Outcomes after ischemic stroke for hospitals with and without Joint Commission–certified primary stroke centers

J.H. Lichtman, PhD
S.B. Jones, MPH
Y. Wang, PhD
E. Watanabe, MPH
E. Leifheit-Limson, PhD
L.B. Goldstein, MD

Address correspondence and reprint requests to Dr. Judith H. Lichtman, Yale University School of Medicine, PO Box 208034, New Haven, CT 06520
judith.lichtman@yale.edu

ABSTRACT

Background: The Joint Commission (JC) began certifying primary stroke centers (PSCs) in the United States in 2003. We assessed whether 30-day risk-standardized mortality (RSMR) and readmission (RSRR) rates differed between hospitals with and without JC-certified PSCs in 2006.

Methods: The study cohort included all fee-for-service Medicare beneficiaries ≥ 65 years old discharged with a primary diagnosis of ischemic stroke (International Classification of Diseases, ninth revision, Clinical Modification 433, 434, 436) in 2006. Hierarchical linear regression models calculated hospital-level RSMRs and RSRRs, adjusting for patient demographics, comorbid conditions, and hospital referral region. Hospitals were categorized as being higher than, no different from, or lower than the national average.

Results: There were 310,381 ischemic stroke discharges from 315 JC-certified PSC and 4,231 noncertified hospitals. Mean overall 30-day RSMR and RSRR were $10.9\% \pm 1.7\%$ and $12.5\% \pm 1.4\%$, respectively. The RSMRs of hospitals with JC-certified PSCs were lower than in noncertified hospitals ($10.7\% \pm 1.7\%$ vs $11.0\% \pm 1.7\%$), but the RSRRs were comparable ($12.5\% \pm 1.3\%$ vs $12.4\% \pm 1.7\%$). Almost half of JC-certified PSC hospitals had RSMRs lower than the national average compared with 19% of noncertified hospitals, but 13% of JC-certified PSC hospitals had lower RSRRs vs 15% of noncertified hospitals.

Conclusions: Hospitals with JC-certified PSCs had lower RSMRs compared with noncertified hospitals in 2006; however, differences were small. Readmission rates were similar between the 2 groups. PSC certification generally identified better-performing hospitals for mortality outcomes, but some hospitals with certified PSCs may have high RSMRs and RSRRs whereas some hospitals without PSCs have low rates. Unmeasured factors may contribute to this heterogeneity.

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GLOSSARY

CMS = Centers for Medicare & Medicaid Services; **FFS** = fee-for-service; **HRR** = hospital referral region; **ICD-9-CM** = International Classification of Diseases, ninth revision, Clinical Modification; **JC** = Joint Commission; **NQF** = National Quality Forum; **PSC** = primary stroke center; **RSMR** = risk-standardized mortality rate; **RSRR** = risk-standardized readmission rate.

The Joint Commission (JC) began certifying primary stroke centers (PSCs) in the United States in 2003.¹⁻⁴ Studies assessing the impact of PSC certification have focused on process measures⁵⁻⁸; information on outcomes is limited. One study found hospitals receiving JC PSC certification within the first few years of the program had lower 30-day mortality and readmission rates than hospitals without certified centers before the program began, suggesting that they already used processes that led to better stroke outcomes.⁹ Whether JC PSC certification per se results in better patient outcomes or simply identifies hospitals with better performance is uncertain.

Risk-standardized mortality and readmission after hospital discharge are being used as indicators of the quality of hospital-level care for several disorders, including acute myocardial

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From the Yale University School of Medicine, Department of Epidemiology and Public Health (J.H.L., S.B.J., Y.W., E.W., E.L.-L.), New Haven, CT; and Department of Medicine (Neurology) (L.B.G.), Duke Stroke Center, Duke University and Durham VAMC, Durham, NC.

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infarction and heart failure.¹⁰⁻¹³ In 2008, the Centers for Medicare & Medicaid Services (CMS) began publicly reporting hospital-level risk-standardized 30-day mortality and readmission rates for these conditions.¹⁴⁻¹⁸ Although similar measures are not currently available for stroke,¹⁹ such measures are planned. High risk-standardized mortality rates (RSMRs) and risk-standardized readmission rates (RSRRs) may indicate poorer quality of care, unresolved problems at initial discharge, the quality of immediate posthospital care, a more chronically ill population, or combinations of these factors.¹⁴ High readmission rates are also associated with substantial economic burden, and the reduction of avoidable readmissions is an important US health care reform goal.^{14,15}

To assess the impact of JC-certified PSCs on stroke outcomes, we determined hospital-level RSMRs and RSRRs for ischemic stroke discharges from all US hospitals in 2006.

METHODS Cohort. The study population included all Medicare fee-for-service (FFS) beneficiaries 65 years of age or older hospitalized with a primary discharge diagnosis of ischemic stroke (International Classification of Diseases, ninth revision, Clinical Modification [ICD-9-CM] codes 433, 434, and 436) from January 1–December 31, 2006. Data were obtained from the Medicare Provider Analysis and Review files that included demographic information and primary and secondary discharge diagnosis codes for all hospitalizations. Patients who were younger than 65 years were not included in the analysis because they do not represent typical Medicare patients. Patients who were discharged from nonacute care facilities, transferred to or from another acute care facility, discharged within 1 day of admission, or who left the hospital against medical advice were excluded. We included patients with 12 months of continuous Medicare FFS enrollment before and 1 month after the hospitalization to obtain complete medical history, mortality, and readmission information. Hospitals were classified as to whether or not they had a JC-certified PSC. We identified 315 JC-certified PSCs from the start of the certification program in November 2003 through May 30, 2007, by matching the Medicare provider numbers with an online list of JC-certified centers available in May 2007.³

Outcomes. Study outcome measures included 30-day all-cause RSMRs and 30-day all-cause RSRRs. Mortality was assessed from the date of hospital admission using the Medicare Enrollment Database. The accuracy of ascertainment of vital status using these data resources is high for this age group.²⁰ Readmissions included those for any cause to acute care hospitals treating Medicare patients occurring within 30 days of discharge. We excluded readmissions for procedures that may represent planned continuation of treatment after discharge from the index stroke admission, unless acute stroke (ICD-9-CM 433.x1, 434.x1) was listed as the principal discharge

diagnosis for the hospital readmission. Planned readmissions included carotid endarterectomy, carotid stenting, percutaneous carotid stenting, intercranial and intervertebral stenting, patent foramen ovale closure, ablation, aortic or mitral valve replacement, and cranioplasty.

Covariates. Patient comorbidities were identified using the primary and 9 secondary codes from claims submitted in the year before the index hospitalization and from claims found in the index admission for those conditions that could not represent a complication of the admission. A total of 29 independent variables were included from inpatient administrative claims data, including 2 demographic variables (age and sex), 7 cardiovascular and stroke history variables, and 20 other variables that identify additional coexisting illnesses. The majority of these variables were included in the validated CMS acute myocardial infarction and heart failure 30-day all-cause hospital-specific mortality and readmission measures.¹⁰⁻¹³

Standard protocol approvals, registrations, and patient consents. The Centers for Medicare & Medicaid Services reviewed and approved the submission of the manuscript, based on data use only. The Human Investigation Committee at Yale University determined that Institutional Review Board approval was not required for this analysis.

Statistical analysis. Bivariate analyses were used to compare patient characteristics and outcomes between JC-certified PSC and noncertified hospitals. χ^2 tests were used for comparing binary variables and Wilcoxon rank sum tests were used for comparing continuous variables. Consistent with methods described in the development of administrative models,^{21,22} we estimated a risk model relating the log-odds of 30-day mortality to patient risk factors for the study cohort. The model provided data to compute standardized hospital-specific estimates as well as quantitative summaries of between-hospital variation after adjusting for case mix. An RSMR was calculated for each hospital using the regression coefficients from the risk model. Because of the need to correct for within-hospital clustering of patients and varying hospital volumes, an adjusted number of observed mortalities in the ratio was used rather than the observed number. Geographic differences were accounted for by classifying hospitals into 305 hospital referral regions (HRRs) based on their locations, and then calculating HRR-specific aggregated weighted RSMRs. The same analytic methods were used to calculate RSRRs, with additional censoring for in-hospital deaths and deaths up to 30 days after discharge. Patient mortality and readmission models were risk-adjusted for age, sex, and comorbid conditions consistent with risk-standardization measures developed for the CMS and endorsed by the National Quality Forum (NQF) for hospital performance evaluation.^{10,12,13} The hospital classification (RSMR/RSRR higher than, same as, and lower than the national average) was based on comparing the 95% confidence intervals with the national average.

The analyses were repeated restricting the ischemic stroke cohort to ICD-9-CM 433.x1, 434.x1, and 436, as these additional modifier codes increase specificity to identify acute ischemic events.^{23,24} All statistical testing was 2-sided, at a significance level of $\alpha = 0.05$. Hierarchical models were estimated using the GLIMMIX procedure in SAS. All analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC) and Stata 9.0 (StataCorp, College Station, TX).

RESULTS There were 310,381 ischemic stroke discharges from the 315 JC-certified PSC hospitals and

Table Patient characteristics for discharges from hospitals with and without JC-certified primary stroke centers

Characteristic	Noncertified, mean $\pm$ SD or %	JC-certified PSC, mean $\pm$ SD or %	p Value for difference
Hospital discharges, total n	246,926	63,455	
Age, y	78.6 $\pm$ 7.8	78.1 $\pm$ 7.7	<0.0001
Male sex	44.7	47.9	<0.0001
Comorbid conditions			
Cerebrovascular disease	34.9	40.7	<0.0001
Hypertension	64.8	65.6	0.0002
Diabetes	28.0	27.0	<0.0001
Renal failure	11.3	12.2	<0.0001
Chronic obstructive pulmonary disease	15.4	14.4	<0.0001
Congestive heart failure	16.9	16.5	0.0081
Acute myocardial infarction	1.4	1.6	0.0003
Peripheral vascular disease	10.4	11.7	<0.0001
Cardiopulmonary-respiratory failure	3.6	4.5	<0.0001
Unstable angina	0.5	0.5	0.0155
Pneumonia	6.3	5.7	<0.0001
Dementia	12.4	10.4	<0.0001
Depression	5.0	5.0	0.6241
In-hospital death	4.7	4.4	0.0014
Discharge to skilled nursing facility/intermediate care facility	21.5	18.6	<0.0001
Length of stay, d	4.6 $\pm$ 4.4	4.5 $\pm$ 4.7	<0.0001

Abbreviations: JC = Joint Commission; PSC = primary stroke center.

4,197 noncertified hospitals in 2006 (table). Patients treated at hospitals with and without JC-certified PSCs were of similar age and had comparable rates of comorbid conditions, but JC-certified PSC hospitals had a higher percentage of men and patients with prior cerebrovascular disease. Hospitals with JC-certified PSCs had slightly lower in-hospital mortality rates (4.4% vs 4.7%) and had a lower percentage of patients discharged to skilled nursing or intermediate care facilities (18.6% vs 21.5%) than hospitals without a JC-certified PSC.

The national RSMR was 10.9% $\pm$ 1.7%, with a weighted mean of 10.7% $\pm$ 1.7% for hospitals with a JC-certified PSC (range 6.9%–16.8%) and 11.0% $\pm$ 1.7% for hospitals without a JC-certified PSC (range 6.2%–18.4%; p < 0.0001 for difference). The national RSRR was 12.5% $\pm$ 1.4%, and rates were similar between hospitals with and without a JC-certified PSC (12.5% $\pm$ 1.3% vs 12.4% $\pm$ 1.7%, p < 0.0001; range 9.2%–19.2% for hospitals with and 8.8%–18.4% for hospitals without JC-certified PSCs). Despite relatively small absolute differences in RSMR and RSRR values between the 2 groups, there was heterogeneity in the

distribution of RSMR and RSRR for certified and non-certified hospitals (figure 1).

Almost half of the hospitals with JC-certified PSCs had RSMRs lower than the national average, 45.4% had rates that were no different, and 5.7% had higher rates (figure 2). In comparison, only 18.5% of noncertified hospitals had RSMRs lower than the national average, 66.9% had rates that were no different, and 14.6% had risk-standardized rates higher than the national average. The RSRRs were similar between the 2 groups: approximately 13.3% of hospitals with JC-certified PSCs had RSRRs lower than the national average, as compared with only 15.1% of noncertified hospitals; 28.3% of JC-certified PSC hospitals and 23.7% of noncertified hospitals had 30-day RSRRs higher than the national average. The analyses were repeated using the more restrictive case definition (limiting the sample to those cases with the .X1 modifier). The RSMR and RSRR values increased for this restricted population; however, differences in the RSMR between JC-certified PSC and noncertified hospitals were reduced (14.7% $\pm$ 2.0% for JC-certified PSC hospitals vs 15.0% $\pm$ 1.9% for noncertified hospitals). Approximately 21.6% of JC-certified PSC hospitals had RSMRs less than the national average as compared with 16.5% of noncertified hospitals. The RSRR values were comparable between groups (14.1% $\pm$ 2.1% in the JC-certified PSC hospitals vs 14.1% $\pm$ 1.5% for the noncertified hospitals), with 12.4% of JC-certified PSC hospitals having an RSRR less than the national average as compared with 13.8% of noncertified hospitals.

DISCUSSION Although the absolute differences were small, a higher proportion of hospitals with a JC-certified PSC had 30-day RSMRs that were lower than the national average as compared with hospitals without a JC-certified PSC, but 30-day RSRRs were similar regardless of JC-certified PSC status. There was heterogeneity in the distribution of risk-standardized outcomes for hospitals, with considerable overlap between these groups. The data suggest that JC PSC certification identifies a large number of high-performing hospitals for mortality outcomes, but does not necessarily guarantee better performance than may be found in hospitals without a JC-certified PSC. Moreover, the lack of certification does not necessarily indicate poorer hospital performance.

The majority of prior studies that have evaluated the impact of organized stroke care have focused on mortality and did not assess readmission rates or compare hospital-level outcomes. Similar to our findings, studies conducted outside of the United States have demonstrated that organized stroke care is associated with

Figure 1 Frequency distribution of 30-day risk-standardized mortality rate (RSMR) and risk-standardized readmission rate (RSRR) by Joint Commission (JC)-certified primary stroke center (PSC) status

(A) Box and whisker plots of RSMR and RSRR by JC-certified PSC status. The upper boundaries of the boxes represent the 25th percentile, the lines bisecting the boxes represent the median or 50th percentile, and the lower boundaries of the boxes represent the 75th percentile. The lower and upper boundaries of the whiskers are set at the 5th and 95th percentiles, with dots representing hospitals beyond these percentiles. (B) Frequency distributions of RSMR and RSRR by JC-certified PSC status.

lower mortality, although there have been inconsistent results as to whether patients uniformly benefit from organized care based on stroke type.²⁵⁻²⁸ One study

found that stroke units improve the outcome in patients with large-vessel infarcts, but not in those with lacunar syndromes.²⁸ Analyses of organized stroke care in Can-

Figure 2

Categorization of hospital-level risk-standardized mortality rate (RSMR) and risk-standardized readmission rate (RSRR) relative to the national average by Joint Commission (JC)-certified primary stroke center (PSC) status

Stacked bars represent the proportions of hospitals significantly higher than (dark blue/green), no different from (medium blue/green), or significantly lower than (light blue/green) the national RSMR and RSRR, stratified by JC-certified PSC status.

ada show that all age groups and stroke subtypes benefit from organized care, even after adjusting for stroke severity.^{26,27} Additional work found that an increasing level of organized care was associated with improved survival after stroke.²⁵ There was heterogeneity in hospital performance within certification categories as well as overlap between JC-certified PSC and noncertified hospitals. This may be partially explained by the variation in the comprehensiveness of care provided within these facilities. In addition, there may be unmeasured factors that contribute to heterogeneity in outcomes. The JC-certified PSC status may be a proxy measure for the resources available at a given facility which serves as an overall indicator of quality of hospital care, but may not adequately measure the variability in the comprehensiveness of care provided.

The present study has several potential limitations. The index ischemic stroke cases were identified using ICD-9-CM codes, and miscoding can occur. Positive predictive values for the selected codes for ischemic stroke, however, are relatively high,^{23,24} and there is no reason to suspect differences in data coding across institutions by JC PSC certification status. Medicare inpatient data do not contain information on stroke severity, an important predictor of out-

come. Although discharge location and length of stay at least partially reflect stroke severity, these outcomes are also affected by quality of care. Their inclusion in risk-adjusted models, as well as receipt of therapies such as tissue plasminogen activator use, would therefore confound the analyses. Not adjusting for factors that reflect hospital-level care is consistent with other NQF-endorsed measures used to compare hospital performance. Although studies show that the benefits of organized stroke care do not differ by age group or stroke severity,²⁶ there may be variations in referral patterns to facilities. For example, depending on local referral patterns and service availability, moribund patients might be more likely to be kept at local facilities whereas patients with acute symptoms, who may be amenable to thrombolytic therapy, might be preferentially routed to a JC-certified PSC, contributing to better outcomes. There may be additional unmeasured factors that could explain the observed differences in outcomes. Finally, because our analyses are limited to FFS Medicare beneficiaries 65 years or older, the results may not be applicable to those without FFS Medicare coverage or to stroke patients younger than age

65 years, although Medicare FFS patients in this age group represent the majority of ischemic stroke events.

There are more than 4.4 million stroke survivors in the United States, with approximately 795,000 new strokes identified annually.^{29,30} Stroke is also one of the 10 highest contributors to Medicare costs.³¹ Among the elderly, stroke and TIAs are a leading cause of hospitalization.^{32,33} Recurrent events, which occur in 185,000 stroke survivors in the United States each year, are associated with higher mortality rates, greater levels of disability, and increased costs as compared with initial stroke events.³⁴ For stroke survivors, significant disability, preventable complications, and discharge to settings with substantial requirements for ongoing care are common. Due to its high prevalence, adverse outcomes, and large economic burden, stroke represents an important condition to target strategies to reduce mortality and avoidable rehospitalizations. Our study provides initial data on how hospital-level outcome measures, potentially reflecting quality of care, differ by JC-PSC certification status. The analysis of hospital-level outcomes after ischemic stroke shows that JC certification of PSCs identifies many high-performing hospitals, but there remains considerable overlap in outcomes between hospitals with and without a JC-certified PSC. Additional research is needed to identify the key determinants of hospital performance, to reduce variability and improve patient outcomes. Risk-standardized stroke mortality and readmission may be used to inform and motivate health care quality improvement efforts.

AUTHOR CONTRIBUTIONS

Conception and design: J.H.L., S.B.J., Y.W., L.B.G. Acquisition of data: J.H.L. Analysis or interpretation of data: All authors. Drafting the manuscript: J.H.L., S.B.J., L.B.G. Revising the manuscript for important intellectual content: All authors. Statistical analysis: Y.W., S.B.J., E.W. Obtaining funding: J.H.L. Administrative, technical, material support: J.H.L. Supervision: J.H.L.

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DISCLOSURE

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