Quality of Care for In-Hospital Stroke
Analysis of a Statewide Registry

Ethan Cumbler, MD; Paul Murphy, MSHA, MA; William J. Jones, MD; Heidi L. Wald, MD, MSPH; Jean S. Kutner, MD, MSPH; Don B. Smith, MD

Background and Purpose—Approximately 4% to 17% of all adult strokes have onset in the hospital. Previous research indicates significant in-hospital evaluation delays and lower adherence to some measures of quality care compared to out-of-hospital strokes.

Methods—Quality of care for in-hospital ischemic strokes compared to stroke with out-of-hospital onset was examined using cohort analysis of a statewide stroke database maintained by the Colorado Stroke Alliance.

Results—One-hundred sixteen in-hospital strokes were compared to 4946 out-of-hospital strokes. Patients with in-hospital strokes were significantly more likely to have history of coronary artery disease (36.7% vs 26.5%; P=0.02), and in-hospital strokes were more severe (NIHSS score 9.5 vs 7.0; P=0.01). Time to brain imaging was not significantly different (54 minutes vs 43 minutes; P=0.13) between groups. Patients with in-hospital stroke were significantly more likely to have documentation of stroke education (90.4% vs 73.1%; P=0.0002) and assessment for rehabilitation (67.7% vs 45.2%; P<0.0001). Total deficit-free care defined as adherence to all Get With the Guidelines Stroke (GWTG-Stroke) measures was better for in-hospital strokes compared to strokes in the community (52.8% vs 32.3%; P<0.0001).

Conclusions—Adherence to GWTG-Stroke performance measures was better for in-hospital strokes in this statewide registry. Variability in reporting by participating hospitals suggests in-hospital strokes are under-recognized or under-reported. In-hospital stroke evaluation times remain more than twice the recommended benchmark of 25 minutes, representing an opportunity for process improvement. (Stroke. 2011;42:207-210.)

Key Words: hospital □ organized stroke care □ outcomes □ quality □ registries

Between 4% and 17% of all ischemic strokes have symptom onset during hospitalization.1,2 Estimates place the number of in-hospital strokes between 35 000 and 75 000 annually in the United States.3 Contributing factors to new cerebral ischemia in the hospital include prothrombotic states, interruption of antithrombotic therapy, and hypotension. Some in-hospital strokes occur in patients admitted for evaluation of a transient ischemic attack, and others may result from new cardiac thrombus, paradoxical embolism, or plaque disruption from vascular manipulation.4 Quality of care for this subset of stroke patients has significant impact on the most common cause of disability in the United States. Evidence suggests time to evaluation for in-hospital strokes exceeds the benchmark standard of 25 minutes from recognition by hospital staff to brain imaging. One study found only 13% of patients with in-hospital stroke were evaluated within 3 hours of symptom onset and another demonstrated only 25% of in-hospital stroke patients had an emergency neurological evaluation.2,5 Evaluation times for stroke alerts have been found to be significantly longer for hospitalized patients compared to those seen in the emergency department, which can lead to greater in-hospital delays to thrombolytic treatment.6,7 In-hospital strokes have been found to have lower rates of cerebral vasculature imaging and lower rates of lipid panel measurement.8,9

Further investigation of quality of care for in-hospital stroke is needed. Few studies represent a wide variety of hospitals and the only previous large multi-center study examining multiple measures of quality care did not analyze deficit-free care. Based on previous research we hypothesized that compared to out-of-hospital stroke, time from symptom recognition to brain imaging would be longer and adherence to other measures of quality care would be lower for in-hospital stroke. Our analysis used a Colorado statewide database to examine both process time and consensus Get-with-the-Guidelines Stroke (GWTG-Stroke) quality measures for in-hospital ischemic stroke/transient ischemic attack (hereafter referred to collectively as stroke).10-11

Materials and Methods
We performed a cohort analysis of a statewide stroke quality database maintained by the Colorado Stroke Alliance, a voluntary...
consortium of 35 hospitals participating in the GWTG-Stroke quality initiative. One hundred sixteen in-hospital strokes were compared to 4946 strokes with onset in the community from the 16 hospitals that contributed at least 1 stroke from both groups to the shared database during study period between August 2005 and April 2009. Exclusion criteria included age younger than 18 years or hemorrhagic stroke. The primary outcome was deficit-free adherence to 9 of 10 GWTG-Stroke consensus measures of quality care for stroke (not including thrombolysis attributable to noncomparable exclusion criteria). Secondary outcomes included adherence to individual GWTG-Stroke consensus measures and time from symptom recognition by hospital staff to initiation of brain imaging.

Statistical Analysis
The groups were compared based on demographics, NIHSS, medical comorbidities, and medication use before stroke. Measures of quality included time from recognition of symptoms by hospital staff to brain imaging, adherence to the 9 GWTG-Stroke consensus markers of quality stroke care (use of thrombolysis considered separately), and the composite measure of deficit-free care. Rates of thrombolysis and medical contraindications to thrombolysis administration were compared between groups. Direct comparison of appropriate use of thrombolysis was not attempted because the most common reason for exclusion for out-of-hospital stroke was delay in arrival to the hospital, which has no equivalent exclusion for the in-hospital stroke. Analysis was performed using SAS statistical software version 9.2. The \( \chi^2 \) and Fisher exact tests were used for dichotomous characteristics, and the independent \( t \) test was used for continuous variables. Wilcoxon rank-sum tests were used for comparisons of evaluation times.

Results
The study cohort consisted of only strokes reported from the 16 hospitals that reported at least 1 in-hospital stroke in addition to out-of-hospital strokes. The 16 included hospitals contributed 82.3% of all strokes reported to the Colorado Stroke Alliance database. Eleven of the hospitals were from an urban setting, 3 were rural, and 2 were frontier. Average bed count was 215 (range, 10–>500). Number of in-hospital strokes reported ranged from 1 to 39. The percentage of in-hospital strokes varied from 0.3% to 18.5% of all strokes reported by these 16 individual Colorado Stroke Alliance hospitals. This cohort had a mean age of 71.5 years, 46% were male, and 77.8% were white. Demographics of in-hospital stroke patients were similar to patients with out-of-hospital strokes, with the exception that patients with in-hospital strokes were significantly more likely to have a history of coronary artery disease (36.7% vs 26.5%; \( P=0.02 \)) and in-hospital strokes were more severe (NIHSS score 9.5 vs 7.0; \( P=0.01 \); Table 1). There was a nonsignificant trend toward longer time to brain imaging for in-hospital stroke (54 minutes vs 43 minutes; \( P=0.13 \)). Quality of care, defined by adherence to the GWTG-Stroke quality measures for which the patient was eligible, was better for in-hospital strokes for the consensus quality measures of stroke education delivered (90.4% vs 73.1%; \( P=0.0002 \)) and assessment for rehabilitation (67.7% vs 45.2%; \( P<0.0001 \); Table 2). Total deficit-free care was better for in-hospital strokes compared to strokes in the community (52.8% vs 32.3%; \( P<0.0001 \); Figure). Thrombolytic treatment rates were similar (9.7% vs 11.7%; \( P=0.54 \)). However in-hospital strokes had a significantly higher rate of medical contraindications to intravenous thrombolysis (68% vs 37%; \( P<0.0001 \)). The most common medical contraindication to thrombolysis for community stroke was rapid improvement or mild stroke severity, whereas for in-hospital stroke it was recent surgery or trauma.

Discussion
Quality of care for in-hospital strokes in our study appears comparable to community strokes for many GWTG-Stroke measures and is better for the composite quality measure of deficit-free care. This was driven primarily by higher adher-
Deficit-free care 52.8% 32.2%

Dysphagia screening 74.4% 74.7% 0.95

Cholesterol-lowering therapy 89.6% 88.9% 0.87

Antithrombotic prophylaxis 100% 96.2% 0.0002

Anticoagulation for atrial fibrillation 100% 93.4% 1.00

Antithrombotic at discharge 97.7% 96.2% 0.77

Deep venous thrombosis prophylaxis 100% 95.1% 0.62

Cholesterol-lowering therapy 89.6% 88.9% 0.87

Dysphagia screening 74.4% 74.7% 0.95

Deficit-free care 52.8% 32.2% <0.0001


ence to delivery of stroke education and assessment for rehabilitation needs. This finding is contradictory to our initial hypothesis that had anticipated adherence to quality measures of stroke-specific care might be lower because of competing priorities from the comorbid illnesses that lead to the index hospitalization. Our findings may reflect increased attention to the rehabilitation and education needs of patients who experienced an adverse event such as stroke while undergoing observation in the hospital setting. Alternately, the in-hospital strokes reported may receive better care than those that go unrecognized for quality reporting.

In addition to a nonsignificant trend toward greater in-hospital delays, in-hospital stroke evaluation times were more

than twice the recommended benchmark of 25 minutes. Research has demonstrated that in-hospital stroke patients who are candidates for thrombolysis receive comparable benefit from treatment compared to out-of-hospital stroke patients.7 Data from this statewide registry suggest that few patients with strokes in the hospital receive intravenous thrombolysis despite the potential advantage of having stroke onset in a monitored setting. This may relate to the observed higher rate of medical contraindications.

Mechanism, risk factors, and hospital processes of care are different for in-hospital stroke, with previous research suggesting higher rates of cardioembolic etiology, higher initial stroke severity, worse functional outcomes, and higher mortality.8,9–12 The present analysis is consistent with previous research finding higher stroke severity and increased cardiac disease for in-hospital stroke patients. It is possible that some of the differences in quality care delivery are explained by the higher stroke severity or differences in etiology between in-hospital stroke and out-of-hospital stroke.

The variability in percentage of total strokes reported by individual hospitals in which symptoms developed during hospitalization was wide, ranging from 0.3% to 18.5%. Some variability is likely explained by differences in patient characteristics between hospitals. It would be expected that hospitals with higher acuity and greater emphasis on cardiovascular diseases or neurovascular procedures might have a greater number of in-hospital strokes that might be counter-balanced by a higher number of strokes from the community sent to the emergency departments of stroke centers and referral hospitals. A scatter plot comparing number of total strokes reported by each hospital to the Colorado Stroke Alliance (with higher numbers likely reflecting larger/referral hospitals) to percentage of in-hospital strokes reported by each hospital did not reveal a clear association between these variables. The degree of variability observed is greater than would be anticipated based on hospital characteristics and suggests potential for under-recognition or under-reporting of in-hospital strokes by some hospitals to the shared quality database. Variation between hospitals not explained by patient characteristics suggests opportunity for standardization and quality improvement.

The limitations of this study include potential for variable practice in identification of in-hospital strokes by participating hospitals. Variability in reported percentages of in-hospital strokes and lower-than-predicted overall proportion of in-hospital strokes suggest under-recognition or under-reporting of in-hospital strokes. This may overestimate quality of care for in-hospital stroke attributable to reporting bias if the same characteristics that cause in-hospital strokes to be identified for reporting also cause these strokes to receive guideline-consistent care. In-hospital strokes have, in the past, been excluded from calculations of hospital stroke quality, which may discourage reporting and reduce ability to recognize discrepancies in care that require remediation. Appropriate utilization of intravenous thrombolysis is one of the GWGT-Stroke quality measures; however, this needed to be considered separately because the ≥2-hour interval from symptom onset to arrival in hospital criteria for exclusion for out-of-hospital strokes made direct comparison of appropriate

Figure. Deficit-free care for Get-with-the-Guidelines Stroke consensus measures of quality stroke management.
use problematic. This study has the strength of including in-hospital stroke from a broad cross-section of hospitals, including academic, community, urban, and rural hospitals, within a statewide stroke quality-improvement consortium.

**Conclusion**

Strokes with onset during hospitalization appear to be under-recognized for quality purposes, but the evidence suggests in-hospital strokes that are reported receive comparable or better adherence to consensus quality measures of care. However, time to brain imaging for in-hospital stroke is twice the recommended benchmark of 25 minutes and represents a target for process improvement. In-hospital strokes have a higher rate of medical contraindications to intravenous thrombolysis, and treatment strategies may anticipate this possibility with consideration of intra-arterial or mechanical thrombolysis for appropriate patients.

Increased attention to reporting of in-hospital strokes is needed in stroke quality databases to permit evaluation and improvement of care quality. Future research should examine optimal methods to identify symptoms of new stroke in the inpatient setting and focus on mechanisms to reduce time to evaluation. The goal of early identification and evaluation of the in-hospital stroke is to allow appropriate patients to be treated with intravenous or intra-arterial thrombolysis, but further investigation is needed regarding outcomes of therapy in this population.

**Acknowledgments**

The authors thank Professional Research Assistant Traci Yamashita, MS, for statistical analysis.

**Sources of Funding**

This project was funded by a University of Colorado Denver School of Medicine, Department of Medicine, Division of General Internal Medicine small grant.

**Disclosures**

Dr Cumbler has no commercial interest relevant to the contents of this manuscript, has full access to all of the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**References**

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Stroke. 2011;42:207-210; originally published online December 2, 2010;
doi: 10.1161/STROKEAHA.110.590265
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://stroke.ahajournals.org/content/42/1/207

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