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Impact of the COVID-19 Pandemic on Urological Care Delivery in the United States

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Study Need and Importance: The COVID-19 pandemic continues to cause severe disruptions along the continuum of medical care. We examined changes in urological care delivery due to COVID-19 in the U.S.

What We Found: We analyzed real-world data from the American Urological Association Quality (AQUA) Registry, representing 157 outpatient urology practices and 3,165 providers across 48 U.S. states and territories, including 3,297,721 unique patients. We found large (>50%) declines in outpatient visits from March 2020 to April 2020 across patient demographic groups and states, regardless of timing of state stay-at-home orders (see figure). Nonurgent outpatient visits decreased more across various nonurgent procedures (49%–59%) than for procedures performed for potentially urgent diagnoses (38%–52%). African American patients had similar decreases in outpatient visits compared with Asians and Caucasians, but also slower recoveries to baseline. Medicare-insured patients had the steepest declines (55%), while those on Medicaid and government insurance had the lowest percentage of recovery to baseline (73% and 69%, respectively).

Limitations: Use of electronic health record data to classify particular diagnoses and demographic factors associated with outpatient visits and procedures may be biased by variations in documentation and billing patterns across practices, and electronic health record vendor platforms utilized. Although the AQUA Registry collects data from across the nation in diverse practice landscapes, the cohort is not a random selection and may not be generalizable to all urology practices across the country.

Interpretation for Patient Care: This study provides real-world evidence on the decline in urological care across demographic groups and practice settings during the pandemic. The decreases were sharp and broad, but the recovery was variable and did not return to prepandemic levels for many at-risk populations. As the pandemic continues to evolve, targeted interventions to help address and alleviate these discrepancies in care will become increasingly important.

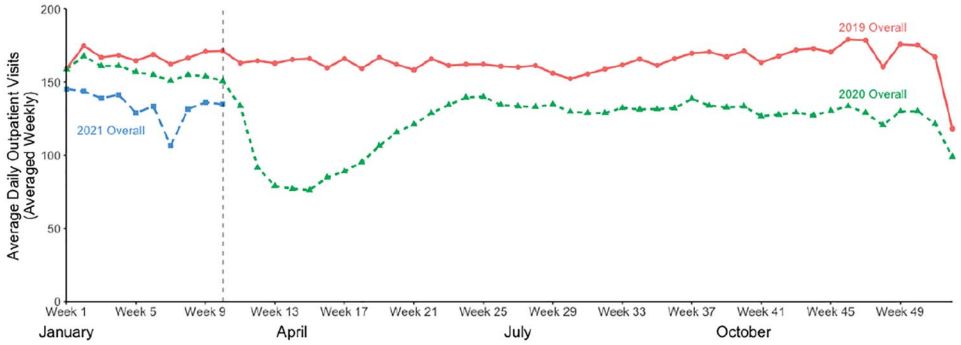

Figure. Weekly average of outpatient clinic visits per practice for overall population.

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Impact of the COVID-19 Pandemic on Urological Care Delivery in the United States

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Abbreviations and Acronyms

ADT = androgen deprivation therapy
AHRF = Area Health Resource File
AQUA = American Urological Association Quality
AUA = American Urological Association
BPH = benign prostatic hyperplasia
COVID-19 = coronavirus disease 2019
CPT = Current Procedural Terminology
EHR = electronic health record
FPL = federal poverty level
ICD-9/ICD-10 = International Statistical Classification of Diseases and Related Health Problems, ninth or tenth revision
TURP = transurethral resection of prostate

Purpose: We examined changes in urological care delivery due to COVID-19 in the U.S. based on patient, practice, and local/regional demographic and pandemic response features.

Materials and Methods: We analyzed real-world data from the American Urological Association Quality (AQUA) Registry collected from electronic health record systems. Data represented 157 outpatient urological practices and 3,165 providers across 48 U.S. states and territories, including 3,297,721 unique patients, 12,488,831 total outpatient visits and 2,194,456 procedures. The primary outcome measure was the number of outpatient visits and procedures performed (inpatient or outpatient) per practice per week, measured from January 2019 to February 2021.

Results: We found large (>50%) declines in outpatient visits from March 2020 to April 2020 across patient demographic groups and states, regardless of timing of state stay-at-home orders. Nonurgent outpatient visits decreased more across various nonurgent procedures (49%–59%) than for procedures performed for potentially urgent diagnoses (38%–52%); surgical procedures for nonurgent conditions also decreased more (43%–79%) than those for potentially urgent conditions (43%–53%). African American patients had similar decreases in outpatient visits compared with Asians and Caucasians, but also slower recoveries back to baseline. Medicare-insured patients had the steepest declines (55%), while those on Medicaid and government insurance had the lowest percentage of recovery to baseline (73% and 69%, respectively).

Conclusions: This study provides real-world evidence on the decline in urological care across demographic groups and practice settings, and demonstrates a differential impact on the utilization of urological health services by demographics and procedure type.

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THE COVID-19 pandemic caused severe disruptions along the continuum of medical care. Understanding national patterns of urological care—including effects on both urgent and nonurgent surgical procedures, cancer-related care, variations in care across a wide payer mix and trends based on patient demographics—will enable providers, policy leaders, patients and administration officials to optimally respond to ongoing and future changes as the COVID-19 pandemic and its sequelae continue to unfold.[1–3] Therefore, we sought to understand the impact of the COVID-19 pandemic on temporal trends in urological care delivery using real-world evidence derived from a national urological data registry. We hypothesized that the pandemic would be associated with significant decreases in nonurgent patient visits and elective procedures but would have significant variation by race or insurance status.

MATERIALS AND METHODS

American Urological Association Quality (AQUA) Registry

In 2013, the American Urological Association (AUA) launched the AQUA Registry,[4] and as of February 2021, over 50 million patient visits from 8.5 million unique patients populated the database. The AQUA Registry comprises extracted electronic health record (EHR)-derived data from participating urology practices nationwide. We limited our analysis to practices that contributed data at least once in both 2019 and 2020, through the end of February 2021. Of 235 total practices contributing to the AQUA Registry, 78 did not meet our inclusion criteria, leaving 157 practices covering 3,165 providers to define the study cohort. The AQUA Registry is supervised by a central institutional review board and there is no applicable IRB number.

Patient Population

The study period was from January 1, 2019 to February 28, 2021. Data from weekends and holidays were excluded. Rurality was defined based on the U.S. Department of Agriculture Rural-Urban Commuting Codes.[5]

Measures and Covariates

Our primary outcome measures were daily outpatient visits and daily procedures per practice. To reduce day-to-day variations, we averaged the daily visits and daily procedures over each week. Based on observed trends, week 10 in 2020 was considered the inflection point for the pandemic impact, as the national state of emergency declaration was issued on March 13, 2020.[6] The nadir was considered the lowest point after the baseline period (February 2020), while the recovery was defined as the highest point after the nadir. We also compared the average visits over the final month (February 2021) compared to the baseline in February 2020.

Additional zip code level characteristics from 2010 U.S. Census data were also incorporated, including the percent below the federal poverty level (FPL) and household median income. Physician distribution data were obtained from the Area Health Resource File (AHRF).[7] We evaluated the density of urologists per 100,000 and median income in the zip code according to the urology practice location. Finally, we categorized states in terms of timing of stay-at-home orders into early, middle and late tertiles (supplementary Appendix 1, https://www.jurology.com).

The 12 most common diagnoses evaluated and managed in urology practices were identified. We also denoted among diagnoses a "nonurgent" subset based on recommendations from the AUA and American College of Surgeons to triage conditions and procedures that potentially require urgent evaluation during the COVID-19 pandemic (supplementary Appendix 2, https://www.jurology.com).[8] Telemedicine video visits could not be identified by CPT codes alone, but telephone-only visits were identified by CPT code 99441-99443.

Statistical Analysis

We quantified the duration and extent of decline and recovery in patient visits (across patient-level and practice-level strata), disease-specific visits and procedures. We illustrated the 2019, 2020 and 2021 trends in overall visits, visits for select nonurgent and potentially urgent diagnoses, new patient visits and telehealth visits. We conducted Pearson's chi-square tests of independence to assess if there was a relationship between select visit types (age, race and tertile of state lockdown timing) and total visits in February (2020 and 2021). Thus, we assessed if the observed drop in February visits from 2020 (pre-pandemic) to 2021 (mid-pandemic) corresponded to what would be expected if each variable stratum responded similarly.

We developed a mixed effects logistic regression model to predict the odds of having a >50% percent drop from week 10 to week 15 in total visits/practice. Because a particular practice is represented in multiple observations (by different age-gender-race-ethnicity combinations), a random intercept by practice was included to help account for the correlation within practices. The putative predictors of a percent drop in practice visits considered were age, gender, race, ethnicity and practice size (<15 providers vs ≥15 providers). Data management was performed with PySpark version 2.4.0 (Apache Spark™), and analyses were computed with R version 3.6.3 (R Core Team, Vienna, Austria).

RESULTS

Characteristics of the unique patients and practices represented in our sample are summarized in table 1. The data include 13,108,874 total visits and 2,194,456 procedures.

Outpatient Clinic Visits by Patient Characteristics

The figure presents the unadjusted trends in outpatient clinic visits from January 2019 through February 2021 for overall, nonurgent diagnoses,

potentially urgent diagnoses, new patient visits and telehealth visits. Overall, there was a similar pattern of a sharp decrease after week 10, followed by a gradual recovery that remained stable through the summer of 2020 to 2021.

There was a 50.6% decrease in daily outpatient visits at its lowest point, which gradually improved over time but still remained about 19% lower in February 2021 compared to baseline levels in February 2020 (table 2). Women, Asians and those with Medicaid or Medicare insurance had some of the largest decreases in outpatient visits during the peak of the pandemic. Smaller decreases were noted for Black patients, with decreases of 49.6% in daily visits at its nadir, which recovered from the nadir through week 22. Outpatient visits for elderly patients were also 21% lower in February 2021 than 2020 vs younger patients ($p < 0.001$ in comparing total visits). In comparing February 2021 to February 2020, white patients had significantly fewer outpatient visits per day per practice compared to baseline (17% decrease) than Black patients (5% decrease, $p < 0.001$ in comparing total visits).

Outpatient Clinic Visits by Practice Characteristics

Practices that were larger, located in the Northeast, and in suburban and affluent areas had the largest percent decreases in outpatient visits. The largest practices (15+ providers) had the highest percent declines (52.5%) and largest percent recovery (−16% from baseline). Practices serving areas with no urologists per 100,000 had lower magnitude decreases in outpatient visits (44%) compared to practices with 5 or more urologists per 100,000 in the county (52.8%). Of note, outpatient visits in February 2021 remained much lower than February 2020 in practices in rural areas (44.8% of 2020), and located in Midwest and Northeast regions (40.1% and 50.5% of 2020, respectively). States that had early lockdown orders had similar percent decreases in outpatient visits compared to middle or late orders during the lockdown period but had lower magnitude recovery of those outpatient visits compared to pre-pandemic levels (44.7% lower, $p < 0.001$).

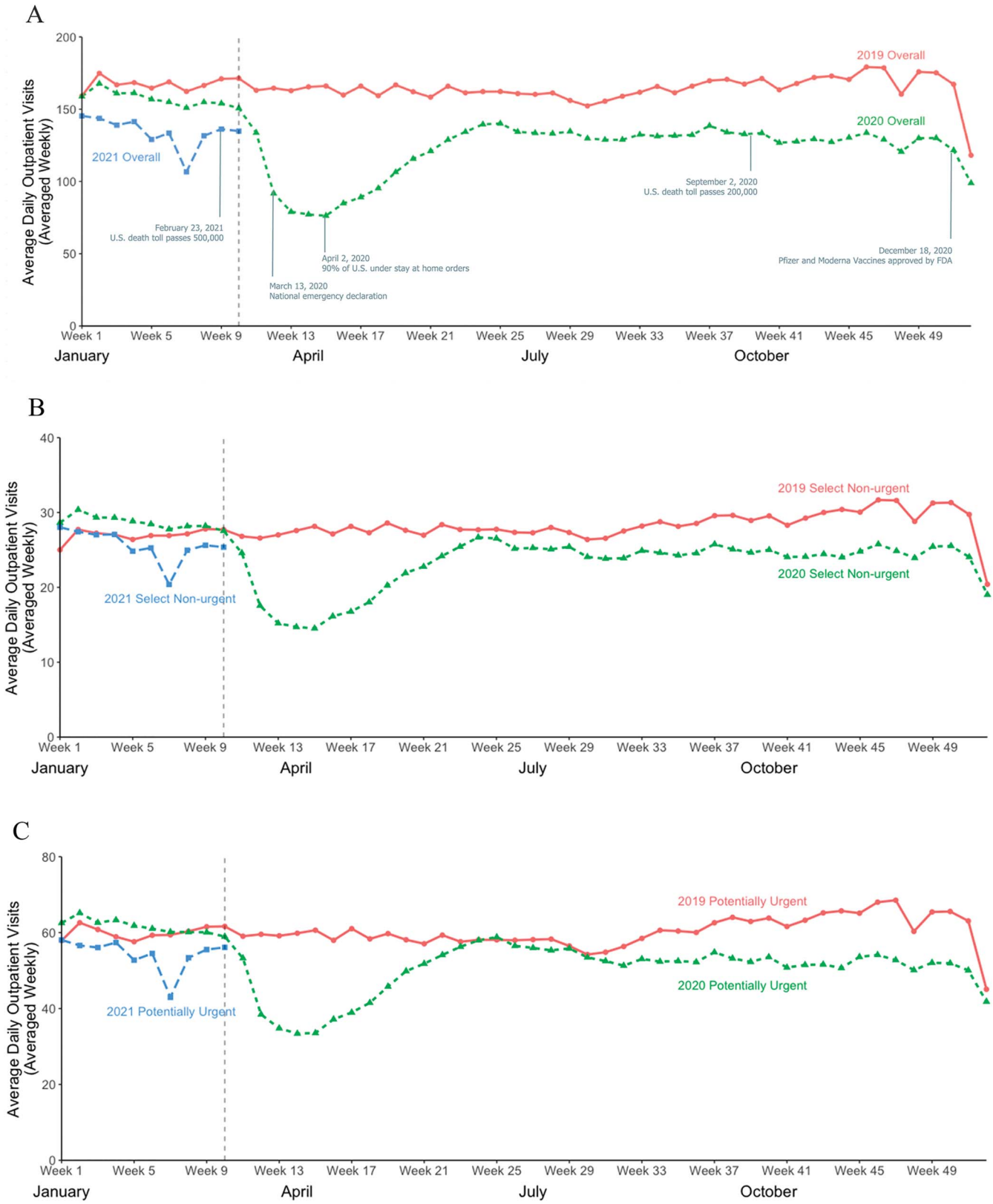
Telephone Visits over Time

Telephone-only visits were minimally done in 2019 and 2020 before the pandemic. After week 9, there was a dramatic and rapid increase in the utilization of telephone-only visits; by week 15, more than 3 telephone visits per day per practice on average were performed. This reflected the timing of the

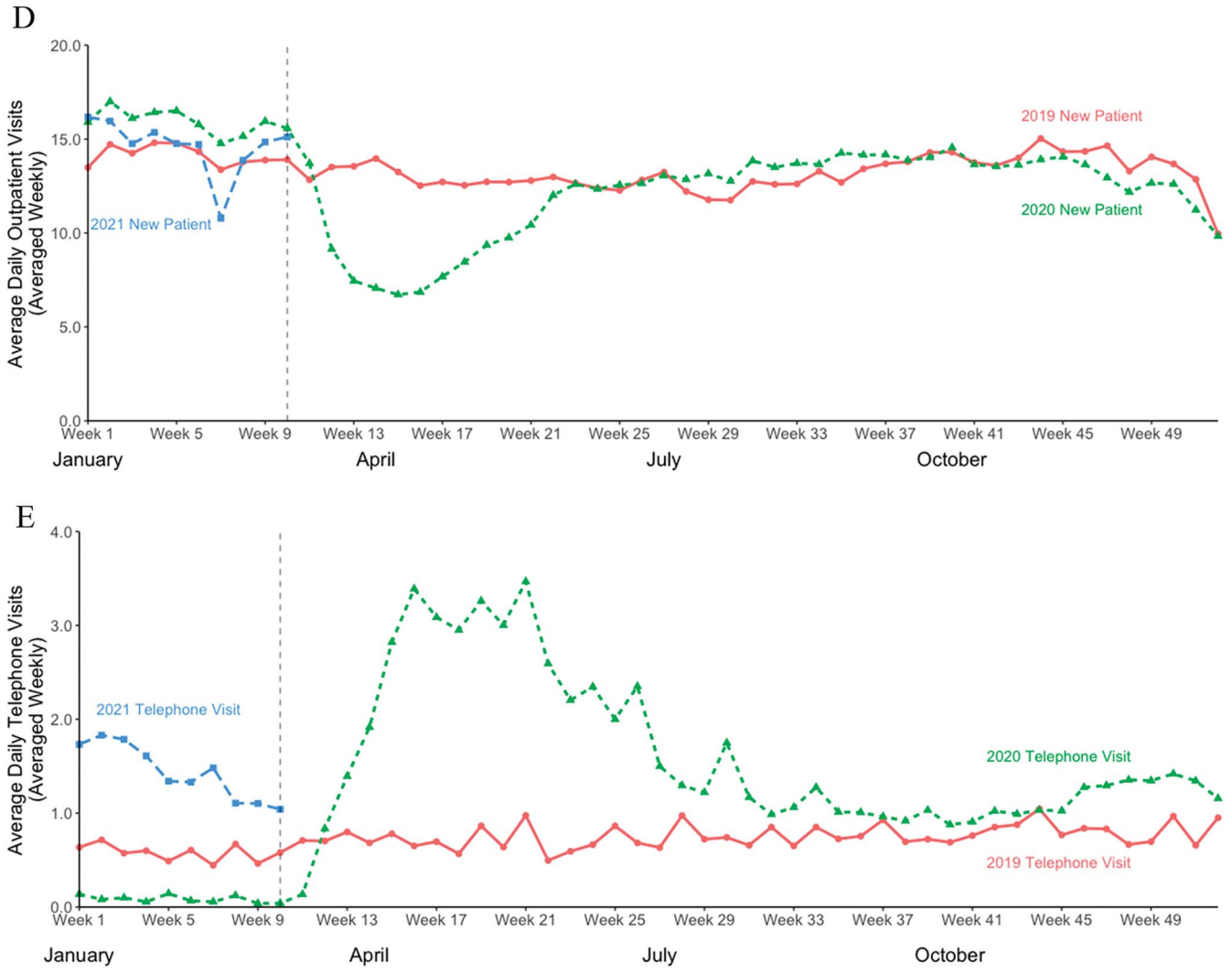
Table 1. *Patient and practice characteristics*

	No.	%
Age:*		
<18 yrs	46,663	1.37
18–65 yrs	1,666,856	49.10
>65 yrs	1,735,551	51.12
Not available	39	0.00
Gender:		
Male	2,451,660	72.22
Female	942,335	27.76
Not reported	907	0.03
Race:		
Caucasian	1,844,801	54.34
Asian	61,674	1.82
Black or African American	234,964	6.92
Other	12,679	0.37
Unknown	1,240,784	36.55
Ethnicity:		
NonHispanic	2,208,653	65.06
Hispanic	187,336	5.52
Unknown	998,913	29.42
Insurance:†		
Commercial	702,043	20.68
Government	46,154	1.36
Medicaid	64,191	1.89
Medicare	350,488	10.32
Medicare Advantage	169,655	5.00
Military	36,538	1.08
No insurance	7,114	0.21
Unknown	2,336,836	68.83
Total practices	157	
Practice size:		
1–5 providers	36	22.93
6–14 providers	45	28.66
15+ providers	64	40.76
Practice region:		
Midwest	25	15.92
Northeast	20	12.74
South	71	45.22
West	41	26.11
Practice rurality:		
City	57	36.31
Rural	49	31.21
Suburban	39	24.84
Timing of stay-at-home orders by state of practice:		
Early	52	33.12
Mid	44	28.03
Late	61	38.85
Practices in zip codes with >25% population below FPL:		
Yes	18	11.46
No	137	87.26
Median income in practice zip code:		
<$50,000	63	40.13
$50,000–$100,000	82	52.23
>$100,000	10	6.37
No. urologists per 100,000 residents within each practice location:		
0	26	16.56
1–4	44	28.03
5+	85	54.14
Health Professional Shortage Area:		
Yes	144	91.72
No	11	7.01

Total number of patients was 3,394,902 and total number of visits was 13,108,874.
* Since this is age at visit date, some patients who had multiple visits appear in 2 age groups.
† Patients with multiple insurance types were classified based on first documented insurance in our study period.



A to *E*, weekly average of outpatient clinic visits from January 2019 to February 2021 per practice for overall population (*A*), select nonurgent diagnoses (*B*), potentially urgent diagnoses (*C*), new patient visits (*D*), and telephone visits (*E*). Nonurgent subset included microscopic hematuria, overactive bladder, elevated prostate specific antigen, erectile dysfunction and BPH (*B*). Urgent subset included prostate cancer, bladder cancer, kidney cancer, kidney stones, urinary tract infection, gross hematuria and renal mass (*C*). Beginning in March 2020 (week 10), there was sharp, nearly 50%, decrease in total outpatient visits, which reached nadir in April (week 15), with rebound period stretching from May to June (weeks 16 to 24) and reaching 92% of baseline, followed by another decrease, with visits at 77% of baseline.



nadir for outpatient visit decreases over time during the lockdown period. After week 21, there was a steady decline in the number of telephone-only visits per day, which became similar to pre-pandemic levels by week 37 (part *E* of figure).

Outpatient Clinic Visits by Diagnosis

Outpatient clinic visits declined substantially for all of the 12 most common urological diagnoses and decreased more for nonurgent diagnoses compared with other diagnoses (table 3 and parts *B* and *C* of figure). Outpatient visits for prostate, bladder and kidney cancer diagnoses saw a 38%–44% decrease in volume during the height of the pandemic, compared to a 54%–59% decrease in visits for benign prostatic hyperplasia (BPH) or microscopic hematuria. This was followed by a fast recovery period where outpatient visits were 6%–15% higher than baseline levels for prostate, bladder and kidney cancer diagnoses. However, as of February 2021, the volume of outpatient visits was still about 17%–19% lower than pre-pandemic values in February 2020. Although outpatient visits for benign indications such as benign prostatic hyperplasia, erectile dysfunction and overactive bladder decreased during the peak of the pandemic (49%–54%), outpatient visit rates in February 2021 were close to pre-pandemic levels (5%–12% lower).

Trends in Procedures

Frequency of inpatient and outpatient surgical procedures during the lockdown and subsequent reopening phases varied. Procedures for benign conditions, such as vasectomy, transurethral resection of the prostate (TURP) and urodynamics, decreased 68%–78% during the height of the pandemic in lockdown. The recovery for vasectomy increased to about 20% above pre-pandemic numbers, whereas other benign procedures had a more blunted response. Procedures for cancer, such as prostatectomy and radical

Table 2. *Changes in average daily outpatient visits per practice relative to baseline*

	Baseline—February 2020	Nadir*	% Decrease	Nadir Week	Recovery from Nadir†	% Recovery	Visits at February 2021	% Difference between February 2020 and February 2021
Overall	154.37	76.27	50.59	15	140.10	81.72	125.19	−18.91
Age (yrs):								
>65	91.16	43.79	51.96	15	84.97	86.94	72.43	−20.55
18—65	62.00	32.04	48.32	15	54.94	76.44	51.91	−16.28
<18	1.22	0.42	65.63	16	1.08	82.57	0.85	−30.10
Gender:								
Male	115.32	58.22	49.51	15	105.96	83.61	95.05	−17.58
Female	39.01	18.03	53.79	15	34.42	78.16	30.08	−22.87
Race:								
Caucasian	89.42	42.35	52.64	15	80.98	82.07	74.11	−17.13
Black	10.93	5.51	49.56	15	10.16	85.89	10.38	−5.03
Asian	2.35	0.86	63.18	15	2.20	90.25	2.23	−4.99
Other	0.60	0.29	52.43	13	0.56	88.30	0.49	−18.63
Ethnicity:								
Hispanic	8.12	3.96	51.23	15	7.48	84.77	6.76	−16.67
NonHispanic	106.40	51.58	51.52	15	96.40	81.75	77.42	−27.24
Insurance:								
Commercial	34.97	16.89	51.69	15	31.96	83.33	24.95	−28.66
Government	2.59	1.37	47.00	15	2.21	68.81	1.83	−29.25
Medicaid	3.45	1.60	53.69	15	2.95	73.10	2.37	−31.32
Medicare	21.29	9.41	55.82	15	19.26	82.87	13.43	−36.93
Medicare Advantage	11.33	5.93	47.61	15	10.21	79.29	7.74	−31.70
Military	1.98	0.98	50.32	15	1.91	92.57	1.31	−33.75
Median income in zip code:								
<$50,000	46.77	24.71	47.17	15	43.84	86.72	35.77	−23.51
$50,000—$100,000	101.73	49.04	51.79	15	92.08	81.68	84.89	−16.56
>$100,000	7.09	3.21	54.76	15	6.60	87.34	6.37	−10.13
>25% Population below FPL:								
Yes	17.33	8.58	50.48	30	15.92	83.96	14.98	−13.57
No	138.27	68.38	50.55	15	126.35	82.94	112.06	−18.95
No. urologists per 100,000 residents within each practice location:								
0	16.79	9.37	44.22	15	16.81	100.21	12.98	−22.72
1—4	29.34	15.93	45.70	15	26.26	77.05	22.62	−22.88
5+	109.47	51.65	52.82	14	99.37	82.54	91.43	−16.47
Practice size:								
1—5 providers	18.19	9.76	46.34	15	17.11	87.13	14.99	−17.58
6—14 providers	29.79	15.53	47.85	15	24.73	64.47	19.96	−32.98
15+ providers	112.83	53.59	52.51	14	104.59	86.10	94.74	−16.03
Practice region:								
Midwest	35.23	17.45	50.47	13	34.33	94.95	21.12	−40.05
Northeast	17.64	7.39	58.11	15	15.19	76.06	8.73	−50.50
South	73.52	34.95	52.47	15	72.14	96.42	70.94	−3.52
West	27.98	14.04	49.81	13	24.94	78.17	24.4	−12.79
Practice rurality:								
City	50.87	26.87	47.18	15	51.17	101.22	49.01	−3.66
Rural	32.88	16.75	49.07	14	29.38	78.30	18.15	−44.80
Suburban	63.76	29.95	53.03	13	57.73	82.15	57.05	−10.52
Stay-at-home order:								
Early	49.67	24.63	50.42	14	44.77	80.41	27.45	−44.73
Mid	57.65	27.77	51.83	15	54.37	89.02	58.62	1.69
Late	47.06	23.83	49.37	15	44.76	90.10	39.11	−16.88
Health professional shortage area:								
Yes	153.68	75.91	50.60	15	139.66	81.97	123.65	−19.54
No	1.92	0.99	48.47	14	1.69	75.66	3.38	76.64

Baseline = average daily visits per practice in February 2020. Nadir = lowest point of average daily visits after baseline. Recovery = highest point of average daily visits after nadir (examined up through week 52). Visits at week 30 = average daily visits per practice in week 30 (July 2020).
* Nadir = lowest point after baseline up through 2020 week 20. Recovery = highest point after nadir through 2020 week 52.
† % Recovery from nadir = (recovery visit average − nadir visit average)/(baseline visit average − nadir visit average).

cystectomy, also had decreases of 43%—53% during the lockdown. Cystectomies increased to more than 60% above pre-pandemic volumes but subsequently decreased in February 2021 to 37% lower volumes than in February 2020. Some of the lowest changes in treatment volumes during the lockdown included androgen deprivation therapy (ADT) and bacillus Calmette-Guérin treatment (20.6% and 27.2% decrease, respectively; table 4).

Logistic Regression of Declines in Outpatient Visits

In our mixed effects logistic regression analysis to predict the odds of having a very large (>50%)

Table 3. *Changes in outpatient visits by diagnosis*

Diagnosis	Baseline—February 2020	Nadir	% Drop	Nadir Week	Recovery	% Recovery from Nadir	February 2021	% Difference between February 2020 and February 2021
Urgent conditions:								
Prostate Ca	19.17	11.88	38.04	14	19.63	106.33	15.96	−16.74
Bladder Ca	4.91	2.93	40.26	14	5.21	115.45	3.96	−19.39
Kidney Ca	1.64	0.91	44.31	14	1.68	105.53	1.36	−17.24
Kidney stones	18.85	10.06	46.65	14	18.62	97.45	16.36	−13.22
Urinary tract infection	20.47	9.92	51.57	15	18.90	85.10	17.22	−15.86
Gross hematuria	9.08	5.10	43.88	15	8.81	93.22	8.48	−6.61
Renal mass	1.62	0.80	50.53	15	1.56	91.99	1.57	−3.31
Nonurgent conditions:								
Microscopic hematuria	9.10	3.72	59.16	15	8.06	80.75	7.56	−16.88
Overactive bladder	5.00	2.32	53.61	14	4.77	91.70	4.62	−7.44
Elevated prostate specific antigen	20.17	9.99	50.47	15	19.42	92.61	18.12	−10.14
Erectile dysfunction	16.95	8.57	49.42	15	16.84	98.71	16.07	−5.18
Benign prostatic hyperplasia	35.86	16.57	53.78	15	34.41	92.49	7.56	−12.24
New pt visits	15.55	6.72	56.80	15	14.55	88.67	13.53	−12.99

Baseline = average daily visits per practice in February 2020. Nadir = lowest point of average daily visits after baseline. Recovery = highest point of average daily visits after nadir (examined up through week 52).

decrease in outpatient visits (supplementary Appendix 3, https://www.jurology.com), elderly patients, women and Hispanic patients were more likely to have a large decline in outpatient visits compared with those under 65 years old, men and nonHispanics, respectively ($p < 0.001$ for all). We did not find significant decreases based on practice size ($\geq$15 providers or <15 providers) or race (Caucasian vs not Caucasian).

DISCUSSION

We evaluated continuous, nationwide data from the AQUA Registry to examine the impact of the COVID-19 pandemic on urological outpatient visits and surgical procedures. In our analyses, profound and rapid declines in visits and procedures were seen across all ages, races and practice types, followed by near-complete recovery and then a secondary decline that varied greatly in severity as COVID-19 case incidence surged again later in 2020. This study illustrates the power of real-world data from a specialty registry to facilitate evaluation of changing practice patterns and to identify at-risk patients to help guide policy and management. We observed that, although the COVID-19 pandemic affected individuals across the country,

Table 4. *Changes in procedures or treatment*

Procedure	Baseline—February 2020	Nadir	% Drop	Nadir Week	Recovery	% Recovery	February 2021 Visits	% Difference between February 2020 and February 2021
Diagnostic:								
Cystoscopy	8.70	2.92	66.48	15	7.62	81.30	6.03	−30.73
Prostate biopsy	2.79	0.99	64.64	15	2.38	77.29	2.11	−24.47
Urodynamics	5.39	1.38	74.35	15	4.58	79.64	4.01	−25.68
Surgeries for benign conditions:								
Vasectomy	1.76	0.55	68.81	16	2.03	122.23	1.39	−21.27
Ureteroscopy/lithotripsy	3.10	1.76	43.38	15	2.86	82.13	2.55	−17.80
Procedures for BPH including TURP	0.92	0.20	78.62	14	0.94	102.92	0.75	−17.82
Surgeries for malignancies:								
Prostatectomy	0.25	0.14	43.23	13	0.24	84.34	0.22	−13.27
Cystectomy	0.02	0.01	52.63	12	0.03	160.00	0.02	−36.59
Transurethral resection of bladder tumor (large)	0.14	0.08	43.41	15	0.13	83.98	0.10	−23.54
Transurethral resection of bladder tumor (small/medium)	0.35	0.17	50.61	15	0.35	99.08	0.28	−21.28
Treatments for malignancies:								
ADT injections for prostate Ca	1.65	1.31	20.56	14	1.80	143.56	1.26	−23.81
Bacillus Calmette-Guérin instillations for bladder Ca	1.21	0.88	27.19	17	1.20	97.24	0.87	−28.46
Intensity modulated radiation therapy fractions	2.31	2.15	6.74	20	2.72	362.79	2.17	−5.85
Image guided radiation therapy	0.98	0.88	9.86	19	1.20	331.06	1.00	1.96

Baseline = average daily procedures per practice in February 2020. Nadir = lowest point of average daily procedures after baseline. Recovery = highest point of average daily visits after nadir (examined up through week 52).

certain patient groups have not recovered as well as others, leaving certain patients more vulnerable than others. Some procedures and diagnoses were more impacted by the lockdown and recovery process than others.

The impact of the COVID-19 pandemic has been immense in its magnitude and scope. Efforts to adapt and restore services must be able to measure the impact as broadly and as close to real-time as possible as we help identify potential levers to guide resources and public policy. However, existing data registries are often reliant solely on claims data with significant lag time and questionable reliability.[9,10] This study is an example of how EHR-based registries can provide near real-time data that can be affordably scaled and used to help guide policy, especially during rapidly changing public health crises.

Overall, outpatient visits and procedures for all patients decreased about 50% during the initial lockdown portion of the COVID-19 pandemic, but the magnitude of the decrease and degree of recovery were variable. We found that the elderly, females and patients with Medicaid insurance had the highest decreases in outpatient visits and among the lowest magnitude recovery compared to pre-pandemic levels. There appears to be an aspect of regional impact as well, as practices in rural areas, lower income areas, and especially the Northeast and Midwest have not fully recovered and are anywhere from 20%–45% below pre-pandemic levels.

There may be multiple explanations for variations in patient visits observed during the different phases of the COVID-19 pandemic,[11] including patient decisions to mitigate risks of COVID-19 infection by delaying or avoiding visits, difficulty obtaining appointments because of re-prioritization during the pandemic, or the possibility of urology offices remaining closed or operating at limited hours for safety, financial or other reasons. Nonetheless, we found no substantial difference in visits or procedures during the initial lockdown period based on the timing of stay-at-home orders across states.

The stay-at-home orders issued may have created economic dislocation and exacerbated health disparities because of concerns for housing, food and financial security,[12,13] further compounding the persistently disproportionate impact of COVID-19 on minority and vulnerable patient populations.[14,15] However, our study found that the association between racial and socioeconomic factors and outpatient evaluations was nuanced and complex. Black patients had relatively smaller decreases in outpatient visits but improved to almost pre-pandemic levels. In comparison, those in poorer neighborhoods or rural counties with less access to urologists had relatively smaller decreases in outpatient visits initially but dramatically lower levels of recovery. These patterns could reflect multiple causes, including loss of employment or insurance coverage, financial insecurity or loss of clinics serving underserved areas. Tighter financial pressures have already led to closures of multiple clinics and hospitals, especially those in rural or underserved areas.[1,16,17]

In addition, given the aging workforce of physicians, with 46% of urologists aged 55 years or older,[18] the current workforce disruptions and questionable financial stability may lead to higher rates of retirement and further compound existing shortages of care, especially in rural and underserved areas. An important lever may be improving the ability of diverse communities to access telemedicine and video visits. A recent cohort study of more than 148,000 patients found that patients who were elderly, female and from lower income levels were almost 30%–40% less likely to complete a telemedicine visit during the COVID-19 pandemic.[19] Understanding patterns in care and barriers that may prevent outpatient evaluations from returning to baseline levels could help ensure adequate return of health care services for patients.

The significant variation in the decline of urological surgical procedures during the COVID-19 pandemic provides further insights into the complex factors that influence the use and timing of procedures. While other studies have observed similar decreases in the number of percutaneous coronary interventions[20] and elective procedures[21,22] during the initial onset of the pandemic, we demonstrated a highly variable rebound and secondary decrease in surgical procedures following the pandemic's resurgence after initial recovery. For example, bladder cancer procedures rebounded to rates greater than observed during the pre-pandemic period, presumably reflecting practices addressing backlogged cases from the initial shutdown. On the other hand, prostate biopsies and prostatectomies had significantly blunted recovery periods compared with other procedures, leading to concerns for downstream delays in prostate cancer diagnoses and treatment. These differences may be related to differences of how prostate and bladder cancer are diagnosed, namely detection through asymptomatic screening, surveillance of disease or symptomatic disease.

Early studies suggest that screening for breast, colorectal and prostate cancer decreased by 74%–85% during the COVID-19 pandemic;[23] current projections estimate that those delays may be associated with a future 10%–17% increased risk of mortality for these types of cancer.[24] Delayed care for other acute and chronic conditions may also

impact the control of comorbid conditions, symptom management and quality of life.[25,26] Using evidence from a diverse, nationwide source of real-world data helps to delineate the full impact of the COVID-19 pandemic on specialty health care utilization and downstream consequences, and thus may inform policy making and planning for recovering from the pandemic.

Overall, the data suggest possible avenues to mitigate risks of potential exposure to COVID-19 for at-risk populations. Programs that provide chemotherapy infusions and ADT injections at home have had dramatic success in providing quality cancer care at home in the midst of the COVID-19 pandemic in a cost-efficient manner.[27,28] Expanding programs that can provide androgen deprivation injections at home may help to mitigate the risk of exposure for patients undergoing treatment. In addition, we noted that elective procedures such as vasectomies and TURP decreased by 69%–79% initially. During the periods of uncertainty and escalating COVID-19 cases, more concerted efforts to decrease benign procedures may help to mitigate risk of exposure.

A limitation of this study was that use of EHR data to classify particular diagnoses and demographic factors associated with outpatient visits and procedures may be biased by variations in documentation and billing patterns across practices and EHR vendor platforms utilized. Also, analyses of EHR data may be incomplete due to lags in the time from clinical encounter to the time the information is included in the database analyzed, although our use of a 3-month buffer period between the data refresh date and last date of analysis should have minimized any data lag effects. The distribution of race/ethnicity in our cohort does not represent the general population and may not detect significant differences in disparities in care in the data available. In addition, there was approximately 36% of the cohort for whom race was unknown or not documented in the EHR, which could potentially impact the findings on race stratification. The AHRF only accounts for providers with an allopathic medical degree (M.D.) and omits those with osteopathic medical degree (D.O.). Therefore, the AHRF may underestimate the representation of urologists in the county. Although the AQUA Registry collects data from across the nation in diverse practice landscapes, the cohort is not a random selection and may not be generalizable to all urology practices across the country. Finally, it was not possible to differentiate telemedicine, remote visits compared with in-person visits from the codes available from EHR data, so we were unable to discern how virtual visits were utilized across the time spans analyzed.

CONCLUSIONS

Our results provide real-world evidence of the broad impact of the COVID-19 pandemic on urological practice across the United States, and provide insights into the disruptions in health care delivery observed within this multimodal medical specialty. While clinical visits initially rebounded and then declined, the frequency of surgical procedures was broadly decreased throughout the time span analyzed, and the use of many diagnostic procedures continue to remain below baseline values, which could impact patient outcomes in the future. Ongoing evaluations of real-world data sources such as the AQUA Registry and emerging data resources in other specialties will therefore be needed to characterize the short-term and long-term consequences of the COVID-19 pandemic on health care delivery in the U.S.

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