



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

## Comparison of Management and Outcomes of Symptomatic Urolithiasis During the COVID-19 Pandemic to a Comparative Cohort



Alex Nourian, Curran Uppaluri, Michelle Chen, Eric M. Ghiraldi, and Justin I. Friedlander

<b>OBJECTIVE</b>	To analyze the clinical presentation and outcomes for patients who presented with symptomatic urolithiasis during the initial months of the COVID-19 pandemic.
<b>METHODS</b>	We retrospectively reviewed Emergency Department (ED) presentations from a Philadelphia healthcare system for symptomatic urolithiasis between March and June 2020 and compared these with presentations for the same time period from the year prior. Patient demographics, stone characteristics, management, and clinical outcomes were compared between the 2 years.
<b>RESULTS</b>	One hundred and thirty-nine patients presented during 2020 compared to 269 in 2019. There were fewer patients who presented during the initial COVID-19 pandemic surge who had obesity (37.41% vs 49.44%, $P = .024$ ), hyperlipidemia (18.71% vs 31.60, $P = .006$ ), and asthma (5.76% vs 16.73%, $P = .002$ ). Although overall stone characteristics did not differ between the 2 groups, a larger proportion of patients in 2020 presented with an obstructing stone (81.16% vs 64.1%, $P = .001$ ). Patients who presented during the COVID-19 pandemic did not have higher rates of infection, acute kidney injury, or complications. Rates of surgical modalities, emergent procedures, and discharges from the ED were similar between the 2 years.
<b>CONCLUSION</b>	The COVID-19 pandemic initial surge resulted in fewer ED presentations for symptomatic urolithiasis; however, patients who did present were more likely to have obstructing stones, perhaps due to delaying presentation to avoid COVID-19 exposure in the ED. Despite higher rates of obstruction, clinical outcomes and morbidity were similar. UROLOGY 165: 178–183, 2022. © 2022 Elsevier Inc.

Symptomatic renal colic due to urolithiasis is a common Emergency Department (ED) complaint, accounting for 2 million yearly ED visits in the United States and costing the healthcare system more than \$10 billion annually.<sup>1,2</sup> The prevalence of urolithiasis has been increasing with 1 in 11 individuals experiencing an event in their lifetime.<sup>3</sup> Obstructive pyelonephritis is a feared complication that may result in mortality if not treated promptly with urinary decompression.<sup>4</sup> The urgency and method of treatment is nuanced, depending on the acuity of presentation, the duration of symptoms, and the likelihood of future healthcare utilization.

The novel coronavirus disease 2019 (COVID-19) was declared a global pandemic on March 11, 2020 and a

national emergency in the United States on March 13, 2020. During the initial months of the pandemic, there was a dramatic reduction in patient presentations to the ED.<sup>5,6</sup> For patients, fears of contracting COVID-19 may have led to a delayed and more severe presentation of the disease when symptoms became intolerable.<sup>5</sup> It is unknown whether patients who presented with symptomatic urolithiasis during the early stages of the pandemic suffered greater morbidity and mortality. In this study, we aimed to analyze the clinical presentation and outcomes for patients who presented with symptomatic urolithiasis during the initial months of the COVID-19 pandemic.

### METHODS

A retrospective chart review was performed to identify patients who presented to the ED within the Einstein Healthcare Network (EHN) between March 1, 2020 through June 30, 2020 and were diagnosed with symptomatic urolithiasis. A comparative cohort with symptomatic urolithiasis presentations during the same time-period in 2019 was also reviewed. The EHN consists of 3 hospitals, Albert Einstein Medical Center (AEMC) in North Philadelphia, a large urban community hospital, and 2

Availability of data and material: <https://doi.org/10.6084/m9.figshare.14757918>.

Financial Disclosure: The authors declare that they have no relevant financial interests.

From the Einstein Healthcare Network, Department of Urology, Philadelphia, PA; and the Fox Chase Cancer Center, Division of Urologic Oncology and Urology, Philadelphia, PA.

Address correspondence to Justin I. Friedlander, M.D. Einstein Healthcare Network, Department of Urology, 1200 Tabor Road, 3rd Floor Sley Building, Philadelphia, PA 19141. E-mail: [friedlaj@einstein.edu](mailto:friedlaj@einstein.edu)

Submitted: June 24, 2021, accepted (with revisions): January 9, 2022

smaller community hospitals located in suburban Philadelphia-Einstein Elkins Park and Einstein Montgomery. The following International Classification of Diseases codes were used to identify patients: N13.2, N20.0, N20.1, N20.2, N20.9, N21.0, N21.8, N21.9, N22.

Data extracted from the electronic medical record included patient demographics, insurance status, body-mass index, and past medical history. Patient stone characteristics were evaluated including the stone history, number of stones, maximum stone size, and presence of an obstructing stone (a stone in the ureter with resulting dilation). We identified whether patients presented with a temperature over 38 degrees Celsius, and evaluated ED labs including the white blood cell (WBC) count, the urinalysis, and presence of a positive urine culture.

We determined whether the urology service evaluated the patient, the disposition of the patient from the ED, and whether a surgical procedure was performed during the admission and if it was done emergently (within 6 hours of presentation). The frequency of patients returning to the ED within 30 days was recorded, as well as the subsequent disposition (discharge, admission, vs surgery). The complication rate and frequency of acute kidney injury (AKI), defined as an increase of 0.3 mg/dL of the serum creatinine in the last 48 hours or 1.5 times the patient's baseline value, were recorded.

Bivariate analysis using Fisher's exact test (for binary variables) and unpaired t-tests (for continuous variables) were used for statistical analysis. All analyses were performed using Stata Version 15 (College Station, TX). A  $P < .05$  was used to indicate statistical significance. Approval from our institution review board was obtained to perform this study.

## RESULTS

### Demographics and Patient Characteristics

139 patients presented with symptomatic urolithiasis between March and June 2020 compared to 269 patients during the same time in 2019 (Table 1, Fig. 1). There were no significant differences between the 2 groups with respect to the average age, gender, insurance status, and primary language. There were fewer patients who presented during the initial COVID-19 pandemic surge who had obesity (37.41% vs 49.44%,  $O = 0.024$ ), hyperlipidemia (18.71% vs 31.60%,  $P = .006$ ), and asthma (5.76% vs 16.73%,  $P = .002$ ).

### Stone Characteristics

The stone burden and stone history were similar between the 2 groups (Table 2). There were fewer patients during the pandemic surge who had previously passed a stone, although this difference was not statistically significant (32.23% vs 43.06%,  $P = .051$ ). During the pandemic surge, a larger proportion of patients presented with an obstructing stone (81.16% vs 64.1%,  $P = .001$ ), however there were fewer patients who presented with a staghorn calculus (0.72% vs 4.35%,  $P = 0.047$ ).

### Clinical Outcomes

Labs at presentation were overall similar between the 2 years (Table 3). There was a higher rate of patients during the pandemic surge who had bacteria present on their urinalysis (64.8% vs 33.94%,  $P < .001$ ), however the rate of positive urine cultures was similar (9.42% vs 11.33%,  $P = .558$ ). The proportion of patients who presented with a fever, AKI, and whom were discharged directly from the ED were similar in 2019 and 2020.

There were no significant differences between patients in 2020 vs 2019 when comparing rates of surgery upon presentation: nonsurgical management (84.06% vs 85.50%), ureteral stent placement (6.47% vs 7.06%), percutaneous nephrostomy tube placement (2.16% vs 1.86%), and ureteroscopy (7.91% vs 5.58%). For patients who underwent initial decompression (stent or nephrostomy tube), the time in days to definitive stone management was non-significantly elevated for the COVID group ( $32.45 \pm 25.79$  vs  $25.86 \pm 22.95$ ,  $P = .46$ ). Both groups suffered from few complications. In 2020, the complications consisted of gross hematuria ( $n = 1$ ), hyperkalemia due to antibiotic prescribing ( $n = 1$ ), and one patient who re-presented with an AKI and urinary tract infection (UTI) ( $n = 1$ ). Whereas in 2019, the complications consisted of postoperative sepsis ( $n = 1$ ), UTI requiring home intravenous antibiotics ( $n = 1$ ), and stent colic prompting repeated ED admissions ( $n = 3$ ).

When comparing ED stone presentations during 2020 between AEMC and the 2 other community hospitals, patients who presented to AEMC had a higher WBC count in their urinalysis ( $24.51 \pm 52.58$  vs  $9.96 \pm 23.68$ ,  $P = .048$ ), a higher proportion of nitrite positive urinalyses (7.5% vs 0%,  $P = .006$ ) and fevers (5% vs 0%,  $P = .025$ ). There were no significant differences with respect to the serum WBC, other urine parameters, rates of AKI, surgical management, immediate surgery, disposition from the ED, or complications.

## DISCUSSION

By the conclusion of June 2020, the city of Philadelphia had 26,133 confirmed cases and 1584 deaths due to COVID-19.<sup>7</sup> The COVID-19 pandemic disproportionately affected racial and ethnic minority groups, which is largely the patient population that AEMC serves.<sup>8</sup> By August 2020, the hospital had treated 1225 of 6682 hospitalized COVID-19 patients in Philadelphia, the most of any hospital within the city. The high volume of COVID-19 at AEMC is reflected by the findings that patients who presented there during the pandemic had more abnormalities in their urinalyses and fevers compared to those who presented to the 2 other community hospitals, suggesting delayed presentations.

The EHN experienced a 48.33% reduction in patient presentations to the ED with symptomatic urolithiasis during the surge of the COVID-19 pandemic compared to the year before. This 48.33% reduction is much higher than reported in the literature,<sup>9-12</sup> demonstrating the impact the COVID-19 pandemic had on our community. Patients were likely hesitant to present to the ED due to fears of contracting COVID-19, whereas hospital resources gravitated towards treating COVID-19 patients.<sup>13</sup> Patients may have also utilized telephone triage services prior to seeking medical attention; these services helped guide symptom management at home and advised patients to present only with uncontrolled symptoms or evidence of infection.<sup>14</sup>

Although the overall patient demographics were similar in both years, patients during the pandemic surge had lower rates of obesity, hyperlipidemia, and asthma. Patients with pre-existing medical conditions faced greater morbidity and mortality when infected with

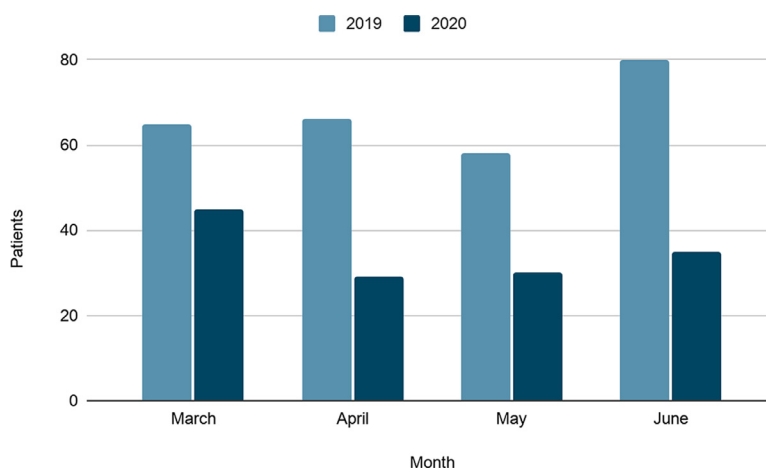
**Table 1.** Patient Demographics of Patients Presenting With Symptomatic Urolithiasis

	March-June 2019	March-June 2020	P-Value
Patients	269	139	
Age (years)	48.04 ± 15.64	48.31 ± 15.24	.870
Body-mass index (BMI)	30.72 ± 7.51	29.05 ± 6.75	.029
Obesity (BMI>30)	49.44% (132/267)	37.41% (52/139)	.024
Gender			
Male	54.28% (146/269)	61.15% (85/139)	
Female	45.72% (123/269)	38.85% (54/139)	.184
Insurance			
None	9.67% (26/269)	13.67% (19/139)	
Medicaid	38.29% (103/269)	25.18% (35/139)	
Private	36.43% (98/269)	42.45% (59/139)	
Medicare	15.61% (42/269)	18.71% (26/139)	.061
Race			
White	47.21% (127/269)	54.68% (76/139)	
AA	21.93% (59/269)	20.14% (28/139)	
Hispanic	20.45% (55/269)	15.11% (21/139)	
Asian/PI	2.23% (6/269)	6.47% (9/139)	
Indian	0.74% (2/269)	0% (0/139)	
ME	1.11% (3/269)	1.44% (2/139)	
Other/Unknown	6.32% (17/269)	2.16% (3/139)	.038
Language			
English	85.87% (231/269)	86.33% (120/139)	
Spanish	10.41% (28/269)	8.63% (12/139)	
Chinese	0.37% (1/269)	1.44% (2/139)	
Russian	0% (0/269)	0.72% (1/139)	
Arabic	0.74% (2/269)	0% (0/139)	
Other	2.60% (7/269)	2.88% (4/139)	.452
Hypertension	31.97% (86/269)	28.06% (39/139)	.416
Hyperlipidemia	31.60% (85/269)	18.71% (26/139)	.006
Diabetes	13.38% (36/269)	11.51% (16/139)	.591
Coronary artery disease	7.06% (19/269)	3.60% (5/139)	.158
Non-alcoholic steatohepatitis	1.49% (4/269)	1.44% (2/139)	.969
Asthma	16.73% (45/269)	5.76% (8/139)	.002
Chronic obstructive pulmonary disease	3.72% (10/269)	1.44% (2/139)	.197

AA, African American; ME, Middle Eastern; PI, Pacific Islander.

COVID-19, therefore these patients may have been hesitant to seek ED evaluation and risk exposure.<sup>15</sup> The pandemic cohort had significantly higher proportions of whites (54.68% vs 47.21%) and Asians (6.47% vs 2.23%), and fewer Hispanic patients (15.11% vs

20.45%). Evidence supports that minority groups such as African-Americans and Hispanics suffered worse morbidity and mortality from COVID-19 infections, potentially due to access to care, and this may have also played a role in our stone cohort.<sup>8,16</sup>



**Figure 1.** Comparison of ED symptomatic urolithiasis presentations by month in 2019 and 2020. (Color version available online.)

**Table 2.** Stone Characteristics of Patients Presenting With Symptomatic Urolithiasis

	March-June 2019	March-June 2020	P-Value
First stone event	45.53% (117/257)	47.83% (66/138)	.662
Previous passed stone	43.06% (93/216)	32.23% (39/121)	.051
Previous stone surgery	28.99% (69/238)	22.96% (31/135)	.159
Maximum stone size (mm)	6.04 ± 4.48	5.76 ± 2.57	.501
Number of stones	2.97 ± 3.20	2.96 ± 2.67	.969
Staghorn calculus	4.35% (11/253)	0.72% (1/138)	.047
Obstructing stone	64.71% (165/255)	81.16% (112/138)	.001
Imaging Modality			
None	3.71% (10/269)	2.16% (3/139)	
CT scan	88.10% (237/269)	93.53% (130/139)	
Ultrasound	7.43% (20/269)	4.32% (6/139)	
KUB	0.74% (2/269)	0.00% (0/139)	.367

Patients presenting with symptomatic urolithiasis during the pandemic were more likely to have an obstructing stone compared to the previous year (81.16% vs 64.1%). This suggests that patients during the pandemic required a higher threshold of symptoms to ultimately present to the ED, and that their presentation may have been delayed. We observed fewer frequencies of patients with staghorn calculi during the pandemic surge (0.72% vs 4.35%). This finding may reflect the chronic, insidious nature of such calculi which may have been associated with less acute pain. There was a higher proportion of patients with bacteria on the initial urinalysis during the pandemic (64.8% vs 33.94%), however no difference with respect to positive urine cultures. We hypothesize that the higher rates of bacteriuria may be due to laboratory error. Despite this higher proportion of patients with bacteriuria on the urinalysis, there was likely not a significant difference in patients who underwent decompression as the 2 cohorts

had no differences in fevers, WBC count, and other urinalysis parameters.

Flammia et al. showed a significant increase in serum creatinine in patients presenting with stones during the pandemic (2.87 vs 1.20,  $P = .026$ ), which they attributed to a delay in presentation.<sup>17</sup> Another retrospective review showed that the time to presentation from symptom onset was significantly delayed in patients presenting to the ED with symptomatic urolithiasis.<sup>18</sup> Despite these findings, there was no difference in patient outcomes related to the management of urolithiasis in either study. Similarly, our study showed no significant differences between the 2 years with respect to multiple clinical outcomes and management including fevers, AKI's, labs, disposition, surgical management, and emergent procedures. As these outcomes were preserved, this suggests that while patients may have been willing to manage their pain at home, they

**Table 3.** Management and Clinical Outcomes of Patients Presenting With Symptomatic Urolithiasis

	March-June 2019	March-June 2020	P-Value
White blood cell count	9.61 ± 3.27	10.27 ± 3.54	.076
WBC in UA	20.41 ± 48.03	14.85 ± 36.48	.284
Nitrite positive UA	4.55% (12/264)	2.19% (3/137)	.238
Leukocyte esterase positive UA	27.65% (73/264)	27.01% (37/137)	.891
Bacteria present UA	33.94% (75/221)	64.8% (57/88)	.000
Positive urine culture	11.33% (29/256)	9.42% (13/138)	.558
Temperature >38 C at presentation	1.40% (4/269)	1.44% (2/139)	.970
Acute kidney injury	14.29% (33/231)	10.08% (13/129)	.251
Urology consult	27.88% (75/269)	34.53% (48/139)	.165
Surgery			
None	85.50% (230/269)	84.06% (116/139)	
Stent	7.06% (19/269)	6.47% (9/139)	
PCN	1.86% (5/269)	2.16% (3/139)	
Ureteroscopy	5.58% (15/269)	7.91% (11/139)	.812
Time to stone management after initial decompression (days)	25.86 ± 22.95	32.45 ± 25.79	.46
Emergent stent/PCN	1.86% (6/269)	0.72% (1/139)	.365
Discharged from ED	82.53% (222/269)	78.42% (109/139)	.315
Re-presented to ED within 30 days	13.38% (36/269)	14.39% (20/139)	.758
Disposition after representation to ED			
Discharge	61.11% (22/36)	35.00% (7/20)	
Medical admit	5.56% (2/36)	10.00% (2/20)	
Procedure	33.33% (12/36)	55.00% (11/20)	.172
Average days returned to ED	8.03 ± 7.01	6.9 ± 7.99	.586
Complication rate	1.86% (5/269)	2.16% (3/139)	.836

ultimately presented when complications of ureteral stones occurred such as fevers and infections.

We found no significant difference with how patients during the pandemic surge were managed surgically. During the pandemic, our department came to the consensus that urolithiasis patients should be managed nonoperatively if possible, and if necessary, a percutaneous nephrostomy tube or ureteral stent should be placed. Although our institution checked the COVID-19 status of patients undergoing surgery, there were concerns that patients with COVID-19 who undergo general anesthesia could suffer from mortality and other pulmonary complications.<sup>19</sup>

There are several explanations for the nonsignificant differences in surgical management. There were similar frequencies of patients presenting with AKI or who were critically ill and required urgent decompression between the 2 years. Additionally, the similarities in surgical management between the 2 years despite the higher frequencies of obstructing stones in 2020 reflects that we may have had a higher threshold to surgically treat obstructing ureteral stones during the pandemic. Patients who underwent initial decompression during the pandemic did not have a significant delay for the time to stone management (32.45 vs 25.86 days). At our institution, we began performing elective surgeries again in June 2020 which may have affected this outcome.

While our results are similar to a study from 3 centers in Spain and Italy which found no significant differences in the type of therapy,<sup>12</sup> a few other studies have found differences in the management of urolithiasis patients during the COVID-19 pandemic. A study by Gul et al. which evaluated 149 patients with ureteral stones between March and June 2020 in a Turkish hospital found a higher rate of patients who received nephrostomy tubes (37.2% vs 0.9%) and lower rates of ureteral stent placement (34.3% vs 43.9%) during the pandemic.<sup>11</sup> A study by Antonucci et al. that compared stone patients who presented to 3 centers in Rome between March and April 2020 to the previous year found that patients were more likely to undergo a stone removal procedure vs a drainage procedure (60% vs 33.3%).<sup>9</sup> These studies are indicative of the different strategies which institutions used to manage urolithiasis during the pandemic.

Although our institution opted for a more conservative approach in managing urolithiasis patients during the pandemic, we found no significant differences in the rates of bounce backs to the ED, and found a low complication rate of 2.16%. This contrasts with Antonucci et al., who found a higher rate of complications (20.4% vs 10.9%) for patients who presented during the pandemic.<sup>9</sup> However, our study is similar to those by Carrion et al. and Flammia et al. which also demonstrated no significant differences in the rate of complications.<sup>12,16</sup>

As a result of the COVID-19 pandemic, there has been much discussion on how to triage and prioritize urolithiasis patients. One model categorized patients into 5 groups with different recommended time frames of intervention.<sup>20</sup> Category 0 patients included those with an

obstructing stone with infection, unilateral kidney with obstruction, or bilateral ureteral obstruction, and recommended intervention within 24 hours. Categories 1 and 2 incorporated ureteral stones of different morbidities, however recommended less urgent intervention, <2-4 weeks and <4-8 weeks, respectively. An article by Proietti et al. also recommended a similar triage of such patients.<sup>21</sup> From our experiences with managing urolithiasis patients during the pandemic, we have learned to prioritize the immediate triage of certain patients with warning symptoms (fevers, UTI symptoms), whereas lower acuity patients can be managed symptomatically and effectively counseled in a less time sensitive manner.

In addition to evaluating patients at a hospital which was impacted greatly by COVID-19, another strength of this study is that includes a total of 408 patients including 139 that presented during the pandemic, which makes this one of the larger cohorts of symptomatic urolithiasis patients studied during the pandemic. Additionally, we decided to incorporate 4 months of data as we believed that this would provide us with a more accurate analysis of how these patients fared compared to previous studies that looked at 1-to-2-month time periods.<sup>9,10,12</sup>

Our study has several limitations including the inherent biases that exist within its retrospective design. We relied on coding data to identify patient presentations, which at times can be inaccurate possibly leading to our chart review missing patients who presented with urinary tract stones to the ED. Our study was conducted within one healthcare system in the city of Philadelphia, and the data could reflect the impact that COVID-19 had within this city and our institution, and may not be consistent with other regions. And finally, while we saw no difference with respect to morbidity, this may have been in part due to a lower-risk cohort presenting during the pandemic as these patients were found to have less medical comorbidities. These findings must therefore be extrapolated with caution for other hospital systems that may experience different presenting patient demographics during the next surge of the pandemic.

## CONCLUSION

The COVID-19 pandemic initial surge resulted in fewer ED presentations for symptomatic urolithiasis; however, patients who did present were more likely to have obstructing stones, perhaps due to delaying presentation to avoid COVID-19 exposure in the ED. Despite higher rates of obstruction, clinical outcomes, and morbidity were similar.

## AUTHORS' CONTRIBUTIONS

Nourian: Project development, data collection, manuscript writing; Uppaluri: Data collection, manuscript writing; Chen: Data collection; Ghiraldi: Data analysis, manuscript writing; Friedlander: Project development, manuscript writing.

## DECLARATION OF COMPETING INTEREST

None.

## References

1. Scales Jr CD, Tasian GE, Schwaderer AL, Goldfarb DS, Star RA, Kirkali Z. Urinary stone disease: advancing knowledge, patient care, and population health. *Clin J Am Soc Nephrol*. 2016;11:1305–1312. <https://doi.org/10.2215/CJN.13251215>.
2. Schoenfeld EM, Pekow PS, Shieh MS, Scales Jr CD, Lagu T, Lindner PK. The diagnosis and management of patients with renal colic across a sample of US hospitals: high CT utilization despite low rates of admission and inpatient urologic intervention. *PLoS One*. 2017;12: e0169160. <https://doi.org/10.1371/journal.pone.0169160>.
3. Scales Jr CD, Smith AC, Hanley JM, Saigal CS. Urologic diseases in America Project. Prevalence of kidney stones in the United States. *Eur Urol*. 2012;62:160–165. <https://doi.org/10.1016/j.eururo.2012.03.052>.
4. Haas CR, Li G, Hyams ES, Shah O. Delayed decompression of obstructing stones with urinary tract infection is associated with increased odds of death. *J Urol*. 2020;204:1256–1262. <https://doi.org/10.1097/JU.0000000000001182>.
5. Mantica G, Riccardi N, Terrone C, Gratarola A. Non-COVID-19 visits to emergency departments during the pandemic: the impact of fear. *Public Health*. 2020;183:40–41. <https://doi.org/10.1016/j.puhe.2020.04.046>.
6. Mahmud E, Dauerman HL, Welt FGP, et al. Management of acute myocardial infarction during the COVID-19 pandemic: a position statement from the Society for Cardiovascular Angiography and Interventions (SCAI), the American College of Cardiology (ACC), and the American College of Emergency Physicians (ACEP). *J Am Coll Cardiol*. 2020;76:1375–1384. <https://doi.org/10.1016/j.jacc.2020.04.039>.
7. City Provides Update on COVID-19 for June 30, 2020 [Internet]. *City of Philadelphia*. 2020. Available from: <https://www.phila.gov/2020-06-30-city-provides-update-on-covid-19-for-june-30-2020/>. Accessed 8 April 2021.
8. Health Equity Considerations and Racial and Ethnic Minority Groups [Internet]. *Centers for Disease Control and Prevention*. 2021. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html>. Accessed 8 April 2021.
9. Antonucci M, Recupero SM, Marzio V, et al. The impact of COVID-19 outbreak on urolithiasis emergency department admissions, hospitalizations and clinical management in central Italy: a multicentric analysis. *Actas Urol Esp*. 2020;44:611–616. <https://doi.org/10.1016/j.acuro.2020.06.005>.
10. Kachroo N, Wright HC, Sivalingam S. A tale of two eras: the effect of the COVID-19 pandemic on stone disease presentations. *Urology*. 2020;144:270–272. <https://doi.org/10.1016/j.urology.2020.06.042>.
11. Gul M, Kaynar M, Yildiz M, et al. The increased risk of complicated ureteral stones in the era of COVID-19 pandemic. *J Endourol*. 2020;34:882–886. <https://doi.org/10.1089/end.2020.0658>.
12. Carrion DM, Mantica G, Antón-Juanilla M M, et al. Assessment of trends and clinical presentation in the emergency department of patients with renal colic during the COVID-19 pandemic era. *Actas Urologicas Espan~olas*. 2020;44:653–658. <https://doi.org/10.1016/j.acuroe.2020.11.004>.
13. Mantica G, Riccardi N, Terrone C, Gratarola A. Non-COVID-19 visits to emergency departments during the pandemic: the impact of fear. *Public Health*. 2020;183:40–41. <https://doi.org/10.1016/j.puhe.2020.04.046>.
14. Cervino G, Oteri G. COVID-19 pandemic and telephone triage before attending medical office: problem or opportunity? *Medicina (Kaunas)*. 2020;56:250. Published 2020 May 20. <https://doi.org/10.3390/medicina56050250>.
15. Sanyaolu A, Okorie C, Marinkovic A, et al. Comorbidity and its impact on patients with COVID-19 [published online ahead of print, 2020 Jun 25]. *SN Compr Clin Med*. 2020;1-8. <https://doi.org/10.1007/s42399-020-00363-4>.
16. Mackey K, Ayers CK, Kondo KK, et al. Racial and ethnic disparities in COVID-19-related infections, hospitalizations, and deaths : a systematic review. *Ann Intern Med*. 2021;174:362–373. <https://doi.org/10.7326/M20-6306>.
17. Flammia S, Salciccia S, Tufano A, Busetto GM, Ricciuti GP, Sciarra A. How urinary stone emergencies changed in the time of COVID-19? *Urolithiasis*. 2020;48:467–469.
18. Liu Z, Man L. Impacts of the COVID-19 outbreak on visits and treatments for patients with ureteral stones in a general hospital emergency department. *Urologia*. 2020. Online ahead of print.
19. COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet*. 2020;396:27–38. [https://doi.org/10.1016/S0140-6736\(20\)31182-X](https://doi.org/10.1016/S0140-6736(20)31182-X).
20. Metzler IS, Sorensen MD, Sweet RM, Harper JD. Stone care triage during COVID-19 at the University of Washington. *J Endourol*. 2020;34:539–540. <https://doi.org/10.1089/end.2020.29080.ism>.
21. Proietti S, Gaboardi F, Giusti G. Endourological stone management in the era of the COVID-19. *Eur Urol*. 2020;78:131–133. <https://doi.org/10.1016/j.eururo.2020.03.042>.