Hospitalization Costs for Acute Ischemic Stroke Patients Treated With Intravenous Thrombolysis in the United States Are Substantially Higher Than Medicare Payments

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Background and Purpose—It is important to know the costs for hospitalization for ischemic stroke patients treated with intravenous thrombolysis so that comparisons can be made with payments to hospitals.

Methods—Using the National Inpatient Sample, we evaluated hospitalization costs for patients treated with intravenous thrombolysis for acute ischemic stroke in the United States from 2001 to 2008. Cost data were correlated with demographics and clinical outcome.

Results—Intravenous thrombolysis for acute ischemic stroke was received by 63,472 patients; 24,094 patients were younger than age 65 years and 40,780 patients were 65 years or older. Median hospital costs in 2008 dollars were $14,102 (interquartile range, $9,987–$20,819) for patients with good outcome, $18,856 (interquartile range, $13,145–$30,423) for patients with severe disability, and $19,129 (interquartile range, $11,966–$30,781) for patients with in-hospital mortality. Average 2008 Medicare payments were $10,098 for intravenous thrombolysis without complication and $13,835 for intravenous thrombolysis with major complication.

Conclusions—Hospitalization costs for patients treated with intravenous thrombolysis are substantially higher than Medicare payments. (Stroke. 2012;43:1131-1133.)

Key Words: acute stroke ■ stroke care ■ thrombolysis ■ tissue-type plasminogen activator

Quantifying the costs of hospitalization of patients with acute ischemic stroke receiving intravenous thrombolysis is important for understanding the economic impact of these patients on the hospitals caring for them. We evaluated National Inpatient Sample (NIS) data to determine costs associated with hospitalization for these patients.

Subjects and Methods

Patient Population

The NIS is a hospital discharge database representing 20% of inpatient admissions to nonfederal hospitals in the United States (www.hcup-us.ahrq.gov/nisoverview.jsp). Using the NIS for years 2001 to 2008, ischemic stroke patients were identified using International Classification of Diseases version 9 codes 433-X1 (occlusion and stenosis of cerebral artery with infarction) and 434-X1 (occlusion of cerebral artery with infarction). Patients receiving intravenous tissue-type plasminogen activator were identified using the International Classification of Diseases version 9 procedure code 99.10 (infusion of thrombolytic agent).

Hospital costs, our primary end point, were determined by multiplying the total hospital charges by the provided mean cost-to-charge ratio for each patient’s hospital. Inflation rates were obtained from the consumer price index calculator (http://data.bls.gov/cgi-bin/cpicalc.pl). Costs were converted to their dollar value in 2008. We examined associations between costs and age group, gender, discharge status, length of stay, hospital region, hospital location/teaching status, intracranial hemorrhage (International Classification of Diseases version 9 codes 430 and 431), and Charlson comorbidity index.1 Discharge to long-term facility was used as a surrogate outcome for disability. Medicare payments for Medicare Severity Diagnosis-Related Groups (MS-DRG) 61 and 63 were compared to hospitalization costs. Medicare payments for treatment of ischemic stroke with intravenous thrombolysis in 2008 are publically available (http://www.cms.hhs.gov) and were obtained for comparison to hospital costs.

Statistical Analysis

For hospitalization costs, we used the nonparametric Wilcoxon rank-sum test to determine statistical significance. Multivariate standard least-squares models were used to determine predictors of cost. Predicting variables were forced into our multivariate model. Statistical analysis was performed using the SAS-based statistical software package JMP (www.jmp.com).

Results

Patient Demographics

From 2001 to 2008, a total of 63,472 patients received intravenous thrombolysis; 22,687 (35.7%) patients were younger than age 65 years and 40,780 (64.3%) patients were 65 years or older; 31,145 (49.1%) patients were discharged to a long-term facility, 7,485 (11.8%) patients experienced in-hospital mortality, and 24,842 (39.1%) patients were discharged home or to a short-term facility. Patient demographic data are summarized in Table 1.
Cost Data
Cost data are summarized in Table 2. There was no significant difference in the median costs for patients younger than age 65 years when compared to those 65 years or older ($P=0.052$). Discharge status was significantly correlated with median costs. Patients discharged to home or to short-term facilities had significantly lower median costs when compared to those patients discharged to long-term facilities ($14,102 versus $18,856; \( P < 0.0001 \)). For patients 65 years or older, patients discharged home had median costs of $13,802 versus a median cost of $18,405 for patients discharged to long-term facilities. Costs varied significantly by hospital region, with patients in the South having the lowest costs of hospitalization and patients in the Northeast having the highest costs of hospitalization.

When performing our multivariate model, we found that increased age ($P<0.0001$), longer length of stay ($P<0.0001$), discharge to long-term facility ($P<0.0001$), intracerebral hemorrhage ($P<0.0001$), hospital region ($P<0.0001$), hospital location or teaching status ($P<0.0001$), and Charlson comorbidity index ($P<0.0001$) were independent predictors of increased costs. Multivariate outcomes are summarized in Table 3. Average 2008 Medicare payments were $10,098 for intravenous thrombolysis without complication (MS-DRG 063) and $13,835 for intravenous thrombolysis with major complication (MSS-DRG 061).

Discussion
The 2008 median cost of hospitalization for patients 65 years or older treated with intravenous thrombolysis was $13,802 for those with a good outcome, which does not compare favorably with the average 2008 Medicare payment of $10,098 for intravenous thrombolysis without (MS-DRG 063) complication. Similarly, the median hospital costs of $18,405 for patients with morbidity and $17,406 for patients with mortality do not compare favorably with the average...
2008 Medicare payment of $13,835 for intravenous thrombolysis with major complication (MS-DRG 061).

Medicare reimbursements for hospitalization are based on the Diagnosis-Related Group (DRG) for the patient visit. Each admission is assigned one DRG, and under that DRG the hospital is paid a predetermined lump sum regardless of the costs associated with care. For example, if a patient was assigned the DRG 061 and the cost of care was $20,000, then the hospital would lose approximately $6,000 for that patient’s care. The DRG system is in place to incentivize hospital efficiency. For Medicare patients in 2008, hospitals typically lost approximately $4,000 for each patient with a good outcome and $4,000 for each patient with disability or mortality. Since 2008, there has been no major change in Medicare payments for the MS-DRG for ischemic stroke treated with intravenous thrombolysis, so it is likely that these losses continue. The high cost of caring for these patients is, perhaps, not surprising, because they are often quite ill and caring for them requires many resources. The severity of their illness is demonstrated by their high rate of morbidity and mortality.

A study of patients treated from 2001 to 2004 in Arizona showed that the hospital cost-to-reimbursement ratio was 1.41 before DRG 559 and estimated it to be 0.82 after DRG 559 was introduced in 2007. The MS-DRG 061, 062, and 063 were introduced in 2008, allowing for tiered payment based on comorbidities and complications, and our study of the NIS database shows that the cost-to-reimbursement ratio for Medicare patients in 2008 was 1.40 for patients with good outcome and 1.36 for patients who experience in-hospital mortality. Another recent study of the NIS showed that hospital costs greatly exceeded Medicare payments for acute ischemic stroke patients treated with endovascular embolectomy. Previous studies have examined predictors of increased cost of stroke care. Major predictors of hospital costs are length of stay, stroke severity, cardiac disease, and room charges. Strategies for decreasing costs revolve largely around the formation of stroke units, which can save approximately $5 million per 1,000 patients.

Limitations
Coding errors are a potential limitation of any study using large administrative databases. The sensitivity of the International Classification of Diseases version 9 code 99.10 at one institution was 55%, whereas the specificity has been reported to be as high as 98%. One study demonstrated accuracy of stroke coding to be approximately 90%. We believe it is unlikely that such a limitation could have introduced a significant bias because it should be equally applied throughout all demographic groups and hospital characteristics. Last, because the NIS only provides data on hospital charges for each discharge, cost data were obtained by taking the mean cost-to-charge ratio for all hospitalizations at each individual hospital and multiplying it by the charge for each patient.

Conclusions
Our study of the NIS shows that hospitalization costs in the United States for ischemic stroke patients treated with intravenous thrombolysis are rather high. Medicare payments have not been adequate reimbursements for these hospitalizations. Hopefully, future reconciliation of costs with payments will be feasible so that hospitals can afford to provide proper care for ischemic stroke patients treated with intravenous thrombolysis.

Disclosures
H.C. received research support from Mindframe, Inc, and Cordis Endovascular.

References
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Stroke. 2012;43:1131-1133; originally published online December 22, 2011;
doi: 10.1161/STROKEAHA.111.636142

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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