The Surgical Management of Kidney Stone Disease: A Population Based Time Series Analysis

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Abbreviations and Acronyms

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

ED = emergency department

NACRS = National Ambulatory Care and Reporting System

OHIP = Ontario Health Insurance Plan

OKSC = Ontario Kidney Stone Cohort

PCNL = percutaneous nephrolithotomy

SWL = extracorporeal shock wave lithotripsy

URS = ureteroscopy

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Study received research ethics board approval.

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Purpose: We evaluate population based trends in the use of extracorporeal shock wave lithotripsy, ureteroscopy and percutaneous nephrolithotomy during the last 20 years, as well as assess the re-treatment rate and morbidity from treatment over time.

Materials and Methods: Using administrative databases in the province of Ontario, Canada, a population based cross-sectional time series analysis was performed between July 1, 1991 and December 31, 2010. All extracorporeal shock wave lithotripsy, ureteroscopy and percutaneous nephrolithotomy procedures were identified, along with all hospital readmissions and emergency department visits within 7 days of treatment. The primary outcome was treatment use, and secondary outcomes were the need for ancillary treatment and hospital readmission or emergency department visit after treatment. Exponential smoothing and autoregressive integrated moving average (ARIMA) models were used to assess trends over time.

Results: We identified 194,781 kidney stone treatments performed during the study period. Time series modeling revealed a significant increase in the use of ureteroscopy over time (25% to 59% of all procedures, $p < 0.0001$) and a reciprocal decrease in the use of extracorporeal shock wave lithotripsy (69% to 34% of all procedures, $p < 0.0001$). A corresponding significant decrease in the need for ancillary treatment over time (23% to 15%, $p < 0.0001$) and increase in the need for hospital readmission (7% to 11%, $p < 0.0001$) or emergency department visit (7% to 11%, $p = 0.0024$) after treatment were also demonstrated.

Conclusions: Our population based study demonstrates a shift in the treatment paradigm with increased use of ureteroscopy over time and a reciprocal decrease in the use of extracorporeal shock wave lithotripsy. We also observed a corresponding decrease in ancillary treatment and increase in posttreatment morbidity over time.

Key Words: kidney calculi, ureteroscopy, lithotripsy, retreatment

During the last 25 years the surgical management of kidney stones has changed as a result of technological and treatment advances, with ureteroscopy in particular being significantly impacted. Few population based evaluations have been conducted to accurately assess temporal trends in the use of different treatment modalities in the management of kidney stone

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disease and the corresponding impact of these trends. Considering the increasing prevalence of nephrolithiasis[1–6] and the economic burden of treatment,[7] it is important to accurately describe treatment trends to allow assessment of the impact of these trends on patient outcomes. We used administrative health care databases in the province of Ontario, Canada to examine surgical treatment trends over time for nephrolithiasis.

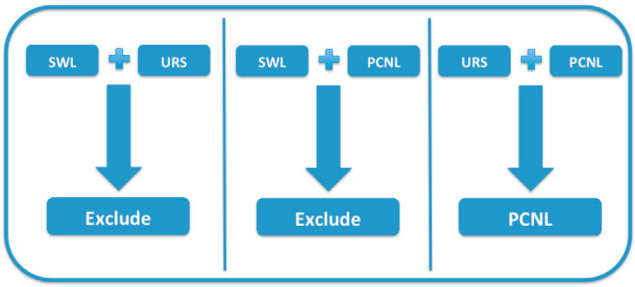

Figure 1. Multiple OHIP procedural fee code algorithm

METHODS

Study Design

We conducted a provincial, population based, cross-sectional time series study using data derived from administrative databases. The study was approved by the Research Ethics Board at Sunnybrook Health Sciences Centre.

Data Sources

The 3 main data sources used in this study were the OHIP database, the CIHI-DAD and the NACRS. These databases are routinely used for research purposes and their quality in this capacity has been previously demonstrated.[8]

In the province of Ontario the Ontario Health Insurance Plan is the single payer universal health care insurance plan. The OHIP data set contains all of the claims paid by OHIP from July 1991 onward. Kidney stone OHIP procedural fee codes have not been specifically validated. However, there is good face validity for other procedural fee codes as billing claims typically provide complete capture of procedure codes.[9]

The CIHI-DAD is a national database of all admissions to acute care institutions. The quality of CIHI-DAD for coding accuracy has been demonstrated via re-abstraction studies.[10]

The NACRS data set contains data on all patient visits to hospitals and community based ambulatory care centers, including outpatient clinics and emergency departments, starting from July 2000. A re-abstraction study has also confirmed the NACRS data set accuracy.[11] All study data sets were held securely in a linked, de-identified form and analyzed at the Institute for Clinical Evaluative Sciences.

Cohort Identification

All SWL, URS and PCNL procedures performed in Ontario between July 1, 1991 and December 31, 2010 were identified from the OHIP database using an algorithm of procedural fee codes (see Appendix). All procedures performed in patients 18 years old or older and residing in Ontario were included in analysis. Kidney stone treatments were excluded from study if multiple OHIP procedural fee codes were present and conflicting (fig. 1). Importantly the OHIP procedural codes for kidney stone treatment did not change during the study period.

Outcome Measures

Primary outcome. The primary outcome was trends in treatment use of SWL, URS and PCNL in the management of kidney stones over time. The measure of treatment use was the proportion of all kidney stone treatments represented by each modality for every 3-month block during the study period, and was determined using the OHIP database.

Secondary outcomes. Secondary outcomes included trends over time in the need for ancillary treatment and morbidity after treatment. Ancillary treatment was defined as a second kidney stone treatment, either of the same modality (ie repeat procedure) or a different modality (ie auxiliary procedure), occurring within 90 days of an index stone treatment. An index stone treatment was considered the initial treatment for any particular stone, and was defined as any kidney stone procedure without another stone procedure occurring within 90 days in advance. The measure of need for ancillary treatment was the proportion of all index stone procedures requiring ancillary treatment for every 3-month block during the study period. For this outcome sensitivity analysis was also performed, whereby the time frame definition for ancillary treatment was changed to 60, 120 and 180 days.

We examined the 2 end points of hospital readmission and ED visit to assess postoperative morbidity. Hospital readmission and ED visit after treatment were defined as readmission to the hospital for any cause or any ED visit, respectively, within 7 days of hospital discharge after kidney stone treatment. The measure of these outcomes was the proportion of all stone treatments that required hospital readmission or ED visit for every 3-month block during the study period. The hospital readmission rate was determined using the CIHI-DAD and the ED visit rate after treatment was determined using the NACRS data set.

Statistical Analysis

To assess for significant trends over time for all outcomes, time series analysis involving exponential smoothing and ARIMA models were used. All time series models were evaluated to ensure they satisfied the necessary assumptions. Specifically, stationarity was assessed using the autocorrelation function and the augmented Dickey-Fuller test.[12] Model parameter appropriateness and seasonality were assessed with the autocorrelation, partial autocorrelation and inverse autocorrelation functions. Lastly, the presence of white noise was assessed by examining the autocorrelations at various lags using the Ljung-Box chi-square statistic.[13] The Schwarz Bayesian