Impact of academic affiliation on radical cystectomy outcomes in North America: A population-based study

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Cite as: *Can Urol Assoc J* 2012;6(4):245-50. http://dx.doi.org/10.5489/cuaj.12032

Abstract

Background: The objective of this study was to examine the rates of blood transfusions, prolonged length of stay, intraoperative and postoperative complications, as well as in-hospital mortality, stratified according to institutional academic status in patients undergoing radical cystectomy (RC).

Methods: Within the Health Care Utilization Project Nationwide Inpatient Sample (NIS), we focused on patients in whom RC was performed between 1998 and 2007. Multivariable logistic regression analyses were fitted to predict the likelihood of blood transfusions, prolonged length of stay, intraoperative and postoperative complications, and in-hospital mortality. Covariates included age, race, gender, Charlson Comorbidity Index (CCI), hospital region, insurance status, annual hospital caseload (AHC), year of surgery and urinary diversion.

Results: Overall, 12 262 patients underwent RC. Of those, 7892 (64.4%) were from academic institutions. Patients treated at academic institutions were younger and healthier at baseline (all $p < 0.001$). RCs performed at academic institutions were associated with fewer postoperative complications (28.8% vs. 32.9%, $p < 0.001$), shorter length of stay (54.0% vs. 56.2%, $p = 0.02$) and lower in-hospital mortality rates (2.1 vs. 3.0%, $p = 0.002$). In multivariable analyses, patients who underwent RC at an academic hospital were 12% less likely to succumb to postoperative complications (odds ratio=0.88, $p = 0.003$).

Interpretation: Even after adjusting for AHC, RCs performed at academic institutions are associated with better postoperative outcomes than RCs performed at non-academic institutions. From a public health prospective, performing RCs at academic institutions may help reduce costs associated with the management of complications and prolonged length of stay.

Introduction

Radical cystectomy (RC) with urinary diversion represents the standard of care for patients with muscle invasive or refractory non-muscle invasive bladder cancer.[1,2] Surgeon and hospital annual caseloads represent established predictors of a variety of RC outcomes, according to the "practice makes perfect" hypothesis.[3,4] Other predictors of favourable outcomes consist of younger patient age, favourable baseline comorbidity profile and select geographical region.[3-6] However, to the best of our knowledge, the relationship between institutional academic status and postoperative outcomes following RC has not been extensively studied. Konety and colleagues reported a reduced risk of postoperative complications in large bed size, high volume, teaching institutions, but the authors failed to account for the role of institutional academic status in their analyses.[7] Given that the practice profile at most academic institutions is generally more focused and specialized than non-academic institutions, it may be expected that the former is associated with more favourable outcomes for highly complex surgical procedures, such as RC.

We explored the impact of academic status on five immediate- and short-term RC outcomes. We relied on a large contemporary population-based cohort that was nationally representative.

Methods

Data source

Data from the most contemporary years (1998 to 2007) of the Nationwide Inpatient Sample (NIS) were abstracted. The NIS includes inpatient discharge data collected via federal-state partnerships, as part of the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project. As of the year 2007, the NIS contained administrative data on 8 043 415 discharges from 1044 hospitals within 40 states, about 20% of community hospitals in the United States, including public hospitals and academic medical centres.

Sample population and surgical procedures

Relying on discharge records, all patients with a primary diagnosis of bladder cancer (ICD-9-CM code 188) were identified. The cystectomy procedure code (ICD-9-CM 57.7) resulted in the identification of 12 262 patients who underwent RC between 1998 and 2007. Urinary diversion was stratified as either continent (orthotopic neobladder or continent cutaneous reservoir, ICD-9 code 57.87) or incontinent (ileal conduit, ICD-9 code 56.51) or unknown.

Hospital characteristics

Hospitals were divided into academic and non-academic institutions. The hospital's academic status was obtained from the American Hospital Association (AHA) Annual Survey of Hospitals.[8] A hospital was considered to be a teaching hospital if it has an American Medical Association (AMA)-approved residency program, is a member of the Council of Teaching Hospitals or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.[9] Annual hospital caseload (AHC) is defined according to the number of procedures performed at each participating institution during each study calendar year.[10] The minimum p-value approach, as described by Mazumdar and Glassman,[11] was used to assess the best cut-offs of AHC, resulting in the following categories: <15 vs. ≥15 cystectomies performed.

Other hospital characteristics included hospital region, which was obtained from the United States Census Bureau.[12] The regions were categorized as follows: South (Delaware, Maryland, District of Columbia, Virginia, Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas); West (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii); Northeast (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania); and Midwest (Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Dakota, Nebraska, Kansas).

Patient characteristics

For all patients, the following information was available: patient age, race (white vs. black vs. other [Hispanic, Asian, Pacific Islander, Native American, unspecified]) vs. unknown, Charlson comorbidity index (CCI), and year of surgery. Age at surgery (in years), coded as a continuous variable, was subcategorized as follows: ≤59, 60-69, 70-79 and ≥80 years. CCI was derived from ICD-9 codes, according to previously established criteria,[13] and was stratified into four levels: 0, 1, 2 and ≥3.

Complications and blood transfusions

The NIS records up to 15 diagnoses and procedures per in-hospital stay. The presence of any complication was defined using ICD-9 diagnoses 2 to 15. Intraoperative complication was defined as accidental puncture or laceration during a procedure (ICD-9: 998.2). The following groups of postoperative complications were identified: complications occurring in the digestive system, respiratory complications, hemorrhage or hematoma, cardiac-related complications, postoperative infections, vascular complications, seroma complicating a procedure, operative wound related complications, urinary complications, fistulas and other. Blood transfusion recipients were identified using the ICD-9 procedure codes: 99.02, 99.04.

Length of stay, provided by the NIS, was calculated by subtracting the admission date from the discharge date. A prolonged length of stay was defined according to the median number of hospitalized days in the entire cohort. In-hospital mortality information is coded based on the disposition of patient. Patients with missing or invalid length of stay or in-hospital mortality status were excluded from the study.

Statistical analysis

Frequencies and proportions were generated for categorical variables. The chi-square test was used to assess the statistical significance of proportions. Logistic regression analyses were computed for prediction of the following outcomes: (1) blood transfusion; (2) intraoperative complication; (3) any postoperative complication that occurred during hospitalization; (4) length of stay above the median; and (5) in-hospital mortality. All models relied on generalized estimating equations (GEE-models) to further adjust for clustering among hospitals.[14]

All tests were two-sided with a statistical significance of $p < 0.05$. All statistical analyses were performed using the SPSS, version 18.0 (SPSS, Chicago, IL).

Results

Overall, 12 262 patients who underwent RCs were identified within the NIS between 1998 and 2007. We tallied the descriptive characteristics of patients stratified according to academic versus non-academic status (Table 1). Overall, 7892 patients (64.4%) were treated at academic centres. Patients from academic institutions had fewer comorbidities at RC (CCI 0: 70.3% vs. 64.2%), were younger (≤59 years: 21.6% vs. 15.5%), and were more likely to receive a continent urinary diversion (8.7% vs. 2.9%, respectively) relative to their non-academic counterparts (all $p < 0.001$). All high AHC institutions, where more than 15 RC are performed annually, were also academic institutions.

Overall, the rates of intraoperative complication, blood transfusion, postoperative complication, prolonged length of stay, and in-hospital mortality were 2.5, 27.3, 30.2, 54.8, and 2.4%, respectively (Table 2). Stratification of outcomes according to institutional academic status showed statistically significant differences between academic versus non-academic centres in regards to postoperative (28.8% vs. 32.9%, $p < 0.001$), respiratory (2.6% vs. 4.1%, $p < 0.001$), digestive (16.0% vs. 18.0%, $p = 0.004$), operative wound-related (3.5% vs. 4.6%, $p = 0.002$) complications. Similarly, academic centres had a lower proportion of patients staying beyond the median length of stay (54.0% vs. 56.2%, $p = 0.02$) and lower rates of in-hospital mortality (2.1% vs. 3.0%, $p = 0.002$). The impact of institutional academic status failed to achieve statistical significance for blood transfusion ($p = 0.2$) intraoperative complications ($p = 0.3$), as well as the remaining complication groups (all $p > 0.05$).

In multivariable analyses that adjusted for AHC, insurance status, age, race, CCI, hospital region, sex, year of surgery and type of urinary diversion, institutional academic status was associated with a protective effect on postoperative complication rates (odds ratio [OR]=0.88, $p = 0.01$) (Table 3). Conversely, academic status had no effect on blood transfusion ($p = 0.7$), intraoperative complication ($p = 0.5$), length of stay ($p = 0.3$), and in-hospital mortality ($p = 0.2$). In multivariable analyses, AHC also achieved independent predictor status in three short-term RC adverse outcomes. Specifically, RCs performed at high AHC hospitals were less frequently associated with blood transfusions (OR=0.73, $p < 0.001$), postoperative complications (OR=0.81, $p = 0.002$ and length of stay beyond the median (OR=0.70, $p < 0.001$). Conversely, AHC had no effect on intraoperative complications ($p = 0.3$) and in-hospital mortality ($p = 0.08$).

Table 1. Characteristics of 12 262 patients treated with radical cystectomy for bladder cancer, stratified according to hospital status*

	Non-academic	Academic	p
No. patients	4370 (35.6)	7892 (64.4)	-
Age, yr			
≤59	677 (15.5)	1703 (21.6)	<0.001
60–69	1277 (29.2)	2340 (29.7)	
70–79	1785 (40.8)	2877 (36.5)	
≥80	631 (14.4)	972 (12.3)	
Sex			
Male	3579 (81.9)	6614 (83.8)	0.007
Female	791 (18.1)	1278 (16.2)	
Race			
White	2910 (66.6)	5107 (64.7)	<0.001
Black	121 (2.8)	286 (3.6)	
Other¥	156 (3.6)	486 (6.2)	
Unknown	1183 (27.1)	2013 (25.5)	
CCI†			
0	2804 (64.2)	5545 (70.3)	<0.001
1	1134 (25.9)	1677 (21.2)	
2	218 (5.0)	386 (4.9)	
≥3	214 (4.9)	284 (3.6)	
Hospital region‡			
Northeast	683 (15.6)	1667 (21.1)	<0.001
Midwest	958 (21.9)	1958 (24.8)	
South	1675 (38.3)	2701 (34.2)	
West	1054 (24.1)	1566 (19.8)	
AHC			
<15	4370 (100)	6377 (80.8)	<0.001
≥15	0 (0)	1515 (19.2)	
Urinary diversion			
Incontinent	3998 (91.5)	6777 (85.9)	<0.001
Continent	128 (2.9)	683 (8.7)	
Unknown	244 (5.6)	432 (5.5)	
Year of surgery			
1998-2001	1798 (41.1)	2500 (31.7)	<0.001
2002-2004	1340 (30.7)	2554 (32.4)	
2005-2007	1232 (28.2)	2838 (36.0)	
Insurance status			
Private	1204 (27.6)	2597 (32.9)	<0.001
Medicaid	113 (2.6)	321 (4.1)	
Medicare	2890 (66.1)	4651 (58.9)	
Other	163 (3.7)	323 (4.1)	

*Nationwide Inpatient Sample, 1998 – 2007.
AHC: annual hospital caseload; CCI: Charlson comorbidity status.
¥Includes Hispanic, Asian, Pacific Islander, Native American, other unspecified;
†Based on Comorbidity developed by Charlson et al. and adapted by Deyo et al.; ‡Hospital region is defined by the US Census Bureau.

Discussion

RC is considered the gold standard for patients with muscle invasive or refractory non-muscle invasive bladder cancer.[1,2] Previous reports also indicate that higher provider volume is associated with improved outcomes in the RC setting.[15-17] However, the importance of institutional academic status has never been assessed in this setting. In consequence, we evaluated the effect of institutional academic status on five types of outcomes within a large contemporary (1998-2007) population-based cohort of individuals undergoing RC.

Our results demonstrated several important points. First, patients treated at academic institutions had fewer comorbidities (CCI=0, 70.3% vs. 64.2%) and were younger (≤59 years, 21.6% vs. 15.5%) than their counterparts treated at non-academic institutions. These observations confirm the presence of an important selection bias that exists in regards to patients treated at academic institutions. Nonetheless, these observations reflect the teaching objective of academic institutions, where the structural and processes components differ from non-academic institutions. Alternatively, it may also be possible that patient preferences, treating physician

Table 2. Intraoperative and postoperative outcomes after radical cystectomy according to institutional academic status

	Overall	Non-academic	Academic	Academic vs. Non-academic OR (95%CI)	*p*
No. patients	12262	4370 (35.6)	7892 (64.4)	–	–
Blood transfusion	344 (27.3)	1226 (28.1)	2118 (6.8)	0.94 (0.87-1.02)	**0.2**
Intraoperative complication	305 (2.5)	117 (2.7)	188 (2.4)	0.89 (0.70-1.12)	**0.3**
Postoperative complication					
Overall	3705 (30.2)	1436 (32.9)	2269 (28.8)	0.83 (0.76-0.89)	**<0.001**
Respiratory	381 (3.1)	177 (4.1)	204 (2.6)	0.63 (0.51-0.77)	**<0.001**
Digestive	2048 (16.7)	787 (18.0)	1261 (16.0)	0.87 (0.79-0.96)	**0.004**
Hemorrhage or hematoma	359 (2.9)	143 (3.3)	216 (2.7)	0.83 (0.67-1.03)	**0.1**
Cardiac	479 (3.9)	165 (3.8)	314 (4.0)	1.06 (0.87-1.28)	**0.6**
Vascular	65 (0.5)	25 (0.6)	40 (0.5)	0.89 (0.54-1.47)	**0.6**
Seroma	44 (0.4)	16 (0.4)	28 (0.4)	0.97 (0.53-1.80)	**0.9**
Operative wound	477 (3.9)	202 (4.6)	275 (3.5)	0.74 (0.62-0.89)	**0.002**
Postoperative infections	422 (3.4)	166 (3.8)	256 (3.2)	0.85 (0.70-1.04)	**0.1**
Urinary	376 (3.1)	146 (3.3)	230 (2.9)	0.86 (0.70-1.07)	**0.2**
Fistula	49 (0.4)	21 (0.5)	28 (0.4)	0.74 (0.42-1.30)	**0.3**
Other	10 (0.1)	3 (0.1)	7 (0.1)	1.30 (0.33-5.01)	**0.7**
Length of stay, days					
Length of stay (≥9 days)	6721 (54.8)	2457 (56.2)	4264 (54.0)	0.92 (0.85-0.99)	**0.02**
In-hospital mortality	291 (2.4)	129 (3.0)	162 (2.1)	0.69 (0.55-0.87)	**0.002**

OR: odds ratio; CI: confidence interval.

attitudes and other medical decision-making variables play a role in the observed patient characteristics differences between academic and non-academic centres.

Second, it is noteworthy that academic status remained an independent predictor of more favourable outcomes, in spite of adjusting to AHC. Within the current study population and consistent with previous studies, AHC was strongly associated with institutional academic status. Interestingly, all high AHC institutions were academic institutions. As such, it is possible that the advantage of academic status over non-academic status stems from the fact that AHC has an impact on outcomes after RC. Indeed, previous studies have documented the effect of AHC on RC outcomes.[3,4] Specifically, RC performed at high AHC hospitals were less frequently associated with blood transfusions, less frequently resulted in length of stay beyond the median and were associated with fewer in-hospital mortality rates. That being said, academic status persistently predicted lower complication rates even after adjusting for AHC. This indicates that the relationship of academic status and outcomes is independent of AHC. In consequence, the benefits of academic status reach beyond the "practice-makes-perfect" hypothesis. Given the processes of care, such as the peer-review process associated with all levels of clinical decision-making inherent within academic institutions, this observation may be expected. However, the choice of an academic institution by itself does not guarantee better outcomes. When an academic institution is chosen instead of a non-academic institution, careful selection of the surgeon and the institution regardless of academic affiliation contribute to the observed outcome superiority.

From a practical perspective, our results indicate that on average, a more favourable postoperative complication profile should be expected in academic institutions after RC. While the difference is statistically significant and has limited clinical impact from the individual patient's perspective, these findings have important ramifications from a public health perspective. Specifically, a higher rate of postoperative complications implies that additional diagnostic/therapeutic procedures and, consequently, more health care dollars, will be required to manage such complications. In this context, performing high-risk procedures, such as RC, at academic institutions may reduce the already elevated costs associated with these procedures.

The current study corroborates the findings of several studies that addressed the same topic. For example, higher quality of care measures,[18-20] and lower complication and mortality rates[18,19,21-24] were observed in patients treated at academic institutions. On the other hand, others have also reported no difference or worse outcomes at academic institutions.[25-29] However, the lack of multivariable adjustment may have precluded these findings. To the best of our knowledge, only two studies reported improved specific outcomes in academic institutions after multivariable adjustment. Allison and colleagues demonstrated an improved quality of care and lower mortality rate in patients treated at major academic institutions after acute myocardial infarction.[19] Similarly, Polanczyk and colleagues found lower heart failure, myocardial infarction and stroke-adjusted mortality rates in major academic institutions.[21] These findings are highly valuable given that several authors have questioned the overall value of academic institutions and

Table 3. Multivariable logistic regression analysis predicting the rate of intraoperative and postoperative outcomes during hospitalization

Outcomes	Academic vs. non-academic odds ratio (95%CI)	p
Blood transfusion	0.99 (0.87-1.08)	0.7
Intraoperative complication	0.93 (0.73-1.19)	0.5
Postoperative complication		
Overall	0.88 (0.81-0.96)	0.003
Respiratory	0.68 (0.54-0.84)	<0.001
Digestive	0.93 (0.84-1.03)	0.1
Hemorrhage or hematoma	0.85 (0.68-1.07)	0.2
Cardiac	1.10 (0.90-1.36)	0.3
Operative wound	0.77 (0.45-1.32)	0.3
Postoperative infections	1.12 (0.59-2.13)	0.7
Urinary	0.84 (0.69-1.02)	<0.01
Vascular	0.87 (0.70-1.07)	0.07
Seroma	0.86 (0.69-1.07)	0.2
Fistula	0.75 (0.41-1.37)	0.3
Other	1.29 (0.33-5.01)	0.71
Length of stay, days		
Length of stay ≥9 days	1.04 (0.96-1.13)	0.3
In-hospital mortality	0.87 (0.68-1.11)	0.2

*Model adjusted for age, race, gender, baseline Charlson comorbidity index, hospital region, hospital caseload, year of surgery and urinary diversion.

support continued investment in funds required to run these institutions.[30,31]

Limitations of the current study include the selection bias related to the database, such as the lack of certain patient variables (disease characteristics, personal preferences, education), surgeon variables (individual surgical volume) and socioeconomic factors. For example, patients with more aggressive disease may be diverted towards certain types of institution. These variables were not available in the database. Additionally, administrative records may underestimate the rate of any transfusion type. Specifically, a 17% underestimation was previously reported relative to blood bank records.[32] Moreover, our mortality estimates are based on in-hospital rates. It is possible that the true mortality is therefore underestimated as some patients may have died at other institutions where their mortality was not captured.

Conclusion

Patients undergoing RC at academic institutions are less likely to experience postoperative complications than those undergoing RC at non-academic institutions, independent of AHC. This finding has important implications from a public health perspective. Selective referral of RCs to academic institutions may help alleviate the heavy economic burden of high-risk procedures by reducing the costs associated with the management of complications and prolonged length of stay.

Competing interests: None declared.

This paper has been peer-reviewed.

Acknowledgements: Pierre I. Karakiewicz is partially supported by the University of Montreal Health Centre Urology Specialists, Fonds de la Recherche en Sante du Quebec, the University of Montreal, Department of Surgery and the University of Montreal Health Centre (CHUM) Foundation.

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