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## Original article

# Electronic health databases for epidemiological research on joint replacements: considerations when making cross-national comparisons<sup>☆</sup>

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## ABSTRACT

**Purpose:** The purpose of this study was to examine the rate of primary knee, hip, or shoulder replacement among persons with osteoarthritis (OA) of the knee by gender and age comparing two nations in similar periods using electronic health records, but with different health-care systems.

**Methods:** Two electronic health care databases of anonymized information were used to construct cohorts of adults with OA of the knee from the United Kingdom (UK) and the United States. Patients were required to have activity in the database at least 6 months before the first diagnosis of knee OA ("index diagnosis") in the study period to ensure that the patient samples were eligible for medical evaluation. The outcomes (numerator) measured were primary knee, hip, or shoulder replacement or the composite of primary knee, hip, or shoulder replacement. The denominator was the person-time at risk computed from time from the date of the index diagnosis to the date of each outcome separately or to the end of the database period if no outcome was documented.

**Results:** There were 93,146 subjects in the UK and 1,468,217 in the United States who were aged 18+ years and met the study eligibility criteria. The composite joint replacement rate (hip, knee, or shoulder) ranged from 11.89 per 100 person-years (PY) in the United States to 4.13 per 100 PY in the UK. Primary knee replacement rates ranged from 10.38 per 100 PY in the United States to 3.40 per 100 PY in the UK and occurred at a somewhat higher rate in males than females in both countries. Both primary hip and shoulder replacement rates were higher in the United States than in the UK (hip: 1.19 per 100 PY and 0.76 per 100 PY; shoulder: 0.19 per 100 PY and 0.03 per 100 PY, respectively). The median time to a primary hip or knee replacement in the UK was approximately twice as long as in the United States.

**Conclusions:** Knee replacements are not an uncommon event in persons with knee OA occurring throughout the adult life span, with the rate steeply rising in both sexes until aged 75 years. Although the pattern of the age-specific joint replacement rates was similar between sexes, the magnitude of the rates was markedly lower in the UK.

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## Introduction

The increasing rate and numbers of joint replacement procedures, particularly of the knee, have been observed in a number of countries for many reasons including improvements in the technology of the procedure, the aging of the population, changes in comorbidities of the affected populations, and lifestyle factors [1–6]. In the United States among Medicare enrollees, the rate of joint replacements increased 59.4% from 1991 to 2010, from 3.2 per 10,000 population to 5.1 per 10,000 population [1]. Early published reports of knee replacement characterized risk based on rates derived from the number of joint replacement procedures among

hospitalized persons or other data sources using the general population as the denominator, or as trends in absolute counts of procedures from registry reports [2–9]. Although such data may be useful for planning health care manpower or resources at a national or state level, they do not accurately estimate rates in specific population subgroups at risk for these procedures, which can be translated into an individual's risk of joint replacement subsequent to or in conjunction with treatment that includes pharmacologic, biologic, or other device interventions. The computation of a rate based on a general population is not necessarily useful as an outcome measure of quality of care as it may underestimate the risk of joint replacement because the definition of at-risk patients is too broad. More recently, some studies have attempted to more precisely quantify the risk of knee replacement based on the osteoarthritis (OA) population. These studies, however, are limited in that the denominator included persons with all forms of arthritis (e.g., including rheumatoid arthritis), were restricted to elderly populations, consisted of persons with OA at any anatomic site or derived from specialty practices [10–12]. Prior studies were also limited in that, that may not have distinguished the joint replacement site (e.g., hip or knee), relied on self-reported joint replacements, included both primary and revisions, may not have considered the follow-up time of the cohort or had varying times of follow-up [4,10–15]. Joint replacement rates in the knee OA population from clinical trials are also likely to be underestimated because of restrictive eligibility criteria and factors affecting follow-up time [13,14].

More precise estimates of risk of joint replacement among those with knee OA are of importance because according to the US Centers for Disease Control, the knee is the most frequent anatomic site of symptomatic OA with an incidence rate of 240 per 100,000 person-years (PY) [16]. Disturbances in the physiology or anatomy of this joint could affect the overall structure and biomechanical function of the entire body system requiring eventual joint replacement at other anatomic sites [17]. Thus, a study of joint replacement rates in the knee OA population should not be restricted to knee replacements. Also, because of the multiple possible underlying mechanisms for knee replacement among those with OA, risk factors for joint replacement other than the disease itself are difficult to isolate. The investigation of the risk for joint replacements in the knee OA population, therefore, also lends itself to further hypothesis formulation regarding risk factors for not only the disease but also its impact on other body large joints. This hypothesis formulation can be strengthened through an examination of joint replacement rates in the knee OA population, a patient population assumed to be at high risk for these procedures, by comparing two nations with different health-care systems.

Because the definitions of outcomes and study populations used in previous studies all differed, as did the ages and periods, the resulting estimates of joint replacement “risk” cannot be directly compared. Thus, the purposes of this study were to address the limitations of previous estimates by (1) computing the rates of primary knee, hip, or shoulder replacements stratified by age and gender, from real-world populations of adults with knee OA in approximately the same periods and (2) comparing the rates of these procedures among two developed countries with similar demographic profiles, but different health-care systems.

## Methods

### *Design, data sources, and subject eligibility criteria*

Two anonymized electronic health databases were used to construct cohorts of persons with knee OA: (1) General Practice Research Database (GPRD) and (2) MarketScan (R) Commercial

Claims and Encounters Database combined with the MarketScan Medicare Supplemental and Coordination of Benefits Database (“MarketScan”). The cohorts were comprised persons using the first diagnosis of knee OA (“index diagnosis”) in the database in the study period and who were at least 18 years of age at the index diagnosis. Patients were required to have activity (health care contact or prescription) in the database at least 6 months before the index diagnosis in the study period to ensure that the patient samples were eligible for medical evaluation and care and activity in the database after the index diagnosis. Those with partial or bilateral knee replacements before the index diagnoses were excluded from the sample (codes available from the first author).

The GPRD has been previously described in detail [18–20]. In brief, the GPRD contains electronic medical records for a nationally representative group of British residents currently enrolled in more than 450 general practice offices in the United Kingdom covering more than 50 million PY of follow-up. General practitioners who participate in the GPRD have agreed to provide patient data for research purposes and are trained to accurately record information about patient demographics, medical diagnoses, and procedures that are part of routine care or resulting from hospitalizations, results of laboratory and pathology testing, and referrals to hospitals and specialists. In addition, the GPRD includes detailed information about prescriptions written including dates, formulation, strength, quantity, and dosing instructions. This database uses a system called “Read Codes” which is a coded thesaurus of clinical terms used by clinicians to record patient findings and procedures in IT systems across primary and secondary care. Read Codes have been in use in the National Health Service of the UK since 1985 (Health and Social Care Information Center <http://systems.hscic.gov.uk/data/uktc/readcodes/index.html>).

The MarketScan Commercial health care claims database contains the inpatient, outpatient, and outpatient prescription drug experience of privately insured individuals covered under a variety of fee-for-service and managed care health plans and health maintenance organizations in the United States. This database contained the health care experience of an average of 30 million patients each year during the study period 2006 to 2010. The Medicare database contains the health care experience of retirees with Medicare supplemental insurance paid for by employers. Both the Medicare-covered portion of payment and the employer-paid portion are included in this database. This database contained the health care experience of an average of 2.5 million individuals for each year during the period 2006 to 2010. The file structures of the databases were identical and thus individuals who transitioned from the commercial to the Medicare database during the study period could be accurately captured. This database captures information from adjudicated medical claims using *International Classification of Diseases* (ICD)-9 diagnoses codes, ICD-9 procedure codes and Current Procedural Terminology codes, and National Drug Code Directory, and the Healthcare Common Procedure Coding System to code drug claims filled.

### *Study variables*

Using the codes in the study databases, OA of the knee was defined as follows. In the UK study sample, the qualifying Read code for knee OA included RN05zL00 (OA NOS of knee), RN05z611 (Knee OS NOS), RN053611 (Patellofemoral OA), RN051B00 (primary gonarthrosis bilateral). Additional codes considered were knee arthritis not otherwise specified (RN06z611) in the absence of a history of rheumatoid arthritis, gout, pseudogout, systemic lupus erythematosus, or psoriatic arthritis anytime before the first knee arthritis diagnosis or within 1 year after the first knee arthritis diagnosis unless they had a diagnosis of OA any time in their

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