



# Impact of COVID-19 pandemic on diagnosis and surgical management of common urological conditions: results from multi-institutional database analysis from the United States

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## Abstract

**Objective** To determine real life impact during the first pandemic year on diagnosis and surgical management of common urological diseases and 90-day postoperative mortality following common urological surgeries.

**Methods** Cross-sectional study from 2016 to 2021. We used TriNetX to obtain the data. Patients with a diagnosis of six common non-oncologic and five oncologic urologic conditions were included. Twenty-four surgical interventions were also analyzed. The total number of diagnosis and surgical procedures were compared yearly from 2016 to 2021 and Chi-square test was used for statistical analysis. Additionally, monthly changes were evaluated during the first pandemic year and a z score period time was reported. The 90-day post-operative mortality rates during the first pandemic year were compared to the preceding year.

**Results** Overall, a decrease in diagnosis and surgeries were observed during the first pandemic year, with maximum drop in April 2020. Among non-oncological conditions, the decrease in diagnosis of enlarged prostate (5.3%), nephrolithiasis (9.4%), urinary incontinence (18.7%), and evaluation for male sterilization (14.8%) reached statistical significance ( $P < 0.05$  in all). Prostate cancer was the only cancer whose diagnosis showed statistically significant decrease (6.2%,  $P < 0.05$ ). The surgical case load for benign conditions showed higher reduction (13.1–25%) than for malignant conditions (5.9–16.3%). There was no change in 90-day post-operative mortality in any of the analyzed surgeries.

**Conclusions** Our study showed that although healthcare delivery decreased in the first pandemic year, causing a decline in the diagnosis and surgical treatment of several diseases, surgical interventions did not increase the risk of death.

**Keywords** COVID-19 · Diagnosis · Pandemic · Surgery · Urology

## Introduction

The onset of the Coronavirus 2019 (COVID-19) pandemic resulted in a decline in elective surgeries to better optimize resources and minimize exposure of patients to the virus. The American College of Surgeons (ACS) were first to provide guidelines with the rationale of deferring nonessential clinical activities and elective surgeries [1]. A systematic review of the guidelines and recommendations for surgery during COVID-19 found consensus on postponing elective

and nonessential surgery. Authors concluded that risk of cancer diagnosis and treatment delay should be weighed against COVID-19 exposure [2]. Amparore et al., reviewed international and European urology associations guidelines and discussed the strain that pandemic had on the urologic practice [3].

Initial studies focusing on the impact of COVID-19 pandemic on urological practices were either single-center or limited by smaller number of patients [4–6]. Recently published large real-world data from the American Urological Association Quality (AQUA) registry, collected from 157 outpatient urological practices from United States (US), confirmed decline and differential impact on utilization of urological care across demographic groups and practice settings [7]. However, the study had scarce information about the impact of the pandemic on common

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urological emergency surgeries for renal drainage and nephrectomy for renal cancers and lacked details about differential impact on various common procedures for enlarged prostate, urolithiasis, and urinary incontinence. With this background, we analyzed TriNetX research network data, which contained over 80 million patients across 49 healthcare organizations (HCO) from US. The primary aim of the present study was to determine the real-life impact of pandemic on diagnosis and surgical management of common benign and malignant urological diseases. The secondary aim was to evaluate 90-day mortality following common urological surgeries during the first pandemic year.

## Methods

### Data collection

Data were obtained from TriNetX, a large multi-center electronic health record network of linked anonymized information from 59 healthcare organizations (HCOs), primarily in the United States of America, accounting for about 81 million patients. Only those organization who partnered with TriNetX are part of this network (<https://trinetx.com/>). The included HCOs represent data from uninsured and insured patients from a mixture both public and private healthcare network. TriNetX has received an Institutional Review Board waiver and provides only de-identified patient data, with additional limitations placed on database queries to protect patient privacy. For example, if a patient count for a particular condition or variable is less than 10, the number of patients displayed is rounded up to 10.

We investigated the number of patients diagnosed with common urological condition and those undergoing common urologic surgeries performed between March 1, 2016 and April 30, 2021, with yearly intervals designated between March 1 and February 28. International Classification of Disease 9 and 10 revision codes (ICD-9, ICD-10) and Common Procedural Terminology (CPT) codes were used to identify urological conditions and their corresponding surgical procedures. We examined the following conditions with its associated ICD codes: benign prostatic hyperplasia (BPH) or enlarged prostate (N40.1), urolithiasis or nephrolithiasis (N20, N 20.1, N20.2 and N 20.9), hydronephrosis with renal or ureteral obstruction (N13.2), urinary incontinence (R 32), phimosis (N47.1) and encounter for male sterilization (Z30.2), prostate cancer (C61), elevated prostate specific antigen (R97.2), testicular tumors (C62), bladder cancer (C67.9) and kidney cancer (C64.9). Urological surgeries were identified with associated CPT codes as described in Supplementary Fig. 1.

## Statistical analysis and outcomes

We calculated the total number of patients with diagnoses of selected urological conditions and number of corresponding procedures from March 1st of each year to February 28th of the following year from 2016 to 2021. We then compared these numbers within the database for each year against its preceding year to determine statistically significant differences in diagnoses and procedures across time. We utilized Chi-square test for comparison and assessed statistical significance at  $P < 0.05$ . Moreover, we calculated 90-day mortality rates following common urological surgical procedure during first year of pandemic (March 2020 to February 2021) and compared it with the preceding year. After calculating mortality rate for unmatched cohort, we performed propensity score matching with various factors as described in Supplementary table 3 to determine 90-day mortality in matched cohort. The monthly changes in number of patients with diagnosis of urological condition and corresponding urological procedures was analyzed from October 1, 2019 to April 30, 2021. SPSS™ v.28 software was used for figure creations, and a  $z$  score period time was reported to further determine the variation between the frequency of diagnosis and procedures among the time of evaluation.

## Results

Overall, we saw a decrease in number of individuals diagnosed with urologic conditions during the 1st year of the pandemic (Supplementary Tables 1 and 2). Among non-oncological conditions, the drop in number of patients diagnosed with BPH (5.3%), nephrolithiasis (9.4%), urinary incontinence (18.7%), and evaluation for male sterilization (14.8%) reached statistically significance. The diagnosis of hydronephrosis with renal or ureteral obstruction also decreased by 7.9%; however, it was not statistically significant ( $P = 0.40$ ). The reduction in individuals diagnosed with oncological condition was lower as compared to those with non-oncological conditions. The decline in individuals diagnosed with prostate, bladder, kidney, and testicular cancer was 6.2%, 8%, 8.5% and 9%, respectively. Prostate cancer was the only urological cancer, whose diagnosis showed statistically significant decrease during the first year of pandemic.

There was a similar decrease in number of all urologic surgeries performed during 1st year of pandemic (Supplementary Fig. 1). Specifically, from March 2020–2021, the surgical case load for benign conditions showed a higher reduction (13.1–25%) than those for malignancy

(5.9–16.3%). Among benign urological procedures, surgeries for urinary incontinence showed maximum decrease (25%) followed by vasectomies (22.8%), BPH procedures (19.2%), surgery for urolithiasis (15.9%) and phimosis (13%). For drainage of renal obstruction or hydronephrosis, stent placement showed a 18.4% decline ( $P < 0.05$ ) as compared to only 5.5% decrease in placement of percutaneous nephrostomy tube ( $P = 0.11$ ) during 1st pandemic year. Number of individuals undergoing prostate biopsy showed 30.1% reduction. Amongst urological malignancies, radical cystectomy saw the lowest decline (5.9%) followed by orchiectomy (8.7%), nephrectomy (13.7%), radical prostatectomy (16.3%) and transurethral resection of bladder tumor (TURBT) (19.4%). This drop was found to be statistically significant only for TURBT and nephrectomy (Supplementary Table 2).

The sub-group analysis of surgical procedures for BPH revealed that the decrease in minimally invasive surgical therapy (MIST) (Urolift and Rezum) and endoscopic enucleation of prostate were not statistically significant (Supplementary Table 1). Regarding procedures for urolithiasis, there was statistically significant drop in individuals undergoing ureteroscopy, percutaneous renal surgery and extracorporeal shock wave lithotripsy (SWL), except for cystolitholapaxy ( $P = 0.33$ ). The decrease in transvaginal procedures for urinary incontinence showed a statistically significant reduction during the first year of pandemic but the decline in laparoscopic procedures, ureterolysis and sling removal or replacement did not reach statistical significance.

On analyzing the monthly changes from October 2019 to April 2021, it was noted that the drop in individuals with diagnosis of urological condition and corresponding urological procedures was maximum in April 2020 and reached baseline by June 2020 (Supplementary Figs. 2–4). There was no change in postoperative 90-day mortality during the 1st year of pandemic (Supplementary Table 3).

## Discussion

The data from 59 HCO revealed that the rising trend in number of patients diagnosed with various urologic conditions and corresponding procedures every year from March 2016 was disrupted with the outbreak of the pandemic. This decline in urologic healthcare was in alignment with recommendations from various guidelines including the ACS [1, 8]. Apart from the impact of lockdown and modified hospital policies during COVID pandemic, heightened patients fear of contracting COVID infection was equally responsible for this decline. A survey of 332 patients with planned elective urologic surgeries concluded that overall, 54.8% of patients considered COVID-19 more harmful than delaying surgery

with 37% being oncologic patient's and 73% non-oncologic patients [9].

We noted a steep decline in number of patients diagnosed with various urological condition in March 2020 with the number being the lowest in April 2020. Similar profound effects of the pandemic on urologic healthcare services were reported across the world. Real-world data from 157 outpatient urology practices in the US, extracted from the AQUA Registry, found > 50% decline in outpatient visits from March 2020 to April 2020 [7]. Non-urgent visits suffered more disruption than urgent visits (49–59% vs. 38–52%). A healthcare center in India noted a similar decline of by 90% from April 2020 to July 2020 in urologic surgeries, admissions, and outpatient visits [4]. A multicentric study from Turkey also reported a 75% decrease in urologic surgery and a negative correlation of the pandemic with outpatient visits and COVID-19 cases and deaths [6].

As anticipated, we noted that the reduction in total number of individuals visiting with diagnosis of oncological condition was lower as compared to those with diagnosis of non-oncological conditions (Supplementary table 1 and 2; Supplementary Figs. 2–4). This is quite worrisome on a public health level since there is definite risks of disease progression, morbidity, and mortality if diagnosis and management of oncological diseases is delayed. Maganty et al., reported a 38% decrease in urologic oncology visits during the pandemic as compared to preCOVID-19 [10].

We also noted a decrease in total number of all urologic surgeries being performed during the first pandemic year (Supplementary Fig. 1). Similar to our study, Lee et al. noted a 43–79% decline in surgical cases load for non-urgent conditions, and 43–53% decrease in surgical cases load for potentially urgent conditions on February 2020 [7].

Even though cases load of cystectomy and orchiectomy were least affected during pandemic, the delay in management of these cancers is worrisome and not supported by current guidelines. Muscle invasive bladder cancer is a high-risk disease and multiple studies demonstrate significantly poor outcomes when there is a delay in cystectomy for more than 12 weeks [11–14]. In one study a delay in cystectomy for > 12 weeks resulted in a twofold increase in disease specific and overall mortality [14]. With regards to orchiectomy for testicular cancer, it is advisable to perform surgery as soon as possible, although this recommendation is based on experts opinion [15]. Despite the generalized understanding that oncologic conditions require prompt attention and treatment, we witnessed a significant decline in radical prostatectomies and nephrectomies by 16.3% and 13.7%, respectively. Both prostate and kidney cancer have a role for active surveillance in selected patients. It has been shown that active surveillance of low-risk prostate cancer with delay of treatment for long duration (years) is safe and has a low risk of adverse events [16,

17]. A similar outcome has been reported for early vs. late intervention of small renal masses [18]. Even for larger renal masses a short-term delay of 3–6 months appears to be safe [9]. It is hence understandable to postpone treatment for low risk and localized prostate cancer and small renal masses during the pandemic. It is prudent to educate patients that certain cancer treatment delays are safe and plausible and not every cancer needs to be treated immediately [15]. However, it is important to mention that radical cystectomy for MIBC, orchiectomy for testicular cancer and nephrectomy for T3 disease should not be postponed [19]. Furthermore, physician stewardship of healthcare resources is of prime importance on a public health level [15].

It is interesting to note that the number of patients with diagnosis of elevated PSA significantly decreased by 8.3% during the first pandemic year, although it increased by 11% the year before. Moreover, the number of prostate biopsies performed also decreased by 30.1%. The significant decline in prostate biopsies may be partially explained by the decline in elective screening, keeping in mind the slow growing nature of cancer and the nonemergent need for prompt diagnosis [16, 17, 20].

The urological healthcare delivery for benign urological conditions was more affected than for oncological conditions. It is important to note that these conditions are more common than oncological conditions and delay in diagnosis and appropriate surgical management might significantly impact patient's quality of life. We noted that the number of patients diagnosed with nephrolithiasis decreased by 9.4% and surgical interventions for same reduced by 15.9% during the first pandemic year. Due to urgent nature and as recommended by multiple guidelines, patients diagnosed with hydronephrosis secondary to renal or ureteral obstruction did not show statistically significant drop during first pandemic year ( $P = 0.40$ ). Stent placement showed a statistically significant reduction of 18.4% and placement of percutaneous of 5.5%. This may be explained by preference of urologists to nephrostomy tube placement during the pandemic because it is routinely done under sedation and may avoid airborne exposure due to general intubation [21]. Michigan Urological Surgery Improvement Collaborative proposed SWL instead of ureteroscopy when possible, as SWL was associated with less post procedure emergency department visits than ureteroscopy (3.5% vs 7.7%). Moreover, SWL did not require general anesthesia and intubation, stent insertion and therefore an extra visit for removal [22]. However, we noted that SWL showed a maximum reduction during the pandemic year of 22.7% followed by percutaneous nephrolithotomy (19.3%), ureteroscopy (14.3%) and cystolitholapaxy (11.8%). Since SWL is usually performed for asymptomatic non-obstructing stones, it is logical to

expect maximum decline in patients undergoing same. The findings of our study echo the recommendation made by Goldman and Haber [23].

Similarly, we noted that the number of patients diagnosed with BPH declined by 5.3% and the case load of surgeries dropped by 19.2% during the first pandemic year. On analyzing different BPH procedures, the minimally invasive office-based surgical procedures like Urolift and Rezum showed least statistically insignificant decline of 7.3% and 7.2% respectively as these could be performed without general anesthesia and endotracheal intubation. The percentage decrease in transurethral resection and photo selective vaporization of prostate was 18.9% and 30.9%, respectively. Our findings follow the suggestion that BPH surgery should be postponed at least until inpatient COVID-19 cases are  $< 25\%$  [24]. Interestingly we noted that transurethral incision of the prostate being performed for smaller prostate revealed maximum decline of 39.5% during first pandemic year. In contrast the 13.2% decline in the number of endoscopic enucleations of prostate was not found to be statistically significant. We hypothesized that the patients undergoing endoscopic enucleation of prostate usually have larger prostates and are more likely to be catheter-dependent justifying urgency of surgical intervention.

It was quite expected to see that incontinence surgeries decreased the most by 25% from the previous year. Being an elective condition, surgery for urinary incontinence is rarely considered emergency, even though incontinence can significantly impact patients' quality of life. Since transvaginal procedures account for  $> 90\%$  of incontinence surgery, they were the only one to show a statistically significant decrease of 25.8% during first pandemic year.

The existing literature confirm a high-risk of complications and even mortality for patients infected with COVID-19 and undergoing surgery [25]. There was a fear in the mind of patients that a visit to health care institutions might put them at higher risk of exposure to COVID virus that might ultimately turn fatal. Hence, we analyzed 90-day mortality of various surgical procedures to see if undergoing surgery during the first pandemic year was associated with increase in 90-days post-operative mortality. Fortunately, the findings are very reassuring and should help counselling patient undergoing surgery during pandemic. The limitation in calculating mortality rate include possibility of missing patients who did not follow-up with same HCO after surgery. Another important limitation of our study is inherent with use of electronic medical record database and include lack of granular data and potential for coding errors. In spite of these limitations our study is the largest study revealing real-world impact of COVID-19 pandemic on urology practice in US.



## Conclusion

The first year of pandemic resulted in a maximum drop in total number of individuals diagnosed with all evaluated urologic conditions in April 2020 with gradual return to baseline by June 2020. Even though not recommended by guidelines, there was drop-in surgeries for bladder and testicular cancers. All definitive non-oncological surgeries showed significant decline with least impact on cystolitholapaxy, Urolift and Rezum. Placement of percutaneous nephrostomy tubes was preferred over stent placement to relieve hydronephrosis. There was no change in 90-day mortality after various oncological and non-oncological procedures during 1st pandemic year as compared with previous year. We believe that our study might act as a framework for future policy decisions with a hope to better manage urologic healthcare at the time of similar pandemics in future.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00345-022-04167-0>.

**Author contributions** KS had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. MH: protocol/project development, manuscript writing/editing. MCS: protocol/project development, manuscript writing/editing. SN: data collection or management, data analysis. RB-B: data analysis. KS: data collection or management, manuscript writing/editing. MT: protocol/project development. DKC: manuscript writing/editing. RM: critical revision of the manuscript for important intellectual content. RR: critical revision of the manuscript for important intellectual content. HS: protocol/project development, manuscript writing/editing, critical revision of the manuscript for important intellectual content.

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## Declarations

**Conflict of interest** Dr Hemendra Shah received \$1000 from Lumenis for mentoring urologists for HoLEP in 2019. He also received research grant from Karl Storz and Boston Scientific. Dr Ranjith Ramasamy is a consultant and grant recipient for Acerus, Boston Scientific, Endo Pharmaceuticals and Coloplast; grant recipient from Empower Pharmacy and Olympus; advisory board of Hims, Inc.; Recipient of NIH funding (1R01DK130991-01). All other authors have nothing to disclose.

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**Consent to participate and ethic approval** TriNetX has received an Institutional Review Board waiver and provides only de-identified patient data, with additional limitations placed on database queries to protect patient privacy.

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