Published in final edited form as:
Stroke. 2013 February ; 44(2): 531–533. doi:10.1161/STROKEAHA.112.670547.

Seasonal Variation in 30-Day Mortality after Stroke: Teaching versus Non-Teaching Hospitals

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Abstract

Background and Purpose—A systematic review found an association between the July start of internships and residencies and higher mortality rates for hospitalized patients, but data related to stroke are limited. We assessed seasonal variations in 30-day risk-adjusted mortality rates (RAMRs) after ischemic stroke by hospital teaching status.

Methods—The analysis included all fee-for-service Medicare beneficiaries ≥65 years old with a primary discharge diagnosis of ischemic stroke (ICD-9 433, 434, 436) from 1999–2006. Hierarchical linear regression models calculated RAMRs, adjusting for patient demographics and comorbidities. Annual data were combined and reconstructed for time series analyses; RAMRs were calculated for each month. Structural models compared monthly seasonal patterns stratified by hospital teaching status.

Results—Of 2,824,694 ischemic stroke discharges, 51.7% were from teaching hospitals. There were seasonal patterns within each calendar year; with the highest 30-day RAMR in the winter and the lowest in the summer, but with a smaller peak in July. Thirty-day RAMRs decreased from 1999–2006 as did seasonal variations within each calendar year. Seasonal patterns were similar for teaching and non-teaching hospitals.

Conclusions—The 30-day RAMR decreased overall, but seasonal patterns were present, with the highest RAMR in January and a smaller peak in July. Because patterns were similar for teaching and non-teaching hospitals, the July peak cannot be explained by the introduction of new trainees in the beginning of the academic year. The reasons for these seasonal patterns warrant further investigation.

Keywords

Ischemic stroke; outcomes; mortality; trends; season

Introduction

A systematic review found higher mortality for hospitalized patients coincident with the start of internships and residencies in the beginning of the academic year, commonly referred to as the “July Effect”.[1] The included studies varied in quality and only one (assessing the impact of new duty-hour regulations on in-hospital mortality) focused on

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Disclosures: None

stroke.[2] Whether the introduction of trainees in July affects 30-day stroke-related mortality is uncertain. We estimated monthly patterns of 30-day risk-adjusted mortality rates (RAMRs) among elderly Medicare patients hospitalized with ischemic stroke from 1999–2006. Analyses were stratified by teaching status to determine whether monthly patterns differed between teaching and non-teaching hospitals.

Methods

The study population included all Medicare fee-for-service (FFS) beneficiaries aged ≥65 years hospitalized with a primary discharge diagnosis of ischemic stroke (*International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]* codes 433, 434, 436) from 1999–2006. Data were obtained from the Medicare Provider Analysis and Review files and included demographic information and primary and secondary discharge diagnosis codes. Individuals <65 years of age were excluded because they do not represent typical Medicare patients. Patients discharged from non-acute care facilities, transferred to or from another acute care facility, discharged within one day of admission, or who left against medical advice were also excluded. The study included beneficiaries with 12 months of continuous Medicare FFS enrollment before, and one month after, the index hospitalization to obtain complete medical history and mortality information. Teaching hospitals were identified based on American Hospital Association data.

Thirty-day all-cause mortality was assessed from the date of hospital admission using the Medicare Enrollment Database. The accuracy of vital status ascertainment using these data is high for this age group.[3] Pre-existing comorbidities were identified using the primary and nine secondary codes from claims submitted in the year before the index hospitalization, and from claims from the index admission for conditions that would not represent an acute stroke complication, as described in prior work.[3]

Thirty-day RAMRs were calculated by month and adjusted for patient-level demographics, medical history, and comorbid conditions used in prior risk-adjustment models for ischemic stroke populations.[3] Risk-adjusted mortality rates were fit using structural models to identify monthly trends. Smoothed annual trends were graphed by month. Separate models stratified by hospital teaching status assessed 30-day RAMR trends over time. An interaction term for teaching status-by-time was tested in the overall model. Sensitivity analysis was performed to compare mortality rates by month (relative to September) in a patient-level logistic regression model. All analyses were conducted using SAS 9.3 64-bit Windows Version (SAS Institute, Cary, NC), and statistical testing was 2-sided with α=0.05.

Results

The analysis included 2,824,694 ischemic stroke hospitalizations from 1,124 teaching hospitals and 3,933 non-teaching hospital. Teaching hospitals had a larger mean bed size (332±252 beds) than non-teaching hospitals (117±112 beds), and they were more commonly privately-owned, not-for-profit hospitals (75% versus 51%, $p<0.01$). Time series analyses show that 30-day RAMRs varied by month within each calendar year; the highest RAMR occurred in January, with a smaller peak in July (Figure 1; $p<0.001$ for July). Sensitivity analyses using logistic regression confirmed these findings. Seasonal patterns were similar for teaching and non-teaching hospitals. Variation in 30-day mortality within each calendar year decreased over time (Figure 2). For teaching hospitals, the difference between the highest and lowest RAMR declined from 2.7% in 1999 to 1.5% in 2006, representing a relative decrease of 44%. For non-teaching hospitals, the difference between the highest and lowest RAMR declined from 2.2% in 1999 to 1.4% in 2006, representing a relative decrease

of 36%. The interaction term for teaching status-by-time was not statistically significant (p=0.5).

Discussion

We found seasonal patterns in 30-day RAMRs, with the highest rates occurring in January and smaller peaks in July within each calendar year. Because the effect was not specific to teaching hospitals, it is unlikely that a reduction in the quality of stroke care associated with the introduction of new trainees is responsible for the modest increase in RAMR during the summer. We also found that overall mortality declined from 1999–2006, with a narrowing of seasonal differences over time.

These results are consistent with other studies finding higher stroke incidence and mortality rates in winter months.[4–8] Few studies examine seasonal variation in case fatality beyond the index hospitalization or how seasonal patterns change over time, and these studies were conducted in non-US populations. A Swedish stroke registry reported higher 28-day case fatality in winter months, and a 15-year study in Japan found higher 7- and 28-day fatality rates in the winter and spring.[7,8] Mechanisms underlying higher winter mortality rates are not fully understood, but are hypothesized to be due to colder temperatures.[4,5,7,8] Exposure to cold weather may result in physiological stresses, including sympathetic activation, increased blood pressure, hypercoagulability, and infection, that may increase post-stroke fatality. Seasonal patterns of influenza, air pollution, and other respiratory tract infections may also contribute to seasonal mortality variations.[9]

The present study has several potential limitations. Stroke hospitalizations were identified using ICD-9-CM codes and were not verified by record review; however, previous studies show that the validity for the selected codes is relatively high.[3] Although not expected to vary seasonally, Medicare inpatient data do not contain information on medication utilization; therefore, we were unable to assess potential differences in the receipt of recommended therapies. Stroke severity, a strong outcome predictor, is not reflected in administrative records.[10] Additional unmeasured factors may explain seasonal differences in mortality such as mode of transportation to the hospital and transit times, which may be longer in winter due to weather conditions. Finally, the results are limited to 1999–2006 and may not be applicable to those without FFS Medicare coverage or to stroke patients <65 years; however, elderly FFS Medicare patients represent the majority of ischemic stroke events.

We found an overall decrease in 30-day RAMRs between 1999 and 2006, with decreased variation across months within each calendar year. These findings are consistent with the general US national trend of decreasing stroke-related mortality over the last decade.[11] Although much of this decline is attributed to better prevention, our finding of lower 30-day case-fatality rates may also suggest improvements in stroke-related care. Future studies should investigate factors contributing to seasonal differences in outcomes, including the role of temperature effects, changes in barometric pressure, and air pollution.

Acknowledgments

Funding

The Centers for Medicare & Medicaid Services reviewed and approved the use of its data for this work and approved submission of the manuscript; this approval is based on data use only and does not represent the Centers for Medicare & Medicaid Services endorsement of or comment on the manuscript content. Project supported by NIH R01 NS043322.

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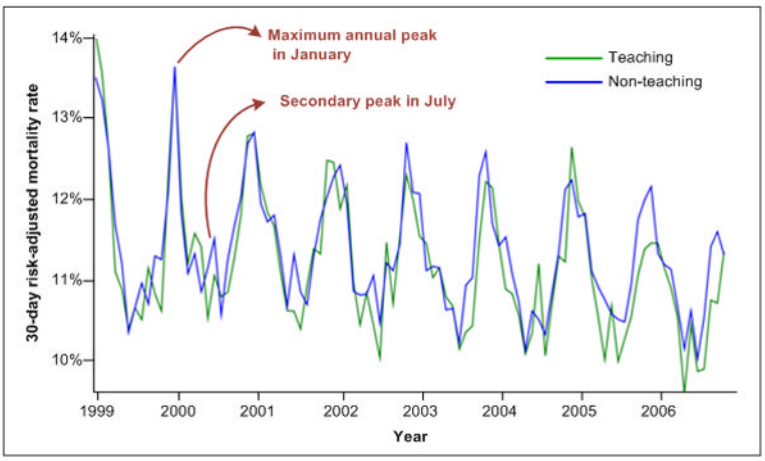

Figure 1.
30-day RAMRs for teaching and non-teaching hospitals

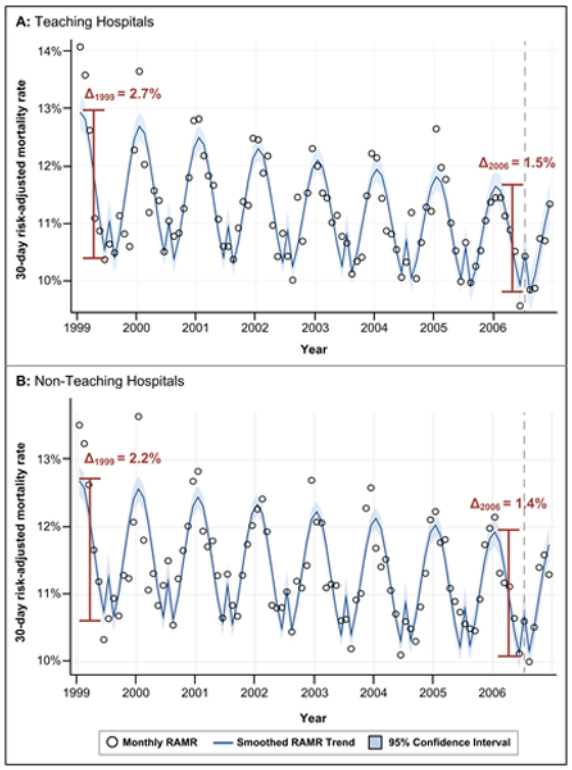

Figure 2.
Relative declines in 30-day RAMRs for teaching and non-teaching hospitals