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Stent Omission in Pre-stented Patients Undergoing Ureteroscopy Decreases Unplanned Health Care Utilization

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Study Need and Importance: To reduce the morbidity associated with ureteral stents, the AUA stone management guidelines describe a selective approach to stenting after ureteroscopy, stating they may be omitted after uncomplicated procedures. However, the guidelines do not consider pre-stented status in these criteria. Therefore, we sought to characterize the practice of stent omission following uncomplicated ureteroscopy in pre-stented and non–pre-stented patients and its impact on postoperative health care utilization in Michigan.

What We Found: Pre-stented patients represent 36% of ureteroscopy cases in MUSIC (Michigan Urological Surgery Improvement Collaborative). While pre-stented patients more frequently have stents omitted compared to non–pre-stented patients, there was substantial variation in practice, with nearly a quarter of urologists never omitting a stent (see Figure). After adjusting for risk factors, we found that stent omission in pre-stented patients was associated with a significant reduction in postoperative emergency department visits and hospitalizations. Collectively, these findings demonstrate that pre-stented patients are ideal candidates to consider a strategy of stent omission.

Limitations: The MUSIC registry includes a variety of urology practices, which enables representation of real-world data; however, the registry does not capture data on renal impairment or laboratory results, and these are thus absent from our uncomplicated ureteroscopy definition. Additionally, we do not capture the reason for stent placement or dwell time prior to ureteroscopy, and it is possible this may have impacted the urologist's decision surrounding stenting.

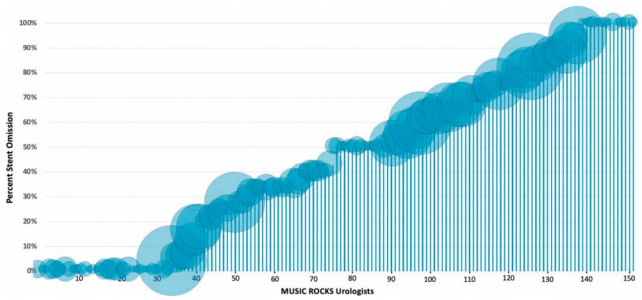

Figure. Variation in rates of stent omission for pre-stented patients undergoing ureteroscopy by urologists in Michigan Urological Surgery Improvement Collaborative (MUSIC) Reducing Operative Complications from Kidney Stones (ROCKS) practices with ≥5 uncomplicated cases. Total ureteroscopy case volume indicated by bubble size.

Interpretation for Patient Care: There is wide variation in stent omission after ureteroscopy in pre-stented patients, and many urologists never perform it. Pre-stented patients have lower postoperative unplanned health care utilization. As such, the pre-stented patient may serve as an ideal target group for quality improvement pathways to increase the use of stent omission, with the goal to improve the patient outcomes after ureteroscopy.

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Stent Omission in Pre-stented Patients Undergoing Ureteroscopy Decreases Unplanned Health Care Utilization

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Abstract

Introduction: Despite AUA guidelines providing criteria for ureteral stent omission after ureteroscopy for nephrolithiasis, stenting rates in practice remain high. Because pre-stenting may be associated with improved patient outcomes, we assessed the impact of stent omission vs placement in pre-stented and non−pre-stented patients undergoing ureteroscopy on postoperative health care utilization in Michigan.

Methods: Using the MUSIC (Michigan Urological Surgery Improvement Collaborative) registry (2016-2019), we identified pre-stented and non−pre-stented patients with low comorbidity undergoing single-stage ureteroscopy for ≤1.5 cm stones with no intraoperative complications. We assessed variation in stent omission for practices/urologists with ≥5 cases. Using multivariable logistic regression, we evaluated whether stent placement in pre-stented patients was associated with emergency department visits and hospitalizations within 30 days of ureteroscopy.

Results: We identified 6,266 ureteroscopies from 33 practices and 209 urologists, of which 2,244 (35.8%) were pre-stented. Pre-stented cases had higher rates of stent omission vs non−pre-stented cases (47.3% vs 26.3%). Among the 17 urology practices with ≥5 cases, stent omission rates in pre-stented patients varied widely (0%-77.8%). Among the 156 urologists with ≥5 cases, stent omission rates in pre-stented patients varied substantially (0%-100%); 34/152 (22.4%) never performed stent omission. Adjusting for risk factors, stent placement in pre-stented patients was associated with increased emergency department visits (OR 2.24, 95% CI:1.42-3.55) and hospitalizations (OR 2.19, 95% CI:1.12-4.26).

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Conflict of Interest: KRG: Boston Scientific, Coloplast, Karl Storz, Olympus, Ambu.

Ethics Statement: This study was deemed exempt from Institutional Review Board review. Data collected are private.

Author Contributions: Conception and design: JMD, AD, SH, CAD, KRG; critical revision of the manuscript for scientific and factual content: JMD, SH, NK, CAD, KR; data analysis and interpretation: JMD, SD-N, NK, CAD; drafting the manuscript: JMD, SD-N, AD, CAD; statistical analysis: SD-N; supervision: JMD, AD, SH, NK, CAD, KRG.

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Conclusions: Pre-stented patients undergoing stent omission after ureteroscopy have lower unplanned health care utilization. Stent omission is underutilized in these patients, making them an ideal group for quality improvement efforts to avoid routine stent placement after ureteroscopy.

Key Words: nephrolithiasis, ureter, stent, ureteroscopy, quality improvement

Ureteral stent placement is commonly performed following ureteroscopy for urinary stones despite the bothersome symptoms experienced by patients due to their presence.[1] Multiple clinical trials have shown that stent omission after uncomplicated ureteroscopy does not lead to ureteral strictures.[2] While a Cochrane review was inconclusive on the impact of stent omission on unplanned return visits after ureteroscopy,[2] a recent analysis of stent placement after ureteroscopy for stone treatment in the state of Michigan demonstrated that stenting increased the risk of postoperative unplanned health care utilization.[3] Because of the issues surrounding stent-related morbidity, the AUA guidelines describe a selective approach to stent placement after ureteroscopy, where clinicians may consider omitting a stent in patients undergoing a single-stage ureteroscopy for a $\leq$1.5 cm stone without ureteral injury or obstruction, solitary kidney, or functional renal impairment.[4] Yet, rates of stenting after ureteroscopy in the United States are high at 73% to 86%.[3,5,6] One hypothesis for why our field has not observed a decline in stenting rates is that guidelines and quality improvement (QI) efforts are not identifying the ideal patient for stent omission.

Multiple studies have shown that pre-stented patients undergoing ureteroscopy have decreased operative times, reduced operative complications, higher stone-free rates (SFRs), and decreased reoperation rates.[7-10] Because of the need for an extra procedure and the associated health care costs, AUA guidelines recommend against routine elective pre-stenting.[4] However, stent placement prior to ureteroscopy represents a common initial step in the management of patients with renal colic to treat obstruction, pain, and/or infection,[11] and also in ureters that do not accommodate a ureteroscope.[12] Interestingly, neither the AUA nor the European Association of Urology guidelines consider a patient's pre-stented status as a criterion for stent omission.[4,10] In particular, there is a paucity of multicenter data on the practice of stent omission in pre-stented patients undergoing ureteroscopy and its impact on unplanned health care utilization.

In this context, we undertook a QI study in the Michigan Urological Surgery Improvement Collaborative (MUSIC) to characterize the practice of stent omission following uncomplicated ureteroscopy in pre-stented and non−pre-stented patients among diverse practices in Michigan. By assessing unplanned health care use after ureteroscopy we aimed to study the safety of stent omission in these patients. Our goal is to provide real-world data and determine whether these patients represent an ideal target group for stent omission after ureteroscopy with stone treatment, with the motivation to inform QI efforts both locally and nationally, and guideline recommendations.

Methods

Data Source

MUSIC was established in 2011 in partnership with Blue Cross Blue Shield of Michigan. The ROCKS (Reducing Operative Complications from Kidney Stones) initiative was started in 2016 and is comprised of community and academic urology practices in the state. ROCKS maintains a clinical registry of unilateral ureteroscopy procedures in adults (age $\geq$18) performed by these practices and urologists in hospitals and ambulatory surgery centers, regardless of insurance type or status. Trained abstractors prospectively record standardized data elements including patient, stone, procedural, and postoperative care data 60 days after the procedure in a web-based registry by independent chart review, as described previously.[13] Stone size is determined by the maximum diameter of the treated stone on preoperative imaging. Intraoperative complications, unplanned health care encounters within 30 days, and imaging results within 60 days of the procedure are recorded. SFR is defined as the absence of any residual fragment on imaging reports. Each MUSIC practice has obtained an exemption or approval by the local Institutional Review Board for participation in the collaborative.

Study Population

We defined uncomplicated ureteroscopy as a single-stage procedure, largest stone size $\leq$1.5 cm with low patient comorbidity ($\leq$1 Charlson Comorbidity Index), and absence of: anticoagulation/antiplatelet therapy, positive preoperative urinalysis or urine culture, anatomic anomaly, solitary kidney, and intraoperative complication or ureteral access sheath use. Using this definition, we identified all uncomplicated ureteroscopy cases from 2016 to 2019. We excluded staged procedures (ipsilateral surgery within 4 weeks).

Outcomes and Statistical Analysis

We characterized cases as pre-stented and non−pre-stented with or without stent omission across a range of demographic and

Table 1.
Demographic Characteristics, Clinical Characteristics, and Outcomes of Stent Omission Compared to Stent Placement in Pre-stented and Non−pre-stented Patients After Uncomplicated Ureteroscopy

	Pre-stented			Non−pre-stented		
	Stent omitted	Stented	*P* value	Stent omitted	Stented	*P* value
Cases, No. (%)	1,132 (50.4)	1,112 (49.6)		1,247 (31.0)	2,775 (69.0)	
Age, median (IQR), y (missing in 0 patients)	52 (39-64)	55 (43-67)	**< .001**	49 (37-60)	53 (40-64)	**< .001**
Gender, No. (%) (missing in 0 patients)			**.029**			**.04**
Male	523 (46.2)	565 (50.8)		571 (45.8)	1,368 (49.3)	
Female	609 (53.8)	547 (49.2)		676 (54.2)	1,407 (50.7)	
Insurance type, No. (%) (missing in 36 patients)			**.003**			.101
Private	717 (63.6)	632 (57.2)		851 (68.6)	1,833 (66.5)	
Public	381 (33.8)	449 (40.6)		355 (28.6)	865 (31.4)	
None	30 (2.7)	24 (2.2)		35 (2.8)	58 (2.1)	
BMI, No. (%), kg/m^2 (missing in 532 patients)			.8			> .9
<25	200 (21.3)	222 (21.1)		265 (22.7)	589 (22.9)	
≥25-<30	301 (32.1)	348 (33.1)		380 (32.6)	820 (31.8)	
≥30-<35	218 (23.2)	252 (24.0		263 (22.5)	616 (23.9)	
≥35-<40	127 (13.5)	122 (11.6)		159 (13.6)	318 (12.3)	
≥40	93 (9.9)	106 (10.1)		100 (8.6)	235 (9.1)	
Stone size, median (IQR), mm (missing in 236 patients)	6 (4-7)	7 (5-9)	**< .001**	5 (4-7)	6 (5-8)	**< .001**
Stone location, No. (%) (missing in 234 patients)			.2			**< .001**
Both	163 (15.0)	177 (16.7)		199 (16.7)	498 (18.5)	
Renal	143 (13.2)	117 (11.0)		320 (26.8)	400 (14.9)	
Ureter	780 (71.8)	767 (72.3)		676 (56.6)	1,792 (66.6)	
Preoperative alpha blockers, No. (%) (missing in 255 patients)	511 (48.2)	529 (49.4)	.6	577 (48.0)	1,177 (44.0)	**.021**
Preoperative hydronephrosis, No. (%) (missing in 457 patients)	881 (83.7)	875 (85.0)	.4	726 (64.8)	2,043 (78.4)	**< .001**
Postoperative alpha blockers, No. (%) (missing 978)	393 (45.8)	543 (56.5)	**< .001**	652 (58.7)	1,528 (64.8)	**< .001**
Postoperative ED visit, No. (%) (missing in 47 patients)	35 (3.1)	66 (6.0)	**.001**	103 (8.3)	212 (7.7)	.5
Unplanned hospitalization, No. (%) (missing in 44 patients)	15 (1.3)	29 (2.6)	**.028**	24 (1.9)	60 (2.2)	.6
Postoperative imaging, No. (%) (missing in 45 patients)	315 (27.9)	465 (42.6)	**< .001**	478 (38.6)	1,074 (39.0)	.8
Stone-free, No. (%)[a]	211 (69.2)	280 (62.8)	.070	322 (69.0)	681 (65.4)	.17

Abbreviations: BMI, body mass index; ED, emergency department; IQR, interquartile range.
P values in bold are statistically significant.
[a] Assessed in cases that received postoperative imaging.

clinical measures. We assessed (1) practice-level and urologist-level frequency of performing stent omission after ureteroscopy in patients who were pre-stented and not pre-stented, including relationship to surgical volume, (2) 30-day emergency department (ED) visit for any reason related to surgery, and (3) hospitalization rates after ureteroscopy in both groups. Demographic factors included age, gender, and insurance type. Clinical factors included body mass index, stone size (≤5 mm, >5 mm to ≤10 mm, >10 mm), and stone location (renal, ureteral, both). Categorical variables were compared using χ^2 tests, and continuous variables were compared using a Wilcoxon rank sum. For reliability purposes, practices with ≥5 ureteroscopy cases for both pre-stented and non−pre-stented patients, and urologists with ≥5 ureteroscopy cases in the registry were included in the practice- and urologist-specific analysis. Practice- and urologist-level variation in stent omission was described using proportions and differences tested using a Wald χ^2. Spearman correlation between ureteroscopy case volume and stent placement rate at a practice and urologist level was calculated. The count and 95% exact binomial confidence intervals are reported. Practice-level and urologist-level rates of stent omission were displayed on a bubble chart to incorporate surgical case volume.

Multivariable logistic regression mixed models were constructed to assess the association of stent omission or placement by pre-stented status with ED visit and with hospitalization within 30 days with fixed effects of age, gender (male and female), insurance (private, public, or none), stone size, and stone location (ureter, kidney, or both). A random intercept was used to account for correlation within practice and urologist with unstructured covariance. The complete case data set was used which included 5,812 (92.8%) for the ED visit model and 5,816 (92.8%) for the hospitalization model. All the statistical analyses were performed using SAS 9.4.

Results

A total of 6,266 uncomplicated ureteroscopy cases were identified from 33 practices and 209 urologists. Of these cases 2,244 (35.8%) were performed in pre-stented patients.

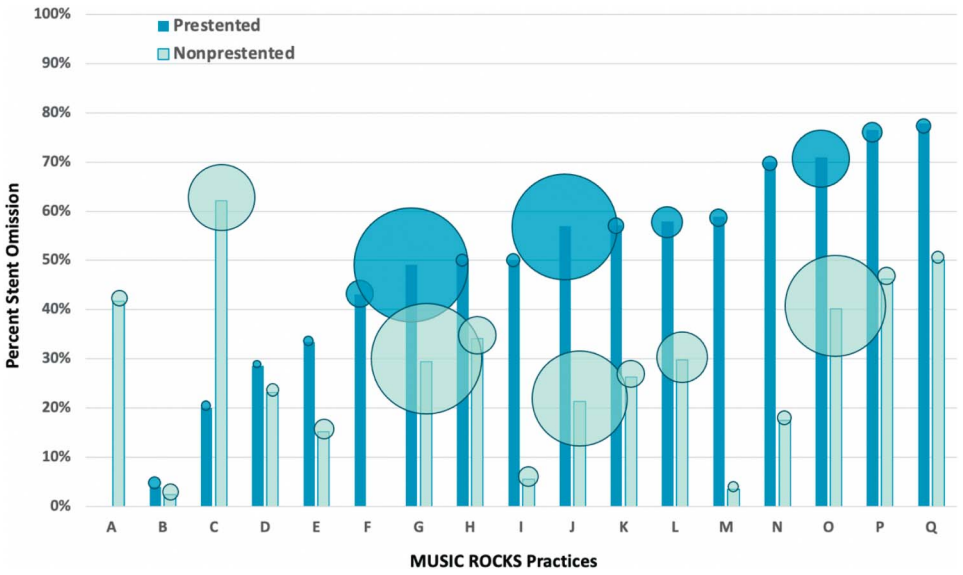

Figure 1. Variation in rates of stent omission for pre-stented and non−pre-stented patients undergoing ureteroscopy in Michigan Urological Surgery Improvement Collaborative (MUSIC) Reducing Operative Complications from Kidney Stones (ROCKS) practices with ≥5 uncomplicated cases in each category. Total ureteroscopy case volume indicated by bubble size.

Overall, ureteral stents were omitted after ureteroscopy in 47.3% of pre-stented and 26.3% of non−pre-stented cases. Table 1 displays the demographic and clinical characteristics of the cohort. There were significant differences between procedures with and without stent omission, within both pre-stented and non−pre-stented patients. In the pre-stented cohort, stent omission was performed significantly more in younger patients, females, patients with private insurance, and smaller stone size. In the non−pre-stented cohort, stent omission was performed significantly more in younger patients, females, smaller stone size, renal stone location, and patients without preoperative hydronephrosis.

There were 17 practices with ≥5 uncomplicated pre-stented and non−pre-stented ureteroscopy cases, and 156 urologists with ≥5 uncomplicated cases. Of these, practice-level stent omission rates varied widely (0%-77.8%) with a mean of 34.4% (Figure 1). Fifteen of 17 (88%) practices had higher rates of stent omission in pre-stented patients compared to non−pre-stented patients. Of urologists with ≥5 uncomplicated cases who treated pre-stented patients, stent omission rates varied widely (0%-100%; Figure 2) with a mean of 44.4%. Further, stent omission was never performed by 34/152 (22.4%) of these urologists in this cohort. For practices and urologists, the frequency varied regardless of case volume (Figures 1 and 2).

Bivariate outcomes analysis of all cases revealed that stent omission compared to stent placement in pre-stented cases had lower rates of ED visits (3.1% vs 6.0%, $P < .001$) and unplanned hospitalizations (1.3% vs 2.6%, $P < .001$; Table 1). There were no significant differences in the frequency of ED visits (8.3% vs 7.7%, $P = .48$) or unplanned hospitalizations (1.9% vs 2.2%, $P = .63$) between non−pre-stented cases with stent omission compared to stent placement. Multivariable analysis demonstrated that stent placement significantly increased the risk of a postoperative ED visit in pre-stented cases (OR 2.24, 95% CI: 1.42-3.55) but not in non−pre-stented cases (OR 1.20, 95% CI: 0.91-1.60; Table 2). The effect of stent placement on ED visits was significantly different between the pre-stented and non−pre-stented cases ($P = .020$). Similarly, stent placement significantly increased the risk of a postoperative ED visit in pre-stented cases (OR: 2.19, 95% CI: 1.12-4.26) but not in non−pre-stented cases (OR: 1.21, 95% CI: 0.72-2.05). However, the effect of stent placement on hospitalization did not significantly differ between the pre-stented and non−pre-stented cases ($P = .16$).

Discussion

We evaluated practice patterns and outcomes of stent omission or placement in pre-stented patients undergoing ureteroscopy among diverse practices in Michigan. Our work has several key findings. We found that pre-stented patients represent a sizeable proportion of cases undergoing ureteroscopy. While pre-stented patients more frequently have a stent omitted compared to non−pre-stented patients, there was substantial variation of this practice in pre-stented patients, with nearly a quarter of urologists never omitting a stent. Importantly, we found that stent omission in pre-stented patients was associated with a significant reduction in postoperative unplanned health care utilization. Collectively, these findings demonstrate that pre-stented patients are ideal

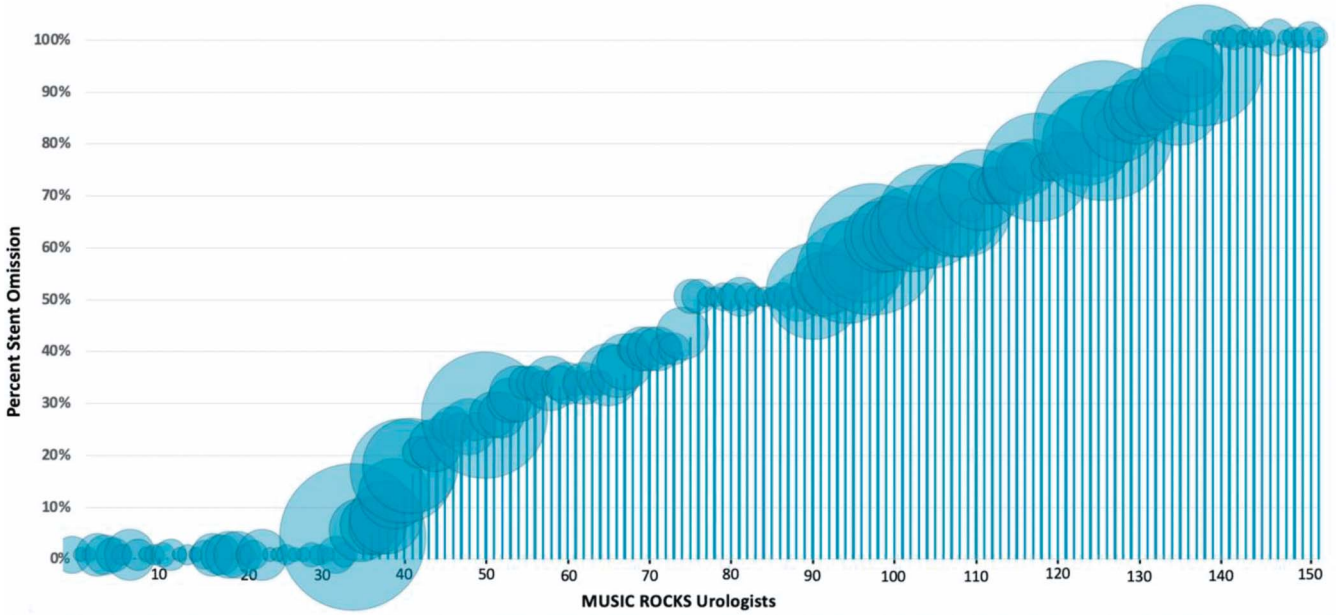

Figure 2. Variation in rates of stent omission for pre-stented patients undergoing ureteroscopy by urologists in Michigan Urological Surgery Improvement Collaborative (MUSIC) Reducing Operative Complications from Kidney Stones (ROCKS) practices with ≥5 uncomplicated cases. Total ureteroscopy case volume indicated by bubble size.

candidates to consider a strategy of stent omission. Implementing clinical pathways in these patients targeted toward stent omission represents a QI opportunity with the potential to improve patient outcomes.

In the MUSIC clinical registry, 36% of patients were pre-stented at the time of ureteroscopy. While we do not document the reasons for pre-stenting, these may include patients with renal colic and/or infection, or failed initial ureteroscopy due to ureteral narrowing.[12] Elective routine pre-stenting for ureteroscopy is not standard practice in Michigan or the United States. While we found that pre-stented patients had significantly higher rates of stent omission compared to non−pre-stented patients, there are limited data on this subject. In a recent retrospective review of a multicenter study from Germany, pre-stented patients had a stent omission rate of 20% compared to 0% in non−pre-stented patients.[14] In a previous analysis from MUSIC, pre-stented patients had a stent omission rate of 50.3% after all ureteroscopies, including complex cases.[3] In the current analysis, where we analyzed only patients meeting criteria for an uncomplicated ureteroscopy, the rate of stent omission was surprisingly lower. These data would suggest that the decision for stent omission may be surgeon preference based and those surgeons who prefer not to omit stents more commonly perform uncomplicated ureteroscopy.

Stent omission in pre-stented patients was associated with more than a twofold decrease in ED visits relative to patients who had a stent placed. Conversely, there was no difference in unplanned health care use between stent omission and stent placement in non−pre-stented patients. A Cochrane review comparing stent omission and placement after uncomplicated ureteroscopy examined unplanned ED visits, postoperative pain at several timepoints, and narcotic use.[2] Although they concluded that stent placement may decrease postoperative ED visits and increase pain, the pooled results were not statistically significant, and the quality of evidence was determined to be poor. Torricelli et al compared the outcomes of ureteroscopy using ureteral access sheaths with stent omission vs stent placement and found that pre-stented patients who underwent an uncomplicated ureteroscopy using a ureteral access sheath and stent omission had significantly lower pain compared to those who were stented.[15] This underscores the fundamental difference between the pre-stented and non−pre-stented ureter.

Small single-center studies have demonstrated that pre-stented patients undergoing ureteroscopy have improved operative outcomes. Chu et al compared 45 pre-stented patients with 59 matched non−pre-stented patients undergoing ureteroscopy and found that pre-stented patients had lower operative times and reoperation rates for patients with large proximal ureteral stones.[9] Rubenstein et al examined 90 patients undergoing ureteroscopy and found that the 36 pre-stented patients had a significantly higher SFR.[7] However, there are no large studies assessing the outcomes of stent omission on pre-stented patients. In this regard our work is unique and represents an opportunity for our field to better understand outcomes in these patients.

Despite the AUA guidelines recommending omitting ureteral stents in uncomplicated cases, rates of stent omission

Table 2.
Multivariable Model Assessing Factors Associated With Postoperative Emergency Department Visits and Unplanned Hospitalization Within 30 Days After Adjusting for Age, Gender, Insurance, Maximum Stone Size, and Stone Location

	Estimate	95% Confidence limit	*P* value	Interaction test
Emergency department visit				
Stent placement (vs stent omission)			**.020**	
Pre-stented patients	2.24	1.42-3.55	**< .001**	
Non−pre-stented patients	1.20	0.91-1.60	.20	
Unplanned hospitalization				
Stent placement (vs stent omission)			.16	
Pre-stented patients	2.19	1.12-4.26	**.022**	
Non−pre-stented patients	1.21	0.72-2.05	.48	

P values in bold are statistically significant.

remain relatively low, but with wide variation. This variation may indicate uncertainty regarding the evidence informing these guidelines and the lack of consensus regarding which patients are suitable for stent omission. While significant variation in stent omission rates for both practices and urologists was observed, nearly 25% of urologists never performed stent omission in pre-stented patients. Understanding the surgical rationale for this decision represents an important area of future study.

The MUSIC registry includes a variety of urology practices which enables better representation of real-world data, but limitations are noted. The registry does not capture data on renal impairment and laboratory results, and these are thus absent from our definition of uncomplicated ureteroscopy. To focus on the most uncomplicated type of patient, we only selected patients with low comorbidity and those without a positive urine study. Additionally, we do not capture the stent dwell time prior to ureteroscopy and it is possible this may have impacted the urologist's decision surrounding stent placement.

Limitations notwithstanding, our work has several implications. This work is the first report of outcomes of stent omission in pre-stented patients in the literature. These findings support the consideration of pre-stented status as a criterion for subsequent stent omission and highlights the patient population in whom benefits are expected to be greatest. As part of our ongoing efforts to reduce stent-related morbidity, MUSIC has developed stent appropriateness criteria and guidelines which incorporate pre-stented status into stent omission decision-making.[16] While we admit that the decision to place a stent is complex, the patient who is pre-stented has a dilated ureter which reduces the risk of ureteral injury, fragment obstruction, and sepsis. We calculated the possible impact of stent omission in pre-stented patients in the state of Michigan. If we were to reduce stenting rates by 50% in this population, it would lead to approximately 850 fewer patients being stented annually resulting in fewer unplanned health care encounters, fewer ambulatory nursing and physician encounters for pain and symptoms, and thus reducing overall health care costs. Future work should include efforts to understand patient-reported outcomes in pre-stented patients and to obtain high-quality prospective data from clinical trials to understand the outcomes of stent omission in patients undergoing ureteroscopy.

Conclusion

One-third of patients undergoing ureteroscopy in Michigan are pre-stented. Pre-stented patients undergoing stent omission after ureteroscopy have lower unplanned health care utilization. Yet there is wide variation in stent omission practice in pre-stented patients, and many urologists never perform it. As such, the pre-stented patient may serve as an ideal target group for QI pathways to increase the use of stent omission, with the goal to improve the patient experience and outcomes after ureteroscopy.

Acknowledgments

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Editorial Commentary

The AUA Surgical Management of Stones Guidelines support stent omission following uncomplicated ureteroscopy with clear criteria provided.[1] Of the 42 statements in this guideline, the recommendation for stent omission is the only statement that reaches evidence level A, indicating a very high level of certainty based on available studies. Despite this, there is a continued gap between evidence and clinical practice. In this paper evaluating practice patterns of 156 Michigan urologists, stent omission rates after uncomplicated ureteroscopy were still only 34.4%. Are we really this resistant to change? I think there is more to the story. The likely reason for this discrepancy is that we still are not confident in our ability to properly select patients for stent omission. More granular criteria may be helpful. The authors provide us with retrospective evidence that pre-stented patients fair better with stent omission as their ureters are already dilated and they may be less likely to have obstructive complications. This may be a population of patients to focus on when embarking on a change in clinical practice to stent omission following uncomplicated ureteroscopy.

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