

# Trends in Long-Term Mortality and Morbidity in Patients with No Early Complications after Stroke and Transient Ischemic Attack

Jodi D. Edwards, PhD,\* Moira K. Kapral, MD,\*†‡§ Jiming Fang, PhD,§ and Richard H. Swartz, MD, PhD\*||

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*Background:* Advances in acute management and secondary prevention have reduced mortality and early recurrent risk after stroke and transient ischemic attack (TIA). However, whether improved outcomes are sustained long term among those *without* early adverse complications is not clear. We describe trends in long-term mortality and morbidity in patients with ischemic stroke or TIA who are clinically stable at 90 days. *Methods:* This is a longitudinal cohort registry study (2003-2013) of patients presenting to stroke centers in Ontario, Canada, with a stroke or TIA, with no hospitalization, stroke, myocardial infarction (MI), institutionalization, or death within 90 days (N = 26,698). Primary outcomes were 1-, 3-, and 5-year age-adjusted composite rates of death, stroke or MI, and institutionalization, and secondary analyses evaluated outcomes individually. Trend tests were used to evaluate change over time. *Results:* One-year adjusted composite rates decreased from 9.3% in 2003 to 7.4% in 2012 (trend test  $P = .02$ ). Significant decreases in 3-year ( $P < .001$ ) and 5-year ( $P = .002$ ) composite rates were also observed. Rates of recurrent stroke decreased at 1 and 3 years ( $P < .01$ ), but not 5 years ( $P = .21$ ), whereas death rates declined across follow-up times. Conversely, rates of institutionalization *increased* at 3 and 5 years ( $P < .01$ ). *Conclusions:* Long-term mortality and morbidity post stroke and TIA have declined, confirming trends for improved long-term outcomes for patients clinically stable during the initial high-risk period. However, increased long-term rates of institutionalization also suggest that stroke and TIA patients are at risk of long-term functional decline, despite improved clinical outcomes. Further studies evaluating challenges for sustaining functional gains after stroke and TIA are required. **Key Words:** Stroke—transient ischemic attack—mortality—morbidity—temporal trends—longitudinal cohort study.

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From the \*Sunnybrook Research Institute, Canada; †Department of Medicine and Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada; ‡Division of General Internal Medicine and Women's Health Program, University Health Network, Toronto, Ontario, Canada; §Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada; and ||Department of Medicine (Neurology), University of Toronto, Toronto, Ontario, Canada.

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Address correspondence to Richard H. Swartz, MD, PhD, Department of Medicine (Neurology), Sunnybrook Health Sciences Centre, University of Toronto, Room A442, 2075 Bayview Ave., Toronto, ON, Canada M4N 3M5. E-mail: [rick.swartz@sunnybrook.ca](mailto:rick.swartz@sunnybrook.ca).

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## Introduction

Over the past 50 years, rates of stroke-related mortality have decreased up to 60%, moving stroke from the third to fifth leading cause of death in the United States.<sup>1</sup> Reductions in overall stroke mortality may be attributed, in part, to concurrent declines in stroke incidence. Epidemiological data indicate that overall age-adjusted rates of incident stroke have declined by up to 42% since the 1970s,<sup>2</sup> with up to 40% of this decline attributable to improved vascular risk factor control.<sup>3</sup>

Recurrent vascular events are a major source of morbidity and mortality in individuals with acute ischemic stroke and transient ischemic attack (TIA).<sup>4</sup> Recurrent stroke represents 23% of all strokes occurring annually,<sup>5</sup> and the risk of recurrent stroke is highest during the early period post stroke or TIA.<sup>6</sup> In patients with stroke and TIA, population-based data have shown that recurrent stroke is associated with an increased risk of disability, institutionalization, and death.<sup>7,8</sup>

Like incident stroke, rates of recurrent stroke have also decreased over time. In a systematic review of randomized controlled trials, Hong et al reported an almost 50% reduction in event rates for recurrent stroke in the control arms of recent secondary prevention trials compared to trials conducted in the 1960s.<sup>9</sup> Population-based studies have also reported reductions in 5-year trends in recurrent stroke hospital admissions<sup>10</sup> and 1-year recurrent stroke rates.<sup>11</sup> Observed decreases in the rate of recurrent stroke have largely been attributed to improvements in acute interventions and prevention targeting the early period of highest recurrent risk post stroke or TIA.<sup>12</sup> However, little is known about whether improvements in poststroke or TIA outcomes are sustained long term among those that remain clinically stable during the initial high-risk period and may have a different trajectory for long-term follow-up than those with early recurrent events. The purpose of the present study was to describe long-term temporal trends in 1-, 3-, and 5-year rates of mortality and morbidity in clinically stable patients with recent ischemic stroke or TIA who did not experience any adverse complications in the first 90 days following discharge.

## Methods

Administrative health data from the province of Ontario, Canada, were used to perform this longitudinal cohort registry study (2003-2013).

### Data Sources

Data from the Ontario Stroke Registry (OSR) were obtained from the Institute for Clinical Evaluative Sciences at Sunnybrook Health Sciences Center. The OSR, authorized under provincial privacy legislation to perform data collection without individual patient consent, cap-

tures data on all consecutive patients with acute stroke or TIA presenting to the emergency department or admitted to hospital in 12 regional stroke centers in Ontario, Canada. Chart abstraction for the registry is performed by trained research nurses and has been validated by duplicate chart abstraction. OSR data collection software requires complete entry before record submission to ensure no missing data and completeness of the registry over time. The OSR and the present study were approved by the Research Ethics Board of Sunnybrook Health Sciences Center.

The OSR was linked with provincial databases using unique encoded patient identifiers to obtain longitudinal data for the identification of outcome events. The Canadian Institute for Health Information Discharge Abstract Database was used to document emergency department visits and hospital admissions, using the International Classification of Diseases, 10th revision (Supplemental Table S1). Out-of-hospital mortality data were obtained from the Ontario Registered Persons Database. The Continuing Care Reporting System was used to capture admissions to long-term and continuing care as a proxy of functional status or disability.

All consecutive patients with ischemic stroke or TIA seen in the emergency department or discharged from hospital at regional stroke centers in Ontario from July 1, 2003, to March 31, 2013, were identified from the OSR. This cohort was then restricted to patients without death, stroke, myocardial infarction (MI), any hospitalization, or admission to a long-term or complex continuing care facility (i.e., institutionalization) within 90 days of discharge (N = 26,698).

### Outcomes

The primary outcome was a composite measure of mortality and morbidity, including the following events: death, hospitalization for recurrent stroke or MI, and admission to a long-term or continuing care facility. We determined age-adjusted 1-, 3-, and 5-year composite event rates for each year of the 10-year study period. Cochran-Armitage trend tests were then used to evaluate changes in 1-, 3-, and 5-year age-adjusted rates over time from 2003 to 2013. Secondary outcomes included the individual outcome events from the composite measure analyzed separately.

### Statistical Analyses

Descriptive statistics were used to characterize the study cohort with respect to all demographic and clinical variables. One, three, and five-year age-adjusted composite event rates of death, stroke or MI, and institutionalization for each year of the 10-year study period were generated and trend tests were used to evaluate changes in age-adjusted rates over time.

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