Economic Outcomes of Treatment for Ureteral and Renal Stones: A Systematic Literature Review

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Purpose: We evaluated the cost-effectiveness of ureteral/renal stone treatment by comparing ureteroscopy, extracorporeal shock wave lithotripsy and percutaneous nephrolithotomy.

Materials and Methods: We performed a systematic literature search to identify studies of treatment for adults with ureteral and renal stones that were published between 1995 and 2010. For inclusion in analysis studies had to provide the stone-free rate and the cost of at least 2 therapies.

Results: Ten studies were identified, including 8 with an observational design and 2 that synthesized data using decision modeling techniques. Five of 6 studies, including 1 of 2 from the United States, compared ureteroscopy vs shock wave lithotripsy for proximal stones and showed a higher stone-free rate and lower cost for ureteroscopy. Four of the 5 studies, including the only American study, compared ureteroscopy vs shock wave lithotripsy for distal ureteral stones and also showed such an economically dominant result. Studies of shock wave lithotripsy vs percutaneous nephrolithotomy and ureteroscopy vs percutaneous nephrolithotomy for renal stones demonstrated higher cost and a higher stone-free rate for percutaneous nephrolithotomy.

Conclusions: Despite the great heterogeneity and limited quality of available cost-effectiveness evaluations most studies demonstrated that ureteroscopy was more favorable than shock wave lithotripsy for ureteral stones in stone-free rate and cost.

Key Words: kidney calculi, ureteral calculi, cost-benefit analysis, lithotripsy, ureteroscopy

Abbreviations and Acronyms

PNL = percutaneous nephrolithotomy

QHES = Quality of Health Economic Studies

SFR = stone-free rate

SWL = shock wave lithotripsy

URS = ureteroscopy

U.S. = United States

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KIDNEY stones affect approximately 10% of the American population with significant increases in disease prevalence for men and women.[1] Most patients who present to the emergency department with a symptomatic kidney stone ultimately pass the stone spontaneously and do not require surgical intervention. However, a significant proportion of patients with stone disease require some form of surgical treatment.[2] Since in many cases the superiority of one surgical approach over another is an unresolved issue, there are often multiple accepted treatment options for a single stone scenario.

In recent years the medical community has become increasingly aware of the economic implications of these treatment decisions. Cost-effectiveness evaluations are a way to evaluate clinical effects and costs when comparing multiple treatment options. A cost-effectiveness evaluation assesses differences in costs between 2 or more

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competing interventions relative to the difference in outcomes. When a therapy is clinically superior and less costly, it is clear that this is the optimal therapy and it is termed dominant. However, in many cases a therapy may have a better clinical outcome but also be more costly or vice versa. In this case decision makers, eg health care payers, clinicians or patients, must decide what is cost-effective or a reasonable ratio of cost per increase in health outcomes.

Cost-effectiveness evaluations can guide policy and optimize the use of health care resources. Costs in a cost-effectiveness analysis can be limited to direct medical costs or they can also include indirect costs, eg those related to productivity loss. The types of costs included depend on the perspective of the evaluation, eg health care payer, societal or patient. Which therapy is cost-effective may differ depending on the perspective.

As health care spending becomes further constrained and entities such as accountable care organizations become widespread, studies of cost-effectiveness will become increasingly important. Thus, we performed a systematic literature review of the cost-effectiveness literature published in the last 15 years to compare the most common surgical options for adults with ureteral and renal stones, including URS, SWL and PNL.

METHODS

Study Identification and Selection

The criteria used to consider published studies for review were population (adults who required intervention for the primary treatment of ureteral and renal stones), interventions (URS, PNL or SWL with a second, third or fourth generation HM3 [Dornier Medtech, Kennesaw, Georgia], excluding comparisons of interventions of interest with open surgery), outcomes (cost and SFR), study design (any comparative design, eg randomized, controlled trials and retrospective and prospective studies), decision analytic modeling studies (decision trees synthesizing any of the mentioned study types and the medical literature to assess the costs and clinical outcomes during the entire intervention period), publication date (1995 to 2010), all perspectives and any country.

The MEDLINE®, Embase® and Cochrane databases were searched with a predefined search strategy using terms related to renal and ureteral stones, URS, SWL and PNL. For each identified citation it was determined whether the study met the predefined selection criteria based on title and abstract. For studies that met the criteria or for which they were unclear full text reports were obtained and evaluated. If SFR or costs were not reported, the study was excluded from analysis.

Data Extraction

Study design, patient characteristics, total costs per patient and SFR were extracted from the included studies. In contrast to modeling studies, for observational studies the corresponding 95% CIs were calculated based on the reported SD and on sample size, if reported. The assumption underlying calculation of the 95% CI was that the sample size was sufficiently large relative to the skewness of the cost data in the study sample that the sampling distribution of the mean cost estimate could be approximated with a normal distribution. Accordingly the 95% CI could be calculated based on the reported SD and sample size.

Differences in costs between the compared interventions of each study and differences in SFR served as the basis for interpreting the relative cost-effectiveness of the compared interventions in each study. All costs were converted to 2008 U.S. dollars using country specific consumer price indexes, 2008 exchange rates and the health care Consumer Price Index.

The validated QHES instrument was used to assess the quality of included studies.[3,4] QHES contains 16 items relating to appropriate methods, validity and transparency results, and comprehensive reporting. Each item carries a weighted point value and has a minimum and maximum score of 0 and 100 points, respectively. The results of the validity assessment served to determine the quality of the evidence base when interpreting the results.

RESULTS

Study Identification and Selection

Figure 1 shows the results of the literature search. The abstract review excluded 137 of 172 studies (80%). The full text review of the 35 remaining studies excluded 25 (71%), primarily since they did not report the required outcomes.

Study and Patient Characteristics

The table lists the study and patient characteristics of the 10 included cost-effectiveness series. Studies were identified from various countries with various designs, perspectives and stone sites. The average stone burden was generally comparable across ureteral stone and across renal stone studies.

Eight cost-effectiveness studies evaluating all parts of the ureter were identified and all compared SWL with URS. Five groups evaluated distal ureteral stones (Bierkens,[5] Chang,[6] Huang,[7] Lotan[8] and Wolf[9] et al), representing American, European and Asian studies. Three groups evaluated mid ureteral stones (Bierkens,[5] Huang[7] and Lotan[8] et al), representing American, European and Asian studies. Five groups evaluated proximal ureteral stones (Huang,[7] Lotan,[8] Izamin,[10] Parker[11] and Wu[12] et al), representing the U.S. and Asia. All except 2 ureteral stone studies used an observational design, that is Lotan[8] and Wolf[9] et al used decision analytic models.

The cost-effectiveness studies by Hyams[13] and May[14] et al that evaluated renal stones were U.S. based and from a payer perspective. May et al compared SWL with PNL using an observational study design supplemented with external efficacy evidence. Hyams et al compared URS with PNL in an observational setting.[13]