=99,658)	Subarachnoid hemorrhage (n=30,217)	P value
Age (years), median (IQR)	75 (65–83)	76 (67–83)	73 (63–82)	65 (53–77)	<0.001
Female (%)	43.8	41.7	42.2	67.3	<0.001
Ambulance use (%)	57.8	51.2	69.6	76.7	<0.001
Comorbidities (%)					
Hypertension	51.6	49.0	59.4	14.8	<0.001
Diabetes mellitus	20.6	24.0	15.2	2.5	<0.001
Dyslipidemia	21.3	26.1	11.1	4.0	<0.001
Atrial fibrillation	12.7	16.8	4.9	0.5	<0.001
Myocardial infarction	0.3	0.3	0.2	0.1	<0.001
Carotid stenosis	3.1	4.5	0.4	0.1	<0.001
Peripheral artery disease	0.03	0.03	0.01	0.03	<0.001
Stroke/TIA	5.4	6.3	2.1	2.3	<0.001
Smoking	41.9	42.1	41.4	12.9	<0.001

Table 3. Characteristics of Hospitals Participating in the J-ASPECT Study Between January 2013 and December 2015

Level	Overall cohort (n=558)	2013 (n=439)	2014 (n=419)	2015 (n=451)	P value
Hospital characteristics					
No. of stroke discharges (%)					
>301	36.9	39.2	44.2	42.6	<0.001
101–300	46.6	44.0	47.3	49.7	
0–100	16.5	16.9	8.6	7.8	
No. of beds					
Median (25–75th percentile)	405.5 (279.2–585)	430.0 (300.5–609)	430 (294.5–605)	413.0 (284–600)	0.164
Hospital type (%)					
Non-academic	86.4	84.7	84.5	85.6	0.685
Academic	13.6	15.3	15.5	14.4	

comprised diagnosis (Indicator 1), intravenous thrombolysis/endovascular recanalization (Indicators 2–7), documentation of initial severity measure (Indicator 8), treatment for subarachnoid hemorrhage (SAH; Indicators 9, 10), and treatment for intracerebral hemorrhage (ICH; Indicator 11) and diagnostic angiography (Indicator 12).

Measurement of the Defined QIs Using the Existing DPC Database

Adherence rates of the defined QIs were calculated from the DPC database for 396,350 acute stroke patients discharged between 2013 and 2015 from 558 participating hospitals (**Table 2**). Patient and hospital characteristics are shown in **Table 2** and **Table 3**. The median age was 75 years, and 43.8% were women (**Table 2**). Patients with ischemic stroke or TIA, ICH, and SAH comprised 67.2%, 25.1%, and 7.6%, respectively. Overall, the patients' characteristics were similar to those in previous reports from Japan. As for hospital characteristics (**Table 3**), 86.4% were non-academic, and the median bed size was 405.

Based on the available data, we found that measurement of the developed QIs using the DPC database was feasible for the following 6 QIs: 4 for PSCs (Indicators 8, 9, 10 and 12) and 2 for the CSCs (Indicators 10 and 12). Because of the lack of time metrics in the DPC database, the adherence rate for administered antiplatelet drugs within 48 h of onset was approximated by the proportion of patients on antiplatelet drugs administered within 2 days of urgent admission in this feasibility study. Adherence rates in patients for the 6 QIs are shown in **Table 4** and **Figure 2A–E**. The adherence rates for patients with ischemic stroke/TIA were intermediate for administered antiplatelet drugs within 2 days of urgent admission (54.6%), antiplatelet drugs at discharge (58.7%), and anticoagulation for atrial fibrillation at discharge (64.4%). The adherence rates of antihypertensive medication for patients with hypertension were intermediate in ICH patients (60.5%), whereas those for patients with other types of stroke/TIA were low (49.2% for ischemic stroke/TIA, 43.7% for SAH). The administration of fasudil hydrochloride or ozagrel sodium for vasospasm was high (86.9%). The occurrence of fatal complications with diagnostic neuroangiography was very low (0.4%) (**Table 4**).

Association Between QI Adherence and Hospital Characteristics

The association between selected QI adherence and hospital characteristics is shown in **Table 5**. Odds ratios represent the degree of high adherence to each QIs (PSCs: 8, 9, 10, 12) or the risk of complication (CSC 12) for hospital characteristics. A higher number of stroke discharges (≥301) and higher CSC score were significantly associated

Table 4. Adherence Rates for PSC and CSC QIs in Patients in the Overall Cohort and for Specific Stroke Types

Indicator	Target population	No. of eligible patients	Adherence rates (CSC12: complication rates) (%)
PSC			
8. Antiplatelet within 2 days of urgent hospitalization*	Ischemic stroke/TIA	265,034	54.6
9. Discharge on antiplatelet medication	Ischemic stroke/TIA	212,080	58.7
10. Discharge on anticoagulation for AF	Ischemic stroke/TIA	40,977	64.4
12. Discharge on antihypertensive medication	Overall stroke patients with hypertension	185,996	51.7
	Ischemic stroke/TIA patients with hypertension	126,185	49.2
	ICH patients with hypertension	47,634	60.5
	SAH patients with hypertension	12,177	43.7
CSC			
10. Fasudil hydrochloride or ozagrel sodium administration for vasospasm	SAH	16,415	86.9
12. Death complication of diagnostic neuroangiography	Overall	27,703	0.4
	Ischemic stroke/TIA	14,032	0.2
	ICH	5,031	0.2
	SAH	8,640	0.7

*The adherence rate of this QI was the approximated value for antiplatelet drugs administered 48 h of onset in this feasibility study. CSC, comprehensive stroke center; ICH, intracerebral hemorrhage; PSC, primary stroke center; SAH, subarachnoid hemorrhage; TIA, transient ischemic attack.

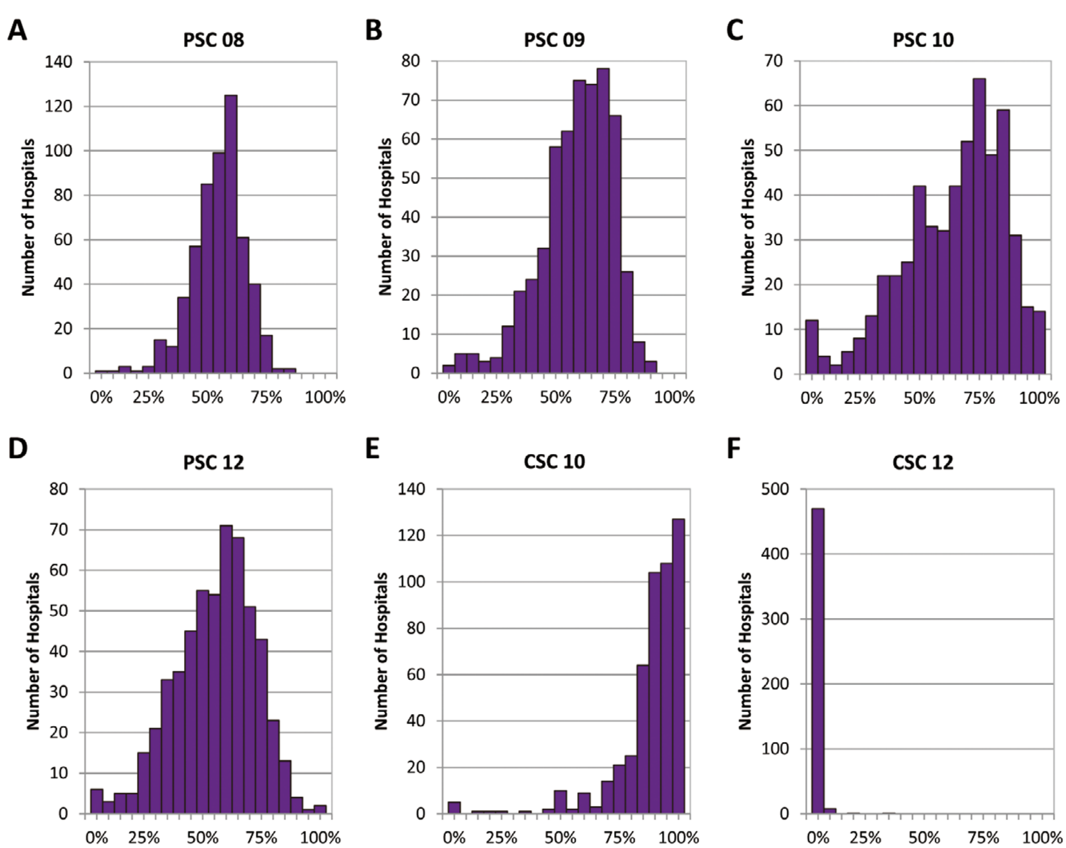

Figure 2. Adherence rates by hospitals for the selected 6 QIs using the DPC database. (**A**) PSC8, antiplatelet drugs within 48 h of onset; (**B**) PSC9, discharge on antiplatelet medication; (**C**) PSC10, discharge on anticoagulation for atrial fibrillation; (**D**) PSC12, discharge on antihypertensive medication; (**E**) CSC10, fasudil hydrochloride or ozagrel sodium administration for vasospasm; (**F**) CSC12, death complication of diagnostic neuroangiography. CSC, comprehensive stroke center; DPC, Diagnosis Procedure Combination; QI, quality indicator; PSC, primary stroke center.

with greater adherence to administered antiplatelet drugs within 48 h of onset, antiplatelet drugs at discharge, and anticoagulation for atrial fibrillation at discharge, whereas a higher number of beds (≥300) had no relation to any higher adherence. Academic institutions were associated with higher adherence to antihypertensive medication for patients with hypertension.

Discussion

The present study describes the development of the CTGS initiative, the first nationwide quality improvement initiative in Japan. This initiative primarily aimed to develop and implement evidence-based indicators for measuring the quality of acute hospital stroke care in Japan. The major findings were as follows. (1) As the first stage, we developed 17 and 12 QIs for PSCs and CSCs, respectively, using a traditional method.[12] (2) Among these QIs, we found successful measuring of adherence rates of 4 and 2 QIs for PSCs and CSCs, respectively, using the existing J-ASPECT DPC database. (3) We found wide inter-hospital variations in adherence rates of QIs in the domains of acute medication and initiation of secondary prevention, which were associated with the number of stroke discharges, comprehensive stroke care capabilities, and academic status.

Development of QIs for PSCs and CSCs

Although the certification of PSCs and CSCs is now in rapid progress worldwide, the gap between clinical evidence and practice is largely unexplored. Thus, we developed the QIs to continuously measure the quality of stroke care at PSCs or CSCs to close such evidence practice gaps in Japan. After certification of PSCs and CSCs, probably based on the recommended structural items,[23] the study group will encourage the PSCs and CSCs to report annually their adherence rates for the 17 QIs (for PSCs) and all of the 29 QIs (for PSCs and CSCs), respectively, to enable international comparison and continuous improvement of the quality of stroke care.

Measuring the Adherence Rates of the Selected QIs Using the J-ASPECT DPC Database

Unlike registries' activities, quality improvement-based activities do not usually have a continuous source of funding, so the issue of sustainability is important.[24] Further, the various QI programs such as GWTG also rely on data that must be collected prospectively or manually extracted from medical records. Although higher quality care, such as increased use of intravenous rt-PA infusion and mechanical thrombectomy, in the acute stroke setting might lead to measurable cost savings,[24] the costs associated with data collection and quality improvement are difficult to quantify. Here we found that the feasibility and validity of measuring adherence rates of 6 of the 29 defined QIs with no significant additional time and cost using the existing DPC-based data collected for the J-ASPECT study suggested the potential sustainability of this initiative.

We found great variations in the adherence rates for the 6 QIs, mainly in the domains of acute medication and initiation of secondary prevention for ischemic stroke and TIA, among the participating hospitals in Japan. The present finding is consistent with the results in the field of cardiovascular medicine in Japan using DPC data (the Japanese Registry Of All cardiac and vascular Diseases).[20]

Table 5. Association Between QI Adherence and Hospital Characteristics

QI no.	OR* (95% CI)	P value
Hospital characteristics		
No. of stroke discharges (≥301)		
PSC8	1.19 (1.10–1.29)	<0.001
PSC9	1.20 (1.07–1.34)	0.002
PSC10	1.19 (1.01–1.40)	0.038
PSC12	0.93 (0.82–1.06)	0.295
CSC12	1.15 (0.71–1.88)	0.573
No. of beds (≥300)		
PSC8	1.00 (0.92–1.10)	0.916
PSC9	0.88 (0.78–1.00)	0.042
PSC10	1.05 (0.87–1.27)	0.594
PSC12	0.94 (0.82–1.08)	0.373
CSC12	0.96 (0.55–1.64)	0.868
Hospital type (academic)		
PSC8	0.84 (0.74–0.94)	0.003
PSC9	0.86 (0.73–1.01)	0.064
PSC10	1.27 (0.99–1.62)	0.056
PSC12	1.33 (1.11–1.59)	0.002
CSC12	0.82 (0.45–1.48)	0.504
CSC score		
PSC8	1.02 (1.01–1.03)	<0.001
PSC9	1.02 (1.00–1.03)	0.028
PSC10	1.03 (1.01–1.05)	0.006
PSC12	1.01 (0.99–1.03)	0.354
CSC12	0.96 (0.89–1.03)	0.235

*ORs of adhering to each QIs (PSC8, 9, 10, 12) or occurrence of complications (CSC12) for hospital characteristics. CI, confidence interval; OR, odds ratio; QI, quality indicator.

Such approaches may contribute to improving the quality of care more efficiently by targeting hospitals with low adherence rates for selected QIs in the fields of cardiovascular medicine and stroke.

International Comparison of the Adherence Rates for QIs

In the context of international comparison, the adherence rates of antiplatelet administration within 48 h of onset, discharge on antiplatelet medication, and discharge on anticoagulation for atrial fibrillation were almost over 95% according to the data of the Joint Commission (US) between 2011 to 2015.[25] In European countries, the rate of discharge on antiplatelet medication was high, ranging from 85% to 95%, from 2004 to 2009, although the rate of discharge on anticoagulation for atrial fibrillation was low (25–50%).[26] In the present study, the adherence rates for antiplatelet administration within 48 h of onset and discharge on antiplatelet medication in Japan were lower than in the USA or European countries. The adherence rate for discharge on anticoagulation for atrial fibrillation was lower than that in the USA but higher than in European countries. Such differences in adherence rates between Japan and other countries might be explained by differences in healthcare policies, guidelines, and clinical background of patients (e.g., age, race and comorbidities). From these comparisons of QIs in different countries, the current status of any country could be ascertained and efforts made to improve QIs. In the USA or Europe, the trends of adherence rates for QIs are increasing through publication of measured QIs for stroke care. These data suggest urgent need for nationwide initiatives of quality improvement of acute stroke care in Japan.

Structural Factors That Influence QI Adherence Rates

Structural factors, such as hospital characteristics, are important for the improvement of the quality of stroke care. Our findings suggested that the characteristics of hospitals that are specialized for stroke care, such as higher numbers of annual stroke discharges and comprehensive stroke care capabilities, may influence the adherence rates for stroke QIs. This is in line with several previous studies regarding the association between structural and performance measures in stroke and cardiovascular diseases. For example, Bray et al reported that in hospitals with higher volumes of thrombolysis activity, there are shorter delays in administering tPA to patients after arrival to the hospital.[27] In the field of cardiovascular disease, it was reported that higher hospital acute myocardial infarction (AMI) volume correlates with better adherence to process of care measures.[28]

On the other hand, the relationship between structural and outcome measures remains uncertain in the field of stroke and cardiovascular diseases. We previously reported the association between comprehensive stroke care capability (structural factors) and reduced in-hospital mortality in patients with all types of stroke.[17] It was also reported that higher hospital volume was associated with lower mortality for stroke in Japan.[29] In contrast, there was no association between AMI volume and in-hospital mortality after adjusting for patient and hospital characteristics. Further study is required to clarify the impact of improving QIs related to structural and performance factors on improvement of stroke outcomes.

Study Limitations

One of the major limitations of using the DPC data is the lack of data about time (onset, arrival or imaging), the National Institutes of Health Stroke Scale (NIHSS) score, or blood test values, so only 6 of the 29 developed QIs were able to be calculated in this feasibility study. Second, we cannot exclude the possibility that the same patients may be counted twice or more in this DPC database if they are readmitted or transferred to another hospital. Third, a validation study of adherence rates for individual QIs may be required, such as prescription of drugs, especially when length of hospital stay is short. Fourth, the association between performance of the process measures and outcomes remains uncertain.[30] Further study is required to assess this relationship. Fifth, no specific training or instructions were provided for data entry in this study. To further improve the accuracy of the DPC data generated in routine clinical practice for research purposes, specific regular training may be required for the participating hospitals in this study.

Future Directions

Previous studies have specified QIs at multiple levels, recognizing that the capacity to collect data varies between health systems and settings.[14] With the urgent need for a nationwide collection of data for the developed QIs, especially related to CSCs, we recently proceeded to the next stage of this initiative to develop a software program to add critical patient data, specifically required for this purpose, such as time metrics on the preset DPC data at the participating hospitals, and to automatically calculate the QI adherence rates. This next stage should further contribute to nationwide improvement in the quality of acute stroke care in Japan.

Recently, the usefulness of composite performance measures attracted increasing attention for reporting on the quality of stroke care.[31] A composite performance measure is the combination of 2 or more indicators into a single number to summarize multiple dimensions of provider performance and to facilitate comparisons. Because the number of developed QIs in the CTGS initiative is high, composite performance measures may reduce the information burden by distilling the available indicators into a simple summary. To develop composite performance measure, the weights of each QIs should be assessed by their clinical importance or relationship with the outcome.

Conclusions

The CTGS initiative in the J-ASPECT study represents the first nationwide quality improvement initiative for acute stroke care in Japan. Despite the limited information available and the need to validate the calculated QIs, the DPC database may contribute to efficient data collection at low cost and decreased administrative burden of evaluating the developed QIs. No substantial improvement of the measured QIs before implementation of this initiative, however, suggests urgent need for nationwide quality improvement initiatives for stroke care in Japan.

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Supplementary Files

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