CADTH RAPID RESPONSE REPORT:
SUMMARY WITH CRITICAL APPRAISAL

Ureteral Stents: A Review of Clinical Effectiveness and Guidelines
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Acknowledgments:

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Context and Policy Issues

The ureters are muscular tubules that connect the kidneys to the urinary bladder and allow the passage of urine into the lower urinary tract. Ureteral stents are devices that are inserted into the ureter to maintain or reestablish patency and facilitate flow of urine or debris into the bladder. Common indications for ureteral stents are to relieve or prevent intraluminal obstruction caused by calculi, stenosis and genitourinary malignancies or extraluminal obstruction caused by compression of the ureter by malignancy or fibrosis. Ureteral stents are most commonly made from silicone based material, but are also available in other materials such as polyurethane, polyethylene and metal. Stent material may also be coated to improve tolerability, be embedded with medication, or be dissolvable. Presently, there is no clear evidence supporting the optimal choice of stent technology.

Ureteral stents are available in a range of sizes and diameters that can be selected based on individual patient anatomy. Most ureteral stent have curled “pigtail” structures on either end. One pigtail sits in the renal pelvis and the other in the urinary bladder. The goal of the curled pigtail ends is to reduce stent migration. Most often stents are placed by a urologist in the operating room under cystoscopic guidance. Stents may come with extraction strings attached. In patients who require short-term stent placement, some urologists may leave the extraction strings in place and secure them to the patient’s external anatomy. Extraction strings may also be removed by the urologist at the time of stent placement. Extraction strings can facilitate stent removal by either the patient or urologist.

Ureteral stents are associated with potential risks and adverse events. Patients have reported irritative symptoms such as urgency and frequency while stent is in situ. Patients may experience pain both during stent placement and while the stent is in place. Common complications of ureteral stents include hematuria, urinary tract infections (UTI), stent migration and stent encrustation. The risk of stent encrustation increases the longer the stent remains in the ureter. Stent retention is a rare but serious complication associated with failure to remove the stent in the indicated timeframe.

Canadian, American and European urological organizations have all recently published guidelines on the management of ureteral stones and the role of short-term ureteral stents. Both shockwave lithotripsy (SWL) and ureteroscopy are common methods for management of ureteral stones. The Canadian, American, and European guidelines all recommend against placement of ureteral stents after SWL as evidence indicates that stents do not improve stone free rates and may prevent the passage of debris. Canadian guidelines recommend that ureteral stents be placed prior to SWL in select patients such as those who have evidence of obstruction, acute kidney injury (AKI), intractable pain, sepsis, or a solitary kidney. The evidence for stent placement before or after ureteroscopy is more controversial. The European and American guidelines recommend against routine stent placement prior to ureteroscopy but acknowledge that there may be an indication for ureteral stenting after ureteroscopy in certain clinical situations. The guidelines also acknowledge that the optimal duration of ureteral stents in the setting of stones is unknown, but short-term stent placement (less than 14 days duration) is associated with fewer adverse events.
This report focuses on evidence for the clinical effectiveness of short-term ureteral stenting in patients undergoing stone removal or kidney transplant, long-term ureteral stenting in patients with retroperitoneal carcinoma or obstructed uropathy, and evidence-based guidelines for long-term use of ureteral stents.

**Research Questions**

1. What is the clinical effectiveness of short-term ureteral stenting in patients undergoing stone removal or kidney transplant?

2. What is the clinical effectiveness of long-term ureteral stenting in patients with retroperitoneal carcinoma or obstructed uropathy?

3. What are the evidence-based guidelines regarding the appropriate patient indications for the use of ureteral stents long-term?

**Key Findings**

In patients undergoing stone removal, short-term ureteral stenting was found to be associated with an increase in irritative symptoms, dysuria, and hematuria but a decrease in unplanned hospital readmission. Ureteral stents were not found to be associated with an increased risk of fever, ureteral strictures, or prolonged hospital stay. Ureteral stent placement is associated with longer operative time.

In patients undergoing kidney transplant, short-term ureteral stenting was found to be associated with a decrease in major urological complications such as urine leak and obstruction but an increase in urinary tract infections. The use of prophylactic antibiotics was shown to prevent the development of urinary tract infections.

No studies met the inclusion criteria to address the clinical effectiveness of long-term ureteral stenting in patients with retroperitoneal carcinoma or obstructed uropathy. No evidence-based guidelines were found that addressed the appropriate patient indications for the use of long-term ureteral stents.

**Methods**

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2017, Issue 2), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses and guidelines. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2012 and February 10, 2017.

**Literature Search Methods**

Rapid Response reports are organized so that the evidence for each research question is presented separately.

**Selection Criteria and Methods**

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and
assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

### Table 1: Selection Criteria

| Population | Q1: Patients undergoing stone removal (ureteroscopy or lithotripsy) or kidney transplant  
| Q2: Patients with retroperitoneal carcinoma or obstructive uropathy  
| Q3: Patients requiring a ureteral stent |
| Intervention | Q1: Short-term ureteral (may also be referred to as ureteric) stenting (2 to 3 days up to 4 to 6 weeks)  
| Q2: Long-term ureteral stenting (greater than 6 weeks) |
| Comparator | Q1: Alternative stent technology (short-term use)  
| Q2: Alternative stent technology (long-term use)  
| Q1 and 2: No ureteral stenting  
| Q3: No comparator required |
| Outcomes | Q1 and 2: Clinical effectiveness (e.g., patient discomfort, dysuria, postoperative infection, pain, unplanned medical visits, major urological complications, operative time, lower urinary tract symptoms, unplanned readmission, frequency of stent replacement);  
| Safety (e.g., fever, post-operative complications, urinary tract infections, haematuria, irritative symptoms, pain and stent migration)  
| Q3: Evidence-based guideline recommendations regarding the appropriate indications for the use of long-term ureteral stenting |
| Study Designs | Q1 and 2: HTA/Systematic Reviews/Meta-Analyses  
| Q3: Guidelines |

Exclusion Criteria
Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2012.

Critical Appraisal of Individual Studies
The included systematic reviews (SR) were critically appraised using the AMSTAR tool. Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described.

Summary of Evidence

Quantity of Research Available
A total of 310 citations were identified in the literature search. Following screening of titles and abstracts, 282 citations were excluded and 28 potentially relevant reports from the electronic search were retrieved for full-text review. Seven potentially relevant publications were retrieved from the grey literature search. Of these potentially relevant articles, 30 publications were excluded for various reasons, while 5 publications met the inclusion criteria and were included in this report. Appendix 1 describes the PRISMA flowchart of the study selection.

Additional references of potential interest are provided in appendix 5.

Summary of Study Characteristics
A summary of the characteristics of the included literature are briefly described below and detailed in Appendix 2.
Study Design
A total of 5 SRs that addressed the clinical effectiveness of short-term ureteral stenting in patients undergoing stone removal or kidney transplant were included in this report. There were no studies that met the inclusion criteria to address the clinical effectiveness of long-term ureteral stenting in patients with retroperitoneal carcinoma or obstructed uropathy. There were no evidence-based guidelines regarding the appropriate patient indications for long-term use of ureteral stents that were included in this report. The SRs included 22 studies, 8 studies, 7 studies and 15 studies. Three of the SRs included only RCTs. The other two SRs included observational studies and cohort studies. Overall, the studies included across all five SRs were published between 1995 and 2015.

Country of Origin
Two of the SRs were conducted by authors located in China, two in the United Kingdom and one in the USA.

Patient Population
Four of the SRs were conducted in patients who were receiving short-term ureteral stents after stone removal. One SR was conducted in patients who were undergoing renal transplant. Duration of stent placement ranged from 3 days to 6 weeks, 7 days to 8 weeks (with most studies evaluating short term stenting less than 6 weeks) and 3 days to 4 weeks. One SR did not report the duration of stent placement. The final SR reported that the duration of stent placement was less than or equal to 1 week in 4 of the included studies and longer than 1 week in 10 of the included studies.

Interventions and Comparators
Four SRs compared post-operative placement of ureteral stents to no stent placement. In three SRs, the main operative intervention was ureteroscopy. One SR compared the use of ureteral stents with extraction strings to ureteral stents without extraction strings.

Outcomes
Various outcomes were reported across the five SRs, including dysuria, pain, fever, UTI, hematuria, irritative symptoms, stone-free rate, major urological complications (MUC), ureteral strictures, ureteral obstruction, infection, overall adverse events, stent dislodgement, operative time, length of hospital stay, unplanned return visits of any kind, unplanned hospital readmission, and unplanned emergency room (ER) visits.

Follow-up Period
The follow-up period of the individual studies in the SRs ranged from 1 to 24 months, 2 months to 3 years and 1 day to 1612 weeks. Two of the SRs did not report on the duration of follow-up.

Summary of Critical Appraisal
Strengths and limitations of the included studies are provided in Appendix 3.
Overall, one of the SR was of high quality\(^{14}\) and four were of moderate quality\(^{11-13,15}\) based on an assessment conducted with the AMSTAR tool.

All five of the SR reported an a priori trial design,\(^{11-14,16}\) Duplicate study selection was completed in four SRs\(^{12-15}\) and not reported in one SR.\(^{11}\) Data extraction was conducted in duplicate in three SRs\(^{11,14,15}\) and not reported in two SRs.\(^{12,13}\) All five SRs reported a comprehensive literature search.\(^{11-15}\) Three SRs limited included studies to only those published in English.\(^{11,13,15}\) Authors of two SRs report having searched the grey literature,\(^{12,14}\) two SRs did not report whether the grey literature was searched,\(^{11,15}\) and one SR reported that the grey literature was not searched.\(^{13}\) All five SRs reported a list of characteristics of the included studies.\(^{11-15}\) Only one SR reported a list of excluded studies and the reason for exclusion.\(^{14}\) Scientific quality of the included trials was assessed, documented and considered when formulating conclusions in four SRs.\(^{11,12,14,15}\) One SR did not assess the quality of the included trials but did comment on study limitations when formulating their conclusions.\(^{13}\) The methods used to combine the outcomes of the individual studies were appropriate in three SRs.\(^{11,14,15}\) Authors of one SR did not report their method of data synthesis.\(^{13}\) It was unclear in one study whether the statistical method used to combine study findings was appropriate.\(^{12}\) In this SR\(^{12}\) a fixed effects Peto odds ratio was used regardless of whether heterogeneity was found. Publication bias was assessed in two SRs.\(^{11,12}\) Publication bias was found for two outcomes (hematuria and dysuria) in one SR.\(^{11}\) The other SR\(^{12}\) did not find any evidence of publication bias. Three SRs did not assess publication bias.\(^{13-15}\) Four of the SR reported that the authors had no conflict of interest\(^{11-14}\) and one SR did not report authors conflict of interest.\(^{15}\) None of the SRs reported on conflicts of interest for the individual studies.\(^{11-15}\)

Summary of Findings
The overall findings are summarized below and details are available in Appendix 4.

1. **What is the clinical effectiveness of short-term ureteral stenting in patients undergoing stone removal or kidney transplant?**

**Dysuria**
Ureteral stenting was associated with a significantly increased risk of dysuria compared to no stenting.\(^{11,12,15}\)

**Pain**
Ureteral stenting was associated with a significantly increased risk of any pain compared to no stenting in two SR.\(^{11,15}\) One SR did not demonstrate a statistically significant difference in pain in patients who received a ureteral stent compared to those who did not based on 9 studies.\(^{12}\) One SR reported that mean pain scores (0-10) on removal of ureteral stent was 3 in those with extraction strings compared to 4.41 in those without extraction strings.\(^{13}\)

**Fever**
Fever was not significantly different between patients who received ureteral stents and those who did not.\(^{11,15}\)
Urinary Tract Infection
UTI occurred significantly more often in patients with renal transplant who received a ureteral stent compared to those who did not. The risk of UTI was not significantly different in patients who received a ureteral stent compared to those who did not when antimicrobial prophylaxis with cotrimoxazole 480mg daily or 960mg every other day was prescribed. One SR showed a significantly increased risk of UTI associated with stent placement in patients with ureteral stones while another did not.

Hematuria
Hematuria occurred significantly more frequently in patients with ureteral stones who received stents compared to those who did not. Ureteral stent placement after a renal transplant was not found to have a significantly increased risk of hematuria compared to no stent placement.

Irritative symptoms
Placement of ureteral stents for patients with stones was associated with a significant increased risk of irritative symptoms.

Stone-free Rate
A significantly lower stone-free rate with ureteral stent placement was found in one SR. No significant difference in stone-free rate was found in another SR.

Major Urological Complications
In patients who received a ureteral stent after renal transplant, there was a significantly decreased risk of MUC (urine leak and obstruction) compared to patients who did not receive a stent.

Ureteral Strictures
No difference was found in the risk of developing ureteral strictures in patients who received a ureteral stent compared to those who did not receive one after stone removal.

Ureteral Obstruction
Ureteral obstruction was not statistically different in patients with stones who received a stent compared to those who did not. In patients who underwent renal transplant, ureteral stents significantly reduced the risk of ureteral stenosis or obstruction.

Infection
Infection was not significantly different between patients with stones who received stents compared to those who did not.

Stent Dislodgement
Ureteral stents became dislodged in 9.9% of patients (n=20) with stents that had extraction strings compared to none of the patients who had stents without extraction strings attached.
Operative Time
Operative time was found to be significantly longer in patients who received ureteral stents for stones compared to those who did not.\textsuperscript{11,12,15} The weighted mean difference in operative time ranged from 3.19 minutes to 4.93 minutes longer in the patients who had stents placed in three SRs.\textsuperscript{11,12,15}

Hospital Stay and Visits
Length of hospital stay was not found to be significantly different between patients who received stents after stone removal compared to those who did not.\textsuperscript{11,15} There was a significantly higher risk of unplanned return visits in patients who did not receive a stent after stone removal in one SR,\textsuperscript{12} and no difference in another SR.\textsuperscript{15} A subgroup analysis by study design found that the increased risk of return visit was only seen when the results of the 13 RCT were pooled and not seen with the 4 observational trials.\textsuperscript{12} There was no significant difference in unplanned ER visits between patients who received stents and those who did not.\textsuperscript{12} The risk of unplanned hospital readmission was significantly higher in patients who did not receive a stent after stone removal compared to those who did.\textsuperscript{11,12}

2. What is the clinical effectiveness of long-term ureteral stenting in patients with retroperitoneal carcinoma or obstructed uropathy?

No clinical studies fulfilling the selection criteria were found.

3. What are the evidence-based guidelines regarding the appropriate patient indications for the use of ureteral stents long-term?

No evidence based guidelines fulfilling the selection criteria were found.

Limitations
The main limitation of this report is the quality of the evidence included in the five systematic reviews.\textsuperscript{11-15} A substantial amount of variability was reported in the quality of the primary studies that were included in the individual SR. One author reported that all the studies included in the SR were associated with a high risk of bias.\textsuperscript{11} Two of the SR included observational data, which can result in selection bias of included patients. Performance bias was also a significant risk in many of the included trials resulting from an inability to blind patients and physicians. Substantial heterogeneity was seen across all SRs in some of the outcomes when studies were combined. Different duration of stent placement across the included trials also made pooling outcome data challenging and contributed to heterogeneity. Publication bias was found for two outcomes in one of the SR.\textsuperscript{11} It is possible this was a result of the authors excluding studies that were not published in English. The generalizability of the study findings to the Canadian population is also limited as the SRs were conducted in the UK, China and the USA. Many of the primary studies included in the SRs were also conducted outside of Canada in Asia, Europe and the USA.
Conclusions and Implications for Decision or Policy Making

Four SRs that evaluated the role of short-term ureteral stenting post-operatively in patients with ureteral stones found that ureteral stents were associated with an increase in irritative symptoms, dysuria, hematuria and longer operative times.11,13,15 Ureteral stents were associated with a decrease in unplanned hospital readmission. These findings are consistent with previous SRs evaluating the effectiveness of ureteral stenting after stone removal by ureteroscopy17,18 that also found an increased risk of irritative lower urinary tract symptoms and with placement of ureteral stents. Stent placement in patients with ureteral stones after ureteroscopy have previously shown to be associated with fewer medical visits and hospital admissions,17 but was not associated with higher stone-free rates.18 A SR from 2011 evaluating the efficacy of ureteral stents prior to stone removal by SWL also found that stents were associated with an increase in lower urinary tract symptoms without an increase in stone free rate.19 Previously published SRs have also been limited by significant heterogeneity and poor quality of included trials. Overall, there is no clear evidence of benefit to support the routine placement of ureteral stents after stone removal with ureteroscopy. Ultimately, individual patient characteristics should be weighed against the benefits and risks ureteral stent placement in the specific circumstances.

There have been many advances in stent technology over the last several years. New materials such as metal beads, mesh, and biodegradable stents have been introduced.20 Antimicrobial and heparin coatings have also been introduced.4,20 None of the studies included in this report specifically compared one stent technology to another. The role and optimal patient population for various types of ureteral stent technology remains unknown. Authors of two recent review articles commented that polymer based ureteral stents often are ineffective for malignant obstruction, metal stents may be more useful in this patient population.4,21

In patients undergoing kidney transplant, short-term ureteral stenting was found to be associated with a decrease in MUC such as urine leak and obstruction and an increase in UTI. The use of prophylactic antibiotics was shown to prevent the development of UTI. These findings are consistent with a previous SR in patients undergoing renal transplant which also demonstrated a lower risk of complications in the group who received a ureteral stent.22 These findings support the routine use of ureteral stents to prevent urological complications in the setting of kidney transplant.

Patients with malignant obstruction or obstructive uropathy may require long term (greater than 6 weeks) ureteral stenting. No evidence or guidelines were found that met the inclusion criteria to address this patient population were found.
References


Appendix 1: Selection of Included Studies

310 citations identified from electronic literature search and screened

282 citations excluded

28 potentially relevant articles retrieved for scrutiny (full text, if available)

7 potentially relevant reports retrieved from other sources (grey literature, hand search)

35 potentially relevant reports

30 reports excluded:
- irrelevant population (8)
- irrelevant intervention (4)
- irrelevant outcomes (1)
- published in language other than English (1)
- other (review articles, editorials)(16)

5 reports included in review
### Table 1: Characteristics of Included Systematic Reviews

<table>
<thead>
<tr>
<th>First Author, Publication Year, County</th>
<th>Types and numbers of primary studies included</th>
<th>Population Characteristics</th>
<th>Intervention(s)</th>
<th>Comparator(s)</th>
<th>Clinical Outcomes, Length of Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wang,13 2017, China</strong></td>
<td>22 included studies (n=2552 participants)</td>
<td>Ureteral stones</td>
<td>Ureteral stents (post-operatively placed)</td>
<td>No ureteral stents</td>
<td>Operating time VAS Length of hospital stay Stone free rate Readmission Pain Dysuria UTI Hematuria Fever Irritative symptoms Ureteral strictures Follow-up: 1 to 24 months</td>
</tr>
<tr>
<td></td>
<td>All RCT</td>
<td>Age (years): WMD (95%CI): 0.55 (-0.81, 1.92)</td>
<td>Proportion of males: WMD (95%CI): 0.97 (0.82, 1.16)</td>
<td>Mean stone size (mm): WMD (95%CI): 0.17 (-0.16, 0.50)</td>
<td>Proportion of lower ureteral stones: WMD (95%CI): 0.86 (0.68, 1.08)</td>
</tr>
<tr>
<td></td>
<td>Published between 2001-2015</td>
<td>Surgical approach: 19/22 studies used URL</td>
<td>Duration of stent placement: 3 days to 6 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pais,12 2016, USA</strong></td>
<td>17 included studies (n=1943)</td>
<td>Patients undergoing ureteroscopy for renal or ureteral stones</td>
<td>Stent omission</td>
<td>Ureteral stent (post-operatively placed)</td>
<td>Unplanned hospital, ER or office visit within 30 days postoperative pain postoperative infection postoperative dysuria/irritative symptoms operative time ureteral obstruction Follow-up: NR</td>
</tr>
<tr>
<td></td>
<td>13 RCTs and 4 observational studies</td>
<td>Duration of stent placement: ≤1 week: 4 studies &gt;1 week: 10 studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Published between 2000-2014</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Oliver,13 2016, UK</strong></td>
<td>8 included studies (n=1279)</td>
<td>Ureteric stents</td>
<td>Ureteric stent with extraction strings (n=483)</td>
<td>Ureteric stent without extraction strings</td>
<td>morbidity tolerability complications</td>
</tr>
<tr>
<td></td>
<td>2 RCT</td>
<td>Age (mean): 49 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Author, Publication Year, Country</td>
<td>Types and numbers of primary studies included</td>
<td>Population Characteristics</td>
<td>Intervention(s)</td>
<td>Comparator(s)</td>
<td>Clinical Outcomes, Length of Follow-up</td>
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<tr>
<td>Wilson, 2013, UK</td>
<td>4 prospective cohort 2 retrospective cohort Published between 1991–2015</td>
<td>Male:female 9:10 Stent size: 4.7 to 7F</td>
<td>Ureteric stent</td>
<td>Control (no stent)</td>
<td>MUC (leak and/or stenosis) graft and patient survival adverse events (UTI, hematuria) Complications (migration, malposition, irritation, encrustation) Follow-up: 2 months to 3 years</td>
</tr>
<tr>
<td>Song, 2012, China</td>
<td>7 included studies (n=1154 participants) All RCT Published between 1995-2004</td>
<td>Kidney transplant recipients (cadaveric, live or multiorgan) Duration of stent placement: 7 days to 8 weeks (most studies short term stenting &lt;6 weeks)</td>
<td>Ureteric stent</td>
<td>No stenting</td>
<td>stone free rate ureter stricture postoperative pain lower urinary tract symptoms complications, need for analgesia, unplanned medical visits or admission mean hospital stay Follow-up: 1 day to 1612 weeks</td>
</tr>
<tr>
<td></td>
<td>15 included studies (n=1496) All RCT Published between 2001–2010</td>
<td>postoperative stenting in patients who underwent ureteroscopic lithotripsy for ureteric calculi Stent size: 6 to 10.5F Duration of stent placement: 3 days to 4 weeks</td>
<td>Ureteric stenting</td>
<td>No stenting</td>
<td>stone free rate ureter stricture postoperative pain lower urinary tract symptoms complications, need for analgesia, unplanned medical visits or admission mean hospital stay Follow-up: 1 day to 1612 weeks</td>
</tr>
</tbody>
</table>

ER=emergency room; F=French; MMS=metal-mesh stents; MUC=major urological complications; NR=not reported; UK=United Kingdom; UTI=urinary tract infection; URL=Ureteroscopic lithotripsy; RCT=randomized controlled trial; VAS=visual analogue score; WMD=weighted mean difference
## Appendix 3: Critical Appraisal of Included Publications

### Table 1: Strengths and Limitations of Systematic Reviews and Meta-Analyses using AMSTAR

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wang, 2017</strong>&lt;sup&gt;11&lt;/sup&gt;</td>
<td><strong>Wang, 2017</strong>&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
<tr>
<td>• Authors reported an <em>a priori</em> study design</td>
<td>• Only studies published in English were included. Authors reported that there were studies published in other languages were missed</td>
</tr>
<tr>
<td>• Data extraction was conducted independently and in duplicate</td>
<td>• All the included studies had a high risk of bias</td>
</tr>
<tr>
<td>• A comprehensive literature search was performed</td>
<td>• The process of selecting studies for inclusion in the systematic review was not reported</td>
</tr>
<tr>
<td>• A list of included studies was provided</td>
<td>• Authors do not report having searched the grey literature</td>
</tr>
<tr>
<td>• Characteristics of included studies were provided</td>
<td>• A list of excluded studies was not reported</td>
</tr>
<tr>
<td>• Scientific quality of included studies was assessed (independently and in duplicate) and documented</td>
<td>• Significant publication bias was found for two outcomes (hematuria and dysuria)</td>
</tr>
<tr>
<td>• Quality of the included studies was considered when formulation conclusions</td>
<td>• Conflicts of interest for the included studies were not reported</td>
</tr>
<tr>
<td>• Statistical methods used to combine the findings of individual studies were appropriate</td>
<td></td>
</tr>
<tr>
<td>• Publication bias was assessed</td>
<td></td>
</tr>
<tr>
<td>• Authors of the systematic review reported that they had no conflicts of interest and no funding was received</td>
<td></td>
</tr>
</tbody>
</table>

| **Pai, 2016**<sup>12</sup> | **Pai, 2016**<sup>12</sup> |
| • Authors reported an *a priori* study design | • Authors do not clearly report whether data extraction was conducted independently and in duplicate |
| • Study selection was conducted independently and in duplicate | • A list of excluded studies was not reported |
| • A comprehensive literature search was performed. No search limits or language restrictions were applied | • Risk of bias was variable across the included trials. Performance bias was of concern due to inability to blind participants and physicians. Selection bias was a concern in the observational trials. Reporting bias was unclear in all included trials as none had published protocols |
| • Grey literature was searched including clinical trial registries, abstracts of major conferences and contacting study authors for unpublished data | • It was unclear whether the statistical methods used to combine the findings of individual studies were appropriate. A fixed effect Peto odds ratio was applied regardless of the degree of heterogeneity |
| • A list of included studies was provided | • Conflicts of interest for the included studies were not reported |
| • Characteristics of included studies were reported | |
| • Scientific quality of included studies was assessed (independently and in duplicate) and documented | |
| • Quality of the included studies was considered when formulation conclusions | |
| • Publication bias was assessed and none was found | |
| • Authors of the systematic review reported that they had no conflicts of interest and no funding was received | |

<p>| <strong>Oliver, 2016</strong>&lt;sup&gt;13&lt;/sup&gt; | <strong>Oliver, 2016</strong>&lt;sup&gt;13&lt;/sup&gt; |
| • Authors reported an <em>a priori</em> study design | • Authors do not clearly report whether data extraction was conducted independently and in duplicate |
| • Study selection was conducted independently and in duplicate | • Only studies published in English were included |
| • A comprehensive literature search was performed | • Authors did not search the grey literature |
| • A list of included studies was provided | • The scientific quality of included studies was not systematically assessed. The authors do report that the included studies are not of high quality and have various sources of bias including being underpowered, response and selection bias |
| • Characteristics of included studies were reported | |
| • Quality of the included studies was considered when formulation conclusions | |</p>
<table>
<thead>
<tr>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>conflicts of interest</td>
<td>Authors do not report how study results were combined</td>
</tr>
<tr>
<td></td>
<td>Publication bias was not assessed</td>
</tr>
<tr>
<td></td>
<td>Conflicts of interest for the included studies were not reported</td>
</tr>
</tbody>
</table>

**Wilson, 2013**

- Authors reported an *a priori* study design                             - Studies had different duration of stent placement and different durations of follow-up
- Study selection and data extraction were conducted independently and in duplicate - Included studies were all low or medium quality with risk of bias ranging from low in 4 studies to high risk in 1 study. Risk of bias was unclear in 2 studies
- A comprehensive literature search was performed                         - Publication bias was not assessed
- Grey literature was searched including clinical trial registries, abstracts of major conferences, reviewing references in textbooks and contacting study authors for unpublished data - Conflicts of interest for the included studies were not reported
- A list of both included and excluded studies, as well as the reason for exclusion, was provided
- Characteristics of included studies were reported
- Scientific quality of included studies was assessed (independently and in duplicate) and documented
- Quality of the included studies was considered when formulation conclusions
- Statistical methods used to combine the findings of individual studies were appropriate
- Authors of the systematic review reported that they had no conflicts of interest

**Song, 2012, China**

- Authors reported an *a priori* study design                             - Literature search was restricted to include only studies published in English
- Study selection and data extraction were conducted independently and in duplicate and triplicate, respectively - Authors do not report having searched the grey literature
- A comprehensive literature search was performed                         - A list of excluded studies was not reported
- A list of included studies was provided                                  - Only 2 of the 15 included studies were found to be of quality level A (all quality components adequate: low risk of bias), most included studies were considered to have a moderate risk of bias
- Characteristics of included studies were reported                       - Publication bias was not assessed
- Scientific quality of included studies was assessed (independently and in duplicate) and documented
- Quality of the included studies was considered when formulation conclusions
- Statistical methods used to combine the findings of individual studies were appropriate
- Authors do not report having searched the grey literature
- A list of excluded studies was not reported
- Only 2 of the 15 included studies were found to be of quality level A (all quality components adequate: low risk of bias), most included studies were considered to have a moderate risk of bias
- Publication bias was not assessed
- Conflicts of interest for systematic review nor the studies included in the systematic review were reported
Appendix 4: Main Study Findings and Author’s Conclusions

Table 1: Summary of Findings of Included Studies

<table>
<thead>
<tr>
<th>Main Study Findings</th>
<th>Author’s Conclusion</th>
<th>Wang, 2017&lt;sup&gt;11&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peri-Operative Variables Stenting vs. No Stenting</strong></td>
<td>Ureteral stenting failed to demonstrate improvement in stone-free survival but were associated with additional complications including discomfort, dysuria, hematuria, irritation and urinary infections. Ureteral stents are valuable in preventing re-hospitalization. Stenting is recommended in select patients with a relatively higher risk of ongoing pain or fever after discharge. The authors suggest that additional RCTs are needed to verify their findings.</td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td>WMD (95%CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Operating time (min)</td>
<td>4.93 (2.07, 7.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of hospital stay (hours)</td>
<td>1.13 (-1.37, 3.64)</td>
<td>0.38</td>
</tr>
<tr>
<td>VAS</td>
<td>0.25 (-0.27, 0.77)</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>OR (95%CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Stone free rate</td>
<td>0.55 (0.34, 0.89)</td>
<td>0.01</td>
</tr>
<tr>
<td>Readmission</td>
<td>0.54 (0.34, 0.87)</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Complications: Stenting vs. No Stenting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td>OR (95%CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Dysuria</td>
<td>3.90 (2.51, 6.07)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Irritation</td>
<td>4.40 (2.19, 9.10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>UTI</td>
<td>2.01 (1.16, 3.47)</td>
<td>0.01</td>
</tr>
<tr>
<td>Hematuria</td>
<td>3.68 (1.86, 7.29)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pain</td>
<td>2.45 (1.45, 4.15)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fever</td>
<td>0.78 (0.52, 1.18)</td>
<td>0.25</td>
</tr>
<tr>
<td>Ureteral strictures</td>
<td>0.52 (0.20, 1.13)</td>
<td>0.17</td>
</tr>
<tr>
<td><strong>Pais, 2016&lt;sup&gt;12&lt;/sup&gt;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stent Omission vs. Stent Placement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td>Studies</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td>Unplanned Return Visits</td>
<td>17</td>
<td>1.63 (1.15, 2.30)</td>
</tr>
<tr>
<td>Unplanned Return Visits</td>
<td>13 RCT</td>
<td>2.12 (1.38, 3.25)</td>
</tr>
<tr>
<td>Unplanned Return Visits</td>
<td>4 obs</td>
<td>0.98 (0.54, 1.77)</td>
</tr>
<tr>
<td>Hospital readmission</td>
<td>12</td>
<td>3.75 (2.09, 6.74)</td>
</tr>
<tr>
<td>Unplanned ER Visit</td>
<td>5</td>
<td>0.89 (0.53, 1.51)</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>Studies</td>
<td>RR (95%CI)</td>
</tr>
<tr>
<td>Infection</td>
<td>9</td>
<td>0.89 (0.59, 1.33)</td>
</tr>
<tr>
<td>Dysuria</td>
<td>9</td>
<td>0.39 (0.25, 0.62)</td>
</tr>
<tr>
<td>Pain</td>
<td>9</td>
<td>0.64 (0.39, 1.05)</td>
</tr>
<tr>
<td>Ureteral obstruction</td>
<td>11</td>
<td>2.24 (0.66, 7.66)</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>Studies</td>
<td>WMD (95%CI)</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>14</td>
<td>-3.19 (-5.64, -0.74)</td>
</tr>
<tr>
<td><strong>Complications: extraction strings vs. no extraction strings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Adverse Events (emergency department visits, unscheduled clinic visits, and telephone calls): 32 (7.5%) vs. 60 (8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stent dislodgements: 20 (9.9%) vs. 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dwell Time (mean): 6.3 days vs. 10.6 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Pain Score on removal (0-10): 3.0 vs. 4.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home stent removal (mean): 88.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients who would have strings again (mean): 81.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Oliver, 2016<sup>13</sup>

Ureteric stents with extraction strings reduces the stent dwell time which reduces patient morbidity and physical and financial burden. This must be balanced against the increased risk of stent dislodgement and therefore may not be a good option in all patients.
<table>
<thead>
<tr>
<th>Stenting vs. Non-Stenting</th>
<th>Wilson, 2013*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Study Findings</strong></td>
<td><strong>Author’s Conclusion</strong></td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td><strong>Studies (participants)</strong></td>
</tr>
<tr>
<td>MUC (urine leak and obstruction)</td>
<td>7 (1154)</td>
</tr>
<tr>
<td>Urine leak</td>
<td>7 (1154)</td>
</tr>
<tr>
<td>Ureteric stenosis (obstruction)</td>
<td>7 (1154)</td>
</tr>
<tr>
<td>UTI</td>
<td>7 (1154)</td>
</tr>
<tr>
<td>UTI (with antibiotic prophylaxis)*</td>
<td>3 (594)</td>
</tr>
<tr>
<td>Hematuria (recurrent or severe)</td>
<td>6 (1046)</td>
</tr>
</tbody>
</table>

* Cotrimoxazole 480 mg per day or 960 mg every other day

**Graft loss (reported in 1 study):**
2 kidneys removed secondary to encrustation due to Corynebacterium refractory to antimicrobials

**Overall Mortality:**
7.8% of participants died over 3 years’ follow-up in 1 included study
6.5% (5 patients) died or lost their graft over 10 months’ follow-up in a different study

**Maximum reported non-infectious complications:**
Irritative symptoms = 5.6% (1 study)
Breakage = 2% (1 study)
migration/malposition/expulsion = 7.4% (1 study)
encrustation/uroliithiasis = 5.7% (1 study)
“forgotten” stents = 7% (1 study)
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Studies</th>
<th>OR (95%CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone free rate</td>
<td>3</td>
<td>0.71 (0.13, 3.87)</td>
<td>0.69</td>
</tr>
<tr>
<td>Stricture formation</td>
<td>3</td>
<td>0.72 (0.16, 3.33)</td>
<td>0.67</td>
</tr>
<tr>
<td>Stone free rate and Stricture formation</td>
<td>5</td>
<td>0.67 (0.24, 1.85)</td>
<td>0.44</td>
</tr>
<tr>
<td>Dysuria</td>
<td>4</td>
<td>6.74 (1.75, 25.98)</td>
<td>0.003</td>
</tr>
<tr>
<td>Hematuria</td>
<td>5</td>
<td>7.28 (2.20–24.06)</td>
<td>0.001</td>
</tr>
<tr>
<td>Loin voiding pain</td>
<td>4</td>
<td>5.24 (1.75, 15.66)</td>
<td>0.003</td>
</tr>
<tr>
<td>Urgency or Frequency</td>
<td>4</td>
<td>4.34 (1.87, 10.08)</td>
<td>0.0006</td>
</tr>
<tr>
<td>Post-op fever</td>
<td>5</td>
<td>0.95 (0.45, 1.99)</td>
<td>0.88</td>
</tr>
<tr>
<td>UTI</td>
<td>5</td>
<td>1.72 (0.40–7.29)</td>
<td>0.46</td>
</tr>
<tr>
<td>Post-op pain (day 1)</td>
<td>3</td>
<td>0.95 (0.34, 1.56)</td>
<td>0.002</td>
</tr>
<tr>
<td>Operative time (minutes)</td>
<td>10</td>
<td>3.36 (0.55, 6.17)</td>
<td>0.02</td>
</tr>
<tr>
<td>Length of Hospital Stay</td>
<td>4</td>
<td>1.70 (-1.04, 4.45)</td>
<td>0.22</td>
</tr>
<tr>
<td>Unplanned hospital visit*</td>
<td>9</td>
<td>0.81 (0.41–1.63)</td>
<td>0.55</td>
</tr>
</tbody>
</table>

There is no difference in stone free rate or ureteric stricture formation between patients who received a ureteric stent compared to those who did not. Stent placement after ureteroscopic lithotripsy was associated with increased lower urinary tract symptoms such as dysuria, frequency, urgency, and irritative voiding flank pain. Stenting after ureteroscopic procedures for stone removal should not be performed routinely. It should be reserved for patients with ureteric injury, large stones, or prolonged operating time.

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ER=emergency room; MD=mean difference; MUC=major urological complications; OR=odds ratio; RCT=randomized controlled trial; RR=relative risk; UTI=urinary tract infection; VAS=visual analogue scale; WMD=weighted mean difference
Appendix 5: Additional References of Potential Interest

Systematic Review


Evidence-based Guidelines

