A Population Based Study of the Changing Demographics of Patients Undergoing Definitive Treatment for Kidney Stone Disease

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Purpose: We examined temporal changes in the demographics of patients undergoing definitive treatment for kidney stones during a 20-year period in Ontario, Canada.

Materials and Methods: Using the Ontario Health Insurance Plan physician claims database and the Canadian Institute for Health Information Discharge Abstract Database we performed a population based cross-sectional time series analysis by identifying all kidney stone treatments done between July 1, 1991 and December 31, 2010. The demographics assessed were patient gender, age and socioeconomic status. The rate and/or proportion of kidney stone treatments per strata of these demographics were calculated for each 1-year block of the study period. We used time series analysis with exponential smoothing and autoregressive integrated moving average models to assess for trends with time.

Results: We identified 116,115 patients who underwent treatment for kidney stones during the study period. The rate of stone procedures performed per year increased steadily from 85/100,000 to 126/100,000 population. With time the rate of females who were treated increased significantly from 40/100,000 to 53/100,000 ($p < 0.0001$). In contrast, the rate of males who were treated remained stable, increasing from 82/100,000 to 83/100,000 ($p = 0.11$). In regard to age the rate of patients older than 64 years increased significantly with time from 67/100,000 to 89/100,000 ($p < 0.0001$). In regard to socioeconomic status approximately 20% of the patients were in each of the 5 income quintiles during the entire study period.

Conclusions: Our population based study shows an increased rate of females and of patients older than 64 years undergoing definitive treatment for kidney stones with time.

Key Words: kidney calculi, ureteroscopy, lithotripsy, demography, Ontario

Abbreviations and Acronyms

ACG = ambulatory care group

CIHI-DAD = Canadian Institute for Health Information Discharge Abstract Database

OHIP = Ontario Health Insurance Plan

OKSC = Ontario Kidney Stone Cohort

PCNL = percutaneous nephrolithotomy

SES = socioeconomic status

SWL = extracorporeal shock wave lithotripsy

URS = ureteroscopy

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Study received approval from the Sunnybrook Health Sciences Centre and University of Toronto research ethics boards.

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KIDNEY stone disease is common with an estimated lifetime prevalence of 1% to 15%.[1] The probability of kidney stones varies according to numerous factors, including patient age, gender, race, geographic location and body mass index. Several studies support an increasing incidence and prevalence of stone disease in numerous countries around the world.[2–6]

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Moreover, a change with time was described in the gender and age distribution of stone formers.[5,7–9] However, specific temporal changes in the demographics of those who require definitive treatment are not well characterized. Considering the economic burden associated with treating kidney stone disease a detailed understanding of demographic trends is important to determine how best to target preventive strategies.

We examined temporal trends in the demographics of patients undergoing definitive treatment for kidney stone disease during a 20-year period in Ontario, Canada.

METHODS

Study Design

We performed a population based, cross-sectional time series study using data from administrative databases. The study was approved by the Sunnybrook Health Sciences Centre and University of Toronto research ethics boards.

Data Sources

We used the OHIP database and CIHI-DAD for the current study. Each database is routinely used for research purposes and their quality in this capacity was previously reported.[10]

In Ontario OHIP, the single payer, universal health care insurance plan, covers all 13 million residents of the province. The OHIP data set contains all claims paid by OHIP from July 1991 and thereafter. While OHIP procedural fee codes for kidney stone treatments have not been specifically validated, other procedural fee codes have good face validity since billing claims typically provide complete capture of procedure codes.[11]

CIHI-DAD is a national database of all admissions to acute care institutions. The quality of CIHI-DAD coding accuracy was demonstrated in re-abstraction studies.[12–14] In addition, CIHI-DAD demographic data were shown to be complete in 97% to 99% of abstracts with 93% to 100% accuracy compared to chart abstraction.[12–14] Notably as discussed we obtained demographic data for this study from CIHI-DAD. We also used the Ontario census, part of the Canadian census, which collects detailed data, including socioeconomic data. All study data sets were held securely in linked de-identified form and analyzed at the Institute for Clinical Evaluative Sciences.

Cohort Identification

All SWL, URS and PCNL kidney stone procedures performed in Ontario between July 1, 1991 and December 31, 2010 were identified from the OHIP database using a previously described algorithm of procedural fee codes.[15] The study sample included all SWL, URS and PCNL treatments performed in patients 18 years old or older who resided in Ontario. Kidney stone treatments were excluded if multiple OHIP procedural fee codes were present and conflicting, as previously described.[15]

Demographic Information

The specific demographics included were patient age, gender, SES for area of residence and region of residence (rural vs urban). Demographic information was obtained from CIHI-DAD (age, gender and region via postal code) and the Canadian census (income quintile for area of residence). In addition, an index of comorbidity (ACG measure) was obtained from CIHI-DAD and included for all patients. ACG is an ambulatory case mix system that can be used to describe the illness burden of a population. Since approximately 30% of patients underwent more than 1 kidney stone treatment during the study period, we used demographic information at the time of the first treatment.

Demographics were summarized for the entire patient cohort and by treatment modality. Age is reported as the mean and range while gender, region of residence and comorbidity measures are reported as proportions. SES was defined by income quintiles and is reported as a proportion. Specifically all residents in the province were assigned to an income based on their postal code, which was in turn determined based on Canadian census data.[16] The income of all residents in Ontario was then divided into quintiles. We report the number of patients with kidney stones in each of the 5 quintiles based on their assignment at the time of the first stone procedure.

Outcome Measures

Select demographic variables (age, gender and SES) were also reported for each study year to allow for assessment of changes with time. Age was divided into 3 strata (18 to 39, 40 to 64 and greater than 64 years). Each stratum is reported as a proportion of all kidney stone treatments per year and as a gender standardized rate per year. The rate was directly standardized by gender to the Ontario population in 2000. Gender is similarly reported as a proportion of all kidney stone treatments per year and as an age standardized rate per year. The rate was directly standardized to age of the Ontario population in 2000 using 3 age strata (18 to 39, 40 to 64 and greater than 64 years). The rate was standardized by age to account for possible changes in the population age distribution of Ontario with time because kidney stone disease is rare before age 20 years, it increases to a peak incidence in patients 40 to 60 years old and then decreases at age 65 years.[6,17] SES was defined by income quintiles. It is reported as the proportion of all kidney stone treatments per year as represented by each quintile.

Statistical Analysis

To assess for significant trends with time in each select demographic variable we performed time series analysis involving exponential smoothing and ARIMA (autoregressive integrated moving average) models. All time series models were evaluated to ensure that they satisfied the necessary assumptions. Specifically we evaluated stationarity using the autocorrelation function and the augmented Dickey-Fuller test.[18] Model parameter appropriateness and seasonality were assessed with the autocorrelation, partial autocorrelation and inverse autocorrelation functions. Lastly we assessed the presence of white noise by examining autocorrelations at