Trends in Survival After Stroke
Among Medicare Beneficiaries

Daniel S. May, PhD; Michele L. Casper, PhD; Janet B. Croft, PhD; Wayne H. Giles, MD, MS

Background and Purpose Most strokes occur among people aged 65 years and older. The increasing proportion of persons who are in this age group underlines the importance for health-care providers to be aware of trends in poststroke survival. We investigated poststroke survival trends from 1985 to 1989 among Medicare beneficiaries.

Methods Medicare hospital claim records and enrollment data were obtained on 1,901,439 Medicare patients with a principal diagnosis of stroke occurring during the years 1985 through 1989. Cox proportional hazard techniques were used to compare the 2-year poststroke survival for strokes occurring in 1986, 1987, 1988, and 1989 relative to strokes occurring in 1985. Poststroke survival trends were examined among groups defined by age, race, region, type of stroke, and, for a 20% subset, history of stroke.

Although the long-term declines in stroke mortality have been well documented among subgroups of the US population, much less is known about the trends in survival after stroke. Given the increasing proportion of elderly people in the United States and the fact that most hospitalizations for stroke and deaths from stroke occur among people aged 65 years and above, health-care providers should be made aware of the trends in poststroke survival.

Improvements in poststroke survival have been reported among several populations in the United States and Scandinavia. Improvement in survival at 28 to 30 days after a stroke has been observed in hospital-based studies in Minnesota (1970-1985) and Quebec (1981-1988) and in community-based stroke registries in Rochester, Minnesota (1945-1984), Finland (1972-1973 to 1978-1980), and Sweden (1971-1987). Improved survival over longer periods (ranging from 1 to 4 years) has been reported in Minnesota (1970-1985), North Carolina (1970-1973 to 1979-1980), and Sweden (1975-1978 to 1983-1986).

No nationally representative study has been published that has examined the temporal trends in both short- and long-term poststroke survival among subgroups of the US population. We used Medicare data to examine trends in poststroke survival among elderly persons who were hospitalized for stroke during 1985 through 1989 and documented the patterns among groups defined by race, age, sex, type of stroke, and geographic region of residence.

Results We observed a modest improvement in poststroke survival from 1985 to 1989 (1989:1985 hazard ratio, 0.96; P<.05). Trends for persons with hemorrhagic stroke showed more improvement (hazard ratio, 0.88; P<.05) than those for persons with ischemic stroke (hazard ratio, 0.98; P<.05). Improvement was also greater among persons without known prior hospitalization for stroke (hazard ratio, 0.94; P<.05) and during periods of follow-up shorter than 2 years.

Conclusions The variations in poststroke survival among subgroups of the population have important implications for the quality of life of stroke survivors and for the future medical and nursing needs of these populations. (Stroke. 1994;25:1617-1622.)

Key Words • aged • cerebrovascular disorders • epidemiology • stroke outcome • survival
We examined Medicare enrollment data to determine vital status and enrollment eligibility during the 2 years after the index-stroke hospitalization. Survival time until death was defined as the number of days between the date of hospital admission for the index stroke and the date of death. Survivors were censored at either 730 days from the index stroke for enrollees who remained eligible for Medicare during the subsequent 2 years or at the last day of the last month of Medicare eligibility. Of the entire population of index-stroke cases, 56.4% remained alive, 43.3% died, and Medicare eligibility ended for 0.3% during the 2 years after the stroke.

To better distinguish incident strokes from recurrent strokes, we used hospitalization files from 1980 through 1990 to identify strokes that occurred during the 3 years before the index stroke. Because the Medicare files for 1980 through 1983 only include hospitalization records for a systematic 20% subset of all Medicare beneficiaries, we could only determine prior stroke hospitalizations for the 20% of index-stroke patients whose health insurance claim numbers qualified them for inclusion. Therefore, we limited the examination of post-stroke survival trends in relation to prior hospitalization for stroke to patients included in the 20% subset.

Descriptive statistics include unadjusted frequencies of selected characteristics and Kaplan-Meier survival estimates, obtained from the SAS procedure LIFETEST.16 We performed Cox proportional hazards analyses17 to investigate the relation of year of stroke event to days of survival. The hazard ratios (HRs) and 95% confidence intervals (CIs) estimated from the SAS procedure PHREG18 are the ratio of the instantaneous risk of dying during the 2 years after the index stroke for persons whose index strokes occurred in either 1986, 1987, 1988, or 1989 relative to those with index strokes in 1985. Therefore, an HR less than 1 is interpreted as improved survival relative to strokes occurring in 1985. Adding sex, race, and region as covariates to a model adjusted for age did not alter the HRs; therefore, only age-adjusted results are presented. To determine whether trends in poststroke survival differed between subgroups defined by either age (persons 75 years or older compared with those 65 to 74 years old), race (white patients compared with black patients), sex, region, stroke type, or prior stroke, we estimated age-adjusted HRs and 95% CIs for year of stroke from proportional hazard models after stratifying on those variables.

The assumption of proportionality inherent in the Cox model was assessed graphically for the exposure variable (year of index stroke), race, sex, region, and age group using plots of the log(—log) survival estimates. Because the curves were essentially parallel, there was no evidence that the proportionality assumption was violated.19 However, proportionality was violated for stroke type. Therefore, no attempt was made to use stroke type as a covariate in any of the models.

Because of computer limitations posed by the large sample size, we divided the data randomly into five subsets of about equal size and performed Cox regressions on each 20% subset. Overall regression coefficients were calculated as the mean of the five subset coefficients. The variance of the mean regression coefficient was calculated under the assumption that the five coefficients are random variables estimated from five independent subsets of the population. The overall variance was thus calculated as the sum of the variances of the five coefficients, divided by 25 (52).

Results

Of the 1,901,439 Medicare stroke patients aged 65 years or older who were hospitalized for stroke during the years 1985 through 1989, 61.6% were 75 years or older, and 57.4% were women. Race was recorded as white for 86.5%, black for 9.4%, and other or unknown for 4.1% of these patients. The region of patient residence was defined as the South for 36.3%, Midwest for 26.3%, Northeast for 21.5%, and West for 15.9%. Within the 20% subsample for whom it was possible to identify prior hospitalizations, 13.3% of stroke patients had a record of a stroke within the 5 years before the index stroke. Overall, 58.7% of strokes were coded as ischemic, 9.9% as hemorrhagic, and 31.3% were ill-defined. The proportions of strokes classified as hemorrhagic or ischemic increased from 1985 to 1989, and the percentage coded as ill defined decreased (Table 1).

Kaplan-Meier survival curves (Fig 1) demonstrated a slightly greater 2-year poststroke survival for patients with strokes occurring in 1989 (58.0%; 95% CI, 57.9 to 58.2) than for those whose strokes occurred in 1985 (57.1%; 95% CI, 56.9 to 57.2). The unadjusted 2-year Kaplan-Meier survival estimates for persons who suffered index strokes in 1985 varied slightly by sex and region and considerably by age group, race, type of

![Fig 1](Graph of Kaplan-Meier survival curves showing the probability of survival after stroke among Medicare patients aged 65 or older hospitalized in 1985 or 1989.)
stroke, and history of stroke (Table 2). Kaplan-Meier survival probabilities increased between 1985 and 1989 for most subgroups. However, they decreased for persons residing in the West, for persons whose index stroke was ischemic, and for persons with a history of a stroke (Table 2).

The age-adjusted HR comparing the instantaneous risk of death within 2 years after a stroke in 1989 to the instantaneous risk in 1985 for the Medicare population as a whole was 0.96 (95% CI, 0.96 to 0.97), indicating a slight improvement in poststroke survival. However, the trends in poststroke survival, as measured by the age-adjusted HR, varied somewhat among subgroups of the Medicare population. After an initial decrease in poststroke survival (indicated by HRs exceeding 1) from 1985 to 1986 for both age groups, the probability of survival improved (HRs declined) in each of the subsequent years 1987 to 1989, particularly for persons aged 75 years and older (Fig 2). Poststroke survival improved from 1985 to 1989 for both blacks and whites (Fig 3), but blacks experienced a slightly greater overall improvement (1989:1985 HR, 0.93; 95% CI, 0.91 to 0.95) than whites (1989:1985 HR, 0.97; 95% CI, 0.96 to 0.97). Further examination of the trends by race- and age-specific group indicated that the improved poststroke survival between 1985 and 1989 for blacks occurred primarily among persons in the older age category (Table 3).

Table 2. 2-Year Kaplan-Meier Survival for Medicare Patients Aged ≥65 Years Hospitalized for Stroke in 1985 or in 1989, and Change In Survival 1985 to 1989, by Selected Characteristics

<table>
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<tbody>
<tr>
<td>Total</td>
<td>383,713</td>
<td>0.571</td>
<td>366,322</td>
<td>0.580</td>
<td>1.58</td>
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<tr>
<td>Sex</td>
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<td>Women</td>
<td>219,764</td>
<td>0.572</td>
<td>210,752</td>
<td>0.577</td>
<td>0.87</td>
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<tr>
<td>Men</td>
<td>163,949</td>
<td>0.570</td>
<td>155,750</td>
<td>0.584</td>
<td>2.46</td>
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<tr>
<td>Race†</td>
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<tr>
<td>Black</td>
<td>34,191</td>
<td>0.514</td>
<td>35,253</td>
<td>0.539</td>
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<td>White</td>
<td>334,640</td>
<td>0.575</td>
<td>314,766</td>
<td>0.583</td>
<td>1.39</td>
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<td>Age group, y</td>
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<tr>
<td>65-74</td>
<td>150,870</td>
<td>0.694</td>
<td>137,385</td>
<td>0.704</td>
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<td>≥75</td>
<td>232,843</td>
<td>0.490</td>
<td>228,937</td>
<td>0.506</td>
<td>3.27</td>
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<tr>
<td>Region‡</td>
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<tr>
<td>Northeast</td>
<td>81,881</td>
<td>0.557</td>
<td>75,218</td>
<td>0.575</td>
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<td>Midwest</td>
<td>103,234</td>
<td>0.581</td>
<td>93,459</td>
<td>0.589</td>
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<td>South</td>
<td>134,338</td>
<td>0.567</td>
<td>134,605</td>
<td>0.580</td>
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<td>West</td>
<td>61,123</td>
<td>0.582</td>
<td>58,681</td>
<td>0.578</td>
<td>-0.89</td>
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<td>Stroke type</td>
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<td>Hemorrhagic</td>
<td>33,917</td>
<td>0.381</td>
<td>39,203</td>
<td>0.419</td>
<td>9.97</td>
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<td>Ischemic</td>
<td>208,812</td>
<td>0.617</td>
<td>225,037</td>
<td>0.616</td>
<td>-0.16</td>
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<tr>
<td>Ill-defined</td>
<td>140,984</td>
<td>0.546</td>
<td>102,082</td>
<td>0.562</td>
<td>2.93</td>
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<td>Stroke, prior 5 years§</td>
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<tr>
<td>Yes</td>
<td>9,363</td>
<td>0.516</td>
<td>9,716</td>
<td>0.503</td>
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<tr>
<td>No</td>
<td>63,940</td>
<td>0.579</td>
<td>62,146</td>
<td>0.593</td>
<td>2.42</td>
</tr>
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*Calculated as [(1989 survival probability - 1985 survival probability) x 100]/(1985 survival probability).
†Excludes patients whose race was coded as "other" or "unknown."
‡Excludes patients for whom region of residence could not be determined.
§Based on 20% sample.

Fig 2. Graph showing 2-year hazard ratios (HRs), giving the instantaneous risk of death within 2 years after stroke for strokes that occurred in each year 1986 through 1989 relative to those that occurred in 1983 among Medicare patients aged 65 or older, according to age group. HRs are adjusted for age within age groups. Data points give HRs, and vertical lines represent 95% confidence intervals.
Regional patterns (Fig 4) indicate that from 1985 through 1989 patients from the West experienced an initial decrease in poststroke survival but that by 1989 the 2-year survival was the same as it had been in 1985. Modest improvements in poststroke survival were observed for the other three regions, and the largest improvements occurred in the Northeast (1989:1985 HR, 0.94; 95% CI, 0.93 to 0.95).

Poststroke survival trends varied greatly according to type of stroke (Fig 5). The HR among persons with hemorrhagic stroke declined steadily over the 4 years to approximately 0.87 in 1989 relative to 1985, indicating improved survival. In contrast, HRs for ischemic stroke changed very little over the 4 years. The trend in the HR among persons with ill-defined stroke showed an intermediate rate of decline.

The substantial improvement in poststroke survival for hemorrhagic stroke from 1985 to 1989 was observed for both blacks and whites; the 1989:1985 HRs were 0.88 for each race. However, a modest improvement for ischemic stroke was observed among blacks, whereas almost no improvement in poststroke survival for ischemic stroke was observed among whites (Table 3). Trends in survival over follow-up periods of fewer than 2 years were investigated by censoring at 30 days, 90 days, or 1 year. Although differences across follow-up periods were small, a progressively steeper decline in the HR occurred as the follow-up period was shortened (Fig 6).

Within the 20% subsample, we observed improvement in poststroke survival only among index-stroke patients with no documented history of a stroke during the 5 years before the index stroke (1989:1985 HR, 0.94;
years before the index stroke (Table 3). Variations in poststroke survival were observed by age and treated as such. HRs are adjusted for age.

FIG 6. Graph showing hazard ratios (HRs), giving the instantaneous risk of death within various intervals after stroke for strokes that occurred in each year 1986 through 1989 relative to those that occurred in 1985 among Medicare patients aged 65 or older, according to length of poststroke follow-up period. HRs are adjusted for age.

95% CI, 0.93 to 0.96). We found no change in poststroke survival for persons who had undergone a Medicare-reimbursed hospitalization for a stroke during the 5 years before the index stroke (Table 3).

Discussion

From 1985 through 1989, poststroke survival among Medicare beneficiaries aged 65 and older improved slightly. We observed variation in the trends of poststroke survival among several subgroups. In particular, improvements in poststroke survival were greater among people with hemorrhagic strokes than those with ischemic and ill-defined strokes, among people without known prior hospitalization for stroke, and during the shorter follow-up periods (30 or 90 days) compared with the longer follow-up periods (1 or 2 years). Modest variations in poststroke survival were observed by age group, race, and region. Improvements in poststroke survival may reflect some combination of trends such as increased detection of milder strokes, a shift in the distribution of stroke severity toward less severe strokes, or improvements in treatment after stroke.

The ability to accurately diagnose stroke and detect milder strokes improved substantially during the 1980s with the increased use of computed tomography (CT) and magnetic resonance imaging (MRI).4,6,21 The use of CT of the head among Medicare beneficiaries increased 25%, from 42.6 per 1000 in 1985 to 53.3 per 1000 in 1989.22 Although the rate of MRI is substantially lower than for CT, there was a 180-fold increase in the rate of MRIs within the Medicare population, rising from 0.05 per 1000 in 1985 to 9.2 per 1000 in 1989.22 Given that survival rates are higher among persons suffering mild strokes than those having more severe strokes,23 an increase in the reporting of mild strokes (such as would result from more sensitive detection) could contribute to improved poststroke survival rates overall. Furthermore, trends in the increased use of CT and MRI show some patterns similar to trends in poststroke survival.

For instance, both increases in the use of these diagnostic imaging techniques22 and improvements in poststroke survival (Figs 2 and 3) were greater for blacks than whites and were greater among the older than the younger age groups.

A shift in the true distribution of stroke severity toward less severe strokes (as opposed to the increased detection of milder strokes as suggested) could also contribute to improved poststroke survival. The secular trends in stroke severity and level of consciousness on admission to the hospital reported from the Framingham data support this hypothesis.24 During a 30-year period from the early 1950s through the early 1980s, the frequency of mild deficits increased from 14% to 44%, while the frequency of severe deficits decreased from 37% to 16%. In addition, the prevalence of patients unconscious on admission to the hospital declined substantially during this time. A decrease in the proportion of stroke patients who arrived at the hospital while unconscious was also observed within a five-county area of rural North Carolina.11 However, even after statistically controlling for the change in this proxy for stroke severity, the authors reported a substantial subsequent improvement in poststroke survival.

Although no major technological improvements in the treatment of stroke patients have occurred, improvements in routine care (such as use of aspirin to prevent recurrent stroke, attention to acute control of blood pressure, emphasis on physical rehabilitation, and admissions to nursing homes, where stroke patients may receive better care than at home) have occurred. A recent meta-analysis of trials that randomized stroke patients to specialized stroke units or general medical wards found better survival patterns among patients in the stroke units.25 The authors hypothesized that the benefits of the stroke units reflect the integrated approach linking acute treatment (ie, more liberal use of antibiotics and heparin) with early mobilization and rehabilitation, as well as the active participation of both patient and family. Furthermore, the improved ability to distinguish hemorrhagic strokes from ischemic strokes,21,26,27 because of the increased use of diagnostic imaging,22 would allow practitioners to make better decisions about using anticoagulants.

It is likely that there was a trend toward more precise coding of stroke subtypes during the late 1980s, such that some strokes that might earlier have been coded to the ill-defined category were coded as ischemic or hemorrhagic, which is suggested by the data in Table 1. If there was a systematic shift from the category of ill-defined to either hemorrhagic or ischemic, then our finding of greater improvements in survival after hemorrhagic stroke than after ischemic stroke should be interpreted with caution. Other studies, which used patient records, have also found greater improvement in poststroke survival among patients with hemorrhagic strokes than with ischemic strokes.11,28 While these studies were not vulnerable to shifts in coding practices, neither they nor our study were able to rule out diagnostic shifts.

Because the Medicare data set does not include information on cause of death, we could not ascertain whether stroke patients died from a stroke or another cause. According to published studies, stroke is the underlying cause of death in approximately 80% to 90% of deaths that occur within 1 month of a stroke,23,29-31 in 70% to 80% of deaths that occur 3 to 6 months after a stroke,23,29,30 and in approximately 50% of the deaths that occur within several years of a stroke.12,26 Therefore, the large majority of deaths that occurred among subjects during our shorter periods of follow-up very likely were related to stroke. The larger improvements in short-term compared with long-term survival support the hypothesis that there has been more improvement.
in acute care of stroke patients than in long-term management of stroke survivors, who are more likely to die of cardiac and pulmonary complications. Variations in poststroke survival between blacks and whites and between regions could be related to changes in detection, severity, or treatment. Although blacks had poorer survival probabilities than whites (Table 2), their trend in poststroke survival was nearly identical to that for whites for 1986 through 1988, and they improved more in 1989. In 1989, the unadjusted probability of survival among blacks was 7.5% lower than among whites, whereas in 1985 the probability had been 10.6% lower. We found a similar trend for the Northeastern region, which consistently had the poorest survival probabilities, yet which experienced slightly greater improvements in poststroke survival than the other regions. Conversely, the most favorable survival probabilities were observed in the West, yet this region experienced the least improvement in poststroke survival.

While statistically significant findings may not always translate into clinically significant results, in 1989 about 5500 fewer poststroke deaths occurred (within 2 years of the event) than would have occurred if the 1985 age-specific Kaplan-Meier survival probabilities had been operating in 1989. This indicates that a small relative improvement in poststroke survival may translate into a substantial increase in numbers of people surviving. Given the high probability of patient disability after a nonfatal stroke, studies are needed to address the impact of improved survival on the quality of life of stroke survivors. Furthermore, health professionals should be aware of the variations in poststroke survival among different subgroups of the elderly population and the implications of these variations for the future medical and nursing needs of this population.

References

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Stroke. 1994;25:1617-1622
doi: 10.1161/01.STR.25.8.1617

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