Trends and Regional Variation in Hospital Mortality, Length of Stay and Cost in Hospital of Ischemic Stroke Patients in Alberta Accompanying the Provincial Reorganization of Stroke Care

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Objectives: This study aimed to evaluate the trends and regional variation of stroke hospital care in 30-day in-hospital mortality, hospital length of stay (LOS), and 1-year total hospitalization cost after implementation of the Alberta Provincial Stroke Strategy. *Methods:* New ischemic stroke patients (N = 7632) admitted to Alberta acute care hospitals between 2006 and 2011 were followed for 1 year. We analyzed in-hospital mortality with logistic regression, LOS with negative binomial regression, and the hospital costs with generalized gamma model (log link). The risk-adjusted results were compared over years and between zones using observed/expected results. *Results:* The risk-adjusted mortality rates decreased from 12.6% in 2006/2007 to 9.9% in 2010/2011. The regional variations in mortality decreased from 8.3% units in 2008/2009 to 5.6 in 2010/2011. The LOS of the first episode dropped significantly in 2010/2011 after a 4-year slight increase. The regional variation in LOS was 15.5 days in 2006/2007 and decreased to 10.9 days in 2010/2011. The 1-year hospitalization cost increased initially, and then kept on declining during the last 3 years. The South and Calgary zones had the lowest costs over the study period. However, this gap was diminishing. *Conclusions:* After implementation of the Alberta Provincial Stroke Strategy, both mortality and hospital costs demonstrated a decreasing trend during the later years of study. The LOS increased slightly during the first 4 years but had a significant drop at the last year. In general, the regional variations in all 3 indicators had a diminishing trend. **Key Words:** Ischemic stroke—hospitalization—mortality—length of stay—hospital cost—trend—regional variation—risk adjustment.
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Introduction

Stroke is the leading cause of serious long-term disability and the third leading cause of death in Canada, accounting for 5.9% of all deaths.[1] It was estimated that the total direct cost of stroke was $1.2 billion in Canada and $99 million in Alberta in 2008.[2]

In 2006, Alberta established the Alberta Provincial Stroke Strategy (APSS) to implement national standards of stroke care and service, and reduce the impact and financial burden of stroke.[3,4] One of the major goals of the APSS was to ensure that all eligible stroke patients should receive care in a specialized stroke center for thrombolytic therapy and inpatient care, neuroimaging, vascular imaging, and preventive treatments. In 2005, there were 2 "comprehensive" stroke centers and 3 "primary" stroke centers in Alberta, and this number increased to 3 and 13 by 2009, and to 3 and 15 by 2012. Primary stroke centers had computed tomography (CT) scanners, standardized protocols for medical care of stroke patients, and could deliver thrombolytic (clot busting) therapy for stroke with the assistance of telemedicine connections with tertiary care center stroke neurologists. In addition to the above stroke services, a comprehensive stroke center is a tertiary hospital that has on-site stroke physicians, neurosurgical, vascular surgery, and neuro-interventionist expertise, and also is a central hub in a telestroke network.[4] Early Supported Discharge Programs for stroke patients is another key component of system change which targeted reductions in length of stay (LOS) in the acute care hospitals. The program was piloted from 2009 and became fully functional in Calgary and Edmonton by 2011. The initial results of the APSS showed a significant improvement in inpatient 30-day mortality for both ischemic and hemorrhagic stroke.[4] Ontario has also demonstrated an association between the organized stroke care and improved outcomes.[5]

In 2009, 9 health regions in Alberta were reorganized into 1 province-wide provider organization, Alberta Health Services, consisting of 5 geographic zones: South, Calgary, Central, Edmonton, and North zones. Comparison of the geographical areas based on health-care performance is important in the determination of the impact of policies on health outcomes and system performance. A disease-based approach using administrative databases is the most suitable for health outcome measurement.[6-9] Using such an approach, the European Healthcare Outcome, Performance and Efficiency (EuroHOPE) study developed standardized risk adjustment methods to compare health-care outcomes and performance in 5 specific diseases including stroke in 7 European countries.[9] The EuroHOPE study has shown that in most of the participating countries, there were significant variations between the 1-year case fatalities of stroke patients between different regions.[10]

The Canadian Healthcare Outcome, Performance and Efficiency project is based on the EuroHOPE study methodology, and compares clinical and financial indicators of 2 diseases: acute myocardial infarction and stroke. In this study we examined the effect of the APSS by describing and comparing the trends of stroke inpatient care in Alberta and its 5 health zones in terms of the risk-adjusted 30 days in-hospital mortality, hospital LOS, and total hospitalization costs after 1 year from index admission. This analysis is the first part of a detailed economic analysis of the impact of the APSS on stroke care in Alberta that was not included in the earlier APSS reports.[4]

Materials and Methods

Study Population

The study population included all patients recorded in the Discharge Abstract Database (DAD) with admission date between April 1, 2006 and March 31, 2011 in Alberta acute care hospitals with the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) most responsible diagnostic code of ischemic stroke (I63).

We excluded patients with the ICD-10 most responsible diagnostic codes of subarachnoid hemorrhage (I60), intracerebral hemorrhage (I61), ischemic stroke (I63), and ill-defined stroke (I64) in the DAD during the previous 365 days, tourists, visitors to Alberta or other residents with incomplete provincial health-care numbers, patients under 18 years of age, and patients with index admission to a subacute sector in a long-term care center or rehabilitation hospital. The patients were followed up for 1 year from index admission date.[9]

Definition of Index Admission and Treatment Episode

The index admission (without stroke hospitalization during the previous 365 days) is defined as the first date admitted to an acute care hospital, with ischemic stroke as the main diagnosis. The first treatment episode starts from the index admission and ends on a discharge to home, a nonacute care hospital, an in-hospital death, or an acute care hospital for an alternate level of care. We assume that a transfer has occurred if admission to an acute care institution occurs on the same, prior, or the next day as discharge from another acute care hospital.[11]

Outcome and Performance Indicators

The outcome and performance indicators used in this study include all-cause in-hospital mortality within 30 days; LOS for the index hospital episode; and the cumulative cost of hospitalizations during the year after index admission date. The index hospital episode was truncated at 365 days if the LOS was longer. The patients were grouped into 5 zones according to their residence postal codes recorded in the DAD.

We extracted the hospital cost data from the Interactive Health Data Application of Alberta Health.[12] The per diem costs were estimated by dividing the median costs