Septic and febrile kidney stone presentations during the COVID-19 pandemic

What is the effect of reduced access to care during pandemic restrictions?

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ABSTRACT

INTRODUCTION: During the early stages of the COVID-19 pandemic, hospitals shifted their resources and focus toward COVID-19 care and non-deferrable conditions. Renal colic is one of the most common urologic presentations to the emergency department (ED). In our study, we examined whether there was an increase in septic/febrile stone presentations to the ED requiring ureteral stent insertion after the public health restrictions during the COVID-19 pandemic.

METHODS: We carried out a retrospective cohort study and reviewed charts of septic/febrile stone patients requiring ureteral stent insertion from January 1, 2019, to March 16, 2020 (pre-COVID) and July 1, 2020, to December 31, 2021 (intra-COVID) at the Queen Elizabeth II Health Sciences Centre in Halifax, NS. The incidence of septic/febrile stone presentation, baseline characteristics, and perioperative outcomes were captured.

RESULTS: There were 54 patients in the pre-COVID group and 74 patients in the intra-COVID group. There were no statistically significant differences found in baseline or stone characteristics between the two groups ($p>0.05$). Patients in the intra-COVID group were found to have a longer presentation to operating room time when compared to the pre-COVID cohort ($U=961.00$, $p=0.04$). The intra-COVID group had 20 more cases of septic stone presentations compared to the pre-COVID group at the 15-month mark (pre-COVID, n=54; intra-COVID, n=74).

CONCLUSIONS: We found increased time to operative intervention in the intra-COVID cohort compared to the pre-COVID cohort. The overall number of urgent and/or critically ill ureteric stone patients increased between cohorts but was not statistically significant.

INTRODUCTION

During the initial stages of the severe acute respiratory syndrome-Cov-2 (COVID-19) pandemic, many hospitals shifted their resources towards COVID-19 care and non-deferrable medical conditions. This had effects across the world in nearly all aspects of healthcare. Many hospitals saw a significant decrease in patients visiting the emergency department (ED), with studies suggesting this was due to fear of contracting COVID-19.[1-4] There are studies in other fields that have demonstrated worse presentation and outcomes of diseases that may have been improved with earlier intervention and assessment.[5,6]

Renal colic, which affects approximately 12% of men and 6% of women, is one of the most common presentations to the ED.[7] Some studies have reported a decrease in the number of patients seeking urologic care, urology referrals, and similar or greater risk of admission during the early phase of the pandemic.[8-10]

There are mixed data on emergency ureteric stenting when comparing the pre-pandemic and pandemic eras, with some studies showing similar rates of emergency stenting and others showing increased rates.[9-11] With limited data examining the presentation of septic and febrile kidney stones during the pandemic, further research is required to examine the volume and severity of septic/febrile stone patient presentations requiring emergent intervention amidst the COVID-19 pandemic. In

KEY MESSAGES

- We compared septic stone presentations before and during the COVID-19 pandemic.
- We found increased presentation to operative intervention time in the intra-COVID groups vs. pre-COVID group.
- We also found that the number of critically ill stone patients increased in the intra-COVID group but was not found to be statistically significant.

this study, the incidence of septic/febrile stone presentations requiring intervention at the Queen Elizabeth II Health Sciences Centre (QEII HSC), a tertiary hospital in Halifax, NS, Canada, was examined using a retrospective, single-institutional approach. The primary outcome of this study was to compare the number of patients in the COVID-19 pandemic requiring emergency stenting with a pre-pandemic cohort. Our secondary outcome included comparing the number of patients classified as "emergency" status between the two cohorts.

METHODS

Study design

After obtaining institutional research ethics board approval (NSHA REB#: 1027503), we used a retrospective, cross-sectional approach to review the charts of all urgent or emergent septic/febrile stone patients requiring ureteral stent insertion from January 1, 2019, to March 16, 2020 (pre-COVID cohort), and July 1, 2020, to December 31, 2021 (intra-COVID cohort) at the QEII. The date of March 17, 2020, was used to delineate cohorts, as this date corresponded to when Nova Scotia implemented their emergency measures in response to the COVID-19 pandemic. We collected "intra-COVID-19" data approximately three full months after the implementation of hospital restrictions to account for changes in policies to be implemented fully.

Population

Operating room (OR) booking forms for patients seen in the ED requiring urgent ureteric stent placement in the setting of febrile and/or septic ureteric stones were reviewed. A fever was defined as a temperature >38.0°C, and urgent stent placement was stratified by an OR booking level of 1–3 urgency (immediately to within eight hours [Table 1]). Patients were assessed by anesthesiology and assigned an American Society of Anesthesiologists (ASA) classification score.

Inclusion criteria included all patients aged 18 years or over, symptomatic nephrolithiasis confirmed using computed tomography (CT) imaging, febrile (temperature >38.0°C) at time of assessment, and an OR booking triage level of 1–3. Exclusion criteria included age <18 years, as these patients would present and be treated at the pediatric center, and those with OR booking forms with level 0, 4, or 5 urgency.

COVID restrictions

During the COVID-19 pandemic, several restrictions and changes in practices occurred at our institution. In summary, primary care appointments were primarily changed to virtually based appointments, with minimal in-person appointments being conducted. In-person appointments with primary care physicians were limited to non-emergent presentations that required physical examination, with all other patient concerns being referred to the ED for assessment. Similarly, urology-based clinic appointments were limited to oncologic assessments and appointments for conditions reliant on appropriate physical examination and/or cystoscopy.

For assessment at the ED, patients were initially screened based on the presence of COVID-19 symptoms, namely fever and/or respiratory symptomatology. Patients who screened positive for COVID-19 symptoms were triaged into negative pressure isolation rooms and healthcare providers were required to don full personal protective equipment during assessment and patient interaction. Patients then were required to undergo rapid COVID-19 testing prior to undergoing CT imaging and were required to have a COVID-19 test result before proceeding to the OR. There were

Table 1. Operating room booking form triage levels as used in QEII Health Center Halifax, Nova Scotia, Canada

Operating room booking level	Target time to operating room
Level 0	Elective
Level 1	Immediate
Level 2	Within 2 hours
Level 3	2–8 hours
Level 4	<24 hours
Level 5	<48 hours

no changes in the logistics for emergency OR coordination, aside from confirmatory COVID-19 testing, due to urology-specific ORs available for emergency after-hour cases at our institution. Due to this, emergency presentations of septic or febrile stones are treated timelier with retrograde ureteric stenting when compared to nephrostomy tube placement, which is performed by interventional radiology at our institution. Nephrostomy tube placement is reserved for cases in which an attempt at retrograde ureteric stenting fails.

Data collection

Baseline characteristics (Table 2) collected included age, gender, ASA score, and OR booking level. Stone number, size, and location were also collected. ED laboratory values of white blood cell count (WBC), creatinine, vital signs, and vasopressor requirements were collected. The time between ED presentation and diagnostic imaging and the time from ED presentation to the OR was collected from review of ED chart records and OR reports. Operative time and additional postoperative factors, such as immediate postoperative disposition (intensive care unit [ICU], intermediate care unit [IMCU], floor care), need for postoperative vasopressors, length of hospital stay, need for additional procedures, and mortality were collected.

Outcomes

The primary outcome was incidence of acute presentations between cohorts and was examined and compared at 7.5 months and 15 months. The timeframe of 15 months was used, as it represents the duration of strict implementation of COVID policies and restrictions at our institution for focused care towards COVID efforts. The ratio between critically ill and non-critically ill patients, as well as total counts per interval, were used for analysis. Our secondary outcome was to compare emergency ASA level (ASA "E") between cohorts, with ASA being a variable that identified patients deemed by anesthesia to require immediate intervention, which if withheld, could lead to imminent mortality.

Statistical methods

Patient demographic and stone-specific factors were expressed as frequencies and percentages and were analyzed using Chi-squared, Mann-Whitney U tests, and Spearman correlation analysis. A 95% confidence interval was used, with a significance threshold of $p<0.05$.

Table 2. Baseline characteristics and perioperative factors

Patient demographics	Pre-COVID (n=54) n (%)	Intra-COVID (n=74) n (%)	p
Sex/gender			0.524
Male	33 (61.1)	46 (62.2)	
Female	21 (38.9)	28 (37.8)	
ASA level			0.401
1	3 (5.6)	4 (5.4)	
2	28 (51.9)	34 (45.9)	
3	20 (37.0)	29 (39.2)	
4	3 (5.6)	7 (9.5)	
ASA – emergency			0.712
Emergency	21 (38.9)	26 (35.1)	
Non-emergency	33 (61.1)	48 (64.9)	
OR booking level			0.114
2	20 (37.0)	17 (23.0)	
3	34 (63.0)	57 (77.0)	
Vasopressor requirement			0.549
Yes	5 (9.3)	7 (10.3)	
No	49 (90.7)	61 (89.7)	
ICU postoperative care			0.453
Yes	6 (11.1)	12 (16.2)	
No	48 (88.9)	62 (83.8)	
IMCU postoperative care			0.759
Yes	4 (7.4)	7 (9.5)	
No	50 (92.6)	67 (90.5)	
Floor care postoperative care			0.215
Yes	44 (81.4)	52 (70.3)	
No	10 (18.5)	22 (29.7)	
Death during admission			0.636
Yes	1 (1.9)	3 (4.1)	
No	53 (98.1)	71 (95.9)	
	Mean (SD)/median [range]		
Age	60.39 (15.16)	61.14 (17.54)	0.752
Length of stay	3.00 [13.5]	3.50 [17.5]	0.203
OR time (minutes)	14.53 (6.94)	14.75 (13.60)	0.164

ASA: American Society of Anesthesiologists; ICU: intensive care unit; IMCU: intermediate care unit; OR: operating room; SD: standard deviation.

RESULTS

One hundred twenty-eight patients were included in the study, with 54 patients and 74 patients in the pre-COVID and intra-COVID cohorts, respectively. The median (range) age for the pre-COVID and intra-COVID cohorts were 62.50 (60) and 61.50 (72) years, respectively. In the pre-COVID cohort, there were 21/54 (38.9%) ASA emergency cases compared to 26/74 (35.1%) emergency cases in the intra-COVID cohort (p=0.66) (Figure 1).

An overview of patient demographics and peri-operative factors is seen in Table 2. There were no statistically significant differences in baseline characteristics (p>0.05) between the cohorts, and there was no difference in patient mortality. For factors associated with ED patient presentations (Table 3), there were no statistically significant differences, except patients in the intra-COVID group had longer wait times before OR of 17.49±9.75 hours compared to 13.78±7.83 hours in the pre-COVID cohort (U=961.00, p=0.04). No patients in either cohort required nephrostomy tube placement.

When analyzing the stone characteristics (Table 4), there were no statistically significant differences observed between the two cohorts. The mean (standard deviation) stone size was 8.05 (4.52) mm in the pre-COVID cohort and 7.63 (4.37) mm in the intra-COVID cohort, with stones being more commonly found on the left side (pre-COVID: 57.4%, intra-COVID: 56.8%).

Patients in the intra-COVID group were associated with having prolonged time from presenting to the ED until OR (ρ=0.204, p=0.040) (Table 5). Patients categorized as ASA "E" septic stone cases were associated with greater frequency of requiring vasopressors for blood pressure support when compared to other ASA scores (ρ=0.200, p=0.03). Patients requiring ICU admis-

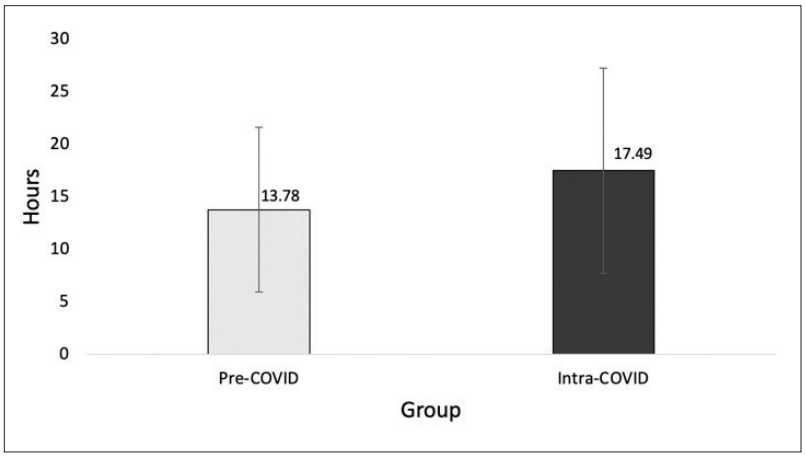

Figure 1. Time to emergency department to operating room based on COVID group.

Table 3. Emergency department patient presentation characteristics

Patient demographics	Pre-COVID (n=54)	Intra-COVID (n=74)	p
	Mean (SD)/median [range]		
WBC	15.67 (7.09)	14.768 (7.65)	0.274
Creatinine	113.0 [341.0]	116.0 [265]	0.718
Temperature	38.07 (1.00)	38.26 (0.93)	0.371
Systolic blood pressure	133.82 (26.08)	127.15 (26.36)	0.394
Diastolic blood pressure	79.28 (15.53)	75.02 (14.15)	0.270
Heart rate	101.63 (20.99)	102.02 (21.19)	0.930
Respiratory rate	20.84 (5.51)	19.87 (3.88)	0.710
O_2 saturation	97.37 (1.79)	96.27 (2.84)	0.056
Time to CT scan	4.69 [25.9]	5.29 [41.97]	0.218
Time to operating room (hours)	13.78 (7.83)	17.49 (9.75)	**0.041**

CT: computed tomography; SD: standard deviation; WBC: white blood cells.

Table 4. Overview of renal and stone-based factors

Renal parameters	Pre-COVID (n=54) n (%)	Intra-COVID (n=74) n (%)	p
Stone side			0.531
Left	31 (57.4)	42 (56.8)	
Right	23 (42.6)	30 (40.5)	
Stone location			0.628
Ureterovesical junction	14 (26.4)	12 (16.7)	
Distal	10 (18.9)	18 (25.0)	
Proximal	12 (22.6)	26 (36.1)	
Pelvis	2 (3.8)	2 (2.8)	
Ureteropelvic junction	12 (22.6)	10 (13.9)	
Mid	3 (5.7)	4 (5.6)	
Solitary kidney			0.206
Yes	3 (5.6)	1 (1.4)	
No	51 (94.4)	72 (98.6)	
Hydronephrosis			0.234
Yes	49 (96.1)	64 (94.1)	
No	2 (3.9)	4 (5.9)	
	Median [range]		
Stone size (mm)	7.00 [19]	6.00 [27]	0.615

Table 5. Correlation analysis between patient and perioperative factors

Patient factors	Age	ASA	OR booking level	Cr	Vasopressor use	Stone size	ICU requirement	LOS
Age								
Coefficient	–	**0.328**	**-0.178**	**0.271**	**0.216**	**0.205**	**0.206**	**0.334**
p	–	**<0.001**	**0.045**	**0.002**	**0.017**	**0.024**	**0.020**	**<0.001**
ASA								
Coefficient	**0.328**	–	**-0.243**	**0.356**	**0.315**	0.125	**0.342**	**0.393**
p	**<0.001**	–	**0.006**	**<0.001**	**<0.001**	0.173	**<0.001**	**<0.001**
OR booking level								
Coefficient	**-0.178**	**-0.243**	–	-0.131	**-0.338**	-0.032	**-0.337**	**-0.200**
p	**0.045**	**0.006**	–	0.145	**<0.001**	0.730	**<0.001**	**0.026**
Cr								
Coefficient	**0.271**	**0.356**	-0.131	–	**0.243**	-0.068	**0.227**	**0.240**
p	**0.002**	**<0.001**	0.145	–	**0.007**	0.463	**0.011**	**0.007**
Vasopressor use								
Coefficient	**0.216**	**0.315**	**-0.338**	**0.243**	–	0.118	**0.716**	**0.318**
p	**0.017**	**<0.001**	**<0.001**	**0.007**	–	0.209	**<0.001**	**<0.001**
Stone size								
Coefficient	**0.205**	0.125	-0.032	-0.068	0.118	–	0.157	-0.055
p	**0.024**	0.173	0.730	0.463	0.209	–	0.085	0.547
ICU requirement								
Coefficient	**0.206**	**0.342**	**-0.337**	**0.227**	**0.716**	0.157	–	**0.347**
p	**0.020**	**<0.001**	**<0.001**	**0.011**	**<0.001**	0.085	–	**<0.001**
LOS								
Coefficient	**0.334**	**0.393**	**-0.200**	**0.240**	**0.318**	-0.055	**0.347**	–
p	**<0.001**	**<0.001**	**0.026**	**0.007**	**<0.001**	0.547	**<0.001**	–

Bolded values are statistically significant. ASA: American Society of Anesthesiologists; Cr: creatinine; ICU: intensive care unit; LOS: length of stay; OR: operating room.

sion postoperatively were associated with being older (ρ=0.206, p=0.02), having higher ASA scores (ρ=0.342, p<0.0001), and having more urgent OR booking levels (ρ=0.337, p<0.0001). These patients additionally had increased creatinine values (ρ=0.227, p=0.01) and had higher heart rates and lower blood pressures, often requiring vasopressor support (ρ=0.716, p< 0.0001). Patients requiring ICU admission correspondingly were associated with having increased length of hospital stay (ρ=0.347, p<0.0001). Patient mortality was also associated with patients requiring vasopressors (ρ=0.248, p=0.006).

The intra-COVID group had 20 more cases of septic stone presentations when compared to the pre-COVID group at the 15-month mark (pre-COVID: n=54, intra-COVID: n=74). No statistically significant difference was found when comparing the proportion of septic stone presentations identified as ASA emergency cases between the two groups (pre-COVID: 21/54 (38.8%), intra-COVID: 26/74 (35.1%), p=0.663). Although not statistically significant, it is notable that there were decreased cases of septic stone presentations in the initial 7.5 months in the intra-COVID cohort, with increased total case numbers in the following quarter (Figure 2) (p=0.833).

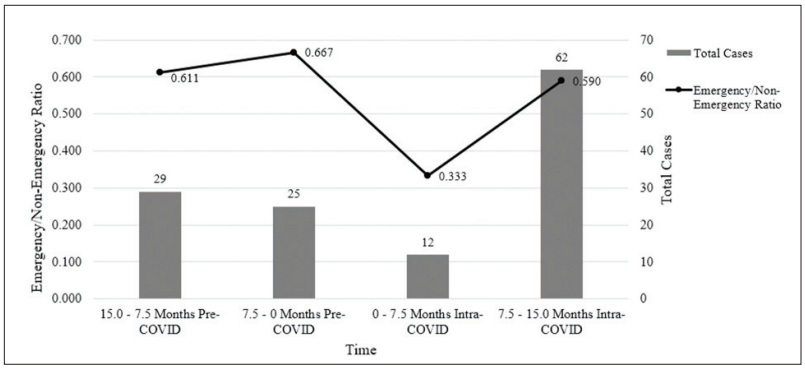

Figure 2. Graphical representation of total urgent and emergent febrile stones (right axis) and the ration of those labeled American Society of Anesthesiologists (ASA) emergency ("E") to those not labeled ASA "E" on the left axis.

DISCUSSION

This study provides insight into the quantitative impact of reduction in healthcare delivery during the COVID-19 pandemic and the rates of febrile/critically ill patients with ureteric stones. Sepsis is often a life-threatening state and is one of the most common causes of morbidity in patients with urolithiasis.[12] A recent systematic analysis reported higher overall complication rates in patients with urinary calculi during the COVID-19 pandemic.[13] The analysis found mixed results in comparing the rates of emergency surgical intervention for ureteric calculi, with one study demonstrating an increased proportion of stented patients, and two studies demonstrating lower rates.[9-11] In addition, the systematic review by Shivakumar et al found no overall increase in the rates of fever or urosepsis during the pandemic.[13] In this Canadian study, we demonstrated an increase in total presentations of febrile and/or septic stones to the ED at our institution during the COVID-19 pandemic, albeit with no statistical difference in those labeled as ASA "E" cases.

Men were more likely to present with febrile stones, which is consistent with stone disease literature showing increased incidence in male patients. Intra-COVID patients more often required ICU and IMCU level care in the postoperative period than just floor care when compared to pre-COVID patients, potentially indirectly signaling more clinically severe septic stones during the COVID-19 era. It is also possible that the worsening presentations of other medical conditions due to deferred care in the intra-COVID period may have shifted the evaluation of emergency level care in the intra-COVID patient group. This may explain the increase in ICU and IMCU-level postoperative care in the intra-COVID cohort.

There were no differences in the total number of cases presenting to the ED when comparing the pre-COVID and intra-COVID cohorts all together. Despite this, there was a substantially greater number of cases in the later half (7.5–15 months) of the intra-COVID group when compared to the first 7.5 months (62 vs. 12, respectively). Although the ratio of emergency/non-emergency cases did not increase between the pre-COVID and intra-COVID groups, it is likely that implementation of COVID restrictions and changes in care deferred patients with stone disease from presenting to the ED. This aligns with the perception that restrictions on in-person visits, laboratory tests (e.g., urinalysis), and fear of contracting COVID-19 gave rise to a larger number of patients presenting later to the ED with acute stone disease when these cases could have been handled more effectively without the delays and restrictions.

With the restricted access to resources, the time to the OR from presentation to the ED was greater in the intra-COVID group. The exact cause(s) of this are unknown but may be related to longer timelines for screening precautions at triage; wait time and delays associated with COVID-19 test results; transportation delays from peripheral hospitals due to limited ambulance and inpatient bed resources; and decreased OR, physician, and nursing resources.

Limitations

This study has some limitations. First, the restrictions imposed in the province of NS were likely not the same across the world or within Canada, and thus the results may not be widely generalizable. To best represent the impact of COVID-19 on the healthcare system, data collection started from July of 2020 to ensure that the effects of government healthcare restrictions had taken place, although it is possible that the full effect of delayed healthcare was still not entirely evident at this point.

CONCLUSIONS

Overall, this study provides insight into the impacts that restricted access to healthcare, investigations, and procedures in patients suffering from urolithiasis had in NS, Canada. With a restricted and overwhelmed healthcare system, the increased number of urgent and/or critically ill patients seen in the latter half of the intra-COVID cohort may have been preventable with more access to investigations and earlier care, as seen in the pre-COVID era.

This study demonstrated an increased time to operative intervention in the intra-COVID cohort compared to the pre-COVID cohort. The overall number

of urgent and/or critically ill ureteric stone patients increased between cohorts but was not deemed statistically significant.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

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