Cost Weights for a Canadian Population Grouping Methodology

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Introduction
In April 2015 the Canadian Institute for Health Information (CIHI) released the alpha (initial) version of its population grouping methodology and software. It is the first grouping methodology developed in Canada that has every person registered for public medicare as its target population, and looks at the population over an extended period of time and over multiple healthcare settings. The methodology consists of a case mix classification accompanied by predictive indicators of morbidity burden.

One of the aims of the methodology is to provide insight into the burden of health, or health risk, of the population. With this in mind, the alpha release contains predictive cost weights, developed to depict the healthcare-cost risk of each person, based upon their clinical characteristics as represented by the 214 health condition categories.

Methods
The alpha release includes two predictive cost-weight indicators, one for the retrospective period and the other for the prospective period. The methodology assigns a value for each of these two indicators, to each person who is registered for healthcare. Each of these cost weights encompasses multiple health sectors. Linear regression models were employed with cost as the response variable, and using predictor variables of age, sex, and the 214 health condition categories.

Based on current and historical information on health services utilization, the population was stratified into three sub-populations: health system non-users, users without any health conditions, and users with health conditions. Predictive models were fitted separately for each sub-population, and for each of the retrospective and prospective cost weights.

Ordinary Least Square (OLS) estimation method was used for the health system non-users and the users without health conditions. Since people in these two sub-populations do not have any health conditions, both the retrospective and prospective cost weights were calculated based on age-sex categories. OLS assigned a predicted cost to a person estimated as the average cost of each of the 38 age-sex categories. However, as an exception, each non-user in the concurrent period was assigned a retrospective cost weight of zero.

For any eligible user with one or more health conditions, both the retrospective and prospective cost weights were produced and assigned by Weighted Least Square (WLS) estimation method using presence or absence of each of the 214 health conditions as the predictors. OLS was first used to obtain a predicted cost for each observation (i.e. person). Each person was then assigned to 1 of 15 groups based on the number of health conditions they had, and the average variance was calculated for each group, based on the average residuals from the OLS predicted values. The inverse of the average variances were next used as the weights in the WLS estimation of the model parameters, to generate the final predicted cost of each person. An exception to this is that any person who was not eligible for healthcare on the last day of the concurrent period was assigned a prospective cost weight of zero. Cost weights were then obtained by dividing the final parameter estimates by the overall average cost.

Results
The explanatory power of the regression models is satisfactory. The overall $R^2$ value for the retrospective model reaches 40%. The goodness of fit analysis on validation data demonstrates that the predictive models are stable and indicate no evidence of overfitting to the estimation data.

Conclusions
The predictive models of alpha release provide a useful tool to forecast the health system utilization, for both the retrospective and prospective periods.

This is the first stage of predictive indicator development in the Canadian population grouping methodology. In the beta release, the cost weight models will be updated. For the users with health conditions, the predictive models will include interactions among pairs of the 214 health condition categories. Functional status information on people receiving continuing care services, and socio-economic status information will also be added as predictors in the models.

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