Conclusions—The percentage of stroke hospitalizations resulting in death decreased over the last decade likely reflecting declining.2,3 These data along with others pointing to reductions in stroke incidence have been rather encouraging.4 However, specific individual/hospital-level characteristics may be targets for facilitating further declines. (Stroke. 2010;41:1748-1754.)

Key Words: disparities ■ epidemiology ■ in-hospital deaths ■ intracerebral hemorrhage ■ ischemic stroke ■ mortality ■ national ■ nationwide hospitalization ■ outcomes ■ prognosis ■ stroke ■ subarachnoid hemorrhage ■ time trends
bed status, teaching status, urban/rural location, and region. All discharges from sampled hospitals for the calendar year are then selected for inclusion into the NIS. To allow extrapolation for national estimates, both hospital and discharge weights are provided. Detailed information on the design of the NIS is available at www.hcup-us.ahrq.gov. From 1997 to 2006, the NIS captured discharge-level information on primary and secondary diagnoses and procedures, discharge vital status, and demographics on discharges per year. Data elements that could directly or indirectly identify individuals are excluded; we thus considered all discharges to be independent. The unit of analysis was the discharge rather than the individual. A unique hospital identifier allows for linkage of discharge data to an NIS data set with hospital characteristics.

To identify stroke hospitalizations, we used all discharges for which International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes 430.xx to 438.xx were included in any of the diagnoses, primary or secondary. For patients who had >1 reported code 430 to 438, only the first reported code was included in the analysis to avoid double-counting patients with multiple reported codes. The current study assumed that using both primary and secondary codes identified all hospital strokes (ie, a false-negative rate of zero), but it was likely that this would also lead to overascertainment. To adjust for the likely overascertainment of stroke as a result of using both primary and secondary diagnoses, the procedure proposed by Williams et al was used. By this procedure, the estimated number of strokes by ICD-9-CM code 430 to 438 was obtained by multiplying the weighted total number of discharges with each ICD-9-CM code by its estimated positive predictive value for stroke. The positive predictive values were derived by pooling data from previously published studies. The total number of stroke hospitalizations was obtained by summing across codes.

Statistical Analyses

Trends in in-hospital mortality after stroke were compared before and after adjustment for covariates. We computed the overall unadjusted weighted proportions of stroke hospitalizations that resulted in death across time. To assess in-hospital mortality trends after adjustment for covariates and to identify independent predictors of in-hospital mortality, the multivariable logistic regression model was used at the same time as taking into account the weighting, clustering, and stratification needed under the complex NIS survey design. Analyses were additionally weighted by the positive predictive value to adjust for overascertainment stroke as noted. The following demographic and clinical characteristics were adjusted for: age, race (white, black, other, unknown), primary payer (Medicare, Medicaid, private, other), comorbid condition, and number of procedures performed as an ordinal variable. In addition, the following hospital characteristics were also adjusted for including region (North East, Midwest, South, West), bed size (small, medium, large), stroke volume by quartile, and location/teaching status (rural, urban nonteaching, urban teaching). The time variable was grouped into 5 2-year intervals from 1997 to 1998 to 2005 to 2006. Index stroke type was categorized as follows: (1) subarachnoid hemorrhage (SAH; ICD-9 430.xx); (2) intracerebral hemorrhage (ICH; ICD-9 431.xx); or (3) ischemic stroke (ICD-9 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, and 436). Weighted in-hospital mortality rates were computed across time separately for each stroke type. To assess whether mortality trends differed by stroke type and hospital type, linear contrasts under a logistic regression model were used. Median length of hospital stay (LOS) was estimated and significant trends were tested through linear regression by including time as a continuous variable in the regression models. To assess the relation between in-hospital mortality and LOS, the logistic regression model was used after adjusting for NIS time interval. LOS was log-transformed for the purpose of these analyses to improve normality.

The number and severity of comorbid conditions were assessed using the Charlson comorbidity index (CCI). The modified version of the CCI was used. The CCI is a weighted score composed of 17 comorbid conditions including congestive heart failure (weight 1), myocardial infarction (weight 1), chronic pulmonary disease (weight 1), cerebrovascular disease (weight 1), hemiplegia or paraplegia (weight 2), dementia (weight 1), diabetes without complications (weight 1), diabetes with complication (weight 2), malignancy (weight 2), metastatic solid tumor (weight 6), mild liver disease (weight 1), moderate or severe liver disease (weight 3), peptic ulcer disease (weight 1), peripheral vascular disease (weight 1), rheumatologic disease (weight 1), renal disease (weight 2), and AIDS (weight 6). For the purpose of the multivariable analysis, CCI was grouped into 4 categories, including a CCI of 1, 2, 3, or ≥4. Because CCI may possibly be a surrogate marker for the overall condition of the patient (eg, capacity for repair and recovery) or severity of admission illness, we evaluated trends in the proportions of patients who had high CCI (≥4) across the study period to determine whether they substantially changed over time.

All data analyses were conducted using SAS (Version 9.1; SAS Institute Inc, Cary, NC). Statistical hypotheses were tested using P<0.05 as the level of statistical significance.

Results

Overall, between 1997 and 2006, stroke hospitalizations lessened from 1 531 293 in 1997 to 1 202 449 in 2005 to 2006, whereas overall percentage stroke hospitalizations that resulted in death decreased from 11.5% in 1997 to 10.3% in 2005 to 2006 (P=0.0001). Over the decade, the peak in percentage stroke hospitalizations that resulted in death occurred in 1999 to 2000 and then declined steadily thereafter, a trend generally seen across stroke types (Supplemental Figure I; available at http://stroke.ahajournals.org). Table 1 shows the summary statistics for demographic, clinical, and hospital factors stratified by stroke type. Comparing 1997 to 1998 with 2005 to 2006, these factors were generally comparable. However, of note, there were fewer whites hospitalized with all 3 stroke types in 2005 to 2006, and there was a modest but significant decrease in the length of hospital stay across the study period for ischemic stroke (trend: P<0.0001) and ICH (trend: P=0.0022), but not for SAH (trend: P=0.6255).

In-hospital mortality rates across time for each stroke type are shown in Table 2 and Supplemental Figure II. From 1997 to 2006, ischemic stroke hospitalizations lessened by 17.5%, ICH hospitalizations lessened by 8.5%, whereas hospitalizations for SAH slightly increased. However, mortality rates significantly decreased across the study period regardless of stroke type. Comparisons of the decrease in in-hospital mortality across time among the different types of stroke are displayed in Table 3 (ORs for the effect of time).

Tables 4 and 5 show the unadjusted and adjusted logistic regression analyses stratified by stroke type. For hospitalizations with ischemic stroke, female sex, older age, non-Medicare insurance, and higher CCI were independently associated with an increase in the odds of dying in the hospital, whereas hospitals located in the Midwest region or West region (versus Northeast), hospitals with higher stroke volume, and urban hospitals (versus rural) were significantly associated with a decrease in the odds of dying in the hospital (Table 4). For hospitalizations with ICH, older age, Medicaid, and “other” insurance (versus Medicare) were independently related to increased the odds of dying in the hospital, whereas private insurance, hospitals in the Midwest or West regions (versus Northeast), and urban hospitals were associated with a significant decrease in the odds of in-hospital mortality (Table 4). For hospitalizations with SAH, older age, high
CCI, and higher hospital stroke volume were independently linked to greater odds of in-hospital mortality, whereas private insurance (versus Medicare), hospital location outside of the Northeast, and urban teaching hospital type were associated with a significant decrease in the odds of in-hospital mortality (Table 5). The OR estimates for the effect of time interval were unaltered after including the covariates in the models.

Analysis of trends in CCI across the study period found that the proportion of very sick patients as defined by CCI \( \geq 4 \)
significantly increased across the study period. LOS significantly decreased across the study period (trend: \( P<0.0001 \)). The odds of dying in the hospital after stroke was inversely related to LOS after controlling for time interval, but the inclusion of LOS in the model did not have any considerable effect on the OR estimates for the effect of time interval.

Supplemental Figure II depicts changes over time in percent in-hospital mortality stratified by stroke type and hospital location/teaching status. For rural hospitals, the percent in-hospital mortality after stroke significantly decreased over time both for ischemic strokes (\( P=0.0018 \)), not for ICH or SAH. For urban nonteaching hospitals, the percent in-hospital mortality after stroke significantly decreased across the study period but only for ischemic strokes (\( P=0.0018 \)), not for ICH or SAH. For urban teaching hospitals, the percent in-hospital mortality after stroke significantly decreased over time both for ischemic strokes (\( P<0.0001 \)) and ICH (\( P=0.0061 \)), but not for SAH. For urban teaching hospitals, the percent in-hospital mortality after stroke significantly decreased across time for all stroke types (ischemic: \( P=0.0013 \); ICH: \( P<0.0001 \); SAH: \( P=0.0011 \)). The percentage of patients who received thrombolytic treatment within 1 day of admission for ischemic stroke rose from 0.1% in 1997 to 1998 to 0.6% in 2005 to 2006 for rural hospitals, from 0.1% to 1.3% for urban nonteaching hospitals, and from 0.1% to 2.3% for urban teaching hospitals (Supplemental Figure III).

### Discussion

This analysis of rates of in-hospital mortality after stroke from 1997 to 2006 in the United States showed that deaths during stroke hospitalization have lessened significantly over time, and since the years 1999 to 2000, this decline has been steady and continuous, probably mainly reflecting improvements in hospital care after occurrence of a stroke. These data are generally in accord with a lowering of the incidence of in-hospital strokes noted in this study and others as well as recently decreasing patterns observed in overall stroke incidence and mortality directly due to stroke.

Recent studies have looked at mortality after SAH and ICH hospitalizations over an almost similar time period, observing a decrease in mortality after SAH over time but no change in mortality after ICH. However, these studies only included primary diagnoses, did not incorporate any index of illness severity, and did not conduct any multivariable analyses.

At first glance, the magnitude of the drop (1.14%) over the decade may not seem very impressive but has to be viewed in the context of the actual number of fewer deaths (almost 31,000), paucity of proven treatments for acute stroke, and the incontrovertible hard outcome studied, mortality, which can often be a difficult outcome to favorably impact from a broad public health perspective. Furthermore, the decreases in in-hospital mortality rates were observed for all major stroke types and so cannot just be explained by potentially wider use of revascularization strategies among ischemic strokes. It is also interesting to see that even for SAH whose incidence slightly rose over the study period, in-hospital mortality declined with time, which would further suggest that reductions in overall in-hospital mortality after stroke were likely driven by better acute stroke care in addition to prevention of stroke. One could speculate that a rise in prevalence of dedicated stroke units that have been shown to favorable impact acute stroke outcomes as well as inpatient quality improvement programs that enhance evidence-based acute care processes have greatly contributed to these reductions.

The multivariable analyses that investigated the independent odds of dying in the hospital after a stroke identified several avenues on the patient and hospital level that could be further explored to possibly boost survival among hospitalized patients by stroke type. Many of these factors were similar across stroke type and included older age, female sex, and non-Medicare insurance, which have previously been associated with greater odds of short-term mortality after stroke, and underscore the need to implement strategies to bridge these sociodemographics in stroke care.

For example, specifically improving the relatively poorer quality of inpatient stroke care that women receive compared with men could go a long way toward improving their clinical outcomes after a stroke.

Analysis by hospital type showed that urban teaching hospitals had a significant decrease in mortality across all 3 stroke types, whereas urban nonteaching hospitals had a decrease for 2 stroke types and rural hospitals had a decrease just for ischemic stroke. This more consistent improvement in mortality after stroke at urban teaching hospitals likely

### Table 2. Distribution of In-Hospital Mortality Rates Across Time by Stroke

<table>
<thead>
<tr>
<th>Diagnosis Type</th>
<th>Year</th>
<th>Total No.</th>
<th>Weighted Percent</th>
<th>SE</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic stroke</td>
<td>1997–1998</td>
<td>934 501</td>
<td>9.76%</td>
<td>0.11%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>1999–2000</td>
<td>868 798</td>
<td>10.11%</td>
<td>0.11%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2001–2002</td>
<td>847 717</td>
<td>9.70%</td>
<td>0.12%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003–2004</td>
<td>800 117</td>
<td>9.19%</td>
<td>0.10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005–2006</td>
<td>800 425</td>
<td>8.78%</td>
<td>0.11%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAH</td>
<td>0.0001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1997–1998</td>
<td>47 602</td>
<td>26.90%</td>
<td>0.58%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1999–2000</td>
<td>48 376</td>
<td>25.65%</td>
<td>0.67%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2001–2002</td>
<td>44 566</td>
<td>27.10%</td>
<td>0.58%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003–2004</td>
<td>51 078</td>
<td>24.76%</td>
<td>0.62%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005–2006</td>
<td>50 742</td>
<td>23.80%</td>
<td>0.58%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ICH</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1997–1998</td>
<td>147 728</td>
<td>30.47%</td>
<td>0.33%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1999–2000</td>
<td>139 157</td>
<td>31.01%</td>
<td>0.38%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2001–2002</td>
<td>134 039</td>
<td>30.84%</td>
<td>0.33%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003–2004</td>
<td>135 727</td>
<td>30.63%</td>
<td>0.33%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005–2006</td>
<td>135 129</td>
<td>28.23%</td>
<td>0.34%</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. ORs for the Effect of Time (2005–2006 Versus 1997–1998) on In-Hospital Mortality for Each Stroke Type

<table>
<thead>
<tr>
<th>Stroke Type</th>
<th>OR</th>
<th>95% Lower Confidence Limit</th>
<th>95% Upper Confidence Limit</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic stroke</td>
<td>0.89</td>
<td>0.86</td>
<td>0.92</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SAH</td>
<td>0.95</td>
<td>0.97</td>
<td>0.92</td>
<td>0.0001</td>
</tr>
<tr>
<td>ICH</td>
<td>0.90</td>
<td>0.86</td>
<td>0.94</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Table 4. Unadjusted and Adjusted Logistic Regression Analyses of Predictors of In-Hospital Mortality After Ischemic Stroke and ICH Between 1997 and 2006 in the United States

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ischemic Stroke Unadjusted</th>
<th>Ischemic Stroke Adjusted</th>
<th>ICH Unadjusted</th>
<th>ICH Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR  LCL  UCL  P</td>
<td>OR  LCL  UCL  P</td>
<td>OR  LCL  UCL  P</td>
<td>OR  LCL  UCL  P</td>
</tr>
<tr>
<td>Years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997–1998 versus 2005–2006</td>
<td>1.12 1.08 1.17 0.0000</td>
<td>1.08 1.03 1.12 0.0005</td>
<td>1.11 1.07 1.16 0.0000</td>
<td>1.11 1.06 1.17 0.0000</td>
</tr>
<tr>
<td>1999–2000 versus 2005–2006</td>
<td>1.17 1.13 1.21 0.0000</td>
<td>1.17 1.12 1.21 0.0000</td>
<td>1.14 1.09 1.20 0.0000</td>
<td>1.15 1.10 1.20 0.0000</td>
</tr>
<tr>
<td>2001–2002 versus 2005–2006</td>
<td>1.12 1.08 1.16 0.0000</td>
<td>1.14 1.10 1.19 0.0000</td>
<td>1.13 1.09 1.18 0.0000</td>
<td>1.15 1.10 1.20 0.0000</td>
</tr>
<tr>
<td>2003–2004 versus 2005–2006</td>
<td>1.05 1.02 1.09 0.0044</td>
<td>1.10 1.06 1.14 0.0000</td>
<td>1.12 1.08 1.17 0.0000</td>
<td>1.13 1.09 1.18 0.0000</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female versus male</td>
<td>1.04 1.03 1.06 0.0000</td>
<td>1.02 1.00 1.03 0.0377</td>
<td>1.03 1.01 1.06 0.0025</td>
<td>0.98 0.96 1.00 0.1221</td>
</tr>
<tr>
<td>Age (per year)</td>
<td>1.02 1.02 1.02 0.0000</td>
<td>1.03 1.03 1.03 0.0000</td>
<td>1.01 1.01 1.01 0.0000</td>
<td>1.02 1.01 1.02 0.0000</td>
</tr>
<tr>
<td>Race: black versus white</td>
<td>0.81 0.78 0.83 0.0000</td>
<td>0.97 0.94 1.01 0.1331</td>
<td>0.88 0.84 0.91 0.0000</td>
<td>0.98 0.94 1.02 0.3849</td>
</tr>
<tr>
<td>Payer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payer: Medicaid versus Medicare</td>
<td>0.79 0.76 0.82 0.0000</td>
<td>1.31 1.25 1.38 0.0000</td>
<td>0.81 0.78 0.85 0.0000</td>
<td>1.10 1.04 1.16 0.0009</td>
</tr>
<tr>
<td>Payer: private versus Medicare</td>
<td>0.67 0.65 0.70 0.0000</td>
<td>1.09 1.04 1.14 0.0004</td>
<td>0.75 0.73 0.77 0.0000</td>
<td>0.95 0.91 0.98 0.0059</td>
</tr>
<tr>
<td>Payer: other versus Medicare</td>
<td>0.84 0.78 0.91 0.0000</td>
<td>1.56 1.42 1.71 0.0000</td>
<td>1.05 1.00 1.11 0.0500</td>
<td>1.43 1.34 1.51 0.0000</td>
</tr>
<tr>
<td>CCI</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2 versus 1</td>
<td>1.43 1.39 1.46 0.0000</td>
<td>1.31 1.28 1.34 0.0000</td>
<td>1.02 0.99 1.05 0.2241</td>
<td>0.94 0.91 0.97 0.0001</td>
</tr>
<tr>
<td>3 versus 1</td>
<td>1.56 1.52 1.60 0.0000</td>
<td>1.41 1.37 1.44 0.0000</td>
<td>0.72 0.69 0.74 0.0000</td>
<td>0.68 0.66 0.71 0.0000</td>
</tr>
<tr>
<td>≥4 versus 1</td>
<td>2.25 2.19 2.31 0.0000</td>
<td>2.01 1.96 2.06 0.0000</td>
<td>0.81 0.78 0.84 0.0000</td>
<td>0.76 0.73 0.78 0.0000</td>
</tr>
<tr>
<td>Hospital characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midwest versus Northeast</td>
<td>0.77 0.74 0.80 0.0000</td>
<td>0.87 0.83 0.93 0.0000</td>
<td>0.86 0.82 0.91 0.0000</td>
<td>0.91 0.86 0.97 0.0046</td>
</tr>
<tr>
<td>South versus Northeast</td>
<td>0.83 0.81 0.86 0.0000</td>
<td>1.05 0.99 1.10 0.0813</td>
<td>0.90 0.86 0.94 0.0000</td>
<td>0.97 0.92 1.03 0.2774</td>
</tr>
<tr>
<td>West versus Northeast</td>
<td>0.80 0.76 0.84 0.0000</td>
<td>0.83 0.78 0.89 0.0000</td>
<td>0.87 0.82 0.92 0.0000</td>
<td>0.92 0.86 0.99 0.0167</td>
</tr>
<tr>
<td>Medium versus small bed size*</td>
<td>1.03 0.98 1.07 0.2571</td>
<td>1.03 0.97 1.09 0.2964</td>
<td>1.10 1.03 1.17 0.0029</td>
<td>1.07 1.00 1.14 0.0361</td>
</tr>
<tr>
<td>Large versus small bed size*</td>
<td>1.03 0.99 1.08 0.1089</td>
<td>1.04 0.99 1.10 0.1275</td>
<td>1.05 0.99 1.12 0.0900</td>
<td>1.04 0.98 1.10 0.2434</td>
</tr>
<tr>
<td>Volume† quartile: 2 versus 1</td>
<td>0.84 0.71 1.00 0.0533</td>
<td>0.84 0.70 1.00 0.0543</td>
<td>1.31 0.85 2.02 0.2183</td>
<td>1.25 0.82 1.90 0.3038</td>
</tr>
<tr>
<td>Volume† quartile: 3 versus 1</td>
<td>0.76 0.65 0.90 0.0010</td>
<td>0.75 0.63 0.90 0.0013</td>
<td>1.32 0.89 1.97 0.1730</td>
<td>1.26 0.86 1.86 0.2322</td>
</tr>
<tr>
<td>Volume† quartile: 4 versus 1</td>
<td>0.72 0.61 0.84 0.0000</td>
<td>0.67 0.56 0.80 0.0000</td>
<td>1.30 0.88 1.92 0.1917</td>
<td>1.27 0.87 1.85 0.2241</td>
</tr>
<tr>
<td>Urban nonteaching versus rural</td>
<td>0.94 0.91 0.97 0.0001</td>
<td>0.90 0.87 0.94 0.0000</td>
<td>0.93 0.88 0.98 0.0040</td>
<td>0.94 0.89 1.00 0.0363</td>
</tr>
<tr>
<td>Urban teaching versus rural</td>
<td>0.98 0.94 1.01 0.1853</td>
<td>0.90 0.86 0.94 0.0000</td>
<td>0.87 0.83 0.92 0.0000</td>
<td>0.88 0.82 0.93 0.0000</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>1.35 1.25 1.47 0.0000</td>
<td>1.07 0.99 1.16 0.0892</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

†No. of stroke hospitalizations per year for a given hospital.
LCL indicates 95% lower confidence limit; UCL, 95% upper confidence limit.
reflects the higher presence of experts with the requisite knowledge and experience in evidence-based stroke management as well as resources (dedicated neurocritical units and stroke units). Indirectly further supporting this notion of expertise and experience, over the study period, urban teaching hospitals had the biggest increase in the rate of thrombolytic treatment for ischemic stroke followed by urban nonteaching hospitals and then rural hospitals. The increasing use of telemedicine by which experts remotely assist in acute ischemic stroke management at rural hospitals and the growing certification of hospitals adept at handling acute ischemic stroke cases may further bridge these disparities. However, it is clear from these data that beyond acute ischemic stroke, improvements need to be made in optimizing outcomes of the more devastating hemorrhagic strokes types (SAH, ICH) at rural hospitals.

Not surprisingly, generally sicker patients (those with several comorbid diagnosis, ie, CCI ≥4) were more likely to die during stroke hospitalization. However, it was surprising to observe that the number of very sick hospitalized patients with stroke has risen over the decade. It could well be that patients are progressively getting sicker, but a more likely explanation in the face of declining in-hospital mortality rates after stroke could be that better diagnostic techniques and better awareness have led to increased diagnoses of several general medical conditions over the years.

This study has limitations. Although CCI level was used as an index of illness severity, the confounding effect of actual severity of index stroke was not specifically adjusted for, because these data were not collected in the NIS data set, and routinely, reliably and consistently measuring admission stroke severity across hospitals nationwide can be challenging. Other limitations include an inability to distinguish first from recurrent strokes, possible inaccurate physician and administrative reporting of ICD codes, and lack of documented information on the rate of nonhospital stroke in the

### Table 5. Unadjusted and Adjusted Logistic Regression Analyses of Predictors of In-Hospital Mortality After SAH Between 1997 and 2006 in the United States

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unadjusted</th>
<th></th>
<th></th>
<th></th>
<th>Adjusted</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>Lower 95% CL</td>
<td>Upper 95% CL</td>
<td>P</td>
<td>OR</td>
<td>Lower 95% CL</td>
<td>Upper 95% CL</td>
<td>P</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Age (per year)</td>
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<td>2 versus 1</td>
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<td>≥4 versus 1</td>
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<td>Urban teaching versus rural</td>
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<td>0.59</td>
<td>0.74</td>
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<td>0.78</td>
<td>0.69</td>
<td>0.87</td>
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†No. of stroke hospitalizations per year for a given hospital.
CL indicates confidence limit.
country because many stroke-related deaths occur out of the hospital. The study was strengthened by its nationwide scope, incident and not prevalent stroke rate data, clinician-diagnosed and not self-reported strokes, and especially by its inclusion of both primary and secondary diagnoses (which minimized the false-negative rate) with simultaneous correction for any potential overascertainment (which minimized the false-positive rate).

Disclosures
None.

References


Nationwide Trends in In-Hospital Mortality Among Patients With Stroke
Bruce Ovbiagele

Stroke. 2010;41:1748-1754; originally published online June 17, 2010;
doi: 10.1161/STROKEAHA.110.585455
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

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