



Personal Protective Equipment for Common Urologic Procedures Before and During the United States COVID-19 Pandemic: A Single Institution Study

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OBJECTIVE	To evaluate the personal protective equipment (PPE) utilized in common urologic procedures before and during the COVID-19 outbreak in the United States. As elective urologic procedures are being reduced to conserve resources, we sought to quantify the PPE used per case to determine the impact on potentially limited resources needed for protecting healthcare providers treating COVID-19 patients.
METHODS	An IRB approved retrospective analysis of all urologic procedures in March 2019 and March 2020 was performed. Additionally, all urologic procedures performed by vascular interventional radiology (VIR) in May 2019 and March 2020 were included in the analysis. Case length, surgical and operating room staff present and number of articles of PPE were quantified. Articles of PPE were defined as surgical bonnet/hat and mask, and disposable or reusable gown with 1 pair of surgical gloves.
RESULTS	Four hundred and thirty-seven urologic and VIR procedures were included in the analysis. The mean PPE per case varied significantly between endoscopic and robotic categories. Robotic assisted laparoscopic cystectomy required the most hats and masks (14.5 per case in March 2019) whereas percutaneous nephrostomy tube placement by VIR required the fewest (3.1 in May 2019 and March 2020).
CONCLUSION	PPE consumption varied significantly across urologic procedures. Robotic-assisted cases require the most PPE and percutaneous nephrostomy placement by VIR requires the fewest. While PPE shortages are currently being addressed national and internationally, our results provide a baseline benchmark for articles of PPE required should another pandemic or global disaster requiring careful attention to resource allocation occur in the future. UROLOGY 141: 1–6, 2020. © 2020 Elsevier Inc.

With the surge of COVID-19 cases in the United States, institutions have begun prioritizing urgent and emergent urologic procedures over elective cases. Guidelines for the triage of elective cases have been released by multiple professional associations including the American Urological Association, the American College of Surgeons (ACS) and the

Center for Medicare and Medicaid Services. The ACS has released “COVID-19 Guidelines for Triage of Urology Patients”¹ which include triage criteria that take into account the “logistical feasibility for a give procedure” based on facilitate resources including beds, staff, equipment, and supplies.² The ACS has also called for a reduction in performing elective complex cases that may require ICU stay and ventilator support postoperatively.³ Center for Medicare and Medicaid Services’ recommendations state that the “conservation of critical healthcare resources is essential, in addition to limiting exposure of patients and staff to the virus that causes COVID-19.”⁴ Personal protective equipment (PPE) use has also been described by these professional associations. Beyond standard surgical PPE, which include surgical bonnet or scrub cap, surgical mask, disposable or reusable gown, and

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surgical gloves, the ACS recommends that “N95 respirators or respirators that offer a higher level of protection should be used when performing or present for an aerosol-generating procedure (eg, patient intubation) in COVID-19 or suspected infected patient.”⁵

One rationale has been aimed at conservation of PPE for surgeons and other healthcare providers is the deferment of procedures that theoretically require more articles of PPE to cut down on the “burn rate” of disposables necessary for the safety of healthcare providers during this unique time in our healthcare environment. A quantitative analysis of PPE consumption for urologic procedures before or during this time, however, has not been reported. We sought to evaluate the PPE utilization for common urologic procedures before the COVID-19 outbreak in the United States to determine whether there is any basis to the rationale of triaging procedures by PPE consumption.

METHODS

An IRB approved retrospective analysis of all urologic procedures during the month of March 2019 and March 2020 performed at a single academic institution was conducted. Additionally, all urologic procedures performed by vascular interventional radiology (VIR) during the month of May 2019 and March 2020 was included in the analysis. Cases were excluded if the procedure was aborted or if percutaneous nephrostomy tube (PCN) placement was unsuccessful. Case length, surgical and operating room staff present, and number of articles of PPE were quantified. All personnel that entered the room were counted as requiring 1 mask and 1 hat (bouffant or scrub cap). All personnel who actively scrubbed during the case were counted as using a single disposable or reusable gown, and 1 pair of surgical gloves. Some assumptions to our methodology were required: attending and resident urologists performing robotic surgery were assigned 2 articles of PPE due to the unscrubbed console time. Surgical technician breaks were accounted for with electronic medical records of operating room staffing. Observers and industry representatives were included in the analysis if electronic medical record documented their presence.

Cases were categorized within domains such as oncology, “stones,” “obstruction,” and benign prostatic hyperplasia (BPH). The Student *t* test and 1-way analysis of variance were utilized to determine differences in PPE utilization rates between procedures within domains. The Tukey-Kramer post hoc test was implemented to clarify specific differences between groups when analysis of variance was utilized. Statistical significance was defined as $P \leq .05$. Analysis of operations such as robotic-assisted laparoscopic cystectomy vs transurethral resection of bladder tumor (TURBT), robotic-assisted laparoscopic pyeloplasty vs ureteral stent placement vs PCN placement by VIR, robotic-assisted laparoscopic prostatectomy (RALP) vs brachytherapy, and transurethral resection of the prostate (TURP) vs GreenLight laser prostatectomy vs suprapubic tube (SPT) placement are examples.

RESULTS

A total of 437 procedures were identified. One hundred and eighty-three urologic surgeries were performed in March 2019 and 37 VIR procedures were performed in May 2019. One

hundred and seventy-two urologic surgeries and 45 VIR procedures were performed in March 2020. Mean number of PPE used per procedure, reported as masks and hats used per procedure as well as gowns and gloves used per procedure, is reported in Table 1. Median number of PPE used per procedure is displayed in Figures 1 and 2.

For management of stone disease, PPE usage between ureteroscopy with stone treatment (URS), shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), and ureteral stent placement was compared. A significant difference in PPE usage between stone management modalities was identified in 2019. Mean number of masks and hats utilized for SWL was lower compared to all modalities, however significantly lower when compared directly with ureteroscopy (6.3 vs 8.3, $P = .03$). Glove and gown utilization were significantly lower in SWL (1.7) than URS (3.2), stent placement/exchange (3.1), and PCNL (3.3); $P < .001$, $P < .001$, $P = .001$, respectively. No SWL cases were captured in the 2020 dataset and as such no differences were identified between stone management modalities in 2020. No differences in PPE utilization between 2019 and 2020 were identified for these cases (Table 2).

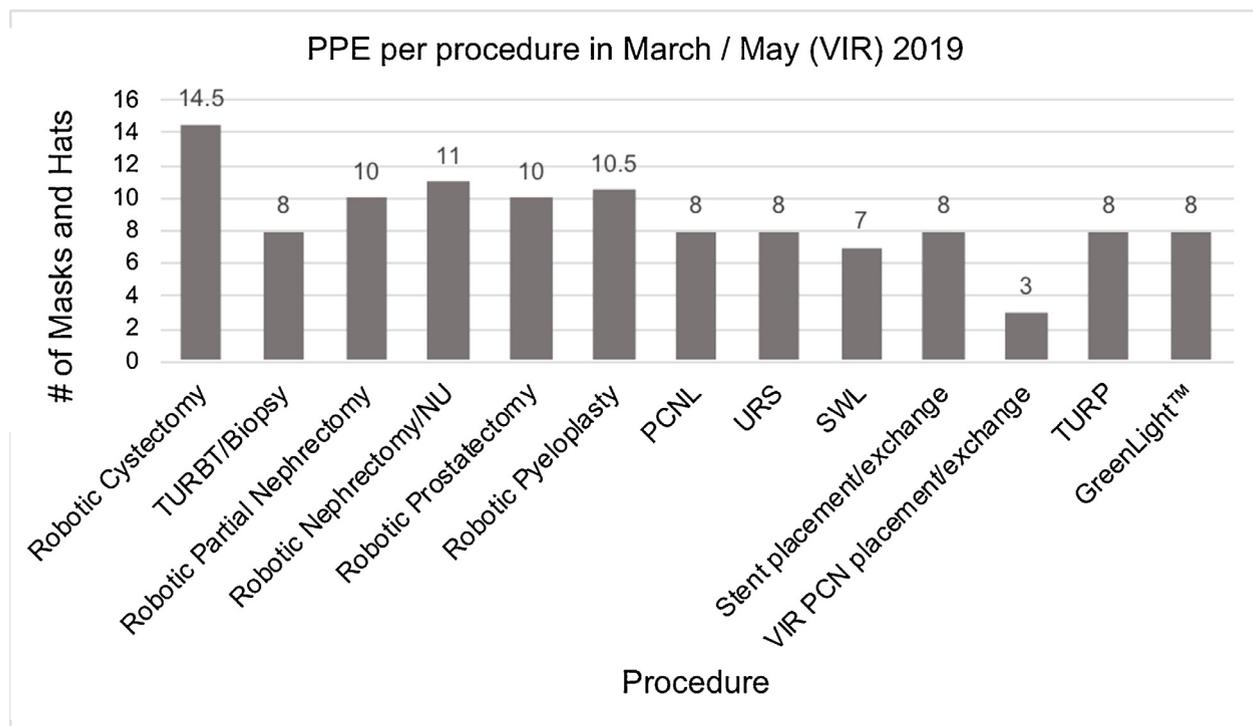
For management of ureteral obstruction, PPE usage was assessed between ureteral stent placement/exchange, PCN placement/exchange by VIR, and robotic-assisted laparoscopic pyeloplasty. Significantly lower numbers of masks/hats as well as gowns/gloves used were seen for management via PCN in 2019 compared to ureteral stent ($P < .001/P < .001$) and pyeloplasty ($P < .001/P < .001$). These findings were again demonstrated in 2020. In 2019 ureteral stent placement utilized significantly fewer masks/gowns and gloves/hats than robotic-assisted laparoscopic pyeloplasty ($P < .001/P < .001$). In 2020 no difference in masks/hats utilization for ureteral stent vs pyeloplasty ($P = .06$) was identified however gowns/gloves use was again significantly lower with stent when compared to pyeloplasty ($P < .001$). Of note, the mean number of masks/hats and gown/gloves utilized for robotic-assisted laparoscopic pyeloplasty decreased from 2019 to 2020 (11/8.5 to 9/6.5). There was no statistically significant difference in usage between years however in gown/glove use ($P = .058$).

For management of bladder outlet obstruction, PPE usage was assessed between TURP, GreenLight laser prostatectomy, and SPT placement or exchange in 2019 and the above in addition to robotic-assisted simple prostatectomy and UroLift in 2020 due to variability in case distribution captured from each year. In 2019 significantly fewer masks and hats were utilized in SPT placement/exchange compared to GreenLight and TURP ($P = .001$ and $.0005$, respectively) while no differences were identified in gloves and gowns utilization between procedures. In 2020 significantly fewer masks and hats were utilized for SPT placement/exchange when compared to robotic-assisted laparoscopic simple prostatectomy, UroLift, and GreenLight ($P = .005$, $.019$, and $.016$, respectively). A trend towards lower utilization of masks and hats for SPT compared to TURP was identified ($P = .053$). Robotic-assisted laparoscopic simple prostatectomy required more masks and hats than TURP ($P = .013$) and GreenLight ($P = .026$), however no difference was seen in comparison to UroLift ($P = .15$). Robotic-assisted laparoscopic simple prostatectomy required increased usage of gowns and gloves compared to all other procedures in the “outlet” subset: SPT placement/exchange ($P = .002$), GreenLight ($P = .002$), TURP ($P = .002$), and UroLift ($P = .005$). No difference in gowns/gloves usage was seen between all other “outlet” procedures.

Table 1. Mean PPE per procedure

	2019			2020		
	N	Masks/hats	Gowns/gloves	N	Masks/hats	Gowns/gloves
Oncology						
Robotic cystectomy	2	14.5	10.5	2	11.5	7.0
Robotic nephrectomy/NU	2	11.0	8.0	6	10.3	7.7
RALP	5	10.2	8.2	11	9.9	7.1
Robotic partial nephrectomy	9	10.2	7.9	4	11.0	7.5
TURBT/biopsy	37	7.8	3.3	30	7.1	2.9
Brachytherapy	0	N/A	N/A	3	12.0	4.7
Other oncological cases	5	8.0	3.8	0	N/A	N/A
Endourology						
Stent placement/exchange	29	7.9	3.1	33	7.7	3.1
URS	61	8.3	3.2	51	8.2	3.1
PCNL	3	7.7	3.3	4	8.3	3.5
TURP	7	7.9	3.4	2	6.0	3.5
GreenLight	3	8.0	3.7	3	7.3	3.0
UroLift	0	N/A	N/A	1	8.0	4.0
SWL	3	6.3	1.7	0	N/A	N/A
Other Endourology cases	7	7.7	3.1	10	6.9	2.9
Reconstructive urology						
Robotic pyeloplasty	6	11.0	8.5	2	9.0	6.5
Urethroplasty	0	N/A	N/A	1	11.0	5.0
Artificial urinary sphincter	0	N/A	N/A	1	11.0	5.0
Urethral sling	0	N/A	N/A	1	6.0	3.0
Other recon cases	3	8.0	4.3	7	7.3	4.1
VIR						
PCN placement/exchange	35	3.1	2.1	44	3.1	2.1
SPT placement/exchange	2	3.5	2.5	1	3.0	2.0

ANOVA, analysis of variance; PCN, percutaneous nephrostomy; PCNL, percutaneous nephrolithotomy; PPE, personal protective equipment; RALP, robotic-assisted laparoscopic prostatectomy; SPT, suprapubic tube; SWL, shock wave lithotripsy; TURP, transurethral resection of the prostate; URS, ureteroscopy with stone treatment; VIR, vascular interventional radiology.

**Figure 1.** PPE per procedure in March / May (VIR) 2019.

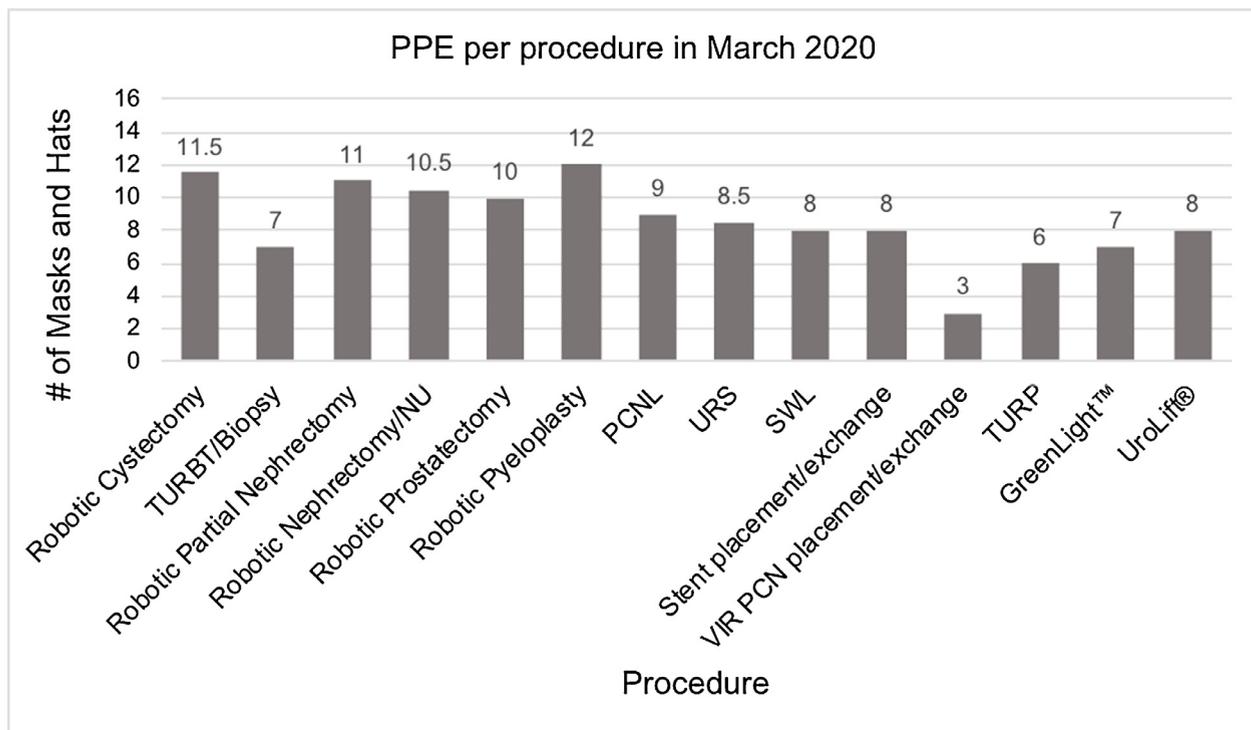


Figure 2. PPE per procedure in March 2020.

In the management of prostate cancer, RALP and brachytherapy were directly compared in 2020 as no brachytherapy procedures were completed in 2019. No difference in masks/hats utilization was identified (9.9 vs 12, $P = .20$) however RALP

required significantly more gowns/gloves comparatively (7.1 vs 4.7, $P < .05$). From 2019 to 2020 no difference was detected in masks/hats usage for RALP (10.2 vs 9.9, $P = .70$) however lower usage of gowns/gloves was seen in 2020 (8.2 vs 7.1, $P < .05$).

Table 2. Mean PPE comparison between procedures within domains

	Masks/hats		Gown/gloves	
	2019	2020	2019	2020
Stones				
URS	8.3	8.2	3.2	3.1
SWL	6.3	N/A	1.7	N/A
PCNL	7.7	8.3	3.3	3.5
Stent	7.9	7.7	3.1	3.1
<i>P</i> (ANOVA)	.026	.212	<.001	.365
Obstruction				
Stent	7.9	7.7	3.1	3.1
PCN	3.1	3.1	2.1	2.1
Robotic pyeloplasty	11.0	9.0	8.5	6.5
<i>P</i> (ANOVA)	<.001	<.001	<.001	<.001
Benign prostatic hyperplasia				
SPT	3.5	3.0	2.5	2.0
TURP	7.9	6.0	3.4	3.5
GreenLight	8.0	7.3	3.7	3.0
Robotic simple prostatectomy	N/A	11.0	N/A	9.0
UroLift	N/A	8.0	N/A	4.0
<i>P</i> (ANOVA)	.0005	.0062	.114	.002

ANOVA, analysis of variance; PCN, percutaneous nephrostomy; PCNL, percutaneous nephrolithotomy; PPE, personal protective equipment; SPT, suprapubic tube; SWL, shock wave lithotripsy; TURP, transurethral resection of the prostate; URS, ureteroscopy with stone treatment.

In management of bladder cancer, robotic-assisted laparoscopic cystectomy and TURBT were directly compared. All cases for the 2019 and 2020 data collection periods were aggregated for this analysis. Compared to TURBT, RALC required more masks/hats (13 vs 7.5, $P = .014$) and more gowns/gloves (8.6 vs 3.1, $P = .017$). An analysis of all recorded robotic-assisted ($n = 50$) vs endourologic ($n = 200$) operations revealed significantly higher utilization rates of masks/hats as well as gowns/gloves in robotic-assisted cases comparatively (10.5 vs 8, $P < .0001$ and 7.8 vs 3.1, $P < .0001$, respectively). Of note, all recorded robotic-assisted cases were included and endourologic cases, for the sake of this analysis, included all recorded stent placement/exchange, URS, PCNL, TURP, GreenLight, UroLift, and SWL.

DISCUSSION

A variety of protocols have been implemented to determine which urologic cases should proceed during the COVID-19 pandemic in the United States. These protocols are targeted towards reducing the risk of transmission to healthcare staff perioperatively and minimizing exposure of patients to COVID-19 positive patients in the inpatient setting postoperatively, as well as conserving and diverting important resources to the management of COVID-19 positive patients.

PPE shortages have been on the forefront of media coverage and healthcare workers cite this as one of their greatest concerns.⁶ One rationale for the cancellation of elective cases has been to minimize PPE utilization. For

procedures deemed urgent or emergent, there has been no consensus on how to triage surgical priority of urologic conditions. A thorough assessment of the PPE required to protect the surgical team, anesthesiologist and operating room staff during different urologic procedures has not been performed. In our study, we aimed to characterize PPE requirements for common urologic procedures and to assess if variability between procedures existed. Should significant differences exist, 1 might choose between 2 equivalent treatments based on which required fewer articles of PPE in times when critical supply shortages call for strict attention to resource allocation.

Our data demonstrate that there are significant differences in the PPE requirements between urologic procedures. PCN placement required fewer articles of PPE than stent placement. From a purely resource and PPE utilization, PCN placement affords fewer resources and reduced exposure to fewer healthcare providers during the procedure in patients in need of emergent upper tract decompression secondary to obstructive pyelonephritis or acute kidney injury.

Robotic-assisted urologic procedures required the most PPE per case primarily due to 2 factors: the donning and doffing of PPE before and after console time as well as the longer length of the procedure necessitating surgical technician substitutions for breaks. In general, VIR procedures required 3 articles of PPE per case: 1 for the attending interventionalist, 1 for the radiologic technician, and 1 for the circulating nurse. In 2019 ureteral stent placement utilized significantly fewer masks/gowns and gloves/hats than robotic-assisted reconstructive ureteral surgery; in 2020 no difference in masks/gowns was seen however gowns/gloves were significantly lower in those undergoing ureteral stent placement. Taken together, as expected ureteral stent placement requires less upfront PPE.

There may be some value to performing a definitive procedure rather than a temporizing procedure if the duration of shortage can be reliably estimated. Should an extended shortage be encountered lasting greater than 1 year, the PPE required upfront for definitive reconstructive surgery in those with ureteropelvic junction obstruction could be justified as more resources (eg, operating room, staffing, PPE) are needed for a year of stent exchanges if performed every 3 months.

Brachytherapy consumed much higher PPE, accounting for the additional staff (radiation oncologist, medical physicist, others) required during the procedure compared to other procedures, however, when compared to RALP in the management of prostate cancer, less PPE was needed. It should be noted that PPE counts included scrubbing and unscrubbing of surgeon and resident for the console. This did not affect the number of masks and hats that were used during these cases. Consideration may be given to non-operative management of prostate cancer in times when PPE is scarce.

Our study has several shortcomings. This was a single center retrospective analysis which limits applicability to other institutions. Data for VIR procedures during the

month of March 2019 were unavailable in the electronic medical record so the month of May 2019 was substituted. Our institution does not routinely count articles of PPE, thus an estimation based on personnel was utilized. Additionally, we did not account for double-gloving practices during procedures, so the number of gowns and gloves represents the minimum PPE required to single glove every scrubbed member of the procedure. Our institution began limiting visitor and industry representative presence in the operating room during the March 2020 due to the COVID-19 pandemic and this may be reflected in the lower numbers of PPE utilized in such cases as RALP where usage of gowns/gloves was significantly lower in 2020 compared to 2019. Medical students were similarly limited, reducing the number of scrubbed team members. A trend towards decreased utilization of both masks/hats and gowns/gloves was also seen in robotic-assisted laparoscopic pyeloplasty was identified however did not reach statistical significance, likely related to low sample size.

It is acknowledged that operations compared directly in the “stones,” “obstruction,” and “outlet” subgroups are not interchangeable depending on the clinical scenario. The decision to proceed with a surgical approach relies on several factors, among which PPE may become a consideration in situations of critical shortages. Further, PPE usage can be optimized through decreasing traffic through the OR and by minimizing double-scrubbing among urologic trainees and medical students. Given that data were collected for individual months for ease of comparison and to streamline efficiency in publication, case distribution and variability is an acknowledged weakness. For example, analysis of procedures such as UroLift ($n = 1$) and robotic-assisted laparoscopic simple prostatectomy ($n = 1$) were included however should be interpreted with this in mind. The PPE usage is not expected to dramatically differ for these cases and the increased PPE needed for UroLift, for example, likely represents the need for a company representative to be present for the procedure, when permitted.

CONCLUSION

PPE consumption is significantly different across urologic operations. Should triaging of types of procedures be conducted based solely on short-term resource allocation, consideration should be given to operations utilizing less PPE. In situations where long-term PPE shortages may be suspected, consideration may be given to more definitive management which may require an upfront cost of higher PPE but may conserve overall resources over time. While PPE shortages related to the COVID-19 pandemic are currently being addressed nationally and internationally, this study provides a baseline benchmark for articles of PPE required for common urologic procedures. Should another pandemic or global disaster accompanied by critical supply shortages occur in the future, these data are pertinent to decision-making with attention to conservation and optimization in resource allocation.

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