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Projecting the direct cost burden of osteoarthritis in Canada using a microsimulation model

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SUMMARY

Objectives: To estimate the future direct cost of OA in Canada using a population-based health microsimulation model of osteoarthritis (POHEM-OA).
Methods: We used administrative health data from the province of British Columbia (BC), Canada, a survey of a random sample of BC residents diagnosed with OA (Ministry of Health of BC data), Canadian Institute of Health Information (CIHI) cost data and literature estimates to populate a microsimulation model. Cost components associated with pharmacological and non-pharmacological treatments, total joint replacement (TJR) surgery, as well as use of hospital resources and management of complications arising from the treatment of osteoarthritis (OA) were included. Future costs were then simulated using the POHEM-OA model to construct profiles for each adult Canadian.
Results: From 2010 to 2031, as the prevalence of OA is projected to increase from 13.8% to 18.6%, the total direct cost of OA is projected to increase from $2.9 billion to $7.6 billion, an almost 2.6-fold increase (in 2010 $CAD). From the highest to the lowest, the cost components that will constitute the total direct cost of OA in 2031 are hospitalization cost ($2.9 billion), outpatient services ($1.2 billion), alternative care and out-of-pocket cost categories ($1.2 billion), drugs ($1 billion), rehabilitation ($0.7 billion) and side-effect of drugs ($0.6 billion).
Conclusions: Projecting the future trends in the cost of OA enables policy makers to anticipate the significant shifts in its distribution of burden in the future.

Introduction

The direct costs associated with Osteoarthritis (OA) are significant compared to other musculoskeletal diseases due to high prevalence of disease and high use of associated resources[1,2]. A patient with OA, even in its early stages, consumes health care resources at almost double the rate of the general population without OA[3]. At the same time, OA's burden is escalating at a fast rate due to the considerable rise in obesity and population aging[4,5].

Estimating the direct cost of OA and its future trends has posed a challenge to health economics researchers[6,7]. The majority of past national cost-of-illness studies (COI) have utilized top-down and prevalence-based methodologies that are defined according to health expenditure data and use of cross-sectional data[1,7]. These types of studies have been criticized because of inconsistencies in their estimates, their lack of flexibility to be used in economic evaluation studies, and their lack of ability to project cost in time and across sub-populations[6,8]. For example, direct cost estimates of OA in the US have been reported to have a 40-fold variation across different studies[6], between 13 and 185 billion dollars (2010 $US)[5,9]. In Canada, the total direct cost of OA without out-of-pocket costs

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was estimated to be between 1.2 and 4.2 billion dollars (2010 $CAD) according to different studies[6,10]. Incident-based or 'bottom-up' studies can be more accurate but due to a lack of appropriate administrative data[11], very few national incident based COI studies have been conducted[1].

Simulation modeling techniques and specifically micro-simulation (MSM) can be used to project health indices across heterogeneous populations. Such models have been used in various chronic conditions[12] such as osteoporosis[13] and diabetes[14]. The capability of these types of models in projecting population demographics and disease risk factors in addition to their flexibility in evaluating the effect of policies on disease burden makes MSM an attractive epidemiological and economic modeling approach[15]. In this study, we use the Population Health Microsimulation Model of Osteoarthritis (POHEM-OA)[16], a validated individual-level, continuous-time simulation model to perform a COI study for projecting the future direct costs of OA in Canada for the period of 2010–2031.

Methods

The POHEM-OA model is based on a validated individual-level simulation model developed by Statistics Canada for several chronic conditions[17]. These models utilize an array of large databases for demographic, immigration, mortality and morbidity statistics (Appendix A1). The POHEM-OA simulation model used in this study is a discrete-event simulation model that generates the probable time to OA-related events[16]. These continuous time variables are generated according to the appropriate hazard distributions for events such as OA diagnoses or hip/knee total joint replacement (TJR) surgery[17]. Fig. 1 shows the diagram of the POHEM-OA model.

The POHEM-OA model uses the Canadian Community Health Survey (CCHS) in 2001 to sample individuals for its initial population[18]. The main risk factors for the OA diagnosis in POHEM-OA are age, sex and body mass index (BMI). The model simulates an individual's life history in terms of OA-related events through inter-related stochastic processes; at each calendar year, the events are assigned to individuals according to their characteristics, e.g., OA diagnosis is determined based on age, sex and BMI of each individual[16] and BMI is modeled as an auto-regression model that includes age, sex, income, education, region, and previous BMI. The progression of OA in POHEM-OA is modeled in terms of patient flow in the healthcare system using BC administrative data. After an OA diagnosis, the first OA progression stage modeled is a visit to the orthopedic surgeon (OS). There may have already been several physician visits (GP, or specialist) by the time of the first OS visit, while most cases of OA never visit an OS. After the (OS) visit, patients may be hospitalized for a short stay and undergo an inpatient procedure or they may be assigned for total knee or hip replacement surgery (TJR). Further details of the POHEM-OA model are discussed elsewhere[16].

Description of the cost algorithm

We developed the cost module of POHEM-OA that consists of input parameters representing the per-patient and per patient-year unit costs of the resources utilized by OA patients. In this cost module, each individual is assigned a cost profile that keeps track of the values of that individual's characteristics as they change throughout the simulation. To capture the heterogeneity among OA populations and account for the variation in their resource utilization, four types of cost factors have been defined so that

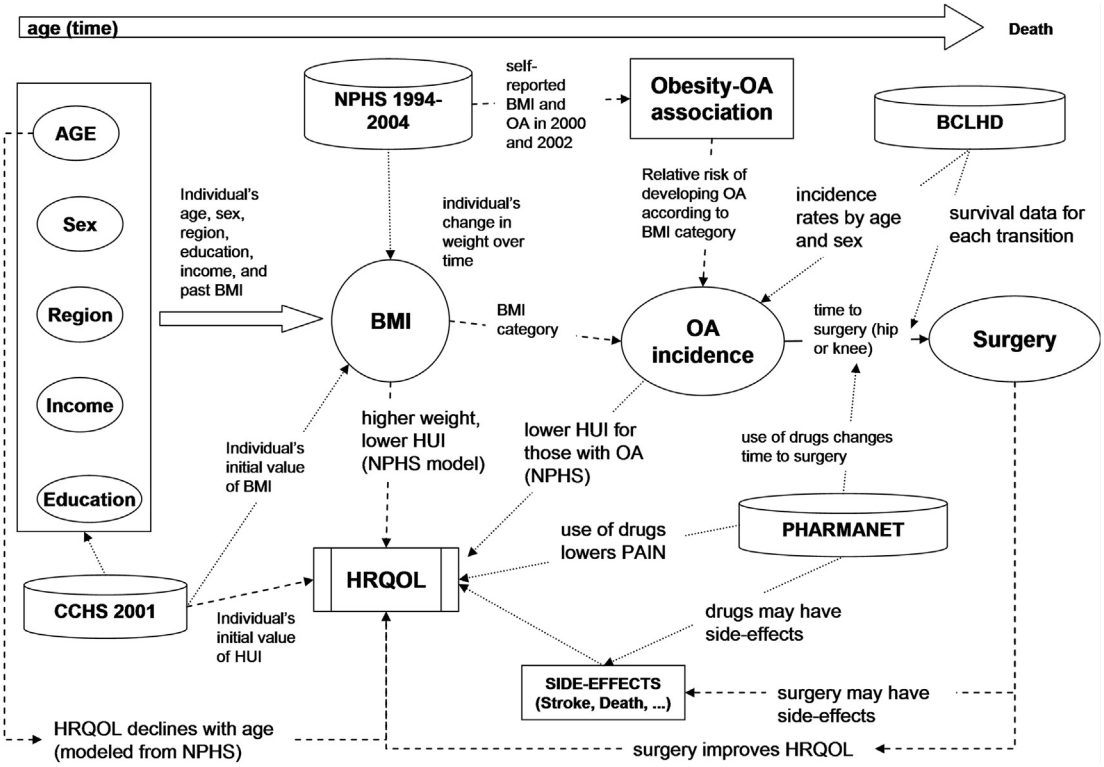

Fig. 1. POHEM-OA: A population-based microsimulation model of osteoarthritis *. The rectangle in the left represents the socio-demographic characteristics of individuals in the model. Cylinders inside the figure are data sets used for estimating model parameters; *NPHS 1994–2004*: National Population Health Survey, a longitudinal household survey by Statistics Canada (ref*) ** *CCHS-2001*: Canadian Community Health Survey (54); ** *BCLHD: British Columbia Population-based administrative data (same as PDBC) (84), PharmaNet is linked to BCLHD and has drugs-related data for all BC population; HRQL: Health-related Quality of life.