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Direct healthcare costs of acute myocardial infarction in Canada's elderly across the continuum of care

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ABSTRACT

A growing number of healthcare policy initiatives around the world have focused on the continuum of care amongst the elderly, calling for renewed investments in integrated care to promote healthy aging and to reduce health system costs. The study objective was to examine healthcare costs and cost drivers for myocardial infarction (AMI) among Canadian Seniors across the care continuum from 2004 to 2012 in Ontario, Canada. Cost estimates represented direct community and hospital-based costs including physician services, diagnostic-testing, pharmaceuticals and hospitalizations obtained from Canadian healthcare data sources. Separate costs were calculated for pre-state care, the hospital event, and post-state care over a 6 year care continuum. Socio-demographic and co-morbid cost drivers were studied using negative binomial regression in a cohort of 16,450 first-time AMI seniors.

The average cost per patient across a six-year care continuum was $28,169 in 2008 constant Canadian dollars. Almost three-quarters of these costs were derived from the event phase ($20,794), while pre-state and post-state costs made up 12% and 14%, respectively ($3400 and $3974). Pre-state costs per patient day were half of post-state costs ($3.11 versus $6.32 per day) when adjusted for survival. Socio-demographic characteristics including age, gender and patient's urban/rural residence, and co-morbid illnesses were key cost drivers across the phases of care. This study provides a person-centered health system perspective in the economic burden of AMI in Canada's elderly and will inform health policy related to integrated care strategies for heart disease in seniors.

Introduction

Acute Myocardial Infarction (AMI) exacts a significant burden of illness world-wide. AMI is responsible for between 40% and 50% of the 17 million annual cardiovascular disease deaths globally (Yusuf et al., 2001; WHO, 2011), and represents the leading cause of morbidity and mortality in North America (Tu et al., 1997). The impact of AMI on the elderly is particularly profound, with a ten-fold greater AMI incidence among those 65–74 as compared to those 35–44, and a persistently high case fatality rate for patients over the age of 65 (Roger, 2007; Yazdanyar and Newman, 2009). Given global trends in population aging and the anticipated increase in corresponding AMI health care costs (Heidreneich et al., 2011; Kim et al., 2013), governments around the world are growing increasingly focused on integrated seniors strategies to address heart disease across the continuum of care in order to promote healthy aging and mitigate healthcare spending (Smith, 2009; Health Council of Canada, 2012; Leatt et al., 2000; Nolte and McKee, 2008).

The last decade has seen a growing interest in models of care for AMI that promote coordination of services across the care continuum, however there remains limited available evidence about actual costs of AMI across the care trajectory (Nolte and McKee, 2008). Despite the substantive disease burden of AMI among the elderly, AMI costing research across the care continuum is particularly lacking for those over 65 (Tarride et al., 2009). In the Canadian context, in which a single-payer universal healthcare provides physician, hospital and drug coverage to all seniors, no study has yet examined direct AMI costs in the elderly across the complete continuum of care; exploring costs in community and hospital-based care, both before and after the index AMI event. This is surprising given that seniors have been shown to be among

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the highest users of AMI healthcare services (CIHI, 2011a; Krumholz et al., 1998) and that integrated care models for seniors in general have been shown to improve health outcomes and cost-savings overall (MacAdam, 2008; Carstairs and Keon, 2009).

The purpose of this study was to examine healthcare costs and cost drivers for AMI among Canadian seniors across the care continuum from 2004 to 2012 in Ontario, Canada. Patient cost data are presented in aggregate but are also delineated in time across the care trajectory to detail the costs of healthcare services prior to AMI, the costs of acute in-patient AMI care, and the costs of disease management following the AMI event. Finally, socio-demographic and clinical factors that are major drivers of cost along the patient's care continuum are explored.

Methods

The Canadian Institute for Health Information's Discharge Abstract Database (DAD), housed at the Institute of Clinical Evaluative Sciences (ICES) of Ontario, Canada was used to identify the population-based study cohort. All patients between the ages of 65 and 105 who were admitted to Ontario hospitals with a most responsible diagnosis of AMI (ICD-10 code (I21)) between April 1, 2007 and March 31, 2009 were included in the study. We established incident AMI cases by selecting only those patients for whom the absence of a hospitalization for AMI could be established for up fifteen years prior to the index AMI. Patients were required to be residents of Ontario for the duration of the study period to ensure that all services could be accurately tracked. Patients living in the Kingston/Quinte/Rideau region were excluded due to alternative billing arrangements in which services could not be captured with available data sources.

For each patient, a trajectory was established to measure the cost of key AMI-related services across a typical patient care continuum. The methodology for developing and presenting cost estimates was adapted from O'Brien et al. (2003) in which services across the care trajectory were reported separately for the event (hospitalizations associated with the patient's AMI and one-year follow-up heart-related readmissions) and for the post-state (community-based services following the AMI event). For the purposes of this study, a third pre-state phase was introduced to account for services associated with the patient's care prior to the AMI event. Cost estimates represented direct healthcare costs within the community and hospital settings.

Longitudinal patient record

Longitudinal patient records were created using deterministic linkage via unique encrypted patient health insurance numbers. Ontario's DAD was used to estimate the cost of in-patient services associated with the AMI event, and all subsequent heart-related readmissions (ICD-10 I codes) for up to one year following the AMI index date. Patient records were linked with Ontario's Hospital Insurance Plan (OHIP) billing data to examine the costs of relevant pre-state and post-state services for three years prior to and three years following the AMI. This approach resulted in a follow-up period of six years for each patient over a total study period ranging between the fiscal years of 2004 and 2012.

Costing data sources and costing techniques

CIHI's discharge abstract database

In-hospital patient costs were generated using a bottom-up activity-based costing model to allocate costs for individual service recipients based on service dates (Chapko et al., 2009; CIHI, 2011b). To estimate event costs, Resource Intensity Weights (RIW™) within the DAD were used to determine the intensity of hospital resource use for each patient based on the standard Canadian patient case-mix classification (Case Mix Groups, CMG™). CMGs represent a standardized grouping of hospital services for a set of major clinical categories, similar to the diagnosis-related grouping (DRG) system used in the United States and in Europe (Hakkinen et al., 2012; Feter et al., 1980). RIWs reflect the relative value of hospital resources utilized for each inpatient case, including fixed and variable, direct and indirect costs attributable to inpatient care (CIHI, 2011b). Indirect costs associated with transient cost centres were allocated to cost centres using a reciprocal costing method – simultaneous equality allocation method (SEAM) (CIHI, 2011b; Young, 2003). Direct and indirect costs in each functional centre were then assigned to the patient based on an algorithm that accounted for unit costs and patient-specific workload (CIHI, 2011b). Canada's activity-based costing methods, and RIW and CMG standards have been documented elsewhere (CIHI, 2004, 2011b).

It should be noted that physician costs were not included in the standard RIW costing methodology as physician payments are handled outside of the hospital funding matrix in Canada. As such, physician billing costs which are handled largely on a fee-for-service basis in Ontario, Canada were directly allocated to relevant hospitalization event costs using the admission and discharge dates to develop complete event costs for each patient (Young, 2003). Individual RIWs for each discharge were multiplied against the 2008 average cost per weighted case for Ontario hospitals, to establish an in-hospital cost for each patient in the cohort (CIHI, 2013).

Ontario's health insurance plan database (OHIP)

OHIP billing data was used to measure of the cost of laboratory and diagnostic services and physician consultations associated with the pre-state, event, and post-state phases of care based on billing dates. Physician costs for targeted heart-related services provided in the community were measured using a defined set of OHIP fee and diagnostic codes, adapted from Tu et al.'s (2001) hospital-based methodology. Ontario's 2008 Schedule of Benefits was used to assign costs to each billed physician service and Ontario's laboratory unit index was used to directly allocate costs for laboratory services (OHIP, 1999).

Ontario's drug benefits database (ODB)

The Ontario Drug Program provides prescription drug coverage for all Ontario residents aged 65 and over. ODB data were used to measure the cost of medications within the pre-state and post-state phases of care. Drug costs in the event phase were built into the RIW hospital costing methodology and could not be isolated for the purposes of comparison in this study. Cost estimates were generated for all prescriptions filled in the community for the following therapeutic drug classes; Statins, Beta Blockers, Calcium Channel Blockers and Ace-Inhibitors as per clinical practice guidelines (Tobe et al., 2011; Daskalopoulou et al., 2012; Anderson et al., 2013). Costs for prescription drugs were generated by multiplying the average cost per tablet by the quantity dispensed for each claim and directly allocated to each patient in the pre-state and post-state phases.

Demographic and clinical data sources

Clinical co-morbidity data were derived from CIHI's DAD at the time of AMI admission based on the Ontario Acute Myocardial Mortality Prediction rules (Tu et al., 2001). Patient demographic