

Use of a Registry to Improve Acute Stroke Care — Seven States, 2005–2009

Each year, an estimated 795,000 persons in the United States experience a stroke. In all, an estimated 7 million U.S. residents have had a stroke, and the cost of cerebrovascular disease in 2007 was estimated at \$41 billion (1). During 2004–2009, CDC funded seven state health departments for different periods to implement stroke care improvement registries. As part of the quality-improvement activities conducted by the Paul Coverdell National Acute Stroke Registry (PCNASR), CDC monitors adherence to 10 quality-of-care measures. This report documents the status of adherence to these 10 performance measures of stroke care through these seven state health departments for the period 2005–2009. The number of participating hospitals in the seven states ranged from 112 to 229 per year, with a total of 303 participating hospitals during the 5-year period. Average annual improvement in adherence to stroke care measures ranged from zero in one measure (prescription of antithrombotic at discharge) to 11% (use of intravenous tissue plasminogen activator [IV tPA]); five measures showed average annual improvements of at least 6%. The proportion of patients receiving “defect-free care” (a descriptor that indicates whether patients received all of the quality-of-care measures for which they were eligible) also improved. These results demonstrate the ability of state health departments to collaborate with hospitals to monitor and improve the delivery of high-quality care for acute stroke patients. This role for public health and state health departments in hospital quality improvement for acute stroke care is a viable approach to improving the quality of stroke care in the United States.

PCNASR was established by Congress in 2001. Its goals are to 1) measure, track, and improve the quality of care and access to care for stroke patients from the onset of symptoms through rehabilitation and recovery; 2) decrease rates of premature death and disability from acute stroke; 3) eliminate disparities in care; 4) support the development of systems of stroke care that emphasize quality of care; and 5) improve access to rehabilitation and opportunities for recovery after stroke. PCNASR is funded by CDC through a cooperative agreement with state health departments. It requires state health departments to recruit hospitals that are representative of all hospitals within a state in terms of size, status as an academic teaching hospital, rural or urban setting, geographic location, and racial/ethnic populations served. The state health departments work with participating hospitals to track the care of hospitalized stroke patients to improve the quality of acute stroke care from the onset of stroke through hospital

discharge. Specifically, the health departments provide hospitals with an interactive program of quality-improvement activities through conference calls, in-person meetings, and individual hospital site visits. Topics include education on data-driven quality-improvement methodology and overcoming barriers to improving stroke care. The methods for data collection and the types of data collected on patients and hospitals have been described previously (2).

In 2008, CDC, the American Heart Association, and the Joint Commission (an independent organization that accredits and certifies health-care organizations and programs) developed a set of 10 performance measures of acute stroke care (Box) (3). These measures are derived from published care guidelines and clinical trials; eight of the 10 measures are endorsed by the National Quality Forum as important measures of care (4). Nine of the measures were bundled into groups that define defect-free care* (5).

CDC examined 2005–2009 data on all patients aged ≥ 18 years who were admitted to a participating hospital with any of four clinical diagnoses[†]: 1) acute hemorrhagic stroke (intracerebral hemorrhage or subarachnoid hemorrhage); 2) ischemic stroke; 3) ill-defined stroke (not classified as hemorrhagic or ischemic); or 4) transient ischemic attack (TIA). In-hospital mortality was calculated for each stroke type as the percentage of patients who died during admission for acute stroke. Cochran-Armitage tests were used to test for a trend in improvement over time.

During the 5-year period, 139,260 patients with one of the four diagnoses were admitted to a participating hospital in the seven states. Overall, 18,921 (13.6%) patients had hemorrhagic stroke; 82,066 (58.9%) had ischemic stroke; 8,236 (5.9%) had ill-defined stroke; and 30,037 (21.6%) had TIA. Median age of patients was 72 years (range: 18–108 years); 53% were female, and 74% were non-Hispanic white.

In-hospital mortality for hemorrhagic stroke (intracerebral or subarachnoid hemorrhage) increased from 21.0% in 2005

* *Ischemic stroke inpatient*: dysphagia screening, early antithrombotic medication, deep venous thrombosis/venous thromboembolism (DVT/VTE) prophylaxis, and lipid testing and/or treatment. *Ischemic stroke discharge*: antithrombotic medication, anticoagulation for atrial fibrillation, rehabilitation assessment, smoking cessation counseling, and education on stroke. *Hemorrhagic stroke and ill-defined stroke*: screening for dysphagia, DVT/VTE prophylaxis, rehabilitation assessment, smoking cessation counseling, and education on stroke. *Transient ischemic attack*: early antithrombotic medication, lipid testing and/or treatment, antithrombotic medication at discharge, anticoagulation for atrial fibrillation, smoking cessation counseling, and education.

[†] In PCNASR, the clinical diagnosis is the diagnosis that the physician wrote in the medical record rather than the *International Classification of Diseases, Ninth Revision, Clinical Modification* code.

BOX. Performance measures for acute stroke care*

1. Screening for dysphagia (ischemic and hemorrhagic stroke). Patients with acute ischemic stroke or acute hemorrhagic stroke who received dysphagia screening (swallow screening) before being given anything by mouth (including food, fluid, or medication) were included in the numerator of this performance measure. In the registry, patients who were on NPO (*nil per os*) orders (i.e., no food, fluid, or medication by mouth) throughout the entire hospitalization were excluded from the measure. If dysphagia screening was not documented or the status was unknown, then the screening was assumed not to have been performed.

2. Education on stroke (all stroke and transient ischemic attack).[†] Patients with acute ischemic stroke, hemorrhagic stroke, or transient ischemic attack (TIA) who were given stroke education before discharge were included in the numerator of this performance measure. Patients who were transferred to another acute-care facility, left against medical advice, were transferred to hospice, or died were excluded.

3. Receipt of intravenous tissue plasminogen activator (IV tPA) (ischemic stroke).[†] Patients with acute ischemic stroke who arrived at the hospital within 2 hours of onset of stroke signs and symptoms or time last known to be well and received IV tPA within 3 hours of onset unless contraindicated were included in the numerator of this performance measure. Patients who received IV tPA at a hospital before being transferred to the current hospital were excluded, as were patients undergoing thrombolytic experimental protocols and patients receiving intra-arterial (IA) tPA, unless the IA tPA was given after IV tPA. If patients did not receive IV tPA because of in-hospital delays, they were included in the denominator.

4. Lipid measurement and/or lipid-lowering medication prescribed at discharge (ischemic stroke and TIA).[†]

- 2005–2007: Acute ischemic stroke or TIA patients who had a lipid profile performed during their hospital admission or had documentation in the medical record that a lipid profile was performed in the 30 days before the event, with results also recorded in the medical record, were included in the numerator of this performance measure. Patients were included in the analysis if they had a low-density lipoprotein (LDL) level recorded or if they had all three of the following recorded: total cholesterol, high-density lipoprotein, and triglycerides.
- 2008–2009: Acute ischemic stroke or TIA patients who were admitted on lipid lowering therapy or who had an LDL ≥ 100 , who were discharged on lipid-lowering therapy (2008), or who were discharged on statins (2009). Patients were excluded in the analysis if they were not admitted on lipid-lowering therapy and their LDL was < 100 . Patients who were not admitted on lipid-lowering therapy and who did not have LDL measured were included in the denominator but not the numerator.

5. Nonambulatory patients given deep venous thrombosis/venous thromboembolism (DVT/VTE) prophylaxis by end of second hospital day (ischemic and hemorrhagic stroke).[†] Patients with acute

ischemic stroke or acute hemorrhagic stroke who were nonambulatory and who began receiving DVT prophylaxis within 48 hours of admission (2005–2007) or by the end of the second hospital day (2008–2009) were included in the numerator of this performance measure. Patients who were discharged or transferred to another short-term facility, left against medical advice, or died within 48 hours of admission were excluded.

6. Assessment for rehabilitation (ischemic and hemorrhagic stroke).[†]

Patients with acute ischemic stroke or hemorrhagic stroke who were assessed for rehabilitation services or who received rehabilitation services were included in the numerator of this performance measure. Patients who were transferred to a rehabilitation facility at discharge were assumed to have been assessed for or to have received rehabilitation services. Patients who were transferred to another acute-care facility, left against medical advice, were transferred to hospice, or died were excluded.

7. Anticoagulation medication prescribed at discharge for patients with atrial fibrillation (ischemic stroke and TIA).[†]

Patients with acute ischemic stroke or TIA who had atrial fibrillation during this hospitalization who were discharged on anticoagulation therapy unless contraindicated were included in the numerator of this performance measure. Contraindications had to be documented in the medical record for exclusion from the measure. Patients who were transferred to another acute-care facility, left against medical advice, were transferred to hospice, or died were excluded.

8. Antithrombotic medication within 48 hours or by the end of the second hospital day (ischemic stroke and TIA).[†]

Patients with acute ischemic stroke or TIA who received antithrombotic medication within 48 hours of admission or by the end of the second hospital day unless contraindicated were included in the numerator of this performance measure. Contraindications to antithrombotic therapy had to be documented in the medical record for exclusion from the measure. Patients discharged within 48 hours but who received antithrombotic medication were included.

9. Antithrombotic medication provided at discharge (ischemic stroke and TIA).[†]

Patients with acute ischemic stroke or TIA who were discharged on antithrombotic therapy unless contraindicated were included in the numerator of this performance measure. Contraindications had to be documented in the medical record for exclusion from the measure. Patients who were transferred to another acute-care facility, left against medical advice, were transferred to hospice, or died were excluded.

10. Counseling on smoking cessation (all stroke and TIA).

Patients with acute ischemic stroke, hemorrhagic stroke, or TIA who had smoked one or more cigarettes in the past year and who were given smoking-cessation counseling before discharge were included in the numerator of this performance measure. Patients who were transferred to another acute-care facility, left against medical advice, were transferred to hospice, or died were excluded.

* Developed by CDC, the American Heart Association, and the Joint Commission in 2008.

[†] Endorsed by the National Quality Forum.

to 23.7% in 2009 ($p=0.02$). However, in-hospital mortality for ischemic stroke decreased significantly, from 6.2% in 2005 to 5.1% in 2009 ($p<0.001$). The in-hospital mortality for ill-defined stroke declined (but not significantly), from 6.2% to 4.9%, and the in-hospital mortality rate for TIA ranged from 0.1% to 0.3% with no significant trend.

Adherence to nine of the 10 performance measures increased significantly during 2005–2009 (Table). The one measure that did not show improvement was provision of antithrombotic therapy at discharge, but this measure was at 98% in 2005 and remained at 98% in 2009. The greatest overall improvements during the 5-year period were adherence to the use of thrombolytic therapy (IV tPA) (average annual improvement of 11%), counseling on smoking cessation (9.2%), and lipid testing and/or treatment (7.6%).

Defect-free care improved significantly ($p<0.001$) for patients in each of the four categories: adherence to measures for patients with TIA showed the greatest average annual improvement (21%, from 28% to 57%), followed by inpatient measures for patients with ischemic stroke (17%, from 37% to 69%), measures for patients with hemorrhagic stroke or ill-defined stroke (17%, from 31% to 57%), and discharge measures for patients with ischemic stroke (8%, from 51% to 72%) (Table).

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Editorial Note

Results from the initial (prototype) phase of PCNASR (i.e., from the period 2001–2004) indicated a range of adherence to recommended guidelines for care of stroke patients: 45% adherence to screening for dysphagia, 34% adherence to lipid profile measurement, 21% adherence to smoking-cessation counseling, 91% for providing antithrombotic medication at discharge, and 74% for anticoagulation for atrial fibrillation (6). The results described in this report for 2005–2009 document substantial and significant progress in performance, and compare favorably with those of other major stroke care quality-improvement programs involving predominantly academic hospitals. One such program, Get with the Guidelines — Stroke (GWTG-Stroke) (7), documented improvement in hospitals participating during the same period as PCNASR (i.e., 2005–2009). Improvements in the PCNASR measures were similar to GWTG-Stroke for seven identical performance measures reported (lipid testing and/or treatment, deep venous thrombosis/venous thromboembolism prophylaxis, antithrombotics at discharge, antithrombotics at 48 hours, anticoagulation for atrial fibrillation, and use of IV tPA) (7). The progress shown for PCNASR is especially encouraging considering that the majority of PCNASR hospitals are small and/or nonacademic and have fewer resources to devote to stroke care quality-improvement programs.

The decrease demonstrated in ischemic stroke in-hospital mortality might be a result of improvement in defect-free care and increased use of IV tPA, although other factors, such as increased use of discharge to hospice, shortened length of stay,

TABLE. Number and percentage of hospitals reporting adherence to 10 performance measures for acute stroke care and those reporting defect-free care, by year — seven states, 2005–2009

Characteristic	2005		2006		2007		2008		2009		Improvement from 2005 to 2009 (%)	Average annual improvement (%)
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)		
Performance measure												
Screening for dysphagia*	3,546	(55)	9,329	(57)	8,959	(57)	16,221	(66)	22,392	(73)	33	6.6
Education on stroke*†	4,378	(54)	11,818	(57)	12,552	(63)	17,767	(55)	27,354	(70)	30	6.0
Counseling on smoking cessation*	965	(66)	2,836	(76)	3,215	(86)	5,592	(92)	7,487	(96)	46	9.2
Lipid testing and/or treatment*†	4,473	(64)	12,815	(69)	13,677	(73)	15,814	(75)	12,981	(88)	38	7.6
DVT/VTE prophylaxis*†	3,249	(81)	9,323	(85)	9,137	(88)	12,631	(91)	15,653	(93)	15	3.0
Antithrombotic at discharge†	6,017	(98)	15,875	(97)	15,929	(98)	26,018	(97)	32,221	(98)	0	0
Antithrombotic at 48 hrs*†	4,745	(92)	12,842	(95)	12,882	(95)	22,108	(96)	26,552	(96)	4	0.8
Anticoagulation for atrial fibrillation*†	514	(82)	1,460	(80)	1,496	(85)	3,766	(89)	4,140	(87)	7	1.4
Assessment for rehabilitation*†	5,437	(88)	14,191	(90)	13,664	(92)	23,025	(94)	29,057	(97)	10	2.0
IV tPA*†	161	(37)	485	(39)	489	(45)	842	(57)	1,166	(57)	55	11.0
Defect-free care												
Ischemic in-patient*	1,803	(37)	5,615	(42)	5,937	(44)	11,733	(55)	18,516	(69)	85	17.0
Ischemic discharge*	2,485	(51)	7,339	(55)	8,502	(64)	12,370	(58)	19,314	(72)	41	8.0
Hemorrhagic stroke*	405	(31)	1,225	(39)	1,193	(47)	1,761	(46)	2,716	(57)	85	17.0
Transient ischemic attack *	565	(28)	1,785	(35)	2,209	(43)	3,258	(40)	5,325	(57)	105	21.0

Abbreviations: DVT/VTE = deep venous thrombosis/venous thromboembolism; IV tPA = intravenous tissue plasminogen activator.

*Trend on yearly result using Cochran-Armitage test for trend was statistically significant ($p<0.001$).

† Endorsed by the National Quality Forum.

or increased use of stroke-prevention medications also might have affected mortality rates. Although a small increase was observed in mortality for hemorrhagic stroke, this unadjusted rate is consistent with previous reports documenting 7-day mortality rates >30% (9). The increase might also reflect changes in characteristics of participating hospitals over time, and this finding warrants further study. Measures of acute-phase care (exclusive of discharge measures) for hemorrhagic stroke patients in this registry include only dysphagia screening and deep venous thrombosis/venous thromboembolism prophylaxis. These patients often develop complex neurologic and hemodynamic conditions associated with their stroke that are not addressed by current performance measures. The GWTG-Stroke program reported comparable rates of in-hospital mortality for ischemic stroke (5.5%) and hemorrhagic stroke (20%–25%) (7).

Little improvement was observed in three of the defect-free care measures through 2008, but in 2009 the three showed substantial improvement. For stroke education, improvement was observed during 2005–2007, declining in 2008 and improving in 2009. The stroke education measure changed in 2008, when stricter requirements were established for reporting adherence; this change likely explains the decline observed in 2008. Dysphagia screening and lipid testing and/or treatment showed little improvement until 2008 and 2009. PCNASR programs worked with hospitals to improve adherence to dysphagia screening and lipid management guidelines. Although use of anticoagulation for atrial fibrillation has improved modestly over time, further improvement is warranted.

The findings in this report are subject to at least four limitations. First, improvement in the quality of care over time most likely is multifactorial, and thus establishing a causal relationship between participation in PCNASR and improvement in quality of care is difficult. Dysphagia screening and provision of stroke education are complex processes. Improvement in stroke education and dysphagia screening has been the focus of intensive quality-improvement efforts recommended to hospitals by state health departments. Because hospital recruitment occurs on a different schedule for each state, this study assessed overall improvement of the program by calendar year rather than assessing improvement over time by length of hospital participation in the program. Second, although state health departments are encouraged to recruit hospitals that are representative of hospitals throughout their state by size, geographic location, and teaching status, participation by hospitals is voluntary, which limits generalizability of these results to other states and hospitals. Third, this report did not include modeling to assess trends in stroke care during the study period. Missing data excluded cases from entering into a performance measure, and this might lead to bias in

What is already known on this topic?

The estimated cost of stroke in 2007 in the United States was \$40.9 billion. During the prototype phase of the Paul Coverdell National Acute Stroke Registry (PCNASR), assessment of the quality of care for acute stroke revealed major gaps in adherence to evidence-based guidelines of care.

What is added by this report?

This study documents the improvement in the quality of stroke care over time among hospitals participating in PCNASR. State health departments have collaborated with hospitals to improve the quality of acute care for stroke, demonstrating significant and steady improvements in the overall quality of stroke care during the past 5 years associated with a voluntary, nonregulatory quality-improvement program. Despite this progress, further improvement in defect-free care is needed.

What are the implications for public health practice?

This role for public health and state health departments in hospital quality improvement for acute stroke is a viable approach to improving the quality of stroke care in the United States and in instituting secondary prevention of stroke.

performance measure estimates. Finally, although PCNASR is intended to include all stroke cases, the completeness of case abstraction varies by hospital and state (state registries report abstraction of 75%–100% of eligible cases). Sampling of cases at the hospital level might lead to biased estimates of performance measures.

Additional efforts in primary prevention, including prevention and control of hypertension and hypercholesterolemia, smoking-cessation counseling, provision of smoke-free environments, and promotion of healthy lifestyle behaviors (e.g., regular physical activity and a healthy diet), are needed to reduce the substantial burden of stroke. PCNASR addresses secondary prevention to reduce the recurrence of stroke. The importance of initiating secondary prevention among ischemic stroke patients at the time of discharge from the hospital was shown by the Preventing Recurrence of Thromboembolic Events through Coordinated Treatment (PROTECT) program. PROTECT was designed to improve early initiation of secondary prevention and resulted in significantly fewer adverse vascular events and improved clinical outcomes through better adherence to the use of medications for secondary prevention (8). The Joint Commission recently added stroke care measures to its core hospital quality measures; in 2009, the Centers for Medicare & Medicaid Services added participation in a stroke care quality-improvement registry as a quality indicator and has added stroke care measures to its core quality measures for reporting on meaningful use of electronic health records. These efforts will assist in improving care for stroke throughout the United States. PCNASR provides a strong model for state

health departments as they work to develop a comprehensive, coordinated approach to responding to the challenge of stroke care from prevention, through prehospitalization emergency services and acute care, to rehabilitation and recovery.

Improving the quality of stroke care requires a multidisciplinary, systems-focused effort that engages both public and private entities. State health departments perform a vital role by providing leadership in elevating the level of stroke care and promoting access to high-quality, organized care for stroke through policy development and quality assurance (10).

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