Background and Purpose—The common medical complications after ischemic stroke are associated with increased mortality and resource use.

Method—The study population consisted of 1,150,336 adult hospitalizations with ischemic stroke as a primary diagnosis included in the 1998 to 2007 Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project. Multiple logistic regression analyses were used to examine changes between 1998 to 1999 and 2006 to 2007 in the prevalence of acute myocardial infarction, pneumonia, deep venous thrombosis, pulmonary embolism, or urinary tract infection, in-hospital mortality, and length of stay.

Results—In 2006 to 2007, the prevalence of hospitalizations with a secondary diagnosis of acute myocardial infarction, pneumonia, deep venous thrombosis, pulmonary embolism, and urinary tract infection was 1.6%, 2.9%, 0.8%, 0.3%, and 10.1%, respectively. The adjusted ORs for a hospitalization in 2006 to 2007 complicated by acute myocardial infarction, deep venous thrombosis, pulmonary embolism, or urinary tract infection, using 1998 to 1999 as the referent, were 1.39, 1.68, 2.39, and 1.18, respectively. The odds of pneumonia did not change significantly between 1998 to 1999 and 2006 to 2007. In-hospital mortality was significantly lower in 2006 to 2007 than in 1998 to 1999. Despite the overall length of stay decreasing significantly from 1998 to 1999 to 2006 to 2007, it remained the same for hospitalizations with acute myocardial infarction, pneumonia, deep vein thrombosis, and pulmonary embolism.

Conclusion—Although in-hospital mortality decreased over the study period, 4 of the 5 complications were more common in 2006 to 2007 than they were 8 years earlier with the largest increase observed for deep venous thrombosis and pulmonary embolism. (Stroke. 2010;41:980-986.)

Key Words: cerebral infarct ■ embolism ■ epidemiology ■ outcomes ■ stroke care ■ venous thrombosis

Although the annual stroke death rate in the United States fell 29.7% during the last decade, and although the actual number of stroke deaths declined 13.5% during the same period, stroke remains a leading cause of death and serious long-term disability in this country.1 Medical complications are common in patients with stroke,2 but the impact of these complications has not been well studied. The complications of pneumonia (PN), deep vein thrombosis (DVT), pulmonary embolism (PE), and urinary tract infection (UTI) after an acute ischemic stroke are recognized as negative indicators of the quality of stroke care.3,4 and acute myocardial infarction (AMI) is not uncommon after an acute ischemic stroke.5 All of these complications are largely preventable or treatable and may adversely affect the patient’s outcome and extend the length of stay (LOS). Even so, there have been few population-based estimates of these complications and very little on their recent trends. Prevention of venous thromboembolic disease (DVT and PE) and PN are a focus of several programs for improving the quality of stroke care, including The Joint Commission’s Primary Stroke Center program, American Heart Association’s Get With The Guidelines—Stroke program, and the Centers for Disease Control and Prevention’s Paul Coverdell National Acute Stroke Registry. Additionally, in October 2008, the Centers for Medicare and Medicaid instituted efforts to reduce catheter-associated UTIs in hospitalized patients.

Recently, a need for initiating surveillance of noncommunicable disease at the national and global levels has been increasingly recognized (World Health Organization web site: www.who.int/ncd_surveillance/en/).6 However, currently no comprehensive surveillance system is available to monitor changes in patient care. Previous experience with the development of surveillance systems in other areas at the national level shows that the standardized nationwide hospital discharge data sets and standardized definitions can be used for this purpose.7 In the present report, we examined hospi-
talizations of adults (age ≥18 years) whose primary diagnosis was ischemic stroke as revealed by International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. The 3 primary objectives were to (1) examine trends in AMI, PN, DVT, PE, and UTI as secondary diagnoses, in-hospital mortality, and LOS; (2) investigate the associations of AMI, PN, DVT, PE, and UTI with in-hospital mortality; and (3) compare LOS for hospitalizations with and without AMI, PN, DVT, PE, and UTI diagnosis. We drew on the 1998 to 2007 Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality. For this analysis, we have chosen to use the term “complications” for these secondary diagnoses rather than comorbid conditions, but we realize that we were not able to distinguish them as present on arrival or developing during the admission.

Methods

Data Sources
The NIS is a stratified, cross-sectional sample that includes approximately 20% of all community (nonfederal) hospital discharges in the United States. The NIS database collects yearly data from approximately 1000 hospitals stratified by region, location/teaching status, number of beds, and ownership and the sampling unit represents a hospitalization, not a person or patient (the same patient may be included in ≥2 hospitalizations). The NIS is the largest all-payer inpatient care database in the United States. The details of the NIS sampling design, data elements, and estimates can be found at the Healthcare Cost and Utilization Project web site (www.hcup-us.ahrq.gov).

Study Variables
Complications were identified by searching the secondary diagnostic codes (ICD-9-CM codes) for AMI, PN, DVT, PE, and UTI (the detailed ICD-9-CM coding is presented in the Appendix to this article). In addition to medical complications, in-hospital mortality and LOS were also assessed in this analysis. Nine comorbidity conditions (congestive heart failure, peripheral vascular disease, hypertension, paralysis, other neurological disorders, chronic pulmonary disease, diabetes with chronic complications, renal failure, and coagulopathy) were chosen from the list of comorbidities proposed by the Agency for Healthcare Research and Quality based on the significance of associations with in-hospital mortality reported in the previous studies and these conditions did not overlap with the complications focused on in this report. Furthermore, we examined the association between the outcome variables and the following demographic features: age (<65 years versus ≥65 years), sex (male versus female), payment type (Medicare, Medicaid, private, and other), and hospital location (urban versus rural).

Statistical Methods
The unit of analysis was the hospital discharge. To develop national estimates from our findings, we used discharge weights; which were developed to extrapolate NIS sample discharges to the total discharges. Five time intervals were selected in this study: 1998 to 1999, 2000 to 2001, 2002 to 2003, 2004 to 2005, and 2006 to 2007. The prevalence of medical complications (AMI, PN, DVT, PE, and UTI) as well as in-hospital mortality was assessed across 5 time intervals. Multiple logistic regression analyses were conducted to examine whether there was a linear trend across the 5 time periods in the prevalence of medical complications after adjusting for age, sex, payment type, and hospital location. To assess the changes over time in in-hospital mortality, multiple logistic regression modeling was used adjusting for age, sex, payment type, the 9 comorbidities mentioned, and hospital location as well as the complications of interest in this report. A linear regression model was used to assess the changes in LOS across the 5 time periods after adjusting for age, sex, payment type, and hospital locations. The orthogonal polynomial coefficients were obtained in both the logistic and linear regression models for testing the linear trend. In addition, we examined the changes in prevalence of medical complications and in-hospital mortality between 1998 to 1999 and 2006 to 2007 by using multiple logistic regression analysis after the adjustments described previously.

To evaluate the patient and hospital factors that might be associated with medical complications and in-hospital mortality, we applied the same logistic regression model within 1998 to 1999 and 2006 to 2007. Adjusted ORs and 95% CIs were obtained from the multiple logistic regression models. Lastly, we used t tests to assess the difference in LOS between hospitalizations with and without medical complications between 1998 to 1999 and 2006 to 2007. Because of the larger sample size, 2-tailed probability values <0.01 were considered to be significant throughout the analyses. All statistical analyses were performed with the statistical software package SUDAAN (Release 9.2; Research Triangle Institute, Research Park, NC) to account for the complex sample design.

Results
During 1998 to 2007, there were 1 150 336 adult hospitalizations with ischemic stroke as a primary diagnosis, representing 5 635 404 hospitalizations across the United States in this time period. The weighted proportions of hospitalizations in which the patient was aged ≥65 years decreased from 77.6% in 1998 to 1999 to 76.5% in 2000 to 2001 to 74.5% in 2002 to 2003, 72.7% in 2004 to 2005, and 71.3% in 2006 to 2007 (Table 1), indicating earlier age of onset over time. Women comprised more than half of the stroke hospitalizations, and the majority of hospitalizations represented patients with Medicare coverage. The proportion of urban hospitals increased from 82.5% in 1998 to 1999 to 86.2% in 2006 to 2007 (P for linear trend <0.001).

Medical Complications
The prevalence of hospitalizations with a secondary diagnosis of PN did not change during the study period (Table 1). In contrast, the prevalence of hospitalizations with a secondary diagnosis of AMI, DVT, PE, or UTI increased significantly across the study period (P<0.001). The prevalence of hospitalizations with at least 1 complication (AMI, PN, DVT, PE, or UTI) increased from 12.8% in 1998 to 1999 to 14.1% in 2006 to 2007 (P for linear trend <0.001).

The prevalence of hospitalizations with complication in 2006 to 2007 and 1998 to 1999 was 1.58% versus 1.17% for AMI; 2.93% versus 2.97%, PN; 0.79% versus 0.46%, DVT; 0.27% versus 0.11%, PE; and 10.08% versus 9.16%, UTI. The hospitalizations with secondary PN did not change significantly between 1998 to 1999 and 2006 to 2007 (Table 2). In contrast, the hospitalizations with the other 4 complications all rose significantly during the time period of interest. After adjustment for age, sex, payer, and hospital location, the OR for prevalence of AMI, DVT, PE, and UTI was 1.39 (95% CI: 1.30 to 1.48), 1.68 (95% CI: 1.52 to 1.86), 2.39 (95% CI: 2.04 to 2.81), and 1.18 (95% CI: 1.14 to 1.22), respectively, in 2006 to 2007 when the 1998 to 1999 period was used as the referent. For hospitalization with at least 1 complication, the adjusted OR was 1.17 (95% CI: 1.13 to 1.21) in 2006 to 2007 by using 1998 to 1999 as the referent (data not shown).
Patient age (≥65 years) was significantly associated with AMI, PN, and UTI (but not DVT or PE) in both 1998 to 1999 and 2006 to 2007 in adjusted analyses (Table 2). Hospitalizations of women were significantly more likely to include UTI and significantly less likely to include PN in both time periods. Female sex was associated with an increased risk of AMI in 2006 to 2007 but was not associated with this risk in 1998 to 1999. In contrast, female sex was associated with an increased risk DVT in 1998 to 1999 but was unrelated to DVT risk in 2006 to 2007. Insurance status and hospital location were also significantly associated with the complications of interest (Table 2).

### In-Hospital Mortality

Overall, the in-hospital mortality rate decreased significantly across the study period after adjustment for age, sex, payer, hospital location, complications, and comorbidities ($P<0.001$). Using 1998 to 1999 as the referent, the adjusted OR for in-hospital mortality was 0.75 (95% CI: 0.72 to 0.79).

### Table 1. Characteristics of Hospitalizations for Ischemic Stroke, 1998 to 2007, United States

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<tbody>
<tr>
<td>Demographic or clinical feature</td>
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<tr>
<td>Age ≥65 years</td>
<td>77.60 (0.23)</td>
<td>76.51 (0.24)</td>
<td>74.49 (0.25)</td>
<td>72.68 (0.25)</td>
<td>71.30 (0.28)</td>
</tr>
<tr>
<td>Female</td>
<td>53.45 (0.15)</td>
<td>53.72 (0.16)</td>
<td>53.08 (0.16)</td>
<td>52.32 (0.16)</td>
<td>51.49 (0.16)</td>
</tr>
<tr>
<td>Payer</td>
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<tr>
<td>Medicare</td>
<td>71.84 (0.37)</td>
<td>72.01 (0.38)</td>
<td>71.99 (0.33)</td>
<td>70.44 (0.35)</td>
<td>68.99 (0.33)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>4.25 (0.14)</td>
<td>4.42 (0.17)</td>
<td>4.69 (0.15)</td>
<td>4.97 (0.15)</td>
<td>5.20 (0.17)</td>
</tr>
<tr>
<td>Private</td>
<td>20.04 (0.34)</td>
<td>19.56 (0.36)</td>
<td>18.98 (0.31)</td>
<td>19.37 (0.32)</td>
<td>19.90 (0.28)</td>
</tr>
<tr>
<td>Other</td>
<td>3.87 (0.16)</td>
<td>4.01 (0.18)</td>
<td>4.34 (0.17)</td>
<td>5.23 (0.20)</td>
<td>5.91 (0.20)</td>
</tr>
<tr>
<td>Urban hospital</td>
<td>82.50 (0.52)</td>
<td>82.63 (0.53)</td>
<td>83.40 (0.54)</td>
<td>85.23 (0.49)</td>
<td>86.18 (0.51)</td>
</tr>
<tr>
<td>Outcome measures</td>
<td></td>
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<tr>
<td>Mean length of stay in days (SE)*</td>
<td>5.56 (0.05)</td>
<td>5.35 (0.05)</td>
<td>5.12 (0.04)</td>
<td>4.92 (0.04)</td>
<td>4.77 (0.04)</td>
</tr>
<tr>
<td>AMI*</td>
<td>1.17 (0.03)</td>
<td>1.40 (0.03)</td>
<td>1.50 (0.03)</td>
<td>1.52 (0.04)</td>
<td>1.58 (0.04)</td>
</tr>
<tr>
<td>PN</td>
<td>2.97 (0.05)</td>
<td>2.90 (0.05)</td>
<td>3.01 (0.05)</td>
<td>3.07 (0.05)</td>
<td>2.93 (0.06)</td>
</tr>
<tr>
<td>DVT*</td>
<td>0.46 (0.02)</td>
<td>0.49 (0.02)</td>
<td>0.60 (0.02)</td>
<td>0.72 (0.02)</td>
<td>0.79 (0.03)</td>
</tr>
<tr>
<td>PE*</td>
<td>0.11 (0.01)</td>
<td>0.13 (0.01)</td>
<td>0.14 (0.01)</td>
<td>0.21 (0.01)</td>
<td>0.27 (0.01)</td>
</tr>
<tr>
<td>UTI*</td>
<td>9.16 (0.10)</td>
<td>8.67 (0.10)</td>
<td>9.07 (0.11)</td>
<td>9.97 (0.11)</td>
<td>10.08 (0.11)</td>
</tr>
<tr>
<td>At least 1 of the 5 complications*</td>
<td>12.82 (0.12)</td>
<td>12.46 (0.11)</td>
<td>13.05 (0.12)</td>
<td>14.01 (0.13)</td>
<td>14.13 (0.14)</td>
</tr>
<tr>
<td>In-hospital mortality†</td>
<td>5.79 (0.07)</td>
<td>5.55 (0.08)</td>
<td>5.17 (0.07)</td>
<td>4.84 (0.07)</td>
<td>4.35 (0.07)</td>
</tr>
</tbody>
</table>

*Statistically significant. Values are OR with 95% CIs.

### Table 2. Adjusted Odds of Type of Medical Complications in 2006 to 2007 Compared With 1998 to 1999 and Selected Characteristics on Type of Medical Complication Within 1998 to 1999 and 2006 to 2007

<table>
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<tbody>
<tr>
<td>AMI*</td>
<td>Reference</td>
<td>1.39 (1.30–1.48)*</td>
</tr>
<tr>
<td>PN</td>
<td>Reference</td>
<td>1.00 (0.95–1.05)</td>
</tr>
<tr>
<td>DVT*</td>
<td>Reference</td>
<td>1.68 (1.52–1.86)*</td>
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</tbody>
</table>

Values of individual covariates (age, female sex, payer, location) reflected adjustment for each of the others.

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<tbody>
<tr>
<td>Age ≥65 years</td>
<td>1.50 (1.30–1.73)*</td>
<td>1.66 (1.46–1.89)*</td>
<td>1.83 (1.65–2.02)*</td>
<td>1.71 (1.56–1.87)*</td>
<td>0.87 (0.71–1.07)</td>
<td>0.96 (0.82–1.12)</td>
</tr>
<tr>
<td>Female sex</td>
<td>0.97 (0.90–1.05)</td>
<td>1.17 (1.09–1.26)*</td>
<td>0.69 (0.65–0.72)*</td>
<td>0.79 (0.75–0.83)*</td>
<td>1.17 (1.03–1.33)*</td>
<td>1.08 (0.98–1.19)</td>
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<td>Payer</td>
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<tr>
<td>Medicare</td>
<td>1.04 (0.91–1.19)</td>
<td>1.09 (0.95–1.23)</td>
<td>1.28 (1.16–1.41)*</td>
<td>1.29 (1.17–1.43)*</td>
<td>0.95 (0.78–1.15)</td>
<td>0.94 (0.79–1.12)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>1.07 (0.84–1.37)</td>
<td>1.65 (1.39–1.96)*</td>
<td>2.03 (1.77–2.34)*</td>
<td>1.98 (1.75–2.24)*</td>
<td>1.62 (1.25–2.10)*</td>
<td>1.47 (1.18–1.82)*</td>
</tr>
<tr>
<td>Private</td>
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<td>Reference</td>
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</tr>
<tr>
<td>Other</td>
<td>1.17 (0.92–1.49)</td>
<td>1.41 (1.20–1.67)*</td>
<td>1.19 (1.02–1.40)*</td>
<td>1.24 (1.08–1.42)*</td>
<td>0.79 (0.55–1.14)</td>
<td>1.04 (0.83–1.30)</td>
</tr>
<tr>
<td>Urban hospital</td>
<td>1.05 (0.93–1.19)</td>
<td>1.11 (0.98–1.25)</td>
<td>1.21 (1.11–1.31)*</td>
<td>1.14 (1.03–1.27)*</td>
<td>1.47 (1.19–1.82)*</td>
<td>1.71 (1.37–2.14)*</td>
</tr>
</tbody>
</table>

*Statistically significant. Values are OR with 95% CIs.
in 2006 to 2007 (Table 3). The unadjusted OR for in-hospital mortality was 0.74 (95% CI: 0.71 to 0.77).

Age ≥65 years and female sex were associated with significantly higher in-hospital mortality in both 1998 to 1999 and 2006 to 2007 (Table 3). In terms of payment source, when private insurance was used as the referent, hospitalizations with Medicare had lower odds of in-hospital mortality in 2006 to 2007 (OR = 0.69, 95% CI: 0.60 to 0.79) but not in 1998 to 1999. However, in both time periods, stays covered by neither Medicare nor Medicaid (“other” in Table 3) had significantly higher odds of in-hospital mortality than the reference group (private insurance). Additionally, hospitalizations in urban areas had significantly lower odds of in-hospital mortality than hospitalizations in rural areas (adjusted OR 0.8 in both 1998 to 1999 and 2006 to 2007).

All 5 complications except UTI in 2006 to 2007 were independent predictors of in-hospital mortality in the multivariable analysis in both time periods with PN, PE, and AMI being the strongest predictors of in-hospital mortality (Table 3).

### Length of Stay

LOS declined significantly across the study period with the mean value (in days) dropping from 5.56 in 1998 to 1999 to 5.35 in 2000 to 2001, then 5.12 in 2002 to 2003, then 4.92 in 2004 to 2005, and finally to 4.77 in 2006 to 2007 (Table 1). The probability value for trend was <0.001 after adjustment for age, sex, payment type, and hospital location. Univariate analyses found that LOS decreased significantly between the first and last time periods among hospital stays without AMI or PN or DVT or PE, stays with or without UTI, or stays with at least 1 complication and without any complication (Figure). However, stays with complications of AMI, PN, DVT, or PE remained the same between these 2 time periods. The mean LOS with a complication was significantly longer than those without the complication in both 1998 to 1999 and 2006 to 2007 (P<0.0001, data not shown). In 2006 to 2007, the mean LOS (in days) for hospitalizations with complications and those without was 9.3 versus 4.7 for AMI; 13.4 versus 4.5, PN; 12.7 versus 4.7, DVT; 13.7 days versus 4.7, PE; and 8.3 versus 4.4, UTI. The mean LOS (in days) for all patients who died was 7.21 in 1998 to 1999 and 6.78 in 2006 to 2007 (P=0.001). The mean LOS (in days) for patients who died without any medical complications was 5.77 in 1998 to 1999 and 5.25 in 2006 to 2007, whereas the mean LOS (in days) for patients who died and with at least 1 medical complications was 10.35 in 1998 to 1999 and 9.55 in 2006 to 2007 (P<0.001 for both). The adjustment for LOS had no effect on our reported unadjusted and adjusted OR for in-hospital mortality in 2006 to 2007 compared with 1998 to 1999.

### Table 2. Continued

<table>
<thead>
<tr>
<th>PE</th>
<th>UTI</th>
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<tbody>
<tr>
<td>Reference</td>
<td>2.39 (2.04–2.81)*</td>
</tr>
<tr>
<td>0.80 (0.52–1.25)</td>
<td>0.86 (0.67–1.11)</td>
</tr>
<tr>
<td>1.12 (0.87–1.44)</td>
<td>1.14 (0.96–1.34)</td>
</tr>
<tr>
<td>0.94 (0.63–1.40)</td>
<td>0.83 (0.63–1.08)</td>
</tr>
<tr>
<td>2.09 (1.27–3.43)*</td>
<td>1.66 (1.22–2.27)*</td>
</tr>
<tr>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>1.13 (0.60–2.14)</td>
<td>0.95 (0.66–1.37)</td>
</tr>
<tr>
<td>0.94 (0.66–1.33)</td>
<td>1.27 (0.96–1.68)</td>
</tr>
</tbody>
</table>

Who we died was 7.21 in 1998 to 1999 and 6.78 in 2006 to 2007 (P=0.001). The mean LOS (in days) for patients who died without any medical complications was 5.77 in 1998 to 1999 and 5.25 in 2006 to 2007, whereas the mean LOS (in days) for patients who died and with at least 1 medical complications was 10.35 in 1998 to 1999 and 9.55 in 2006 to 2007 (P<0.001 for both). The adjustment for LOS had no effect on our reported unadjusted and adjusted OR for in-hospital mortality in 2006 to 2007 compared with 1998 to 1999.

### Discussion

Consistent with results from other studies,9,10 we found that in-hospital mortality for ischemic stroke decreased significantly during the period of study (1998 to 1999 to 2006 to 2007). Unfortunately, we found increasing trends in the prevalence of 4 of the 5 complications we examined with the largest increases observed for DVT and PE.

Among all the medical complications evaluated in this study, UTI was the most common, and estimates for this event were comparable to other studies.11,12 The nationwide prevalence of AMI, PN, DVT, PE, and UTI among hospitalizations with ischemic stroke has been reported by Qureshi and colleagues,9 but it is difficult to compare their results with ours because of the differences in the ICD-9-CM codes used to identify the complications. Regardless, the increasing trends in the prevalence of DVT reported by Qureshi and coworkers were seen in our study as well. Moreover, the increasing trends we found in DVT and PE are parallel to...
trends reported in other studies as well as reports in other
groups of hospitalized patients.7,13,14 These trends may reflect
a true increase in the prevalence of these conditions or they
may indicate improved detection due to the increasing avail-
ability of new and improved diagnostic procedures. Finally,
changes in hospital coding practices in the later years of the
targeted analysis period compared with the earlier years could
contribute to the trends reported by us.

Recommendations have been developed to improve the
quality of acute stroke care by several professional and
scientific organizations.15,16 For example, the guidelines of
the American Heart Association Science Advisory and Co-
ordinating Committee recommend early mobilization, general
supportive care, and treatment of acute complications such as
AMI, PN, and UTI and prevention of venous thromboembolic
disease in patients with ischemic stroke.15 Prophylactic low-
dose subcutaneous heparin or low-molecular-weight heparins
are recommended for patients with acute ischemic stroke with
restricted mobility.16 Currently, the extent to which prevent-
ive measures for DVT and PE among patients with ischemic
stroke are implemented in the United States is not known.
However, our results underline the importance of preventing
venous thromboembolic disease and PE in these patients and
the need to collect and evaluate information on the imple-
mentation of these preventive measurements using registries
and other related clinical data sets.

We found that all 5 of the complications except UTI in
2006 to 2007 were significant predictors of in-hospital
mortality after adjustment of comorbidities with AMI, PN,
and PE the strongest predictors. Several studies have found
a significant association between both PN and PE and early
mortality (≤30 days) among patients hospitalized for acute
stroke.17–19 In fact, the German Stroke Registers study group
found that PN was the complication with the highest attrib-
utable proportion of deaths in the entire stroke population,
accounting for 31% of all deaths.19 Although stroke as a
serious complication among patients with AMI has been
documented,20–22 few studies have focused on associations
between in-hospital AMI and outcomes among patients with
stroke. A recent study published by the Canadian Stroke
Network, however, found that AMI was an important medical
complication after acute ischemic stroke and was independ-
ently associated with 1-year mortality or severe dependence
discharge.5 We were unable to distinguish between early
and late mortality in our study, but our results confirmed that
AMI, PN, and PE are strong predictors of in-hospital mortal-
ity. In addition, although the overall LOS decreased signifi-
cantly from 1998 to 1999 to 2006 to 2007, it remained
the same among the hospitalizations with AMI, PN, DVT, or PE
during this study period. Our study confirmed the findings
that patients hospitalized with complications had significantly
longer LOS than those without.11,12 These results suggest the
longer LOS among hospitalizations with complications may
contribute significantly to acute treatment cost.23,24 Future
studies are needed to examine the impact of decreased LOS
on cost, quality of care, and long-term outcomes among
ischemic stroke hospitalizations without complications.

The results of this analysis should be interpreted in light of
several limitations. First, the unit of the analysis was the
hospital discharge, not the patient. We were unable to identify
whether patients were admitted to the hospital multiple times
in any 1-year period, and thus the results might be overesti-
mated. Second, medical complications were identified by
using ICD-9-CM codes abstracted from discharge records.
Although any complication should be coded if this condi-
tion interferes with the patient management,25 bias associ-
ated with coding is possible. Unavailability or inconsistent
use of standardized diagnostic criteria for some conditions

Figure. LOS of patients with medical complications and those without between 1998 to 1999 and 2006 to 2007, United States. The
asterisk (*) indicates a significant difference between 1998 to 1999 and 2006 to 2007.
among physicians, differences in ICD-9-CM coding at the hospital level, and decreased likelihood of coding for nonthreatening conditions among patients with severe illness may contribute to this. In addition, we were unable to identify if secondary conditions defined by ICD-9-CM codes were pre-existing or developing during the hospitalization. Currently, except for 4 states (California, New York, Florida, and Wisconsin), the Healthcare Cost and Utilization Project data did not include a present-on-admission indicator. Thus, the time of onset of secondary diagnoses cannot be established from this administrative data set and pre-existing conditions and complications cannot be distinguished. Third, although we used payment source as a proxy of socioeconomic status, a lack of information on race precluded us from assessing this confounder. Fourth, it is possible that an increase in discharge to a hospice could account for some decrease in in-hospital mortality. Early discharge to home, rehabilitation, or chronic care could account for the decrease of LOS. We were unable to examine the impact of discharge destination such as a hospice or rehabilitation on mortality and LOS due to lack of detailed information on discharge destination collected in Healthcare Cost and Utilization Project data. Finally, clinical (stroke severity, history of DVT, body mass index, use of oral contraceptives or estrogens, and so on) and healthcare factors (anticoagulation therapy, long immobilization, recent major surgery, and so on) and their contribution to the trends could not be examined because of the absence of clinical details in our database.

In conclusion, given our findings on the 5 complications of interest, there is clearly a need for further investigation of the sociodemographic, clinical, and healthcare factors associated with these conditions during hospitalizations with ischemic stroke. Our results also underscore the need for continued efforts to reduce complications from acute stroke through active quality improvement programs. Additionally, these results suggest the need for further studies to investigate AMI as a complication of stroke hospitalizations. Finally, we believe that our results can be applied to extend surveillance for quality improvement initiatives at the state and hospital level as well as internationally and provide valuable information for comparisons across many settings.

Disclosures
None.

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Incidence of and risk factors for medical complications during stroke 
Medical Complications Among Hospitalizations for Ischemic Stroke in the United States From 1998 to 2007
Xin Tong, Elena V. Kuklina, Cathleen Gillespie and Mary G. George

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Abstract

Secondary Prevention of Ischemic Stroke in Urban China

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Background and purpose: This paper aims to introduce the situation of secondary prevention of ischemic stroke in urban China.

Methods: This study is a prospective, multicenter study, with subjects being 4,782 acute ischemic stroke cases registered in urban China in 2006. Secondary prevention schemes were assessed at discharge and 3 and 12 months after stroke. The use of antihypertensive, antithrombotic, and lipid lowering treatments was assessed in relation to baseline characteristics, and in relation to their use 12 months after stroke.

Results: During hospitalization, 63% of patients received antihypertensive treatment, 81% received antithrombotic treatment, and 31% received lipid lowering treatment. These results were associated with the presence of these treatments prior to hospitalization and with baseline cardiovascular risk factors. Antihypertensive treatment was maintained during follow-up, whereas use of antithrombotic and lipid lowering treatments decreased significantly (66% and 17%, respectively; P < 0.001) 12 months after stroke. This was due to patients and doctors not adhering to treatment.

Conclusion: Most stroke patients in China receive secondary prevention, but there is a significant decrease in use of antithrombotic and lipid lowering treatments after discharge. This highlights the need to improve education about stroke risk factors among both patients and doctors.

Keywords: China, prevention, stroke

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USA 1998-2007年的住院治疗缺血性卒中的并发症

Medical Complications Among Hospitalizations for Ischemic Stroke in the United States From 1998 to 2007

Xin Tong, MPH; Elena V. Kuklina, MD, PhD; Cathleen Gillespie, MS; Mary G. George, MD, MSPH, FACS

Background and purpose: Medical complications of ischemic stroke are associated with increased mortality and increased use of medical resources.


Results: During 1998-1999, the ORs for acute myocardial infarction, deep vein thrombosis, and pulmonary embolism were 1.18, 1.16, and 1.17, respectively. During 2006-2007, the ORs for acute myocardial infarction, deep vein thrombosis, and pulmonary embolism were 1.39, 1.68, and 2.39, respectively. The OR for pneumonia was 1.09 during 1998-1999 and 1.13 during 2006-2007. During 1998-1999, the ORs for in-hospital mortality and hospital stay for transient ischaemic attacks and ischemic stroke were 1.06 and 1.10, respectively. During 2006-2007, the ORs for in-hospital mortality and hospital stay for transient ischaemic attacks and ischemic stroke were 1.15 and 1.20, respectively.

Conclusion: During 1998-1999, there was a significant increase in the prevalence of acute myocardial infarction, deep vein thrombosis, and pulmonary embolism in stroke patients. During 2006-2007, the prevalence of pneumonia increased. During 1998-1999, the prevalence of transient ischaemic attacks and ischemic stroke was lower than in 2006-2007. During 2006-2007, the prevalence of transient ischaemic attacks and ischemic stroke was higher than in 1998-1999.

Keywords: stroke, complications, medical resources, stroke care