Appendix 2

Prevalence of Stroke-Related Hospital Discharge Over Time: Emerging Trends in Ontario

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INTRODUCTION

Preliminary findings from the World Health Organization Monitoring Trends and Determinants in Cardiovascular Disease (WHO MONICA) Stroke Project[1] reveal a tendency toward declining stroke incidence rates in most of the populations studied. However, given the association between higher incidence of stroke and increasing age[2], a great deal of uncertainty surrounds the future burden of stroke in an aging population. As a recent study has demonstrated, a null effect of the burden of stroke may arise over time since the gain achieved from decreasing incidence rates may be counterbalanced by population aging[3]. The objective of this study was to estimate future stroke burden with respect to hospitalization taking into consideration both trends in stroke incidence and the effects of the aging population.

METHODS

We used a cross-sectional series to examine the prevalence of stroke-related hospital discharge in Ontario for each calendar year from 1989 through 1998. The Canadian Institute for Health Information (CIHI) Discharge Abstract Database was used as the primary data source. Stroke was defined as a subarachnoid hemorrhage (ICD-9 code 430), intracerebral hemorrhage (ICD-9 code 431), or ischaemic stroke (ICD-9 codes 434, 436). Initial stroke-related hospitalizations resulting from a complication of in-hospital care or transfers from other acute care hospitals were excluded from analysis. To account for age the data was analyzed according to the following age groups: 0-34, 35-44, 45-54, 55-64, 65-74, and 75 +

years. In calculating age-specific rates, census data from Statistics Canada was used. Weighted least squares regression was used to project age-specific estimates using age-specific population as weights until the year 2010. The projected age-specific rates were then multiplied by the projected age-specific populations to arrive at projected age-specific hospital discharges. These estimates were then added together for each calendar year to arrive at projected stroke-related hospital discharges for the population in the respective years. The variance of the mean was calculated at each point, which was used to derive 95% confidence intervals around each projection.

RESULTS

The expected demographic shifts in Ontario with respect to age over time are presented in Figure 1. The age-specific annual discharge rates over time are presented in Figure 2. All age groups except for the 35-44 and 55-54 year groups showed statistically significant downward trends in hospital discharge rates over time (i.e. 0-35: β=-0.11, p=0.03; 55-64: β=-0.86, p<0.01; 65-74: β=-7.72, p<0.01; 75+: -28.11, p<0.01). The 35-44 year age group displayed a non-significant upward trend over time (β=0.133, p=0.26) whereas the 45-54 year age group displayed a non-significant downward trend over time (β=-0.732, p=0.09). Overall, the number of stroke-related hospital discharges is expected to rise modestly over time (Figure 3) when these decreasing trends and the aging population are taken into consideration. The 15-year increase in the number of stroke-related discharges is expected to increase from 15,565 in 1995 to approximately 16,979 in the year 2010 (i.e. a 9.1% increase).

COMMENTS

The results of this analysis indicate that the detrimental effects of demographic shifts in age with respect to stroke-related hospitalization may be expected to outweigh the encouraging age-specific trends in hospital discharge rates over time. The net result appears to be a modest increase in the number stroke-related hospital discharges over time. This finding is consistent with a previously published study which found stable stroke occurrence despite incidence reduction[3].

Several issues must be considered when interpreting the results of this analysis. Linear regression was used to project estimates of age-related hospital discharge rates. Floor effects may not be accounted for in our analysis and this may overestimate the beneficial age-specific rates of decrease over time, thus underestimating the overall effect of aging. However, it must also be recognized that the model projections were greater than the actual number of discharges observed in calendar years 1997 and 1998. During these years, drops in the number of stroke-related hospital discharges were observed, despite an increasing and aging population. All estimates were also based on the accuracy of census projections from Statistics Canada and assumed reasonably accurate projection of demographic issues such as immigration and aging.

The projected estimates are also subject to a stable environment without significant changes in stroke prevention. The results are thus not generalizable in the presence of new stroke prevention discoveries. Stroke was defined as encompassing subarachnoid hemorrhage, intracerebral hemorrhage, and ischaemic stroke. Transcient ischaemic attacks were not included in the analysis. Although it was previously estimated that a 15-year increase of 30% in stroke-related hospitalizations is expected (internal estimation by Acute/Emergency Care Task Group), the estimates were based on a constant rate over time and perhaps dated

information. The Heart and Stroke Society of Ontario estimates an approximately 40% increase over a similar time period. This analysis attempts to overcome some of the methodological limitations of the previous analyses and provide a more reasonable estimation.

Although the results of this analysis should be interpreted with the above considerations in mind, the projections provide reasonable estimates of the future burden of stroke-related hospital discharges in Ontario.

REFERENCES

1. WHO MONICA Project. Stroke trends in the WHO MONICA project. *Stroke.* 1997;28:500-6.
2. Anonymous. Heart and Stroke Facts: 1995 Statistical Supplement. Dallas, American Heart Association, 1994.
3. Thorvaldsen P, Davidsen M, Bronnum-Hansen H, et al. Stable stroke occurrence despite incidence reduction in an aging population: stroke trends in the Danish Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) population. *Stroke.* 1999;30:2529-34.

Figure 1. Past and projected age-related shifts in population.

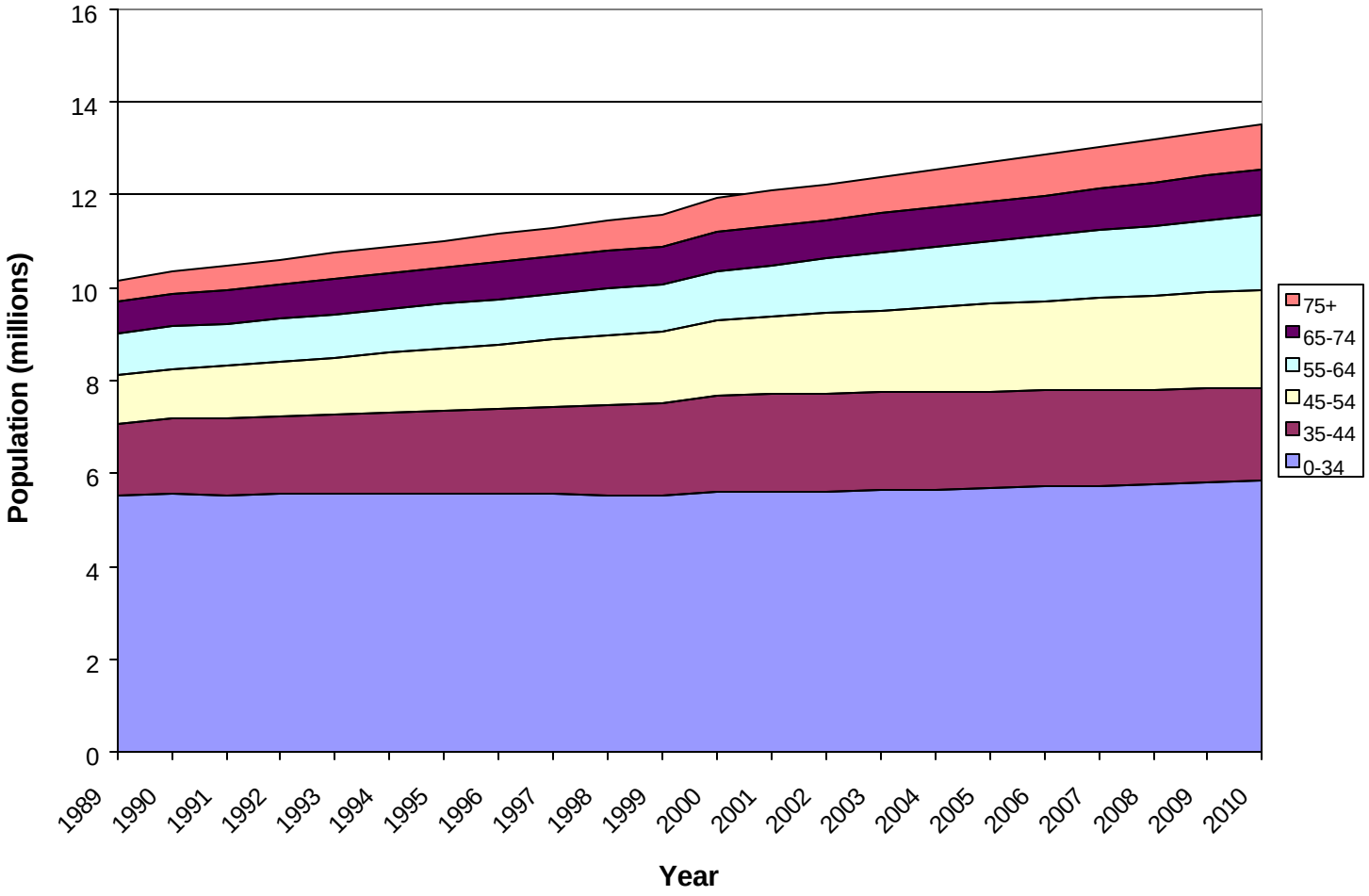
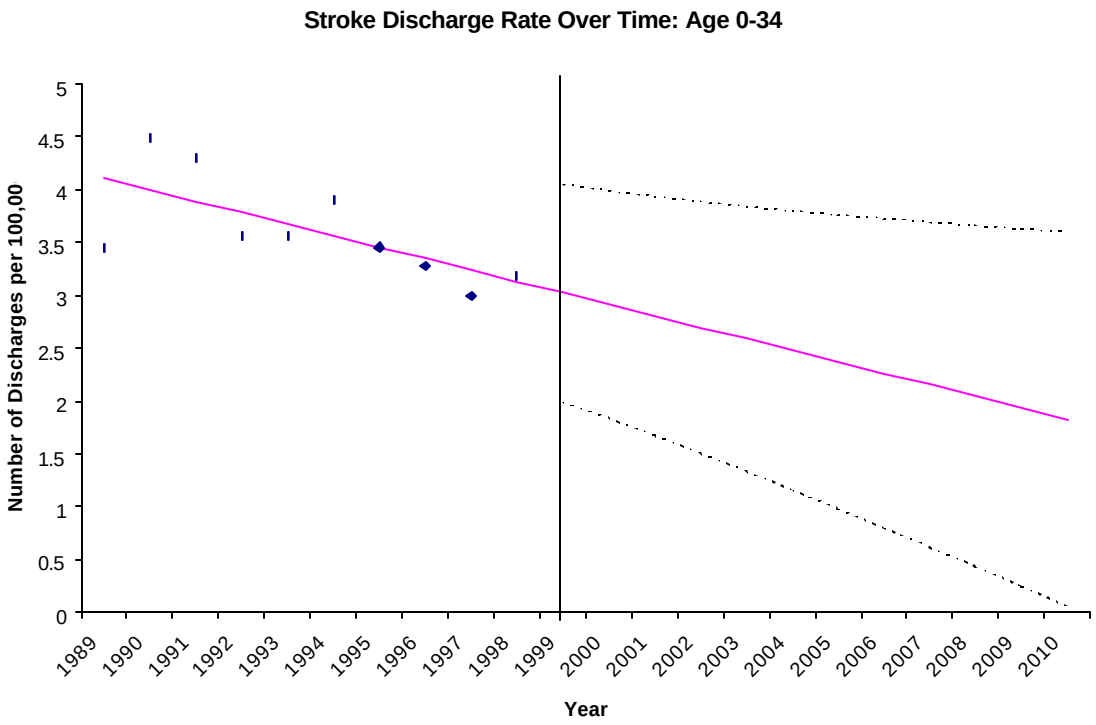
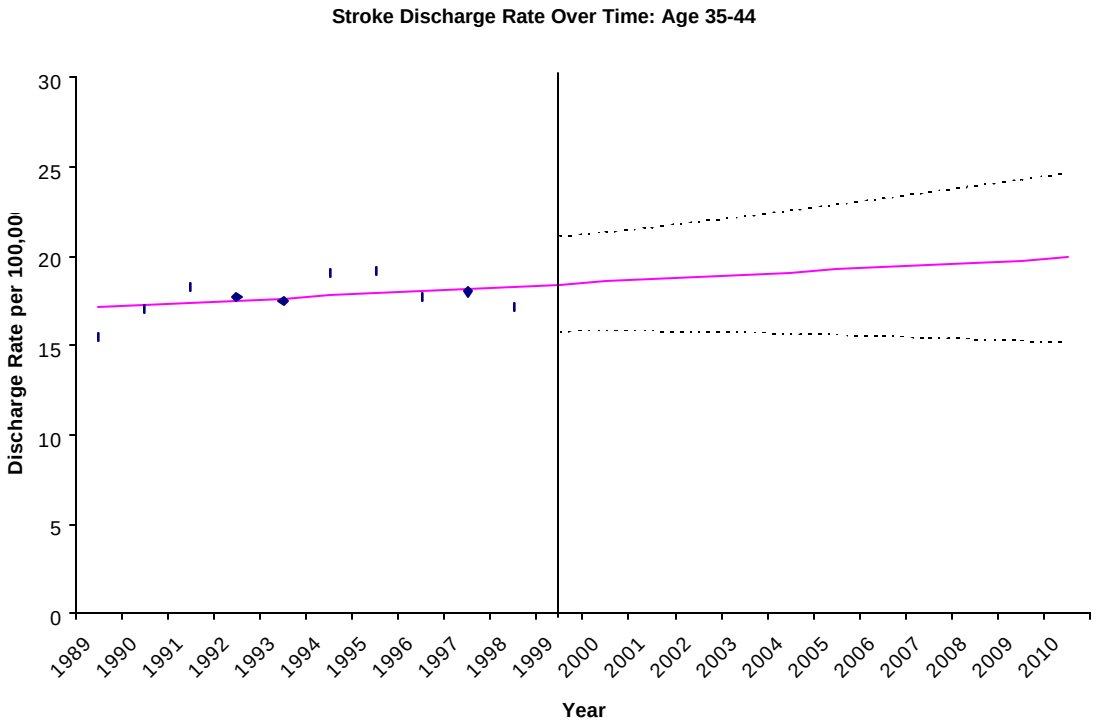
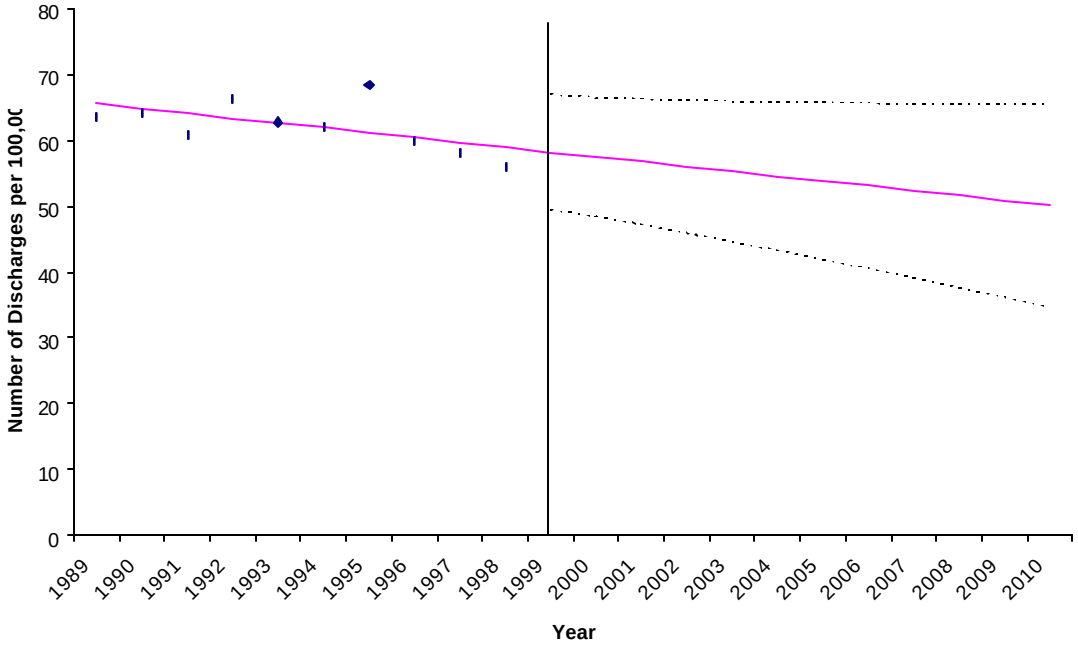


Figure 2. Age-Specific

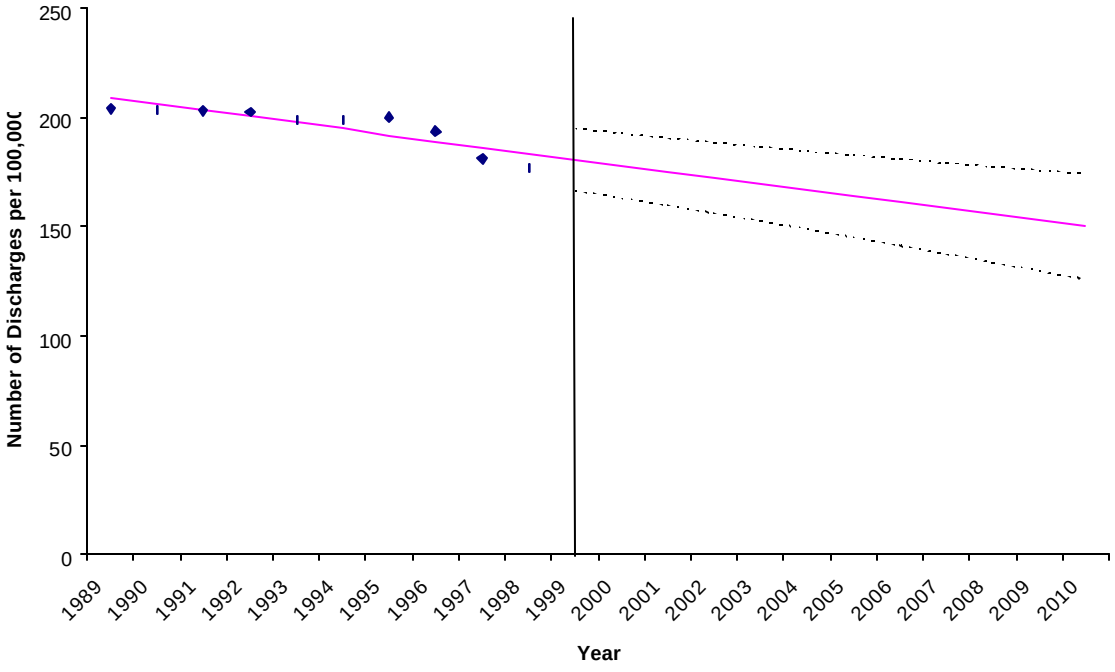




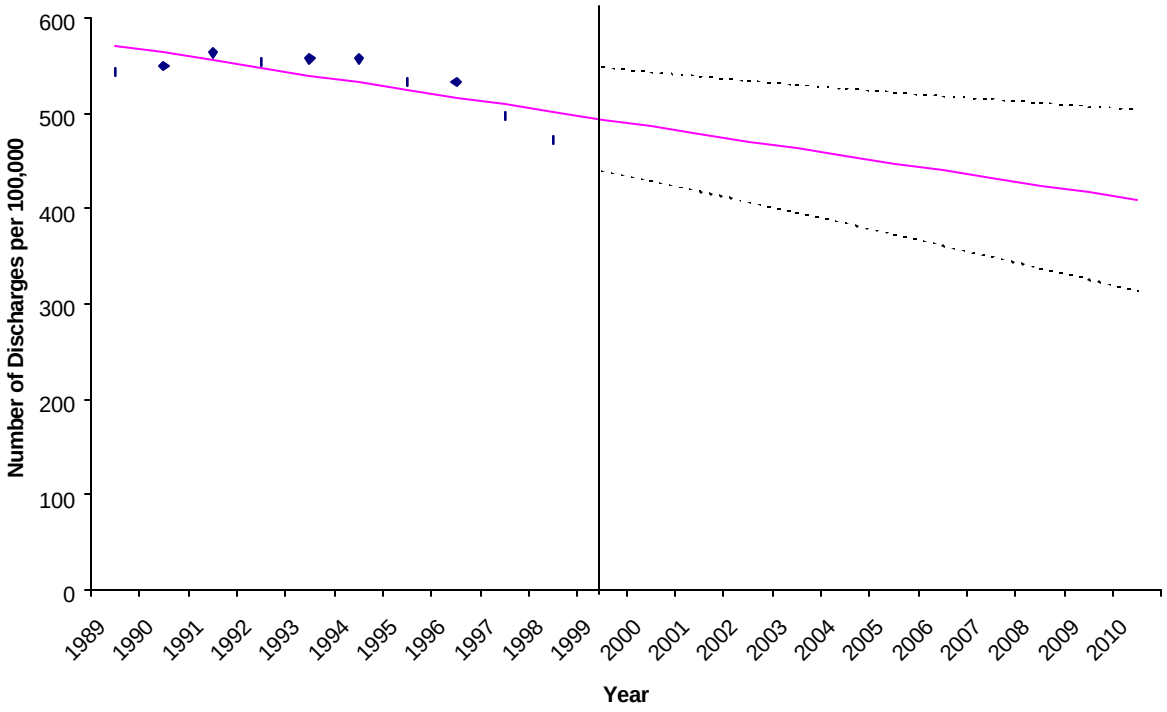
Stroke Discharge Rate Over Time: Age 45-54



Stroke Discharge Rate Over Time: 55-64 year olds



Stroke Discharge Rate Over Time: Age 65-74



Stroke Discharge Rate Over Time: Age 75 +

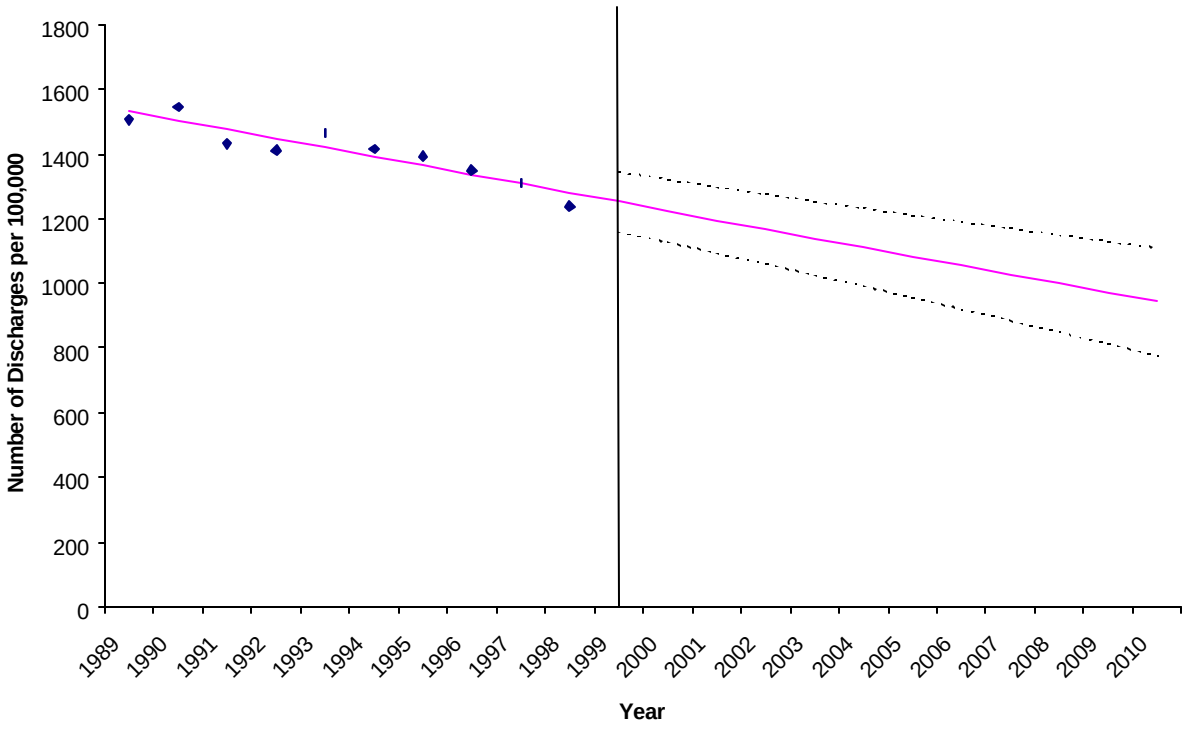
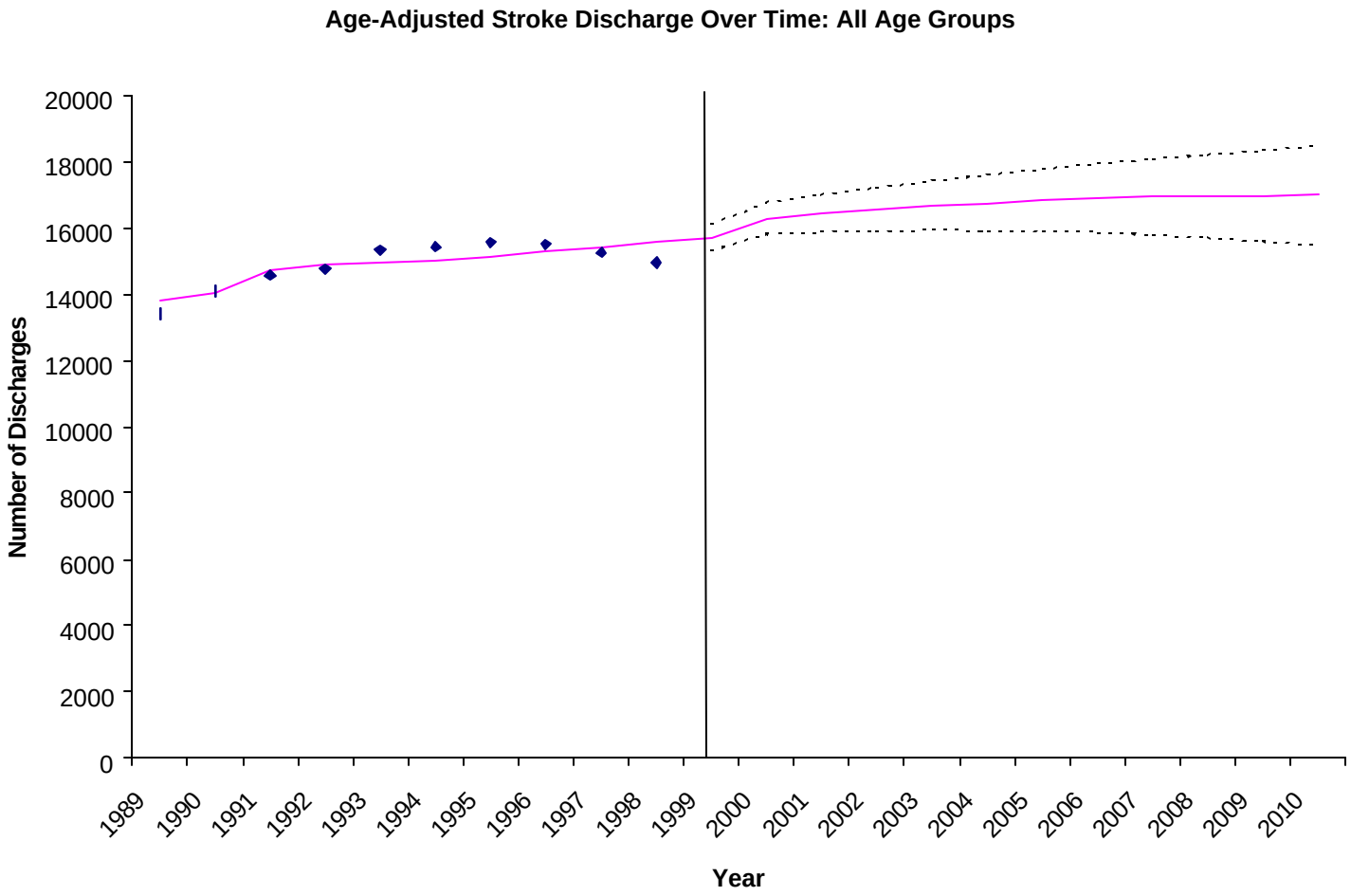


Figure 3. Actual and Projected Annual Estimates for Annual Age-Adjusted Stroke-Related Hospital Discharges



Actual and Projected Numbers of Strokes:

Year	Actual Discharges	Projected Discharges	UCI	LCI
1989	13396	13831.03359		
1990	14097	14018.56457		
1991	14573	14741.40922		
1992	14757	14861.53311		
1993	15331	14950.57561		
1994	15427	15019.33867		
1995	15565	15141.12275		
1996	15503	15273.86398		
1997	15261	15429.76663		
1998	14937	15579.78899		
1999		15708.65459	16105.77	15311.54
2000		16289.81816	16773.93	15805.71
2001		16429.92056	16994.81	15865.03
2002		16558.37161	17208.25	15908.49
2003		16668.94095	17408.8	15929.08
2004		16752.34863	17586.29	15918.4
2005		16832.4616	17765.93	15898.99
2006		16893.18789	17930.46	15855.91
2007		16927.01317	18071.62	15782.41
2008		16950.45563	18206.96	15693.95
2009		16956.33668	18328.37	15584.31
2010		16978.82214	18474.08	15483.56