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Canadian Case Mixed Groups (CMG+) Costing Proxy for Acute Myocardial Infarction

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Abstract

Economic evaluations require accurate costing data. However, when these costs are absent, proxy data is needed such as the Canadian Case Mix Groups+ (CMG+). This is the first study to evaluate the CMG+ as a costing proxy for acute myocardial infarction patients by comparing actual micro-costing data with the CMG+. Intra-class correlation coefficients based on Kappa statistics cut points show "good agreeability" between the costing proxy and actual cost (ICC of 0.66).

Keywords: Hospital cost; Canada; Costing estimate; Case-Mix groupers; Economic evaluations; Acute myocardial infarction

Introduction

All economic evaluations require accurate estimates of health-care cost when detailed Management Information System (MIS) -costing data is unavailable [1]. Canadian health care executives rely on valid cost estimates for determining resource allocations [2]. Currently, very little research has been done on the impact of using a cost proxy for micro-costing data [3], which has lead to criticisms of the Canadian Case Mixed system in whether the cost weights from the system accurately represent mean hospital episode costs [4]. This study validates the Canadian Institute for Health Information's (CIHI) cost proxy for patients with acute myocardial infarction (AMI) in Edmonton, Alberta between years 2006 to 2009.

Background

Case Mixed Groups Plx (CMG), the first Canadian version of the Diagnosis-related group (DRG) system, was first introduced in 1983. This system assigned discharge patients to one of approximately 600 resource groups with 25 major clinical categories based on the most responsible diagnosis. This methodology grouped patients with similar cost and hospital length of stay (LOS) by isolating complicated conditions that were statistically associated with higher cost. Average patient costs were derived from costing data submitted to CIHI annually [4-6]. CMG's were originally designed to collapse the ICD-9-CM and Canadian Classification of Procedure codes to a smaller, more manageable number of patient groups for gross-costing estimates [3,7].

Case Mix Groups+ (CMG+) introduced by CIHI in 2007 replaced the former CMG system. CMG+ accounts for five factors: age category (cost variations associated with the different needs and durations for older and younger patients), comorbidity level (pre-existing conditions patients may have prior to the diagnosis, and hospital induced conditions such as infections), flagged interventions associated with higher costs, intervention event (consists of inpatient visits to an operating room or procedure suite during the hospital stay), and out-of-hospital intervention (selected interventions that are performed outside the admitting facility that results in lower hospital costs). Based on CIHI's formula to estimate inpatient cost, two components are required to derive a CMG+ cost estimate. The first are the Resource Intensity Weights (RIW), which are calculated and updated annually based on the Discharge Abstract Database (DAD) and from case cost data from hospitals in British Columbia, Alberta, and Ontario [6]. These RIW's are controlled for the five factors discussed above, and represent the relative resource used by each average patient within a CMG+ group. RIW values are adjusted for observed differences in LOS reported and Expected LOS by CIHI. The second component is the Cost Per Weighted Case (CPWC), which are calculated annually from the CIHI's Canadian Management Information System Database. The CPWC is calculated by dividing the net inpatient cost for a facility by the total weighted cases in that facility, which provides a measure of the average cost the facility incurs per inpatient. These two components are then multiplied together to derive a Cost Per Case estimate [6]. The Cost Per Case estimate can also be divided by its associated Expected Length Of Stay (ELOS) to obtain a Cost Per Diem rate for typical patients [8]. Average cost, ELOS, and other factors used in the process of deriving the RIW's for each CMG+ category are publically available through the Alberta Health and Wellness Interactive Health Data Application (IHDA). We have used these intermediate variables to derive an additional cost estimate that researchers may be able to use when in absent

of RIW's and MIS-costing data. The aim of this study is to provide a side-by-side comparison of the different costing estimates and compare it with the MIS costs for typical patient with new AMI hospitalization.

Data and Methods

Hospital discharge data was for 4802 AMI (ICD-10 code I21) patients in the Edmonton area hospitals between fiscal periods of April 1, 2006 to March 30, 2009 were excluded if the patient transferred to an acute care facility, died, signed-out, or had a LOS greater than 90 days. These restrictions ensure that only typical patients (3708 patients) remained in our data set. Following EuroHOPE methodology [9,10], we included only new AMI patients (3291 patients remaining). All functional costs in Canadian dollars (hospital direct costs, hospital drug cost, patient supply cost, patient drug cost, and indirect cost) were aggregated and matched with their associated CMG+ cost estimates.

We determined 3 possible estimates for MIS-costing data. The first estimate follows the CIHI (2008) method for calculating a Cost Per Case estimate (Equation 1), where i represent each inpatient and t represents the fiscal year. CPWC values are publically available through the CIHI website for recent years, however due to a change in CPWC calculations, the older values from fiscal years 2006/2007 to 2008/2009 are no longer available online. We have included the CPWC values from the older years for future references. The second Cost estimate follows Perry and Homan (2009) RIW estimation of Cost Per Diem using ELOS from IHDA, which is extracted for each CMG+ group prior to using it as a denominator for the Cost Per Case (Equation 2). It is important to note that ELOS statistics excludes atypical patient cases and long-stay cases [8]. Given the available information in the IHDA database, we extracted the average cost used in the process of the RIW calculations to derive a "last resort" Per-Diem cost estimation (Equation 3), where the average cost per each CMG+ is divided by the ELOS for its associated CMG+ group and then multiplied by the MIS-costing LOS. It is important to note that this derivation does not follow CIHI standards and does not take into account many cost-varying factors compared to the RIW cost estimates.

$$[\text{CMG Cost Per Case}]_{i,t} = [\text{RIW}]_{i,t} \text{ X } [\text{CPWC}]_t \quad (1)$$

$$[\text{CMG PerDiem}]_{i,t} = [\text{CMG Cost Per Case}]_{i,t} / [\text{ELOS}]_{i,t} \quad (2)$$

$$[\text{IHDA PerDiem}]_{i,t} = \{[\text{IHDA Average CMG+ Cost}]_{i,t} / [\text{ELOS}]_{i,t}\} \text{ X } [\text{MIS LOS}]_{i,t} \quad (3)$$

The difference between the cost estimates and actual costs will be calculated for each inpatient prior to calculating the descriptive statistics, which will provide us with the mean differences for each costing methodology.

A linear regression analysis was used to determine which costing methodology best correlates with the MIS-costing data. Similar to the majority of economic studies, costs were logarithmically transformed. The coefficient closest to 1 in the linear regression indicates the best correlation between the costing method and MIS-costing data.

Intra-class correlation coefficients were used to determine which costing methodology best "agrees" with the MIS-costing data based on Kappa statistics cut points; less than 0.4 signalling a weak agreement, 0.4-0.6 suggest a moderate agreement, 0.6-0.8 a good agreement, and 0.8 or higher showing an excellent agreement [3,9].

Results

The overall mean MIS cost is 11,387 (SD 9,930). The average overall age is 71 (SD 14) years old. The data set contains approximately 32% females and 68% males. By gender the average costs are 11,812 (SD 9367) CAD and 11,190 (SD 10,176) for females and males, respectively. The average ages by gender are 78 and 70 years old for females and males, respectively.

The mean difference between CMG+ cost estimates and actual cost (**Table 1**) indicated that the RIW Cost Per Case produced cost estimates closest to the real mean and with the lowest standard deviation. The RIW Cost Per Case cost estimate overestimates the mean by approximately $359 (SD 7,086) while RIW Cost Per Diem produced a cost estimate that underestimated the real mean by approximately $9,109 (SD 8841). When in absent of RIW values the Cost estimate derived using information available on IHDA produced a mean that overestimates the MIS-costing mean by approximately 3,816 (SD 8441) Canadian dollars.

Table 1: Mean differences between cost estimates and MIS cost.

Cost Estimates	Mean Difference	Observations
RIW Cost Per Case	359 (7086)	3291
RIW Cost Per Diem	-9,109 (8841)	2891
IHDA Derived Cost2	3,816 (8441)	2891
All cost are expressed in Canadian dollars		
All cost in 2010/2011 values		
Difference = [Cost Estimate]- [MIS Costs]		
Standard deviation in parentheses		
1. All lost observations in CMG estimates occurred in 06/07 fiscal years due to conversion from CMG Plx to CMG+ and were unable to be matched.		
2. This cost estimate is derived from intermediate variables in the calculations of RIW estimates and does not follow CIHI methodology. It should be noted that this cost estimation should only be used when in absent of RIW's.		

Regression results (**Table 2**) shows that the costing method using RIWs to produce Cost Per Case as specified by CIHI produced almost perfect correlation with actual MIS-costing data (Coefficient of 0.9). The RIW Cost Per Diem had the lowest correlation from the MIS-costing data (Coefficient of 0.71). When in absent of RIWs, the cost estimate derived with IHDA data produces a correlation of 0.88, which is secondary to the RIW method but relatively similar.

In regards to agreeability from the cost estimates (**Table 2**), both RIW methodologies are in "good agreement" and the

IHDA cost estimate is in "Excellent agreement with the MIS-costing data based on the Kappa Statistic cut points (0.66, 0.65, 0.82 for RIW Cost Per Case, RIW Cost Per Diem, and IHDA Cost estimate, respectively).

Table 2: Linear regression and intra-class correlation coefficient.

Cost Estimates	Regression Coefficient	Intra-class Correlation
RIW Cost Per Case	0.90*	0.66
RIW Cost Per Diem	0.71*	0.65
IHDA Derived Cost	0.88*	0.82
* indicates 1% significance level		

Discussion

The RIW Cost Per Case estimate provides good agreement and highly correlates with the MIS-costing data. The mean difference between using the RIW Cost Per Case estimates and MIS-costing data is minimal but the high standard deviation may increase the uncertainties for economic evaluations. The CMG+ system is not used for reimbursement in Canada except of the small proportion of payment in Ontario. Based on our estimated the MIS and CMG+ methodologies produce that close estimates that for the typical AMI patients it would produce a reasonably good basis for activity based funding system. When the RIW values cannot be applied, we found that using the average cost publically available through IHDA produces reasonably accurate and close results to the RIW estimates. It is important to note that deriving cost estimates using average cost in IHDA does not follow the CIHI methodology and should not be used when RIW's are available.

Our results are similar to a previous study 3 where the old Canadian CMG was similar to MIS-costing estimates. However when they used the CMG in a cost-utility analysis in economic evaluation they found that the ratio was 16% lower compared to MIS-costing data. Our results are also similar to a study from the United States where no difference was found between the DRG cost estimates and MIS-costing data [11]. However an Irish study found large differences between the DRG system and MIS-costing data for percutaneous cardiac procedures for AMI [1]. Based on the results and similarities from the previous studies, it is recommended that further research on the differences in outcome between using the new Canadian CMG+ and actual cost for health services research including economic evaluation studies.

A limitation to our study is that our sample is restricted to the Edmonton area hospitals, which may reduce the variations between CMG+ and actual cost leadings to a possible upward bias on the association. In addition, recent changes in the calculation of the CPWC methodology may have an affect on the representation of MIS-costing data but due to the lack of data we are unable to investigate further. A higher-level provincial study using data after 2009 would be ideal to provide additional evidence for this type of costing studies. The study was limited to typical cases that include only patients who have undergone a normal and expected course of treatment as defined by CIHI. Since the atypical cases and alternate level of care days that constitute hospital days after patients planned discharge day produce substantially higher costs (long LOS) and lower costs (deaths shortly after arrival), further studies are needed to analyse the best costing methods for these type of atypical patient groups.

Conclusion

To our knowledge this is the first study to compare the new Canadian Case Mix Groups+ (CMG+) and it's associated MIS-costing data. The study provides supporting evidence for using the new CMG+ system to estimate typical inpatient Cost Per Case. It is recommended for researchers to use the RIW Cost Per Case formulation when in absent of MIS-costing data. These findings are the first step in validating alternative costing estimates for health care administrators, executives, and health researchers in absent of MIS-costing data for AMI in Canada.

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