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UNDERSTANDING POPULATION-BASED DIFFERENCES IN READMISSION AFTER OPEN AND ROBOTIC-ASSISTED CYSTECTOMY: IMPLICATIONS FOR POST-DISCHARGE CARE

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Abstract

Introduction—Readmissions after radical cystectomy are common. Details regarding readmissions after robotic surgery are limited to institutional series. To inform whether readmission reduction strategies should consider surgical approach, we examined readmission differences between open and robotic-assisted radical cystectomy (RARC) using population-based data.

Methods—We identified patients who underwent cystectomy between January 2010 and September 2013 based on ICD-9 codes and administrative claims from a large, national US health insurer (Clinformatics™ Data Mart Database, OptumInsight, Eden Prairie, MN). We assessed post-discharge health system utilization and tested for differences in readmissions after the two surgical approaches.

Results—We identified 935 patients treated with cystectomy (785 (84%) open, 150 (16%) RARC). Patients undergoing RARC were slightly older, male, had more ileal conduit urinary reconstruction, and less need for intensive care. Index length of stay was shorter for RARC than

for open surgery (7 days vs. 8 days, $p<0.001$). However, we found no differences in 30-day readmission rates (24% open vs. 29% RARC, $p=0.26$) or other readmission parameters including: readmission length of stay (5 days open vs. 4 days RARC, $p=0.32$), emergency department use (22% open vs. 24% RARC, $p=0.86$), reasons for readmission, or timing of first outpatient visits (11.5 days open vs. 9 days RARC, $p=0.41$). For both approaches, the majority of patients were readmitted within 2 weeks.

Conclusions—The surgical approach to cystectomy does not appear to impact readmissions. Strategies to reduce the readmission burden after cystectomy do not need to consider surgical approach, but should focus on timing of medical contacts

INTRODUCTION

Hospital readmission after major surgical procedures is common,¹ occurring in roughly 1 of 8 patients, and rates after major cancer surgery are particularly high.^{2–5} This notion is clearly evident in the treatment of invasive bladder cancer where 1 in 4 patients are readmitted within 30 days of hospital discharge after radical cystectomy.^{4,6} This is one of the highest rates for any surgery and among the most burdensome with an average readmission length of stay of one week.^{6,7}

Despite standardization in surgical technique, advances in perioperative management,⁸ and systems-level efforts to decrease readmissions spurred by the Centers for Medicare and Medicaid Services Hospital Readmission Reduction Program,⁹ readmissions after cystectomy have remained stable over the past decade.⁶ Minimally-invasive surgery has been shown to decrease morbidity, mortality and readmissions in other major cancer surgery, and is being rapidly adopted for radical cystectomy.^{10,11} To date, single-institution robotic-assisted cystectomy (RARC) studies have demonstrated similar oncologic outcomes, morbidity, and mortality rates.^{4,12,13} However, it is unknown whether adoption of this new surgical approach has unintended consequences from novel complications (e.g., positioning, out-of-field injury)¹⁴ that should be considered in readmission reduction strategies. Also, you could get into the collateral damage phenomenon that occurs during new procedure adaption(e.g., CBD injuries during lap chole).

For these reasons, we examined the impact of robotic-assistance on readmissions following cystectomy using a large, population-based cohort. Even with a similar readmission rate, robotic-assistance may be associated with differences in severity of presentation or reasons leading to readmission that need to be addressed in efforts to decrease readmissions after cystectomy.

METHODS

Data Source

We used the Clinformatics™ Data Mart Database (OptumInsight, Eden Prairie, MN) to conduct our study. This database includes administrative claims data from a large, national health insurer and contains medical (hospital and outpatient) and prescription claims for between 12 and 14 million unique members every year. All data are de-identified but each patient is assigned a unique identifier to permit longitudinal analysis. The database has no

restrictions on patient age, therefore our study included a nationally-representative panel of patients rather than just Medicare enrollees as is common in other population-based bladder cancer studies.

Study Population

We performed a retrospective cohort study of patients treated with cystectomy between January 1, 2010 and September 30, 2013. We limited our study to patients that had continuous data available from 6 months before surgery to 30 days after surgery or death. We identified patients treated with cystectomy based on International Classification of Diseases-9th edition (ICD-9) codes for open cystectomy (57.7, 57.71, 57.79) and robotic-assisted radical cystectomy (open cystectomy code plus 17.4x). We identified relevant patient and surgical characteristics including age (years), gender, race/ethnicity (Caucasian, African-American, Hispanic, Asian), Deyo modification of the Charlson comorbidity score (0, 1, 2, 3+), type of urinary reconstruction (ileal conduit, neobladder), use of neoadjuvant chemotherapy (yes/no), complications during index admission (infection, gastrointestinal, cardiac, pulmonary, metabolic/endocrine, hematologic, vascular, urinary, failure to thrive, wound/hematoma, other),⁶ need for intensive care unit (ICU) (yes/no), length of stay (LOS) (days) and discharge destination (home, home with services, skilled nursing facility, other) using prior approaches.⁶

Defining Readmission Parameters after Open and Robotic-Assisted Radical Cystectomy

We defined a readmission as any hospital admission that occurred between one and 30 days following hospital discharge after cystectomy consistent with the Centers for Medicare and Medicaid definition.⁹ Post-discharge admission to a skilled nursing facility or similar destination was therefore not considered a readmission, however, we did include readmissions after initial discharge to these destinations.

For each surgical approach (i.e., open and RARC), we calculated 30-day readmission rates as our primary outcome. We had several secondary outcomes including days from hospital discharge to readmission, and days to first outpatient visit for each surgical approach. We identified readmission diagnoses based on ICD-9 codes not present at the time of surgery but occurring during the index hospitalization or later as in our prior work.⁶ We also identified readmission length of stay (LOS), need for intensive care unit, and emergency department visits in the administrative claims.

Statistical Analysis

First, we compared patient and surgery characteristics using a Student t-test for continuous variables, chi-square for nominal categorical variables, and Mantel-Haenszel chi-square for ordinal categorical variables. Next, we compared readmission characteristics according to surgical approach using similar univariate statistics. To understand whether the time to readmission differed across surgical approaches and inform readmission reduction strategies, we then divided time to readmission in days into 5 categories (4, 5–7, 8–14, 15–21, and 22–30) for comparison across surgical approaches. Last, we used multivariable logistic regression, adjusting for age, gender, race, comorbidity, urinary reconstruction type, receipt

of neoadjuvant chemotherapy, discharge destination and year of surgery, to determine the association between surgical approaches and our readmission parameter outcomes.

All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA). All tests were two-sided and a p-value <0.05 was considered significant. This study was deemed exempt by the University of Michigan institutional review board.

RESULTS

We identified 935 patients treated with cystectomy during our study period. Of these, 785 (84%) were open cystectomy cases and 150 (16%) were RARC. Patients undergoing RARC were more likely to be male and receive ileal conduit urinary reconstruction, but were otherwise similar to patients treated with open cystectomy (Table 1). Notably, there was no difference in intensive care (ICU) use or overall complications during the index admission. The RARC cohort did have a lower rate of infectious complications during the index admission (3% vs. 0%, $p=0.04$); however, all other complications occurred at similar rates. The median length of stay was shorter for the RARC cohort (7 vs. 8 days for open, $p<0.001$) and fewer patients were discharged to a skilled nursing facility.

In the unadjusted comparison of the open and RARC approaches (Table 2), we found no difference in 30-day readmission rates (24% vs. 29%, $p=0.26$), readmission LOS (5 vs. 4 days, $p=0.32$), or emergency department use (22% vs. 24%, $p=0.86$). After adjusting for patient, hospital and temporal characteristics, we again found no significant changes in these parameters. Preferably, you would just report the adjusted %.

As illustrated in Figure 1, the most common reasons for readmission were infection, followed by urinary, gastrointestinal and metabolic/endocrine complications. Almost all readmitted patients (96% for open and 98% for RARC) had more than one readmission diagnosis while 18% of open and 16% of RARC readmitted patients had 5 or more new diagnoses. Overall, we identified no significant differences in the reasons for readmission between the open and RARC groups.

In both groups, the majority of readmissions occurred within the first two weeks following discharge (Figure 2). Similarly, median time to first emergency department visit was 9.5 days for the open cohort and 12 days for the RARC cohort ($p=0.41$). However, as shown in Table 2, over half of the first outpatient visits occurred within two weeks of discharge in both groups.

DISCUSSION

This contemporary, population-based study found approximately 1 in 4 patients were readmitted in 30 days after radical cystectomy regardless of surgical approach. We found no associations between the open or robotic surgical approaches to radical cystectomy and the subsequent readmission rate or other readmission parameters. Notably, two thirds of all readmissions occurred within two weeks of discharge in both groups. Our readmission rates are comparable to those reported from other contemporary open and robotic series (18–28%),^{4,12,15–18} however no studies to date have examined these aspects of readmission that

are so relevant to informing readmission reduction strategies. Further, our analysis represents the most contemporary analysis of population-level data during the national adoption phase of a new technology-based approach to major cancer surgery. Given that the broader adoption of the robotic approach did not occur until around 2009,^{12,17} this study captures surgery being performed outside early adopting centers of excellence thus reflecting real-world practice. Given we found that the surgical approach to cystectomy does not appear to impact various aspects of readmission, strategies to reduce the readmission burden after cystectomy should not necessarily focus on the surgical approach, but rather on the critical one to two weeks after discharge.

The current study significantly expands our understanding of readmissions following cystectomy by exploring the effect of surgical approach not only on overall readmission rates at the population-level, but also on readmission parameters that better characterize the readmission itself. Data comparing readmission rates between open and robotic approaches is currently limited with two prior studies also reporting a lack of difference in overall readmission rate based on surgical approach.^{12,17} We chose to more deeply explore the readmission episode since robotic surgery has the potential to result in novel complications compared to the open approach (e.g., due to positioning, out-of-field injury).¹⁴ In addition, even though both approaches could lead to the same complication, the severity of the complication, and thus the burden of the readmission, could vary substantially. Nonetheless, we found no differences in the reasons for the readmission between the two surgical approaches; that is, patients undergoing RARC were not being readmitted due to a novel or distinct set of complications. This finding is supported by a recent randomized trial of open cystectomy versus RARC that found no difference in the number, severity or type of post-operative complications between the two arms.¹³ Though the initial hospitalization median LOS was 1 day shorter for the RARC cohort, the median LOS for the readmission was not significantly different, meaning that the severity of the complications and readmissions were likely comparable.

Consistent with prior work,^{6,13,15,19} we found infection, urinary, gastrointestinal, metabolic/endocrine and failure to thrive to be the most common reasons for readmission (Figure 1). Despite the lack of a difference, we highlight the fact that readmissions following cystectomy are high intensity stays as most readmitted patients had multiple new diagnoses at the time of readmission, and the readmission LOS was 5 days following open cystectomy and 4 days following RARC.¹⁶ Emergency department use was substantial in both cohorts, with just under one quarter of patients seen within 30 days of discharge, but did not differ significantly by approach. Taken together, our findings demonstrate that the substantial burden of readmissions following cystectomy on patients, providers and hospital systems is not altered by whether someone has an open or robotic-assisted surgery. Therefore, efforts to reduce readmissions after cystectomy should likely focus on early communication after discharge,²⁰ prompt detection of clinical decompensation, and providing support during the first week after discharge,²¹ rather than on the surgical approach itself.

Our findings should be considered in the context of several limitations. First, though the Clinformatics™ Data Mart Database allows for a granular inspection of multiple inpatient and outpatient outcomes, mortality data is absent in an effort by the vendor to protect patient

confidentiality. While it is possible that differences in 30-day mortality between approaches could change our readmission findings, previous studies have found similar, low mortality rates for the two approaches.^{13,17,22} Second, our database lacks clinically relevant data such as tumor grade and stage, extent of lymphadenectomy, approach to urinary reconstruction (open or intra-corporeal) and pathology results. However, we did adjust for neoadjuvant chemotherapy and diversion type which reflect, at least to some degree, the burden of disease. For example, neoadjuvant chemotherapy use is more common for patients with more advanced disease.²³ Moreover, it is likely that during this early phase of robotic surgery adoption for radical cystectomy, surgeons preferred more straightforward cancer cases for the robotic approach therefore further limiting concerns regarding these absent clinical data. Ref? By using a large, national insurance database without age restrictions, our findings also mitigate some of the generalizability concerns that arise from current single and multi-institutional series.^{4,15} These series tend to reflect early adopting centers of excellence, and potentially fail to capture readmissions occurring outside their health system. Similarly, use Surveillance, Epidemiology, and End Results (SEER) Program-Medicare data^{6,12,24} is limited to patients 65 years of age and older where comorbidity status and baseline function could differ compared to younger patients. Hmm. Why this here. Seems out of left field. Last, we have no information on perioperative care pathways for our cohort. It is possible that early adopters of RARC may also be early adopters of standardized perioperative care pathways which could, but did not appear to alter readmission parameters. Going forward, re-evaluating the effect of RARC on readmissions in the setting of greater adoption of perioperative and post-discharge care pathways may be warranted. In addition, continued investigation into the types and timing of post-discharge follow up care is needed to minimize preventable readmissions and readmission intensity for those in need of inpatient care.²⁰ I mean, you are also limited by sample size. Also, the benefits of RARC may become more apparent overtime as surgeons become more facile with the technique.

These limitations notwithstanding, our findings have (I think the word considerable may be overstating things a bit) implications for patients, physicians and policy makers. We've shown that the robotic approach has neither a beneficial nor deleterious effect on readmission rates or readmission parameters after radical cystectomy. As such, the higher cost of RARC^{13,17} would not seem to be offset by savings from the readmission episode. Additionally, the robotic approach appears to have a comparable set of complications to the open approach. More importantly, we found that, despite the increased attention paid to readmission reduction at a policy level as a result of the Centers for Medicare and Medicaid Services Hospital Readmission Reduction Program⁹ and introduction of standardized perioperative care pathways,^{8,25} the rates of readmission following cystectomy have not improved in a clinically meaningful way. This may be due, in part, to the inherent morbidity of the procedure and the baseline comorbid state of patients that leads to some degree of non-modifiable reasons for readmission,¹⁸ but is also likely related to suboptimal post-discharge follow up. In an administrative database analysis, James et al. showed that 26% of cystectomy readmissions were considered modifiable¹⁸ and Krishnan et al. demonstrated that detection of at-risk patients could be improved with early clinician contact.²¹ It is likely that even in the cases of some non-modifiable readmissions, earlier identification of at-risk patients would allow for prompt intervention and a reduction in the intensity of the overall

readmission episode¹⁶ as was evident by the multiple new diagnoses present in our cohort at the time of readmission.

CONCLUSIONS

This contemporary, population-based study found approximately 1 in 4 patients were readmitted within 30 days after radical cystectomy regardless of surgical approach. We found no associations between the open or robotic surgical approaches to radical cystectomy and the subsequent readmission rate or other readmission parameters. The surgical approach to cystectomy does not appear to impact readmissions, at least in the early stage of robotics diffusion. Given our finding that the surgical approach to cystectomy does not appear to impact various aspects of readmission, strategies to reduce the readmission burden after cystectomy should not necessarily focus on the surgical approach, but rather on identifying at risk patients and intervening in the critical one to two weeks after discharge.

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ABBREVIATIONS

RARC	Robot-assisted cystectomy
ICD-9	International Classification of Diseases - 9th edition
ICU	Intensive Care Unit
LOS	Length of Stay

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Figure 1.

Comparison of reasons for hospital readmission for open and robotic-assisted cystectomy in a population-based cohort.

96% of open and 98% of robotic-assisted cystectomy patients had multiple new diagnoses at readmission. There were no significant differences between the open or robotic approaches.

Figure 2.

Days to hospital readmission after open and robotic-assisted cystectomy. There were no differences between the open and robotic approaches.

Table 1

Cohort demographics and index admission characteristics.

Characteristic	Open Cystectomy N=785	Robotic Cystectomy N=150	p-value
Mean Age, years (standard error)	69 (0.37)	71 (0.81)	0.06
Gender (%)			<0.01
Male	80	91	
Race/Ethnicity (%)			0.72
White	85	86	
Black	9	13	
Hispanic	4	4	
Asian	2	1	
Comorbidity Score (%)			0.12
0	0	0	
1	0	0	
2	37	43	
3	63	57	
Urinary Reconstruction (%)			0.05
Ileal Conduit	87	93	
Neobladder	13	7	
Neoadjuvant Chemotherapy (%)	15	17	0.55
Complication during index admission (%)	39	49	0.16
Complication Category (%)			
Gastrointestinal	10	12	0.51
Pulmonary	5	5	0.83
Metabolic/Endocrine	5	6	0.80
Hematologic	6	3	0.12
Failure to Thrive	5	3	0.18
Wound/Hematoma	5	3	0.35
Vascular	2	3	0.22
Urinary	2	2	0.67
Cardiac	3	1	0.30
Infection	3	0	0.04
Other	3	1	0.27
Intensive care (%)	46	38	0.07
Index Length of stay, median days	8	7	<0.01
Discharge Destination (%)			0.04
Home	53	54	
Home with Services	32	38	
Skilled Nursing Facility	11	3	

Characteristic	Open Cystectomy N=785	Robotic Cystectomy N=150	p-value
Other	4	5	

Table 2

Readmission characteristics for open and robotic-assisted cystectomy.

Characteristic	Open Cystectomy (N=785)	Robotic-assisted Cystectomy (N=150)	p-value
30-day Readmissions (%)	24	29	0.26
Time to readmission (%)			0.92
4 days	20	16	
5–7 days	18	23	
8–14 days	29	26	
15–21 days	24	26	
22–30 days	19	9	
Readmission Length of stay, median days	5	4	0.32
Readmission Diagnosis (%)			
Infection	59	65	0.43
Gastrointestinal	42	49	0.41
Cardiac	20	14	0.37
Pulmonary	24	21	0.71
Metabolic/Endocrine	34	46	0.12
Hematologic	15	9	0.32
Vascular	6	2	0.31
Urinary	51	67	0.06
Failure to Thrive	24	33	0.25
Wound/Hematoma	20	16	0.54
Other	61	49	0.16
Emergency Department Visits (%)	22	24	0.86
Time to ED Visit (%)			0.41
4 days	26	19	
5–7 days	15	17	
8–14 days	28	28	
15–21 days	16	22	
22–30 days	15	14	
Time to 1st Outpatient Visit (%)			0.15
4 days	31	40	
5–7 days	10	8	
8–14 days	14	15	
15–21 days	12	10	
22–30 days	8	5	
>30 days	25	22	

* Significant for p-value 0.05; P-values for continuous variables generated from Student-t-tests. p-values for nominal and ordinal categorical variables generated from general chi-square and Mantel-Haenszel chi-square tests, respectively.