Comprehensive Stroke Centers: Recognizing the Need for Complex Stroke Care and Interventional Radiology's Contribution

Alexandra Graves, NP¹ David Case, MD¹ Rajan Gupta, MD¹ Angel Pulido, MD¹ Kimberly Rapp, RN¹
Jennifer R. Simpson, MD¹ Doreen Smith, MS¹ William J. Jones, MD¹

¹ Stroke Program, University of Colorado Hospital, Aurora, Colorado

Semin Intervent Radiol 2013;30:325–330

Address for correspondence Alexandra Graves, NP, Stroke Program, University of Colorado Hospital, 12631 East 17th Avenue, C307, Aurora, CO 80045 (e-mail: alex@skabber.com).

Stroke is the leading cause of long-term disability and ranks fourth among all causes of death, accounting for 1 in every 19 deaths in the United States.¹ In 2009, approximately 795,000 people had a new or recurrent stroke. The estimated direct and indirect medical cost of stroke during that year was \$38.6 billion; the cumulative direct and indirect cost of stroke care between now and 2050 are projected to exceed \$1.5 trillion.

Predominantly, on the basis of the National Institute of Neurological Disorders and Stroke (NINDS) recombinant tissue plasminogen activator (rt-PA or tPA) trial, intravenous (IV) tPA quickly became the mainstay of acute ischemic stroke (AIS) treatment, and in 1996, the US Food and Drug Administration (FDA) approved IV tPA for the treatment of AIS within 3 hours of symptom onset.² Recognizing that the time sensitive and complex nature of treating patients with AIS required an organizational approach to care, The Joint Commission (TJC) developed Advanced Disease-Specific Care Certification standards for Primary Stroke Centers (PSCs). Since 2003, when TJC began certifying PSCs, over 1,000 have been certified nationwide in the United States.³ Over the last decade, new treatments and technology for the treatment of stroke patients has increased the complexity of stroke care. In addition, the focus of PSCs was on care for ischemic stroke patients. It has been long recognized that care for hemorrhagic stroke patients is equally, if not more, complex. Thus, drawing on the evidence-based recommended requirements from the Brain Attack Coalition (BAC) and American Stroke Association, a thorough literature review and a technical advisory panel that included experts from multiple specialties related to stroke, TJC established standards for Comprehensive Stroke Center (CSC) certification, which became effective on September 1, 2012.^{4,5} This distinct certification is the eighth Advanced Disease-Specific Care Certification offered by TJC.

TJC CSCs will typically be elite academic medical centers or tertiary care facilities. PSCs will continue to represent a wide range of hospitals that offer standard stroke care, use tPA, and often have a designated stroke unit. A complex stroke patient

requires advanced diagnostic imaging and treatment procedures by specially trained physicians and other health-care providers.⁴ Large complex ischemic strokes may be further defined as those needing endovascular therapies, hemicraniectomies, management of systemic disease with multi-organ involvement, or monitoring and/or management of increased intracranial pressure. Complex intracerebral hemorrhages may be defined as those needing intensive care unit (ICU) and/or neurosurgical intervention, while complex subarachnoid hemorrhages (SAH) may require these services and/or vasospasm treatment. A CSC is a hospital that has the necessary personnel, expertise, infrastructure, and programs to care for complex stroke patients. Many advocate for a “hub and spoke” model, where the CSC acts as a resource for expertise and education for other centers in the region.

Interventional management of the complex stroke patient is an integral part of CSC certification. As a result, guidelines have been established to help facilitate the care of patients receiving interventional management.^{6,7} TJC certification requirements are detailed in the “Advanced Disease-Specific Care Certification Requirements for Comprehensive Stroke Center.”⁵ Key requirements specific to interventional management will be summarized followed by considerations of endovascular stroke therapy and examples of process improvement.

Comprehensive Stroke Criteria

Eligibility

Eligibility as a TJC CSC requires specific minimum case volumes. Currently, a CSC must provide care to a minimum of 20 SAH patients, perform endovascular coiling, or surgical clipping of at least 15 cerebral aneurysms, and averaged over 2 years, administer IV tPA to at least 25 AIS patients per year.⁵ Because these volumes are not universally accepted as appropriate, revisions are anticipated. Indeed, in 2013, all the CSC requirements and the certification model, including

Issue Theme Neurointerventions for the Interventional Radiologist; Guest Editors, Gregory M. Soares, MD, FSIR, and Sun Ho Ahn, MD

Copyright © 2013 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <http://dx.doi.org/10.1055/s-0033-1353487>.
ISSN 0739-9529.

structure, process, and outcomes, will be reviewed (true of all TJC Advanced Disease-Specific Care Certification programs).

With regard to *structure*, TJC uses 28 standards and weaves the BACs recommendations throughout. Everything is included from design, implementation, evaluation of the program, and individualizing care to meet specific needs. There is an emphasis on information sharing amongst providers throughout the continuum of care for the patient. The BAC outlined four areas that distinguish the CSC including personnel and clinical expertise, diagnostic imaging (techniques and personnel), neurosurgery and vascular surgery, and infrastructure.⁴ TJC has considered all areas and linked them to current standards. These represent requirements for CSC structure.

Requirements for the CSC *process* is based on identified clinical practice guidelines. The expectation is to identify current evidence-based guidelines and embed them into practice. This may be through the use of readily available disease-specific order-sets and/or institutional policies and procedures. Typically, this is evaluated through patient tracer activities during the CSC survey.

Finally, CSC *outcomes* are currently based on the eight PSC performance measures. New CSC performance measures, which includes the eight PSC performance measures, have been drafted and are being pilot tested (►Table 1). It is expected that the final CSC measures will be announced in 2013.

Data

Timely access to and analysis of multiple stroke variables are a key part of a comprehensive stroke program. There are a plethora of stroke data points that may be abstracted from an electronic medical record, electronically transferred from one database to another, or obtained through electronic report queries. Data extraction, management, and analysis are manpower intense and time consuming. In determining which variables to track, the stroke leadership team must consider

their institution's manpower limitations and select data and analyses that are meaningful and actionable for their institution while also avoiding data overload. Actionable metrics should address patient outcomes, standards of care, and institutional processes that impact outcome and quality of care. With the use of an appropriate stroke database, the patient outcome metrics can be updated daily allowing for identification of outliers and areas in need of rapid cycle improvement.

CSCs must monitor aggregate periprocedural complications for diagnostic catheter cerebral angiography, endovascular cerebral recanalization and aneurysm coiling, carotid endarterectomy (CEA), endovascular carotid artery stenting, and other procedures performed on stroke patients. For diagnostic catheter cerebral angiography, the periprocedure stroke and death rate must be 1% or less and the aggregate rate of "serious" complications must be 2% or less. Mortality rates must be tracked for cerebral aneurysmal clipping and coiling. The aggregate complication rate for CEAs and stenting of carotid arteries must be 6% or less. If the CSC has an electronic medical record, a routine procedure report can be generated using the *International Classification of Diseases Ninth Revision (ICD-9)* procedure codes for procedures of interest (►Table 2).⁸ However, ICD9 procedure codes cannot be used alone to identify purely diagnostic catheter angiograms, so the American Medical Association's Current Procedural Terminology (CPT) codes must also be used (►Table 2).⁹ It is not just the total number of endovascular procedures that must be monitored, but also the rate of serious complications and the rate of procedure-related strokes and mortality related to specific procedures. CSCs are also required to publicly report outcomes related to interventional procedures. Each CSC may choose which specific procedures and related outcomes they publicly report.

CSCs must clearly identify serious complications and establish a process for monitoring and review of complications, including predefined "triggers" for review. The entire

Table 1 Current primary stroke center measures and proposed comprehensive stroke center measures

PSC measures	Proposed CSC measures
STK1 VTE prophylaxis within 48 hours of admission	NIHSS on arrival
STK2 antithrombotic at discharge	Modified Rankin score at 90 days
STK3 anticoagulation therapy for atrial fibrillation/flutter	Severity measurement on arrival
STK4 IV tPA, arrived by hour 2, treated by hour 3	Median time to treatment with a procoagulant reversal agent
STK5 antithrombotic treatment by end of hospital day 2	Median time to INR reversal
STK6 statin therapy at discharge	Hemorrhagic complications for patients treated with IV tPA
STK8 stroke education teaching	Hemorrhagic complications for patients treated with IA tPA or mechanical endovascular reperfusion procedure
STK10 Rehabilitation considered	Nimodipine treatment
	Median time to recanalization therapy
	TICI posttreatment reperfusion grade

Abbreviations: CSC, comprehensive stroke center; IA, intra-arterial; INR, international normalized ratio; NIHSS, National Institutes of Health Stroke Scale; PSC, primary stroke center; STK, stroke; TICI, thrombolysis in cerebral infarction; tPA, tissue plasminogen activator; VTE, venous thromboembolism.

Table 2 Commonly used ICD9 and CPT codes used for stroke interventions

Procedure	ICD9 procedure codes	CPT codes
Aneurysm clipping	39.51	
Aneurysm coiling	39.72 39.75 39.76	
CEA	38.12	
Decompressive craniotomy	01.24	
Diagnostic cerebral angiogram	88.41	36,222 36,223 36,224 36,225 36,226
Endovascular recanalization	99.10 39.74	
Carotid stenting	00.63	
Cranial transducer	01.10 01.26	
Cerebral ventriculostomy	02.21	

Abbreviations: ICD9, International Classification of Diseases Ninth Revision; CEA, carotid endarterectomy; CPT, Current Procedural Terminology.

stroke team including coordinators, data analysts, nurses, technologists, neurointensivists, neurosurgeons, neurointerventionalists, fellows, residents, and attendings must work together to ensure cases are identified and reviewed in the format identified in the programs performance improvement plan. The format for review may include multiple levels that may include peer review, morbidity and mortality conferences, or risk management review.

Implications for Interventional Radiology

TJC requires all CSCs to identify and implement quality improvement, using data interpretation to help identify opportunities for improvement. From a clinical perspective, there are numerous challenges involved in optimizing care for patients receiving interventional management of stroke (IMS). Endovascular stroke therapy requires extraordinarily complex coordination of care where clinical outcome is highly dependent on timely intervention and established care pathways and procedures. The literature is clear that time is a critical element to patient outcomes. Data from the IMS III trial suggest that for every 30-minute delay in revascularization, there is a 10% decline in good outcome (modified Rankin Scale [mRS] 0–2 at 90 days).¹⁰ Quality improvement requires dedicated, ongoing multidisciplinary involvement. One of the greatest obstacles for quality improvement for endovascular stroke therapy is achieving rapid and sustainable performance improvement for unscheduled procedures that may be infrequently performed and involves multiple providers across many specialties. A recently published work by Sacks et

al provides an excellent review of definitions and goals for key time metrics, complications, and outcomes to measure and review within an interventional stroke program.⁶

One of TJC proposed metrics for CSC is achieving patient arrival to femoral artery puncture in less than 90 minutes, although the literature suggests a goal of 120 minutes.⁶ Many institutions struggle with these time goals and application of dedicated quality improvement processes to improve the time from patient arrival to femoral artery puncture and, ultimately, patient outcomes.

Multidisciplinary support from multiple levels of the stroke team is needed, including the emergency department (ED), neurology, neurointerventional radiology, interventional radiology (IR) technologists, neurosurgery, IR nurses, clinical educators, and data analysts. The first step is to identify consistently slow areas of the process. This may be done by mapping out all steps leading to endovascular stroke therapy and tracking the average times of each step in the process. Once the areas of delay are identified, targeted action items can be implemented to affect each step. Potential action items include: obtaining rapid advanced imaging, streamlining the notification and mobilization of the IR team, standardizing the IR tray for stroke-specific interventions, and considering forgoing general anesthesia, and instead provide monitored anesthesia care. In addition, debriefings at the conclusion of each endovascular stroke case may help identify time delays, ensure that all tracked time metrics have been recorded, and provide an avenue to quickly brainstorm regarding process improvement. Straightforward timed data points, a motivated interdisciplinary team, and rapid cycle process improvement initiatives at the University of Colorado Hospital substantially improved the percent of patients who had femoral artery access within 90 minutes of arrival from 2012 to 2013 year-to-date.

Education

Sustained education requirements for staff, patients, families, and the community are key components of TJC CSC certification. All staff members must have knowledge of stroke, including how to recognize signs and symptoms of a stroke, how to call an alert, and where stroke resources are located. Preliminary education may be necessary to change a culture that does not recognize that a stroke may occur at any time and that stroke is an emergency. It can also be challenging to educate groups that are employed by an organization outside the facility but interact with patients, staff, and visitors daily, such as security, housekeeping, transport services, and dietary services.

Staff members who routinely work directly with stroke patients are required to have “expertise” and knowledge of the stroke scale used at their institution. Departments requiring such expertise include the ED, IR, stroke unit, neuro-intensive care unit (Neuro-ICU), and the core stroke team. Each year, ED staff must obtain 2 hours of cerebrovascular education and one education program on acute stroke management. IR, Neuro-ICU, and stroke unit nurses must obtain 8 hours of stroke-related education yearly. Stroke education hours are not required to be continuing education but must

be approved by the Stroke Program Medical Director as stroke-related education. At least, one staff member from each CSC is required to attend or present at a regional, national, or international conference, meeting, or seminar related to stroke each year. Such attendance is also an excellent opportunity for staff to learn from and network with staff from other CSCs and disseminate ideas and best practices with their colleagues at home. CSCs are also required to present at least two educational programs annually for internal or external health-care providers.

Education for patient, family members, or caregivers, and the community at large should not be overlooked. CSCs should place a strong emphasis on education throughout patient's hospitalizations and include documentation of an organized approach to daily education. Partnership with local emergency medical service (EMS) agencies to deliver community education is important. Whether it is through participating in community health fairs, offering support groups and stroke seminars, presenting at EMS education fairs, or participating in statewide stroke awareness campaigns, a CSC should be a leader among health-care facilities and in the community for delivering stroke-related education.

Availability

Availability of stroke-related resources, personnel, and equipment are required of CSCs. Required personnel and clinical expertise include vascular neurologists, neurointerventionalists, neuroradiologists, neurosurgeons, radiology technologists, magnetic resonance imaging (MRI) technologists, endovascular technologists and nurses, therapists (physical, occupational, and speech), advance practice nurse, pharmacist, data managers and analysts, nurse managers, and social workers. In addition to personnel, diagnostic imaging including carotid ultrasound, catheter angiography, computed tomographic angiography, MRI, transcranial Doppler, and transthoracic and trans-esophageal echocardiography are also required.

Implications for Interventional Radiology

Endovascular resources and educational requirements for physicians, nurses, and technologists are mandatory requirements that must be demonstrated to achieve TJC CSC Certification. At least one neurointerventional physician, one or more experienced vascular neurologists, one IR nurse, one endovascular technologist, and one certified radiology technologist must be available 24 hours a day, 7 days a week. Neurointerventional and vascular neurologists must also be available by phone within 20 minutes 24/7.

Protocols for stroke patient care, treatment, and services are a requirement. The CSC must have a process to administer endovascular fibrinolytics and other recanalization procedures according to current evidence-based practices and research. An interdisciplinary intervention-based approach must be addressed to reduce complications. Multidisciplinary team members must be incorporated to evaluate patients before and after endovascular procedures. In addition, the CSC must have the ability to handle multiple complex stroke patients simultaneously. Protocols and processes should be in

place to meet the concurrent emergent needs of two or more complex stroke patients in an emergency situation. This could include two stroke patients requiring assessment or advanced imaging by members of the stroke team at the same time.

Care Coordination and Discharge Planning

In addition to the elements needed to provide emergent care to stroke patients, the CSC must also have a coordinated multidisciplinary process to provide a plan for posthospital care. Expert social workers, case managers, and pharmacists must be a part of this discharge planning team. Because stroke patients frequently suffer from depression and cognitive decline, the CSC must assess stroke patients for changes in mood and cognition and help the patient and their family or caregiver identify medical and community resources that they may turn to for support. Patient and family/caregiver goals of care and discharge goals also need to be a part of the discharge plan. For patients going home who are not self-sufficient, their families or caregivers resources, knowledge, and commitment to provide ongoing safe care must be assessed. Physical and occupational therapists assessments and recommendations regarding the level of supervision, ongoing therapy needs, and discharge disposition must be considered. If necessary, ongoing speech therapy, swallowing evaluations, and special diet or feeding needs must also be provided, including education and training for patients and their families/caregivers. TJC expects an individualized discharge plan of care to be documented in the patient's chart.

High acuity stroke patients will often need placement in skilled care facilities (acute inpatient rehabilitation, long-term acute care, or skilled nursing facilities) and the CSC team should identify high-risk patients early in the hospitalization. Not only high-risk patients are those who have large strokes with severe deficits, but also patients who are uninsured or underinsured, patients who are undocumented, patients who are homeless, and patients without family support. Social workers, case managers, and financial counselors should be involved early in the hospitalization to identify any and all available resources. This may help decrease length of stay and assist in providing a safe discharge plan.

Conclusion

Since the NINDS rt-PA trial proved the benefit of treating AIS patients with IV tPA, most of the subsequent advances in the care of AIS have been endovascular therapies for treatment of patients with AIS. However, as importantly, care for hemorrhagic stroke patients and advanced treatment and monitoring for complications of both ischemic and hemorrhagic stroke patients have increased the complexity and expertise needed to care for patients with stroke. Recognizing the need for more complex care for patients with stroke, TJC developed standards for Advanced Disease-Specific Care Certification first for PSCs and more recently CSCs. Hospitals that receive this prestigious designation, TJC Certified CSC, are expected to provide excellent care for complex stroke patients. Only, elite

Table 3 Benefits of becoming a comprehensive stroke center

- Improved efficiency in patient care—decreased length of stay
- Improve quality of stroke care
- Reduced morbidity and mortality
- Reduced costs
- Fewer stroke complications
- Improved long-term outcomes
- Increased patient satisfaction
- Demonstrates commitment to a higher standard of service
- Provides a framework for organizational structure and management
- Provides a competitive edge in the marketplace
- Enhances staff recruitment and development
- Is recognized by insurers and other third parties
- CMS reporting—hospitals must begin and report stroke measures starting in 2013
- Stroke measures are also specified under the Electronic Health Record Incentive Program in 2011 (CMS)
- Recognize those centers who are treating complex stroke patients
- Extensive review process
- Market distinction
- National advertising
- Future standardized performance measures (currently in testing)

Abbreviation: CMS, Centers for Medicaid and Medicare Services.

academic medical centers and tertiary hospitals are likely to have the required volumes and expertise necessary to achieve and maintain TJC CSC Certification. Initial certification and maintenance requires ongoing and intense evaluation of related advances, such as, staff, patient, and community education, data collection, evaluation, and management, and process and quality improvement efforts. CSCs must also be committed to advancing stroke and stroke-related science through, at a minimum, participation in clinical trials. Clearly, the resources and commitment required of CSCs is substantial; however, the numerous benefits for the CSC, patients, and CSC staff are even greater (► **Table 3**).

References

- 1 Go AS, Mozaffarian D, Roger VL, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2013 update: a report from the American Heart Association. *Circulation* 2013;127(1):e6–e245
- 2 Tissue plasminogen activator for acute ischemic stroke. The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. *N Engl J Med* 1995;333(24):1581–1587
- 3 Quality Check Stroke Certification Programs. Available at: <http://www.qualitycheck.org/StrokeCertificationList.aspx>. Accessed April 25, 2013
- 4 Alberts MJ, Latchaw RE, Selman WR, et al; Brain Attack Coalition. Recommendations for comprehensive stroke centers: a consensus statement from the Brain Attack Coalition. *Stroke* 2005;36(7):1597–1616
- 5 Joint Commission. Available at: <http://www.jointcommission.org>. Accessed April 25, 2013
- 6 Sacks D, Black CM, Cognard C, et al. Multisociety consensus quality improvement guidelines for intraarterial catheter-directed treatment of acute ischemic stroke, from the American Society of Neuroradiology, Canadian Interventional Radiology Association, Cardiovascular and Interventional Radiological Society of Europe, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of NeuroInterventional Surgery, European Society of Minimally Invasive Neurological Therapy, and Society of Vascular and Interventional Neurology. *J Vasc Interv Radiol* 2013;24(2):151–163
- 7 Jauch EC, Saver JL, Adams HP Jr, et al; American Heart Association Stroke Council; Council on Cardiovascular Nursing; Council on Peripheral Vascular Disease; Council on Clinical Cardiology. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2013;44(3):870–947
- 8 Hart AC, Stegman SM, Ford B, eds. *International Classification of Diseases 9th Revision*. 6th ed. Salt Lake City, UT: Optum Insight; 2012
- 9 Abraham M, Ahlman JT, Boudreau AJ, et al, eds. *Current Procedural Terminology Professional Edition*. Chicago, IL: American Medical Association; 2013
- 10 Broderick JP, Palesch YY, Demchuk AM, et al; Interventional Management of Stroke (IMS) III Investigators. Endovascular therapy after intravenous t-PA versus t-PA alone for stroke. *N Engl J Med* 2013;368(10):893–903