

**Original Article: Clinical Investigation****An Italian multicenter analysis of emergency admissions and treatment of upper tract urolithiasis during the lockdown and reopening phases of the COVID-19 pandemic: Are we ready for a second wave of the outbreak?**

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**Abbreviations & Acronyms**

AKI = acute kidney injury  
AOP = acute obstructive pyelonephritis  
CI = confidence interval  
COVID-19 = coronavirus disease-19  
CT = computed tomography  
ED = emergency department  
OR = odds ratio

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**Objectives:** To assess if the lockdown period (March–April 2020) during the coronavirus disease-19 outbreak in Italy influenced the number, presentation, and treatment of urgent admissions to the emergency department for ureteral lithiasis, and to evaluate the same variables during the reopening phase (May–June 2020).

**Methods:** We performed a retrospective analysis of patients admitted to the emergency department of three different hospitals (two coronavirus disease-19 hubs). Demographics and data on acute pyelonephritis, acute kidney injury, urinoma, hematuria, inpatient admission/discharge home, and type of treatment were gathered and compared with the same periods in 2019.

**Results:** A total of 516 patients were admitted during the study period, of whom 62.4% were male. Their mean age was  $58.86 \pm 16.24$  years. The number of admissions decreased significantly, by 51.25% ( $P = 0.003$ ), during lockdown compared to 2019 (78 vs 160 admissions). The number of admissions in the reopening phase (May–June 2020) was in line with that in 2019 ( $n = 138$ ). The number of hospitalizations ( $P = 0.005$ ), acute obstructive pyelonephritis ( $P = 0.019$ ), and complications ( $P = 0.02$ ) was statistically significantly higher during lockdown compared to 2019. The increase in the rate of surgical procedures nearly reached significance ( $P = 0.059$ ). The odds of having complications and being hospitalized were almost fivefold (odds ratio 4.68, 95% confidence interval 1.98–11.07) and twofold greater (odds ratio 2.39, 95% confidence interval 1.29–4.43) compared to the same period in 2019. No difference was noted between May–June 2020 and 2019.

**Conclusion:** The coronavirus disease-19 lockdown period provoked a meaningful reduction in symptomatic ureteral lithiasis admission. Most patients presented with complicated disease, which required an increased rate of interventional procedures compared to the equivalent period in 2019. Admissions reverted to normal levels during the reopening phase.

**Key words:** COVID-19, emergency service, hospital, patients admission, ureteral calculi, urolithiasis.

**Introduction**

On 11 March 2020, the World Health Organization declared the COVID-19 outbreak to be a pandemic.<sup>1</sup> From that date, there were significant reductions worldwide in urology department services and surgical procedures, and benign diseases were the most affected.<sup>2</sup> However, upper urinary tract lithiasis is far from a true “benign” condition, since an obstructed kidney can develop severe complications, such as acute renal failure, infection, and sepsis. Furthermore, the latter can be life-threatening if an urgent collecting system decompression is not performed in a timely manner.<sup>3</sup> A survey among experts in urolithiasis carried out during the peak of the COVID-19 outbreak in Europe evidenced that the workload of outpatient clinics

decreased by >50% and stone patients presented to the ED with more severe conditions (acute renal failure and pyelonephritis).<sup>4</sup> Moreover, standard stone treatment was reported as modified by 91.3% of the responders.<sup>4</sup>

The Italian population experienced a national lockdown in March and April 2020 as a consequence of a COVID-19 outbreak that was, at that time, the most severe after that in China.<sup>5</sup> The spread of the epidemic in Italy had a huge impact on the national healthcare system, with the increasing requirement to meet COVID-19 patients' care needs. Many hospitals were dedicated to COVID-19 treatments, and ED, subintensive and intensive care beds were full with COVID-19 pneumonia patients. Furthermore, anesthesiologists were involved mostly in caring for COVID-19 patients. Consequently, elective surgeries and outpatient clinics for benign conditions, such as urolithiasis, were interrupted<sup>6</sup> and urgent surgery was also reduced in non-COVID-19 hospitals.<sup>7</sup> During the COVID-19 lockdown, there was a reduction in ED admissions for urolithiasis, associated with increased complication rates and worse clinical presentation, which led to the anticipation of a possible overload of complicated cases in the following months.<sup>8</sup>

The reopening phase after the lockdown in Italy started gradually in May 2020. To date, no studies have evaluated the trend in ED admissions, clinical presentation, hospitalization, and treatment for upper tract stone disease during the reopening phase.

The present study aimed to assess whether the COVID-19 outbreak peak in Italy influenced the number of ureteral stone disease ED admissions, clinical presentations, hospitalizations, and treatments in three hospitals with different patient volumes. We also aimed to evaluate whether the same variables had returned to normal levels during the reopening phase.

## Methods

We performed a retrospective analysis on all patients with ureteral stone disease admitted to the ED of three Italian hospitals, with different patient volumes, during the COVID-19 lockdown period (March–April 2020) and the reopening phase (May–June 2020). The centers involved were Hospital A (COVID-19 hub), Hospital B (non-COVID-19 hub), and Hospital C with 1500, 185, and 65 beds, respectively. Both Hospitals A and B are tertiary referral centers for urolithiasis.

Ureteral lithiasis was confirmed with an abdomen ultrasonography, plain abdomen X-ray, or low-dose CT. All patients with renal colic but without ureteral stones were excluded from the study. Patients presenting with impacted stones in the ureteropelvic junction were also included. We gathered the following data: age, sex, presence of urinoma, AKI, hematuria and AOP, and admission/discharge home.

AKI was defined as a sudden decrease in kidney function in the presence of any of the following: (i) an increase in serum creatinine by  $\geq 0.3$  mg/dL within 48 h; (ii) diuresis  $\leq 0.5$  mL/kg/h for 6 h; (iii) a  $\geq 1.5$ -fold increase in serum creatinine compared to baseline, which is known or presumed to have occurred within the previous 7 days.<sup>9</sup>

AOP was diagnosed in the simultaneous presence of (i) hydronephrosis; (ii) body temperature  $\geq 38^\circ\text{C}$ ; and (iii) pyuria.<sup>10</sup> A negative urine culture was allowed since, in many cases, antibiotic therapy was started in ED before urological consultation.

In the case of admission to the urology ward, surgical treatment was also included (lithotripsy, ureteral stent, or percutaneous nephrostomy placement). Patient management was carried out in accordance with the current guidelines.<sup>11</sup>

Demographics and clinical data were reported on a standardized study Excel proforma. The total number of ED admissions for ureteral stones, the number of patients hospitalized, and the type of treatment received was also reported. The collected data were analyzed and compared with the same period in 2019. Finally, we performed a further analysis comparing data from the end of the lockdown period (May–June 2020) with the same period in 2019.

## Statistical analysis

Age was reported as mean  $\pm$  SD. Comparison of variables between study periods was performed using one-way analysis of variance. Categorical variables were expressed as absolute number and percentage, and statistical significance was analyzed using Pearson's chi-squared test. Variables with significant difference at descriptive statistics were selected for binary logistic regression models to estimate the association between study periods and outcomes. Two-tailed *P* values  $< 0.05$  were taken to indicate statistical significance. Data were analyzed using STATA version 15.1 (StataCorp, College Station, TX, USA).

The study was approved by the INRCA Ethical Board (number 141-DGEN 2020). All patients signed informed consent. The original data from this study are available at *Mendeley Data* (<https://data.mendeley.com/datasets/7r9rymybwc/1>).

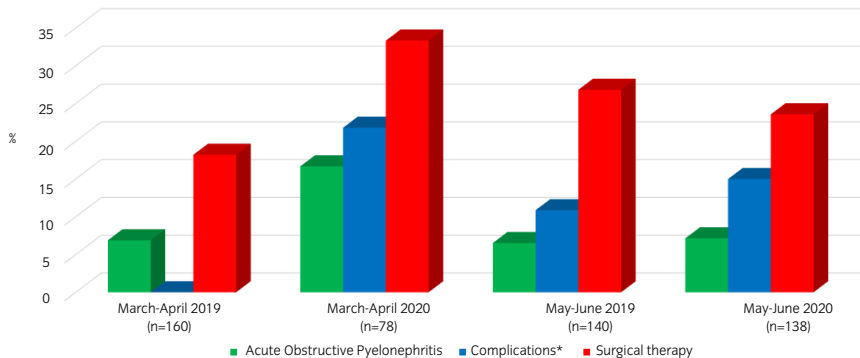
## Results

Table 1 shows the ED admissions and clinical characteristics of patients with ureteral lithiasis during the study period (March–April 2020 vs March–April 2019 and May–June 2020 vs May–June 2019).

Overall, 516 patients were admitted to the ED for ureteral lithiasis, of whom 322 (62.4%) were male, and 394 (76.36%) were discharged home with medical therapy. Their mean age was  $58.86 \pm 16.24$  years. In the period March–April 2019, 160 patients were admitted to the ED, and this was in line with the number of admissions in May–June 2019 ( $n = 138$ ) and 2020 ( $n = 140$ ). Conversely, the number of total admissions decreased by 51.25% during the COVID-19 lockdown compared to the same period in 2019 (78 vs 160; Fig. 1; Table 1). This reduction was statistically significant ( $P = 0.003$ ). Likewise, the number of hospitalized patients ( $P = 0.005$ ), AOP cases ( $P = 0.019$ ), and complications ( $P = 0.02$ ) was statistically significantly higher during March–April 2020 compared to 2019 (Fig. 1; Table 1). Conversely, the data analysis comparing May–June 2020 and May–June 2019 showed no difference in terms of hospitalization, AOP cases, and complications (Table 1). No hospitalized stone

**Table 1** ED admissions and clinical characteristics of patients with ureteral lithiasis during the study periods

	All <i>n</i> = 516	March–April 2019 <i>n</i> = 160	March–April 2020 <i>n</i> = 78	<i>P</i>	May–June 2019 <i>n</i> = 138	May–June 2020 <i>n</i> = 140	<i>P</i>
Center, <i>n</i> (%)				0.003			0.010
Hospital C	54 (10.47)	11 (6.88)	11 (14.10)		17 (12.32)	15 (10.71)	
Hospital B	191 (37.02)	51 (31.88)	37 (47.44)		39 (28.26)	64 (45.71)	
Hospital A	271 (52.52)	98 (61.25)	30 (38.46)		82 (59.42)	61 (43.57)	
Sex, <i>n</i> (%)				0.602			0.980
Male	322 (62.40)	106 (66.25)	49 (62.82)		83 (60.14)	84 (60.00)	
Female	194 (37.60)	54 (33.75)	29 (37.18)		55 (39.86)	56 (40.00)	
Age, years (mean ± standard deviation)	54.86 ± 16.24	59.33 ± 15.36	57.44 ± 15.08	0.855	52.75 ± 16.48	50.39 ± 16.20	0.843
Hospitalization, <i>n</i> (%)				0.005			0.140
Discharged	394 (76.36)	131 (81.88)	51 (65.38)		100 (72.46)	112 (80.00)	
Admitted	122 (23.64)	29 (18.13)	27 (34.62)		38 (27.54)	28 (20.00)	
AOP, <i>n</i> (%)				0.019			0.837
No	473 (91.67)	149 (93.13)	65 (83.33)		129 (93.48)	130 (92.86)	
Yes	43 (8.33)	11 (6.88)	13 (16.67)		9 (6.52)	10 (7.14)	
Complications, <i>n</i> (%)				0.002			0.266
No	454 (87.98)	151 (94.38)	61 (78.21)		123 (89.13)	119 (85.00)	
AKI	38 (7.36)	4 (2.50)	11 (14.10)		9 (6.52)	14 (10.00)	
Urinoma	20 (3.88)	4 (2.50)	5 (6.41)		4 (2.90)	7 (5.00)	
Hematuria	4 (0.78)	1 (0.63)	1 (1.28)		2 (1.45)	0 (0.00)	
Therapy, <i>n</i> (%)				0.059			0.927
Medical	391 (75.78)	131 (81.88)	52 (66.67)		101 (73.19)	107 (76.43)	
Lithotripsy	58 (11.24)	12 (7.50)	13 (16.67)		17 (12.32)	16 (11.43)	
Stent	55 (10.66)	12 (7.50)	10 (12.82)		18 (13.04)	15 (10.71)	
Nephrostomy	12 (2.33)	5 (3.13)	3 (3.85)		2 (1.45)	2 (1.43)	

**Fig. 1** ED admission, complications and surgical therapy for ureteral stone disease. \*Urinoma, AKI, hematuria.

patients tested positive for severe acute respiratory syndrome coronavirus 2.

Binary logistic regression confirmed that during March–April 2020, patients were admitted to the ED with more complicated clinical presentations (Table 2). The odds of having complications and being hospitalized were almost fivefold (OR 4.68, 95% CI 1.98–11.07) and twofold greater, respectively (OR 2.39, 95% CI 1.29–4.43), compared to the same period in 2019.

Regarding treatment (medical therapy vs lithotripsy/upper tract drainage), the incidence of surgical procedures between March–April 2019 and 2020 differed with an increasing trend during the lockdown (18.12% vs 33.33%, respectively) even if the difference did not reach significance ( $P = 0.059$ ). Conversely, we recorded no difference in treatment rates ( $P = 0.927$ ) during the reopening phase (May–June 2020) compared to the same period in 2019 (Fig. 1; Table 1).

## Discussion

Urolithiasis is a frequent condition that urologists are faced with on a daily basis, and renal colic is a frequent cause of presentation to the ED.<sup>12</sup> The rate of ED admissions for renal colic in Italy was reported to be as high as 1.5% of all annual visits<sup>13,14</sup> and is in line with that reported in the United States and Asia.<sup>15,16</sup> Urolithiasis therefore has a substantial impact on ED workload.

The present study showed a reduction of 51.25% in total ED admissions for symptomatic ureteral stones in three Italian hospitals with different volumes during the COVID-19 lockdown (March–April 2020) compared to the corresponding period in 2019. The reduction was higher in both COVID-19 (69.4% in Hospital A) and non-COVID-19 hub (27.4% in Hospital B). However, the admission difference was more evident in the COVID-19 hospital, where the impact of the outbreak was more

**Table 2** Binary logistic regression of clinical characteristics of patients admitted to the ED for upper urinary tract stone disease during the COVID-19 lockdown phase (March–April 2020) and March–April 2019

Clinical outcomes (no: ref.)	March–April 2020 (baseline: March–April 2019)	
	OR (95% CI)	P-value
AOP	2.71 (1.15–6.37)	0.022
Complications†	4.68 (1.98–11.07)	0.001
Hospitalization	2.39 (1.29–4.43)	0.006
Lithotripsy	2.47 (1.07–5.70)	0.035

†Urinoma, AKI and hematuria.

significant. The reduction of hospitalizations in the COVID-19 era was also substantial in other areas of medicine in Italy. For example, in a study involving centers from all over the country, De Rosa *et al.* observed a 48.4% reduction in admissions for acute myocardial infarction.<sup>17</sup> A parallel increase in complications was also registered, with a concomitant increase in mortality compared to the same period in 2019.<sup>17</sup>

During the reopening phase (May–June 2020), the rate of admissions and complicated cases was similar to that in 2019. This finding supports the hypothesis that the COVID-19 lockdown caused a meaningful reduction in ED admissions for ureteral lithiasis in Italy. Gul *et al.* confirmed our results, showing decreased access by 69.3% in Turkey during the COVID-19 pandemic era (35 patients) compared to the previous year (114 patients).<sup>18</sup> An important reduction was also reported in the United States.<sup>19</sup> Conversely, a study in a small series in Italy showed no change in the COVID-19 period, but patients had significantly higher serum creatinine levels on admission.<sup>20</sup>

The results of the present study highlight another significant outcome. During the COVID-19 period, compared to the period March–April 2019, patients attending the ED had more severe clinical presentations, which is highlighted by the higher OR for complications (urinoma, hematuria and AKI). Consequently, there were higher rates of hospitalization (34.63% vs 18.13%) and interventional procedures (33.33% vs 18.12%) during the COVID-19 period. Conversely, in the reopening phase, the admission rate and clinical presentations were similar to those in the same period in 2019, and the expected overload of complicated cases in the months following the lockdown was not demonstrated.<sup>8</sup> That said, we can assume that the COVID-19 lockdown led to an increasing rate of complicated ureteral stone disease that required more interventional procedures compared to the corresponding period in 2019. Our findings are in line with the study by Gul *et al.*, which also demonstrated that serum creatinine levels, white blood cell counts, and number of interventional procedures were significantly higher in the COVID-19 lockdown period.<sup>18</sup>

The higher incidence of complicated ureteral stone disease in the COVID-19 lockdown period could be partially explained by patients' fear of becoming infected with COVID-19, leading to delayed presentation at the hospital. Romantini *et al.* described a life-threatening case of bilateral urolithiasis that required two urgent hemodialysis sessions and bilateral drainage of the collecting system.<sup>21</sup> The patient reported 7 days of long-lasting

anuria and did not seek medical attention due to the fear of becoming infected. Of the 35 patients analyzed by Gul *et al.*, 18 presented late to the ED, mostly as a result of the fear of COVID-19 transmission (62%) and postponable cases (21%).<sup>18</sup> The Italian lockdown was a necessary and inevitable action to reduce the spread of infection but at the same time produced an environment of fear of getting infected with COVID-19 in case of non-COVID-19-related hospital visits. The latter was highlighted by Mantica *et al.*, who demonstrated that the ED visits for non-COVID-19 symptoms reached their lowest peak in two northern Italian hospitals, at the time of the highest peak in the COVID-19 daily mortality course. The reduction in COVID-19 mortality turned in an upward trend in non-COVID-19 ED visits. Italian public healthcare system provides free of charge ED access for everybody and not only for residents and citizens. Hospitalization from the ED is also free of charge. Thus, the reduction of ED access, as shown by Mantica *et al.*, was doubtless associated with the fear of being infected. As a matter of fact, these findings can be interpreted in two ways: (i) an overuse of Italian EDs by cases of low complexity during normal times; (ii) an alarming tendency to postpone consultations, even when necessary, because of the fear of getting infected with COVID-19 on the other hand.

At the time of submission of the present paper, European countries, especially Italy, France, Spain, and the UK, are facing an increasing number of people becoming infected with COVID-19, and a possible further wave of massive hospital admission of pneumonia patients.<sup>22,23</sup> Sadly, a new lockdown might be around the corner, and consequently, urologists have to be prepared to face another era of complicated urolithiasis presentation. Hence, stone management in a second COVID-19 era needs to be modified accordingly.

Stone triage should be the first step, screening patients according to urgent need for surgical treatment. Metzler *et al.* suggested categorizing patients into five groups, ranging from emergent (life-threatening) cases that require immediate collecting system drainage to postponable cases (asymptomatic non-obstructing stone), which can be delayed, avoiding hospitalization in overwhelmed hospitals.<sup>24</sup>

Low-dose CT should be the preferred diagnostic test if an interventional procedure is planned because, if this shows foci with ground-glass appearance at the base of the lungs, it can reveal asymptomatic COVID-19 infection.<sup>25</sup>

Urgent endourological stone surgery must be different for confirmed/suspected COVID-19 patients, who have to be managed in a dedicated operating room with a negative pressure environment.<sup>26</sup> Ureteral stent positioning or percutaneous nephrostomy should be preferred over ureteroscopy and stone fragmentation to reduce the operative time.<sup>26</sup> Spinal anesthesia should be employed to avoid the need for ventilation and aerosol generation.<sup>26</sup>

Another important point to raise is running outpatient stone clinics that were severely affected worldwide during the first pandemic wave.<sup>2</sup> Telemedicine could be the answer because it is very helpful in keeping more patients at home reducing virus transmission and guaranteeing at the same time an adequate patient care and screening. Moreover, the virtual clinic is also safer for both patients and healthcare workers than traditional face-to-face consultation during this pandemic.<sup>27</sup>

The present study has some limitations, the first of which is its retrospective nature. Second, it was a multicenter study with a lack of standardization in treatment decisions. However, the definition of AKI and AOP was standardized, and all centers adopted an international standard of care on urolithiasis.<sup>11</sup> Third, stone size was not taken into account in the analysis because of the lack of homogeneity in the imaging techniques (abdomen ultrasound, plain abdomen X-ray, or low-dose CT) performed during the lockdown and reopening phases that would have made size comparison among the centers and between study periods not reliable. Indeed, in COVID hubs many patients did not undergo CT scan because CT was mainly dedicated to COVID-19 patients. Finally, a further wave of COVID-19 might have a different impact on the Italian population and healthcare system, which might not replicate the situation faced in March–April 2020.

In conclusion, the COVID-19 lockdown period led to a significant reduction of symptomatic ureteral lithiasis admission to the ED in three Italian hospitals with different patient volumes. Most patients presented with complicated disease as a result of delayed presentation, which required an increased rate of interventional procedures compared to the equivalent period in 2019. ED admission and clinical severity returned to standard levels during the reopening phase. Urologists should be prepared to face a possible second wave of the COVID-19 outbreak, screening patients according to urgency of their need for treatment.

## Conflict of interest

None declared.

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