The impact of resident involvement in minimally-invasive urologic oncology procedures

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Abstract

Introduction: Robotic and laparoscopic surgical training is an integral part of resident education in urology, yet the effect of resident involvement on outcomes of minimally-invasive urologic procedures remains largely unknown. We assess the impact of resident participation on surgical outcomes using a large multi-institutional prospective database.

Methods: Relying on the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) Participant User Files (2005-2011), we abstracted the 3 most frequently performed minimally-invasive urologic oncology procedures. These included radical prostatectomy, radical nephrectomy and partial nephrectomy. Multivariable logistic regression models were constructed to assess the impact of trainee involvement (PGY 1-2: junior, PGY 3-4: senior, PGY ≥5: chief) versus attending-only on operative time, length-of-stay, 30-day complication, reoperation and readmission rates.

Results: A total of 5459 minimally-invasive radical prostatectomies, 1740 minimally-invasive radical nephrectomies and 786 minimally-invasive partial nephrectomies were performed during the study period, for which data on resident surgeon involvement was available. In multivariable analyses, resident involvement was not associated with increased odds of overall complications, reoperation, or readmission rates for minimally-invasive prostatectomy, radical and partial nephrectomy. However, operative time was prolonged when residents were involved irrespective of the type of procedure. Length-of-stay was decreased with senior resident involvement in minimally-invasive partial nephrectomies (odds ratio [OR] 0.49, $p = 0.04$) and prostatectomies (OR 0.68, $p = 0.01$). The major limitations of this study include its retrospective observational design, inability to adjust for the case complexity and surgeon/hospital characteristics, and the lack of information regarding the minimally-invasive approach utilized (whether robotic or laparoscopic).

Conclusions: Resident involvement is associated with increased operative time in minimally-invasive urologic oncology procedures. However, it does not adversely affect the complication, reoperation or readmission rates, as well as length-of-stay.

Introduction

While the adoption of laparoscopy and robotics has provided new tools that may benefit patients, they are associated with a learning curve.[1-3] Several studies have demonstrated a relationship between surgeon experience and outcomes in minimally-invasive prostate surgery.[4,5] Discrepancies in patient outcomes also lie in the hospital characteristics, with high-volume and teaching hospitals providing better quality care.[6,7]

An integral aspect of surgical care in teaching hospitals is resident involvement.[8] In urologic surgical training, minimally-invasive techniques are an important part of surgical training, and resident participation is common and expected, as the demand for minimally-invasive procedures continues to grow.[9] Given their associated complexity and considering the changing dynamics brought about by Accreditation Council for Graduate Medical Education (ACGME)-mandated work hour limitations and an increasing focus on patient safety and quality improvement measures, optimizing resident involvement in minimally-invasive urologic procedures is crucial. This has been evaluated in the past in the general surgery literature with mixed results, while data on safety of resident participation in minimally-invasive urologic surgery is limited.[10-15]

We examine the impact of resident involvement on critical perioperative outcomes, including operative time, complications, readmission and reoperation rates, as well as length-of-stay. We assessed these endpoints for the commonly performed minimally-invasive urologic oncology procedures using data from American College of Surgeons National Surgery Quality Improvement Program (ACS-NSQIP) participating hospitals.

Methods

Data source

The ACS-NSQIP collects a sample of risk-adjusted patient data from member hospitals to facilitate the assessment of outcome measures after surgery. A trained Surgical Clinical Reviewer prospectively collects the NSQIP data from clinical records.[16,17] Validated data from patients' medical charts allow quantification of 30-day risk-adjusted surgical outcomes, including post-discharge information. In 2011, the NSQIP included data from 315 participating sites and more than 442 149 cases.

Study population

Using Current Procedural Terminology [CPT] codes, we identified patients who underwent major urologic cancer surgery using a minimally-invasive approach, including a pure laparoscopic technique, as well as laparoscopic technique with robotic-assistance. The nature of the data barred us from distinguishing among these techniques. Overall, we identified 8381 patients who underwent radical prostatectomy (CPT code: 55866), and 2753 who underwent radical nephrectomy (CPT codes: 50545, 50546, 50548) and partial nephrectomy (CPT code: 50543) between 2005 and 2011. We excluded 3149 patients with unavailable resident involvement information. This resulted in a final population of 7985 patients.

Covariates

For each patient, gender, age, body mass index (BMI), race, smoking status, and American Society of Anesthesiology (ASA) physical status were evaluated. Additionally, the highest post-graduate year for the resident who scrubbed for the surgical procedure was assessed. Residents were categorized into groups defined by their PGY status, as junior (PGY1-2), senior (PGY 3-4) or chief (PGY ≥5).

Outcomes

Complications were categorized as follows for univariable analysis: cardiovascular (including postoperative cardiac arrest, myocardial infarction or cerebrovascular accident), pulmonary (including pneumonia, need for postoperative reintubation, and need for ventilatory support >48 hours), thromboembolic (including deep venous thrombosis and pulmonary embolism), septic (including sepsis and septic shock), renal (including acute renal failure and progressive renal insufficiency), urinary tract infections, and wound complications (including superficial, deep, and organ space surgical site infections, and wound dehiscence) according to previously reported methodology.[18] They were then grouped into the composite outcome of overall complications on multivariable models. Additional outcomes consisted of prolonged length of stay (pLOS) and prolonged operative time (pOT), defined according to the highest quartile (≥75th percentile). Specifically, for pLOS, these cutoffs were 3, 5 and 4 days for radical prostatectomy, radical nephrectomy and partial nephrectomy, respectively. For pOT, these cutoffs were 244, 220 and 255 minutes, respectively. Finally, 30-day readmission data were defined dichotomously and reported for procedures beginning January 2011.

Statistical analyses

Descriptive statistics of categorical variables focused on frequencies and proportions. The chi-square test was used to compare proportions. Subsequently, multivariable logistic regression models tested the association between preoperative covariates and the aforementioned outcomes. Covariates consisted of gender, age, BMI, race, smoking status, ASA score, and highest resident level.

All statistical tests were performed using the R statistical package (version 3.0.2), with a two-sided significance level set at $p < 0.05$. An institutional review board waiver was obtained prior to conducting this study, in accordance with institutional regulation when dealing with de-identified administrative data.

Results

Table 1 summarizes the baseline characteristics and univariable analyses of the patients.

A total of 5459 minimally-invasive *radical prostatectomies* were included, of which 2925 were performed with resident involvement. There was no difference between the groups with regards to BMI and ASA classification. Postoperative outcomes did not differ with respect to 30-day cardiovascular, pulmonary, renal, thrombotic, sepsis, urinary tract infection (UTI), wound and overall complications rates between patients treated by attending only and resident involved groups. LOS, reoperation, and readmission rates were also not statistically different between the groups. However, operative time was significantly longer in the resident group compared to the attending group, with 28.3% of the procedures in the resident group in the longest operative time quartile compared to 21.6% in the attending only group ($p < 0.001$).

A total of 1740 minimally-invasive *radical nephrectomies* were included, of which 891 were performed with resident

Table 1. Baseline patient characteristics and univariable predictors of outcomes as a function of resident involvement in each of 3 minimally-invasive urologic surgeries, as drawn from the National Surgical Quality Improvement Program Participant User Files from 2005-2011

	Partial nephrectomy (n = 786)			Radical nephrectomy (n = 1740)			Radical prostatectomy (n = 5459)		
Variables	**Non-resident (%)**	**Resident (%)**	***p* value**	**Non-resident (%)**	**Resident (%)**	***p* value**	**Non-resident (%)**	**Resident (%)**	***p* value**
Race (%)									
White	172 (80.8)	429 (74.9)	0.084	657 (77.4)	608 (68.2)	<0.001	2017 (79.6)	2147 (73.4)	<0.001
Non-white	41 (19.2)	144 (25.1)		192 (22.6)	283 (31.8)		517 (20.4)	778 (26.6)	
Sex (%)									
Female	80 (37.6)	259 (45.2)	0.055	359 (42.3)	392 (44.0)	0.471	N/A	N/A	N/A
Male	133 (62.4)	314 (54.8)		490 (57.7)	499 (56.0)				
BMI (%)									
<25	39 (18.3)	123 (21.5)		192 (22.6)	219 (24.6)		530 (20.9)	561 (19.2)	
25-30	64 (30.0)	223 (38.9)	0.009	304 (35.8)	325 (36.5)	0.469	1172 (46.3)	1375 (47.0)	0.272
>30	115 (51.6)	227 (39.6)		353 (41.6)	347 (38.9)		832 (32.8)	989 (33.8)	
Smoking									
No	178 (83.6)	463 (80.8)	0.374	667 (78.6)	744 (83.5)	0.009	2177 (85.9)	2611 (89.3)	<0.001
Yes	35 (16.4)	110 (19.2)		182 (21.4)	147 (16.5)		357 (14.1)	314 (10.7)	
ASA									
1-2	107 (50.2)	274 (47.8)	0.547	339 (39.9)	335 (37.6)	0.318	1687 (66.6)	1996 (68.2)	0.190
3-5	106 (49.8)	299 (52.2)		510 (60.1)	556 (62.4)		847 (33.4)	929 (31.8)	
Cardiovascular complications (%)[a]									
No	213 (100.0)	571 (99.7)	0.388	845 (99.5)	885 (99.3)	0.577	2528 (99.8)	2922 (99.9)	0.223
Yes	0 (0.0)	2 (0.3)		4 (0.5)	6 (0.7)		6 (0.2)	3 (0.1)	
Pulmonary complications (%)[a]									
No	210 (98.6)	566 (98.8)	0.835	835 (98.4)	865 (97.1)	0.077	2519 (99.4)	2913 (99.6)	0.340
Yes	3 (1.4)	7 (1.2)		14 (1.4)	26 (2.9)		15 (0.6)	12 (0.4)	
DVT (%)[a]									
No	212 (99.5)	563 (98.3)	0.176	845 (99.5)	885 (99.3)	0.577	2510 (99.1)	2903 (99.2)	0.432
Yes	1 (0.5)	10 (1.7)		4 (0.5)	6 (0.7)		24 (0.9)	22 (0.8)	
Septic shock (%)[a]									
No	211 (99.1)	567 (99.0)	0.893	841 (99.1)	876 (98.3)	0.176	2521 (99.5)	2899 (99.1)	0.100
Yes	2 (0.9)	6 (1.0)		8 (0.9)	15 (1.7)		13 (0.5)	26 (0.9)	
Renal failure[a]									
No	212 (99.5)	568 (99.1)	0.564	833 (98.1)	873 (98.0)	0.838	2520 (99.4)	2910 (99.5)	0.841
Yes	1 (0.5)	5 (0.9)		16 (1.9)	18 (2.0)		14 (0.6)	15 (0.5)	
UTI complications[a]									
No	211 (99.1)	567 (99.0)	0.893	836 (98.5)	871 (97.8)	0.275	2493 (98.4)	2866 (98.0)	0.273
Yes	2 (0.9)	6 (1.0)		13 (1.5)	20 (2.2)		41 (1.6)	59 (2.0)	
Wound complications[a]									
No	209 (98.1)	569 (99.3)	0.143	824 (97.1)	878 (98.5)	0.034	2519 (99.4)	2907 (99.4)	0.911
Yes	4 (1.9)	4 (0.7)		25 (2.9)	13 (1.5)		15 (0.6)	18 (0.6)	
Overall complications[a]									
No	204 (95.8)	540 (94.2)	0.395	780 (91.9)	819 (91.9)	0.972	2417 (95.8)	2799 (95.7)	0.877
Yes	9 (4.2)	33 (5.8)		69 (8.1)	72 (8.1)		107 (4.2)	126 (4.3)	
Reoperation[a]									
No	210 (98.6)	560 (97.7)	0.448	821 (96.7)	868 (97.4)	0.397	2499 (98.6)	2895 (99.0)	0.227
Yes	3 (1.4)	13 (2.3)		28 (3.3)	23 (2.6)		35 (1.4)	30 (1.0)	
pLOS[b]									
No	166 (77.9)	428 (74.7)	0.347	498 (58.7)	539 (60.5)	0.435	2195 (86.6)	2567 (87.8)	0.209
Yes	46 (22.1)	145 (25.3)		351 (41.3)	352 (39.5)		339 (13.4)	358 (12.2)	
pOT[c]									
No	134 (62.9)	234 (42.4)	<0.001	700 (82.4)	596 (66.9)	<0.001	1987 (78.4)	2098 (71.7)	<0.001
Yes	79 (37.1)	330 (57.6)		149 (17.6)	295 (33.1)		547 (21.6)	827 (28.3)	
Readmission[a]									
No	54 (94.7)	206 (94.5)	0.943	155 (94.5)	273 (94.1)	0.869	531 (96.9)	881 (95.9)	0.314
Yes	3 (5.3)	12 (5.5)		9 (5.5)	17 (5.9)		17 (3.1)	38 (4.1)	

[a]Using 30-day data; [b]Defined according to the highest quartile; [c]Defined according to the highest quartile. BMI: body mass index; UTI: urinary tract infection; pLOS: prolonged length of stay; pOT: Prolonged operative time.

involvement. There was no difference between the groups with regards to sex, BMI and ASA classification. Among complications, the attending-only group had higher wound complications rates compared to the group with resident involvement, 2.9% versus 1.5%, respectively ($p = 0.04$). Outcomes between attending only and resident involved groups did not differ with respect to 30-day cardiovascular, pulmonary, renal, thrombotic, sepsis, UTI, and overall complications rates. LOS, reoperation, and readmission rates were not statistically different between the groups. However, the operative time was significantly longer in the resident group compared to the attending group, as 33.1% of the procedures in the resident group had pOT ($p < 0.001$).

A total of 786 minimally-invasive *partial nephrectomies* were included, of which 573 were performed with a resident. The groups of patients operated on by an attending only and those with resident involvement did not differ in terms of race, tobacco use and ASA classification. However, a higher percentage of patients with BMI greater than 30 were operated on by an attending only, 51.6% versus 39.6% ($p = 0.01$). Patient outcomes between the attending only and resident-involved groups did not differ in terms of 30-day cardiovascular, pulmonary, renal, thrombotic, sepsis, UTI, wound and overall complication rates. LOS, reoperation and readmission rates were not statistically different between the groups. However, the operative time was significantly longer in the resident group compared to the attending group, with 57.6% of the procedures in the resident group in the longest operative time quartile ($p < 0.01$).

Adjusted outcomes

Table 2 shows the impact of PGY group versus attending-only involvement on LOS, operative time, overall complications and readmission.

In the minimally-invasive prostatectomy group, multivariable regression models revealed a decreased rate of pLOS with resident involvement at the PGY 3-4 level (OR 0.68, $p = 0.01$). Rates of pOT were higher with all levels of resident involvement (PGY 1-2 OR 2.00, $p < 0.001$; PGY 3-4 OR 1.31, $p = 0.01$; PGY ≥5 OR 1.32, $p < 0.001$). Resident involvement was not associated with increased overall complications, reoperation and readmission rates.

In the minimally-invasive radical nephrectomy group, multivariable models revealed an increased rate of pOT with all levels of resident involvement (PGY 1-2 OR 2.29, $p < 0.001$; PGY 3-4 OR 2.50, $p < 0.001$; PGY ≥5 OR 2.35, $p < 0.001$). Resident involvement at any level was not associated with pLOS, overall complications, reoperation and readmission rates.

In the minimally-invasive partial nephrectomy group, multivariable logistic regression analyses revealed an increased rate of pLOS with PGY 1-2 involvement (OR 1.85, $p = 0.02$). Resident involvement at the PGY 3-4 level was associated with a decreased rate of pLOS (OR 0.49, $p = 0.04$). Statistical significance was not reached with resident participation at the PGY ≥5 level. Higher rates of pOT were associated with resident participation at all resident levels (PGY 1-2 OR 3.01, $p < 0.001$; PGY 3-4 OR 1.86, $p = 0.01$; PGY ≥5 OR 2.44, $p < 0.001$). Resident involvement was not associated with overall complications, reoperations and readmissions.

Discussion

A significant proportion of operations in the United States are conducted in teaching hospitals and resident involvement is an integral part of surgical care at teaching institutions.[10-15] In an increasingly cost-conscious medical culture, delivering high quality care is of utmost importance, translating in greater involvement of attending surgeons and less resident independence.[12] Moreover, surgical resident education is increasingly challenging due to expense,[19] work hour limitations[20] and an ever-increasing array of minimally-invasive surgical options to complement open surgical techniques. Thus, in an effort to maintain efficiency while achieving the highest standards of care, resident education will need to be optimized. In this context, we evaluated the safety of resident participation in the most common minimally-invasive urologic oncology procedures.

Several of our findings are noteworthy. Firstly, our study demonstrates that resident involvement in the most commonly performed minimally-invasive urologic oncology procedures has no adverse impact on overall complication, reoperation and readmission rates. The growing literature on resident involvement in urologic procedures suggests that their integration can be done safely and without significantly adversely affecting patient outcomes. Our findings on radical prostatectomies are consistent with prior studies on open[21] and laparoscopic[15] prostatectomies that demonstrated resident involvement in those surgeries to be safe, with equivalent morbidity, although with increased operative time. Kern and colleagues also utilized the NSQIP database to examine the impact of training level on outcomes of partial nephrectomies from 2005 to 2010 and showed increased operative time, overall morbidity, surgical site infections, bleeding, sepsis, and septic shock when residents at any level were involved.[14] However, their analysis grouped together minimally-invasive and open surgery. In a subset analyses of the Kern study, trainee involvement at any level decreased overall (OR 0.45, $p < 0.001$) and major (OR 0.40, $p < 0.001$) complications for minimally-invasive versus open partial nephrectomies, while in the attending only group, complication rates between the two groups were similar. One of three explanations are possible: either resident involvement in minimally-invasive partial nephrectomies decreased morbidity, their involvement in

Table 2. Multivariable logistic regression analysis on the impact of PGY group versus attending-only involvement on length of stay, operative time, overall complications, and readmission as drawn from the National Surgical Quality Improvement Program Participant User Files from 2005-2011*												
		Partial nephrectomy				**Radical nephrectomy**				**Radical prostatectomy**		
Variables	No resident	Junior (PGY 1-2)	Senior (PGY 3-4)	Chief (PGY >5)	No resident	Junior (PGY 1-2)	Senior (PGY 3-4)	Chief (PGY >5)	No resident	Junior (PGY 1-2)	Senior (PGY 3-4)	Chief (PGY >5)
pLOS	1 (Ref.)	1.85 (1.09-3.12)	0.49 (0.25-0.96)	1.21 (0.80-1.82)	1 (Ref.)	1.04 (0.74-1.45)	0.78 (0.56-1.10)	0.92 (0.73-1.17)	1 (Ref.)	1.19 (0.93-1.51)	0.68 (0.50-0.92)	0.90 (0.75-1.09)
***p* value**		0.022	0.039	0.366		0.844	0.156	0.504		0.159	0.014	0.293
pOT	1 (Ref.)	3.01 (1.85-4.90)	1.86 (1.15-3.01)	2.44 (1.70-3.49)	1 (Ref.)	2.29 (1.59-3.31)	2.50 (1.75-3.58)	2.35 (1.82-3.05)	1 (Ref.)	2.00 (1.66-2.41)	1.31 (1.06-1.62)	1.32 (1.14-1.53)
***p* value**		<0.001	0.012	<0.001		<0.001	<0.001	<0.001		<0.001	0.012	<0.001
Overall complications	1 (Ref.)	2.13 (0.78-5.77)	0.72 (0.19-2.72)	1.71 (0.76-3.83)	1 (Ref.)	0.84 (0.44-1.60)	1.02 (0.57-1.85)	1.10 (0.74-1.65)	1 (Ref.)	1.00 (0.65-1.52)	0.94 (0.59-1.49)	1.04 (0.77-1.42)
***p* value**		0.140	0.625	0.194		0.599	0.943	0.629		0.985	0.781	0.788
Reoperation	1 (Ref.)	1.29 (0.21-8.00)	0.65 (0.67-6.34)	1.97 (0.53-7.35)	1 (Ref.)	1.02 (0.41-2.52)	0.78 (0.30-2.08)	0.65 (0.33-1.30)	1 (Ref.)	0.64 (0.27-1.53)	0.38 (0.12-1.25)	0.90 (0.52-1.57)
***p* value**		0.786	0.708	0.316		0.972	0.622	0.223		0.316	0.111	0.716
Readmission	1 (Ref.)	0.47 (0.05-4.83)	0.95 (0.15-6.19)	1.41 (0.35-5.64)	1 (Ref.)	1.61 (0.54-4.83)	1.00 (0.29-3.45)	0.82 (0.29-2.28)	1 (Ref.)	1.53 (0.70-3.35)	1.61 (0.74-3.54)	1.12 (0.56-2.26)
***p* value**		0.529	0.961	0.626		0.394	0.998	0.697		0.283	0.233	0.754

pLOS: prolonged length of stay; pOT: Prolonged operative time. *Multivariate model controlled for patient age, race, body mass index, smoking status, and American Society of Anesthesiologists category.

open surgery increased morbidity, or their involvement in minimally-invasive surgery increased morbidity less than it did in open partial nephrectomies. The results of our analyses help clarify this question, as we show that complications are not increased by resident involvement.

Our findings of equivalence in postoperative morbidity with resident involvement can be explained by several possible phenomena. One explanation may point to the impact of resident supervision. In the general surgery literature, Itani and colleagues showed that among surgeries within the Veterans Affairs system, cases in which attendings were not scrubbed had no increased morbidity or 30-day mortality after risk adjustment, suggesting that attendings are able to determine the appropriate degree of resident supervision and adjust their involvement accordingly.[12] As some of the first adopters of minimally-invasive techniques and as a group of surgeons uniquely reliant upon it, academic urologists have long had the opportunity to assess trainee readiness in varying complexity laparoscopic and robotic surgeries and grade responsibility accordingly in real-time. This may stand in contrast to laparoscopic appendectomies and cholecystectomies, which are cases in which residents first gain their laparoscopic independence, and in which increased morbidity has been shown.[10,11]

The equivalence in major postoperative outcomes may also point to the fact that urology trainees are being exposed to significantly more minimally-invasive surgeries in recent years and thus may be further along the learning curve.[22] In our study, having PGY 3-4 involved as the most senior resident decreased the odds of pLOS in minimally-invasive partial nephrectomies and radical prostatectomies, surgeries that may be more challenging and require a more finely tuned skill set. Alternatively, residents involved at this level may demand less console time and be better adjusted to collaborate with attending surgeons at the assistant level. Furthermore, resident involvement may also serve as a protective factor,[13] helping to identify and prevent critical adverse outcomes both intraoperatively and postoperatively.[23]

Given that resident participation occurs at teaching hospitals, it is important to consider that there may also be an effect of overall hospital and attending surgeon volume on minimizing complications. With respect to partial nephrectomies, it has been shown that postoperative outcomes are better at academic institutions.[24] Although this may be due to high volume of partial nephrectomies at academic hospitals and patient selection, resident involvement likely plays an integral part of surgical treatment at academic hospitals.

Another finding of ours was the increased rate of pOT with resident involvement at all levels for all procedures examined; this is consistent with other studies.[10,11] This deserves attention given that this may translate into increased morbidity including surgical site infections.[25] Moreover, in partial nephrectomies, increased operative time may be deleterious with short- and long-term consequences on renal function given longer ischemia time.[26] However, we found that increased operative times with resident involvement did not translate into higher rates of associated perioperative morbidities, including rates of 30-day renal failure after partial nephrectomies. Whether those same surgeries had longer ischemia times or whether resident involvement prolonged other portions of the procedure could not be assessed within the NSQIP.

The results of our study come at an important time. Striking a balance between patient safety and adequacy of surgical training is increasingly challenged by work hour restrictions, limited resources, accountability of care and job transparency. A recent survey of general surgery fellowship program directors demonstrated dissatisfaction with residency graduates along multiple domains of patient care, including independent practice, patient responsibility and motor skills.[27] The first step in quality improvement relies on adequate accreditation and assessment methods available during training to ensure that specific competencies of trainees are met.[28] Aware of such shortcomings, the American Board of Urology and the ACGME have developed a Milestones project with the goal of standardizing assessment of Urology program graduates.[29] Opportunities for improvement do exist; a simulation based curriculum in general surgical laparoscopic training has been shown to decrease operative time, improve resident performance and decreased complications.[30] The next step involves translating this basic skill-set to the challenges of real-time performance on live patients. Such a reliance on graded responsibility in minimally-invasive urologic surgery has started to become formally adapted in training programs with acceptable preliminary results.[31] Integrating such techniques into residency training may help overcome the learning curves inherent to such procedures, which are not insubstantial.

There are a number of limitations with our study. Given the retrospective design, we were unable to control for all unknown variables on multivariable models, which can introduce unknown bias. The NSQIP did not allow us to adjust for variations in case complexity, such as tumour size and location. Furthermore, the de-identified data did not allow us to assess the impact of attending surgeon or hospital volume on outcome data. We were also unable to differentiate robotic from laparoscopic cases since robotic CPT codes was not a mandatory variable. Furthermore, the ACS-NSQIP had no data detailing the extent of resident involvement in each case, for example time spent on the console, or degree of attending supervision. It is possible that resident participation on the console was limited, as surgeons were in the midst of adopting robotic surgery during the study period. While this study was designed to measure outcomes from the standpoint of surgical complications, future studies that assess the impact of resident involvement on oncologic outcomes, including surgical margins and pathology, can add significantly to our understanding of trainee impact on patient outcomes.

Conclusion

Resident involvement is associated with increased operative time in minimally-invasive urologic oncology procedures. However, it does not adversely affect the complication, reoperation or readmission rates, as well as LOS.

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