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Comparison of perioperative outcomes between open and robotic radical cystectomy: a population based analysis

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Abstract

Introduction: Radical cystectomy represents the standard of care for muscle invasive bladder cancer (MIBC). Due to its novelty the use of robotic radical cystectomy (RARC) is still under debate. We examined intraoperative and postoperative morbidity and mortality as well as impact on length of stay (LOS) and total hospital charges (THCGs) of RARC compared to open radical cystectomy (ORC).

Material and methods: Within National Inpatient Sample (NIS) (2008-2013), we identified patients with non-metastatic bladder cancer treated with either ORC or RARC. We relied on inverse probability of treatment weighting (IPTW) to reduce the effect of inherent differences between ORC vs. RARC. Multivariable logistic regression (MLR) and multivariable Poisson regression models (MPR) were used.

Results: Of all 10 027 patients, 12.6% underwent RARC. Between 2008 and 2013, RARC rates increased from 0.8 to 20.4% [Estimated annual percentage change (EAPC): +26.5%, CI: +11.1 to +48.3; p=0.035] and RARC THCGs decreased from 45 981 to 31 749 United States Dollars (EAPC: -6.8%, CI: -9.6 to -3.9; p=0.01). In MLR models RARC resulted in lower rates of overall complications (OR: 0.6; p <0.001) and transfusions (OR: 0.44; p <0.001). In MPR models, RARC was associated with shorter LOS [relative risk (RR) 0.91 ; p <0.001]. Finally, higher THCGs (OR: 1.09; p <0.001) were recorded for RARC. Data are retrospective and no tumor characteristics were available.

Conclusion: RARC is related to lower rates of overall complications and transfusions rates. In consequence, RARC is a safe and feasible technique in select muscle invasive bladder cancer patients. Moreover, RARC is associated with shorter LOS, albeit higher THCGs.

Introduction

Radical cystectomy is the standard of care for localized muscle-invasive bladder cancer (MIBC). To date, the use of laparoscopic or robotic surgery is still under debate for patients with MIBC. Specifically, robotic surgery represent a surgical option according to National Comprehensive Cancer Network (NCCN) guidelines. However, the European Association of Urology (EAU) guidelines rank robotic radical cystectomy (RARC) as investigational procedure[1]. This recommendation is based on absence of data indicating an advantage of RARC over open radical cystectomy (ORC) [2][3]. In randomized controlled trials (RCTs) no differences in length of stay (LOS), in hospital mortality, intraoperative and in hospital complications were identified between ORC and RARC . However, RARC patients had lower transfusions rates. It is noteworthy that only one of three RCT was adequately powered to compare RARC to ORC. [4][5][6] Based on these considerations, we re-examined[7] the effect of RARC on in-hospital morbidity and mortality as well as its impact on LOS and total hospital charges (THCGs).

Materials and methods

2.1 Data source

To assess complications and in hospital mortality rates of RARC vs ORC we relied on the National Inpatient Sample (NIS) database (2008-2013). The NIS is a set of longitudinal hospital inpatient databases included in the Healthcare Cost and Utilization Project family, created by the Agency for Healthcare Research and Quality through a Federal-state partnership [8]. The database includes 20% of United States inpatient hospitalizations, with discharge abstracts from 8 million hospital stays. It incorporates patient and hospital information, including Medicare, Medicaid, private insurance, and other insurance type patients.

2.2 Study population

Within the NIS database (2008-2013), we focused on patients with a primary diagnosis of bladder cancer (ICD-9-CM code 188; 233.7) aged ≥18 years. Patients with a secondary diagnosis of metastatic disease were excluded (ICD-9-CM code 197.x and 198.x).

Primary procedure codes were used to identify radical cystectomy (ICD-9-CM code 57.7; 57.71; 57.79) patients. Secondary procedure codes were used to identify lymph node dissection (ICD-9-CM code 40.3; 40.5). Use of ileal conduit or continent (orthotopic neobladder or continent cutaneous reservoir) urinary diversion were identified using ICD-9 codes 56.51 or 57.87. Robotic procedures were identified according to the modifier codes 17.4 and 17.42[7].

2.3 Outcomes of interest

Complications rates were defined using secondary ICD-9 diagnostic codes, as previously described [9–11]. Intraoperative complications consisted of accidental blood vessel and/or nerve and/or organ puncture or laceration during the procedure. Postoperative complications consisted of cardiac, respiratory, vascular, operative wound, genitourinary, transfusion, parenteral nutrition, miscellaneous medical and miscellaneous surgical [7]. LOS, provided by the NIS, is calculated by subtracting the admission date from the discharge date. Inflation-adjusted THCGs were defined according to NIS information[12]. In-hospital mortality information is coded from the disposition of the patient.

2.4 Patient and hospital characteristics

Patient age, gender, race/ethnicity (Caucasian, African American and Others), Charlson comorbidity index (CCI)[13][14] and insurance status (private insurance, Medicare, Medicaid, and other [self-pay]) were defined according NIS information. Additional risk variables consisted of hospital region (Northeast, Midwest, South, West)[15], hospital size (small, medium and large) and hospital teaching vs. non-teaching status. Teaching institutions had an American Medical Association-approved residency program, were a member of the Council of Teaching Hospitals, or had a ratio of 0.25 or higher of full-time equivalent interns and residents to non-nursing home beds.[8] Lastly, annual hospital volume (low, medium and high), representing the number of performed at each participating institution during each study calendar year was calculated and stratified according to tertiles.

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2.5 Statistical analysis

First, medians and interquartile ranges, as well as frequencies and proportions were reported for continuous (age, LOS and THCGs) and categorical variables (gender, race, insurance status, CCI, annual hospital volume, region, hospital size, teaching status, lymph node dissection, parenteral nutrition, ileal conduit or continent urinary diversion and complications), respectively. The statistical significance of differences in medians and proportions was evaluated with the Kruskal-Wallis and chi-square tests.

Second, estimated annual percentage change (EAPC), was generated using the log-linear regression methodology. Third, nine separate sets of multivariable logistic regressions (MLRs) tested complications and in-hospital mortality rates after ORC and RARC. Fourth, multivariable Poisson regressions (MPR) models compared LOS after ORC and RARC. Fifth, log-linear regression compared THCGs after ORC and RARC. Sixth, the analyses where repeated after inverse probability of treatment weighting (IPTW) adjustment and clustering [16].

All statistical tests were two-sided. The level of significance was set at $p<0.05$. Analyses were performed using the R software environment for statistical computing and graphics (version 3.4.1; http://www.r-project.org/).

Results

Descriptive characteristics, rates of cystectomy and total hospital charges over time

Among 10 027 patients, 8 768 (87.4%) underwent ORC and 1 259 (12.6%) underwent RARC.

Most were ≥ 65 years old (66.4%), male (77.5%) and Caucasian (76.7%). Most (57%) harbored CCI 0 **(Table 1)**.

Between 2008 and 2013, RARC rates increased from 0.8 to 20.4% (EAPC: +26.5%, CI: +11.1 to +48.3; p=0.035) **(Figure 1)**. Conversely, ORC rates decreased from 97.5 to 78.8% (EAPC: -3.7%, CI: -2.2 to -5.5; p=0.008).

During the study span THCGs decreased in RARC. In 2008 RARC average THCGs were 45 981 United States dollars (USD) vs. 31 749 USD in 2013 (EAPC: -6.8%, CI: -9.6 to -3.9; p=0.01). Conversely, THCGs did not decreased in ORC. In ORC 2008 average THCGs were 35 953 USD vs. 30 858 USD in 2013 (EAPC: -2.8%, CI: -5.1 to -0.5; p=0.08) **(Figure 2).** RARC patients, compared to their ORC counterpart, had higher income (third quartile 27.2 vs 24.5%, fourth quartile 25.7 vs 23.3%; p=0.006) and were more likely to receive lymph node dissection (91.2 vs. 82.2%; p<0.001). No significant differences were observed in term of continent urinary diversion rates and CCI rates **(Table 1)**.

Overall complications rates were respectively 70.2% in ORC patients and 59.3% in RARC patients. Overall complications rates did not change over the study span for both RARC (EAPC: -1.4%, CI: -3.8 to 1; p=0.3) and ORC (EAPC: -0.9%, CI: -3.8 to 2.10; p=0.6) Most common complications for ORC and RARC were, respectively, miscellaneous medical (39.4 vs. 37.3%; p=0.2), transfusions (35 vs. 19.4%; p<0.001) and genitourinary complications (17.6% vs. 15.1; p=0.01). **(Table 2)**

Multivariable logistic regression models testing complications and in-hospital mortality rates after ORC and RARC

In MLR models adjusted for all covariates, overall complications (OR: 0.62, p<0.001), intraoperative complications (OR: 0.61, p=0.03), respiratory complications (OR: 0.76, p=0.001), wound complications (OR: 0.51, p<0.001), genitourinary complications (OR: 0.81, p=0.02), and miscellaneous surgical complications (OR: 0.58, p<0.0005) were lower after RARC. Moreover, RARC patients had lower parenteral nutrition rates (OR: 0.70, p=0.002) and transfusions (OR: 0.45, p =0.0001) rates. No statistically significant difference was recorded for in-hospital mortality rates. **(Table 3)**

Multivariable logistic regression models testing complications and in-hospital mortality rates after ORC and RARC after IPTW and clustering

After IPTW and adjustment for clustering, overall complications (OR: 0.6, p<0.001), respiratory complications (OR: 0.77, p=0.01), wound complications(OR: 0.48, p<0.001), genitourinary complications (OR: 0.78, p<0.001) and miscellaneous surgical (OR: 0.62, p=0.002) complications rates were lower after RARC. Moreover, patients underwent RARC had lower rates of parenteral nutrition (OR: 0.66, p=0.001) and transfusions (OR: 0.44, p=0.007).**(Table 4)**

Multivariable Poisson regression models testing for impact of surgical technique on LOS adjusted for clustering and IPTW

In MPR models adjusted for all covariates, RARC [relative risk (RR): 0.91, p<0.001] represented an independent predictor for shorter LOS. After either RARC or ORC, the strongest determinants of higher LOS were wound complications (RR: 1.85, p<0.001), miscellaneous medical complications (RR: 1.4, p<0.001) and respiratory complications (RR: 1.27, p<0.001). **(Table 5)**

Multivariable log-linear regression models testing for impact of surgical technique on total hospital charges adjusted for clustering and IPTW

In multivariable log-linear regression models adjusted for all covariates, RARC (OR: 1.09, p=0.005) represented an independent predictor for higher THCGs. After either RARC or ORC the strongest determinants of higher THCGs were wound complications (OR:1.48; p<0.001), miscellaneous surgical complications (OR: 1.33, p<0.001) and respiratory complications (OR: 1.26, p<0.001). **(Table 6)**

Discussion

Robotic surgery is nowadays widely adopted in urological surgery. However, its role in radical cystectomy for MIBC is still under debate. Data from RCTs are in disagreement[4][5] [6] . Institutional series were published comparing ORC and RARC. However, the sample sizes were small and usually, originated from tertiary care referral centers [17][18][19].

The most recent population based study focused on NIS database was published by Yu et al.[7] considering 224 RARCs performed in 2009. The authors reported fewer complications and fewer in-hospital deaths in RARC compared to ORC, moreover, RARC patients had lower parenteral nutrition use compared to the counterpart, LOS was comparable. Additionally, Hu et al.[20] reported on perioperative outcomes and costs relying on Surveillance, Epidemiology, and End Results Program-Medicare linked database and Hanna et al.[21] reported on perioperative outcomes relying on the National Cancer Database. Nonetheless, this is the most contemporary study based on NIS database and the first study to analyze trend of costs. Our analyses revealed several noteworthy findings.

First, RARC use rates increased over the study span (2008-2013) from 0.8 to 20.4% and ORC rates decreased from 97.5 to 78.8% **(Figure 1)**. This increase is higher than reported by Hu et al.[20] and can be explained by greater contemporary nature of our data that include patients operated in 2013. These findings also confirm the confidence in RARC based on an ongoing increase in annual RARC rates.

Second, average THCGs difference between RARC and ORC was 10 028 US dollars in 2008. However, a significant decrease of THCGs was recorded after RARC (EAPC: -6.8%, CI: -9.6 to -3.9; p=0.01). Conversely, decreasing in THCGs in ORC was not statistically significant (EAPC: -2.8%, CI: -5.1 to -0.5; p=0.08). However, ORC represents the standard of care. In consequence, little changes in THCGs were expected during the span of the study, given that relative few modifications have been made to the surgical technique and perioperative care in ORC. It is noteworthy that overtime the decreasing average THCGs for RARC reduced the difference between RARC and ORC from an initial gap of 10 028 USD to 891 USD. To the best of our knowledge we are the first to provide a detailed charge analyses that is based on annual figures **(Figure 2)** in additional to annual trends. Other investigators reported THCGs comparison that relied on analyses on figures recorded for one single year of observation [7] or cumulative figures over several years[22], neither allowed to arrive at the observation reported in the current study where a decreasing gap was observed between RARC and ORC. This finding is particular important in the context of cost containment for health expenditures. This said, when the entire patient cohort is considered over the entire study span RARC remains more expensive relative to ORC (OR: 1.09, p<0.001) (**Table 6)**.

Third, in MLR models predicting complications, RARC resulted in lower overall, respiratory, wound, genitourinary and miscellaneous surgical complications. Moreover, patients underwent RARC had lower transfusions and parenteral nutrition rates. The results were confirmed after IPTW and adjustment for clustering **(Table 4)**. Our results showed several differences from the previous report of Yu et al.[7], who found no difference between ORC and RARC in transfusion, respiratory, wound, genitourinary and miscellaneous surgical complications rates. Conversely, the authors reported lower in-hospital mortality in RARC patients, this finding was not confirmed in our analyses. Taken together, our findings are equally encouraging to those reported for THCGs with an advantage shown for RARC over ORC.

Fourth, in MPR models predicting LOS after RARC and ORC, RARC resulted as a predictor of shorter LOS (OR: 0.91, $p<0.001$) **(Table 5)**. Our results are in disagreement with Yu et al.[7] who reported no difference between RARC and ORC after propensity score matching. However, our results are consistent with Leow et al.[22], Hu et al. [20] and Hanna et al.[21]. Taken together, these observations show an advantage on LOS for RARC in more contemporary patients.

In summary, we examined several different endpoints and RARC demonstrated better outcomes for postoperative complications and LOS. However, RARC still showed a THCGs disadvantage. Moreover, analyses overtime showed improvement in RARC characteristic. For example, THCGs decreased overtime. Based on this observation RARC represent a valid alternative to ORC in properly select patients in whom RARC can be delivered at tertiary care institutions by experienced surgeons.

Our study is not devoid of limitations. First, only inpatients information were available in the database we analyzed and no data were available regarding readmissions and late complications[7]. Second, our study was unable to adjust for tumor characteristics. Third, we were not able to control for some risk factors, such as laboratory values, opioid use and anesthesia-specific considerations.

Fourth, in our analyses was not possible to distinguish between intra-corporeal and extra-corporeal urinary diversion in RARC patients because of the lack of a specific modifier code. Finally, we were also not able to assess whether chemotherapy or radiation therapy was given prior to surgery.

Conclusion

RARC is related to lower in-hospital rates of overall complications and transfusions. In consequence, RARC is a safe and feasible technique in select muscle invasive bladder cancer patients. Moreover, RARC is associated with shorter LOS albeit, higher THCGs.

Author contributions: Sebastiano Nazzani and Zhe Tian had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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Sebastiano Nazzani certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

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Conflict of interest

None to declare.

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Muscle invasive bladder cancer = MIBC

Robotic radical cystectomy = RARC

Length of stay = LOS

Total hospital charges = THCGs

Open radical cystectomy = ORC

National Inpatient Sample = NIS

Multivariable logistic regression = MLR

Multivariable Poisson regression = MPR

Estimated annual percentage change = EAPC

United States Dollars = USD

Randomized controlled trials =RCTs

National Comprehensive Cancer Network = NCCN

European Association of Urology = EAU

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Table 1

Descriptive characteristics of 10 027 non-metastatic bladder cancer patients older than 18 years undergoing open or robotic cystectomy before and after inverse probability after treatment weightening (IPTW), Nationwide Inpatient Sample, 2008-2013.

			Original Cohort(%)				**IPTW Cohort(%)**	
Variables		**Overall n=10.027**	**Open n=8.768**	**Robotic n = 1.259**	**p-value**	**Overall n=10.027**	**Open n=5.431**	**Robotic n =4.596**
Length of stay (days)	Mean	10	10	9	**<0.001**	10	10	9
	Median	8	8	7	**<0.001**	8	8	7
	IQR	6-11	6-11	6-10		6-11	6-11	6-10
Total hospital charges (USD)	Mean	35 062	34 894	36 170	**0.1**	33 618	33 406	35 016
	Median	27 751	27 204	30 951	**<0.001**	26 648	26 106	29 933
	IQR	20 450 – 39 502	20 107 – 39 256	23 541 – 41 120		19 686 – 37 977	19 252 – 37 650	22 959 – 39 326

Age (years)	Mean	68	68	68	**0.02**	68	68	68
	Median	69	69	68	**0.001**	69	69	68
	IQR	62-76	62-76	61-75		62-76	62-76	62-76
Year of surgery					**<0.001**			
	2008	18.5	21	1.2		11.3	19.3	1.8
	2009	14.8	15	13.7		15.7	14.1	17.5
	2010	17.7	17.5	19		20.2	17.1	23.8
	2011	19.2	19	20.1		20.2	19.2	21.4
	2012	15.1	14.1	21.8		17	14.9	19.5
	2013	14.7	13.4	24.1		15.7	15.4	16
Age cat. (years)					**0.1**			
	18-54	9.6	9.4	10.8		9.8	9.6	9.9
	55-64	24	23.8	25.3		24.1	24	24.1
	65-108	66.4	66.7	63.9		66.2	66.4	65.9
Gender					**0.8**			
	Female	22.5	22.4	22.8		22.3	22.5	22.2
	Male	77.5	77.6	77.2		77.7	77.5	77.8
Race					**0.03**			
	Caucasia	76.7	77.1	73.9		76.7	76.7	76.8

	n							
	African-american	5	4.9	5.2		4.9	5	4.8
	Other	18.4	18	21		18.4	18.4	18.4
Charlson comorbidity index					**0.4**			
	0	57	57	56.9		58	57.1	59
	1	30.6	30.4	31.7		30.1	30.5	29.6
	≥2	2.5	12.6	11.4		11.9	12.4	11.4
Ileal conduit					**0.3**			
	No	23.9	24.2	21.4		23.8	23.9	23.8
	Yes	76.1	75.8	78.6		76.2	76.1	76.2
Continent urinary diversion					**0.7**			
	No	92.1	92.2	91.8		91.4	92.1	90.7
	Yes	7.9	7.8	8.2		8.6	7.9	9.3
Hospital volume					**<0.001**			
	High	34.1	34.6	30.5		34	34.1	33.9
	Low	32.5	32.2	34.5		32.3	32.5	32

	Medium	33.4	33.1	35		33.8	33.5	34.1
Insurance status					**0.02**			
	Medicaid	4.5	4.5	4.6		4.6	4.5	4.7
	Medicare	61.7	62.2	57.8		61.3	61.7	60.9
	Private	29.4	28.8	33.1		29.7	29.4	30
	Other	4.4	4.4	4.4		4.4	4.4	4.4
Bedsize					**<0.001**			
	Small	9.2	8.4	14.5		10.3	9.3	11.6
	Medium	16.2	16.5	14.3		15.8	16.2	15.3
	Large	74.6	75.1	71.2		73.9	74.6	73.1
Income (Quartiles)					**0.006**			
	First	22.9	23.4	19.5		22.3	22.9	21.6
	Second	26.9	27	26.2		26.9	26.9	26.8
	Third	24.8	24.5	27.2		25.3	24.9	25.9
	Fourth	23.6	23.3	25.7		23.9	23.6	24.2
	Unknown	1.7	1.8	1.4		1.7	1.7	1.6
Region					**<0.00**			

					1			
	Midwest	27.4	26.7	32.2		28	27.3	28.7
	Northeast	19.5	19	23.4		19.9	19.5	20.4
	South	36.1	37.1	29.3		35	36.1	33.8
	West	17	17.3	15.1		17	17	17.1
Lymph node dissection					**<0.001**			
	No	16.7	17.8	8.8		13.7	17.6	9.1
	Yes	83.3	82.2	91.2		86.3	82.4	90.9

Table 2

In-hospital complications 10 027 non-metastatic bladder cancer patients older than 18 years undergoing open or robotic cystectomy before and after inverse probability after treatment weightening (IPTW), Nationwide Inpatient Sample, 2008-2013.

			Original Cohort(%)			**IPTW Cohort(%)**		
Variables		**Overall n=10 027**	**Open n= 8 768**	**Robotic n = 1 259**	**p-value**	**Overall n=10 027**	**Open n=5 431**	**Robotic n =4 596**
Parenteral Nutrition					<0.001			
	No	89.9	89.5	92.2		90.9	89.6	92.5
	Yes	10.1	10.5	7.8		9.1	10.4	7.5
Overall complications					<0.001			
	No	31.2	29.8	40.7		34.5	30	39.8
	Yes	68.8	70.2	59.3		65.5	70	60.2
Intraoperative complicatio					0.01			

ns								
	No	97.1	96.9	98.2		97.3	96.9	97.8
	Yes	2.9	3.1	1.8		2.7	3.1	2.2
Cardiac complications					0.1			
	No	92.5	92.3	93.4		92.8	92.4	93.2
	Yes	7.5	7.7	6.6		7.2	7.6	6.8
Respiratory complications					<0.001			
	No	87	86.5	90.2		88	86.6	89.6
	Yes	13	13.5	9.8		12	13.4	10.4
Genitourinary complications					0.002			
	No	82.4	82	84.9		83.6	82	85.5
	Yes	17.6	18	15.1		16.4	18	14.5
Vascular complications					0.2			
	No	96.4	96.3	97.1		96.7	96.4	97.2

	Yes	3.6	3.7	2.9		3.3	3.6	2.8
Wound complications					<0.001			
	No	93.1	92.7	96.1		94.4	92.7	96.3
	Yes	6.9	7.3	3.9		5.6	7.3	3.7
Transfusions					<0.001			
	No	67	65	80.6		72	65.2	80.2
	Yes	33	35	19.4		28	34.8	19.8
Miscellaneous medical					0.3			
	No	60.9	60.6	62.7		61.3	60.7	62.1
	Yes	39.1	39.4	37.3		38.7	39.3	37.9
Miscellaneous surgical					<0.001			
	No	92.4	92	95.5		93.5	92.1	95.3
	Yes	7.6	8	4.5		6.5	7.9	4.7

In-hospital death					0.02			
	No	98.3	98.2	99		98.6	98.2	99
	Yes	1.7	1.8	1		1.4	1.8	1

Table 3 – Multivariable analyses predicting main outcomes in robotic vs. open cystectomy. Analyses adjusted for year of diagnosis, age at diagnosis, gender, Charlson comorbidity index, insurance status, region, teaching status, urinary diversion, lymph node dissection, hospital volume, income and bed-size.

Outcome of interest	**Odds ratio (95% Confidence interval)**	**p-value**
Intraoperative complication	0.61 (0.39-0.94)	**0.03**
Postoperative complication		
Overall	0.62 (0.56-0.73)	**<0.001**
Cardiac	0.94 (0.74-1.20)	0.6
Respiratory	0.76 (0.62-0.93)	**0.001**
Vascular	0.76 (0.53-1.08)	0.1
Wound	0.51 (0.37-0.68)	**<0.001**
Genitourinary	0.81 (0.69-0.96)	**0.02**
Transfusions	0.45 (0.38-0.52)	**<0.001**
Miscellaneous medical	0.92 (0.81-1.04)	0.2
Miscellaneous surgical	0.58 (0.43-0.76)	**<0.001**
Parenteral nutrition	0.70 (0.56-0.87)	**0.002**
In-hospital mortality	0.73 (0.41-1.31)	0.3

Table 4 – Multivariable analyses predicting main outcomes in robotic vs. open cystectomy after inverse probability after treatment weighting adjustment and clustering. Analyses adjusted for year of diagnosis, age at diagnosis, gender, Charlson comorbidity index, insurance status, region, teaching status, urinary diversion, lymph node dissection, hospital volume, income and bed-size.

Outcome of interest	**Odds ratio (95% Confidence interval)**	**p-value**
Intraoperative complication	0.87 (0.67-1.13)	0.46
Postoperative complication		
Overall	0.6 (0.52-0.69)	**<0.001**
Cardiac	0.89 (0.69-1.15)	0.4
Respiratory	0.77 (0.58-0.95)	**0.01**
Vascular	0.71 (0.46-1.09)	0.12
Wound	0.48 (0.34-0.68)	**<0.001**
Genitourinary	0.78 (0.65-0.93)	**<0.001**
Transfusions	0.44 (0.37-0.52)	**0.007**
Miscellaneous medical	0.89 (0.77-1.02)	0.06
Miscellaneous surgical	0.62 (0.45-0.84)	**0.002**
Parenteral nutrition	0.66 (0.51-0.84)	**0.001**
In-hospital mortality	0.62 (0.36-1.07)	0.08

Table 5

Multivariable Poisson regression predicting the effect of surgical technique, lymph node dissection, urinary diversion and complications on length of stay in 10 027 radical cystectomy patients after adjustment for all covariates (Income, year of surgery, age, gender, race, charlson comorbidity index, hospital volume, insurance status, bedsize, region and teaching status) and clustering.

			Original Cohort			**Weighted and clustered cohort**	
Variables		**Relative Risk**	**Confidence interval**	**p-value**	**Relative Risk**	**Confidence interval**	**p-value**
Approach							
	Open	Ref					
	Robotic	0.93	0.92-0.95	<0.001	0.91	0.87-0.95	<0.001
Lymph node dissection							
		0.93	0.91-0.94	<0.001	0.94	0.88-1.01	0.09
Ileal conduit							
		0.98	0.96-0.99	0.005	0.98	0.94-1.02	0.4
Continent urinary diversion							

		1.01	0.98-1.04	0.56	1.05	0.99-1.12	0.07
Overall complications							
		1.05	1.03-1.07	<0.001	1.06	1.01-1.1	0.01
Intraoperative complications							
		0.98	0.95-1.02	0.4	1.03	0.81-1.31	0.8
Cardiac complications							
		1.07	1.05-1.09	<0.001	1.1	1.03-1.17	0.004
Respiratory complications							
		1.3	1.28-1.32	<0.001	1.27	1.21-1.33	<0.001
Vascular complications							
		1.28	1.25-1.31	<0.001	1.29	1.18-1.41	<0.0001
Wound complications							
		1.84	1.81-1.87	<0.001	1.85	1.7-2	<0.0001
Genitourinary complications							

		1.08	1.06-1.10	<0.001	1.05	1.01-1.1	0.03
Miscellaneous surgical							
		1.15	1.12-1.18	<0.001	1.13	1.06-1.21	<0.001
Miscellaneous medical							
		1.41	1.39-1.43	<0.001	1.4	1.35-1.46	<0.001
Transfusions							
		1.01	0.99-1.02	0.4	1.03	0.99-1.06	0.2
Parenteral Nutrition							
		1.29	1.27-1.32	<0.001	1.34	1.26-1.41	<0.001

Table 6

Multivariable log-linear regression predicting the effect of surgical technique, lymph node dissection, urinary diversion and complications on total hospital charges in 10 027 radical cystectomy patients after adjustment for all covariates (Income, year of surgery, age, gender, race, charlson comorbidity index, hospital volume, insurance status, bedsize, region and teaching status) and clustering.

			Original Cohort(%)			**Weighted and clustered cohort (%)**	
Variables		**Odds Ratio**	**Confidence interval**	**p-value**	**Odds Ratio**	**Confidence interval**	**p-value**
Approach							
	Open	Ref					
	Robotic	1.09	1.09-1.09	<0.001	1.09	1.03-1.16	<0.001
Ileal conduit							
		0.94	0.94-0.94	<0.001	0.94	0.89-0.99	0.01
Lymph node dissection							
		1.04	1.04-1.04	<0.001	1.05	0.97-1.13	0.2
Continent urinary							

diversion							
		1.05	1.05-1.05	<0.001	1.09	1.01-1.17	0.03
Intraoperative complications							
		0.92	0.92-0.92	<0.001	0.9	0.8-1.02	0.1
Cardiac complications							
		1.19	1.19-1.19	<0.001	1.25	1.16-1.35	<0.001
Respiratory complications							
		1.32	1.32-1.32	<0.001	1.26	1.19-1.34	<0.001
Vascular complications							
		1.09	1.09-1.09	<0.001	1	0.9-1.1	0.9
Wound complications							
		1.37	1.37-1.37	<0.001	1.49	1.38-1.6	<0.001
Genitourinary complications							
		1.10	1.10-1.10	<0.001	1.15	1.09-1.31	<0.001

Miscellaneous surgical							
		1.26	1.26-1.26	<0.001	1.33	1.23-1.44	<0.001
Miscellaneous medical							
		1.18	1.18-1.18	<0.001	1.24	1.2-1.29	<0.001
Transfusions							
		1.07	1.07-1.07	<0.0001	1.06	1.02-1.11	0.001
Parenteral Nutrition							
		1.05	1.05-1.05	<0.001	1.11	1.05-1.17	0.001

Journal of Endourology
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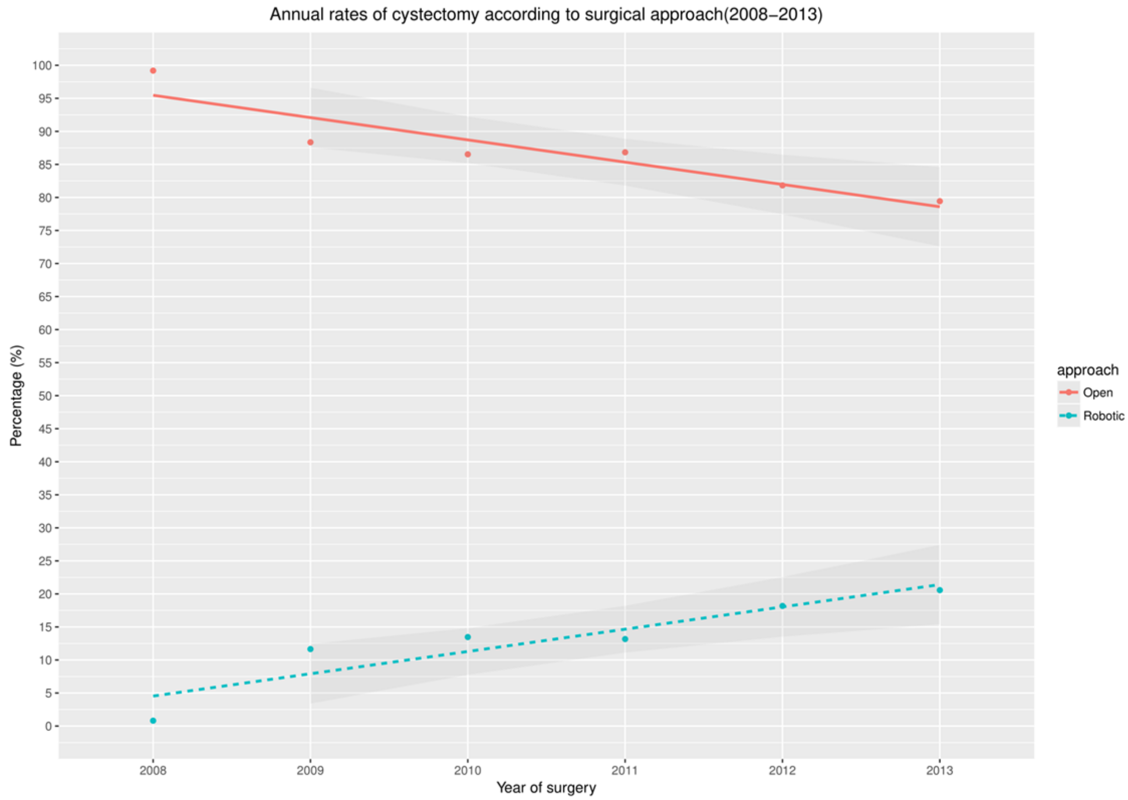

Figure 1.

Cystectomy rates over time.

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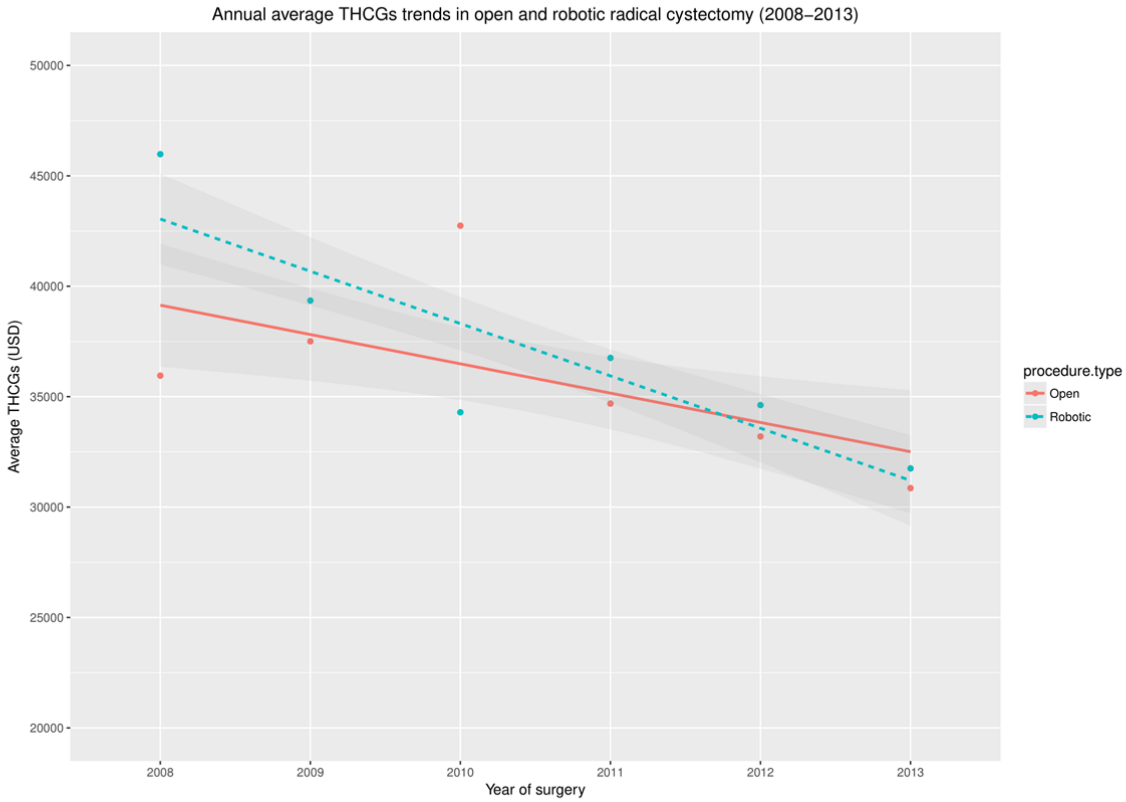

Figure 2

Annual average cost trend according to open and robotic cystectomy