Impact of provider volume on operative mortality after radical cystectomy in a publicly funded healthcare system

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Abstract

Introduction: We assess the effect of cystectomy provider volume on postoperative mortality in a publicly funded healthcare system. Hospital and surgeon (provider) volume have been shown to be associated with clinically important outcomes for many types of surgery. Volume-outcome studies in patients undergoing radical cystectomy for bladder cancer have primarily originated from privately funded healthcare systems.
Methods: We identified patients undergoing cystectomy in Ontario, Canada, between 1992 and 2004 using administrative databases. The effect of provider volume on postoperative mortality was assessed with multilevel (hierarchical or random effects) logistic regression models, adjusted for patient characteristics. Separate models were fit to examine the effect of surgeon volume and the effect of hospital volume.
Results: Of the 3296 cystectomy patients identified, 126 (3.8%) experienced a postoperative death. Neither hospital volume (odds ratio [per 1 unit increase in volume] 0.98, 95% confidence interval [CI] 0.95-1.00; $p = 0.074$) nor surgeon volume (odds ratio 0.96, 95% CI 0.90-1.02; $p = 0.143$) were statistically significantly associated with postoperative cystectomy mortality.
Conclusions: In Ontario's publicly funded healthcare system, provider volume was not significantly associated with postoperative mortality.

Introduction

A number of studies have demonstrated that higher volume hospitals and surgeons generally have better postoperative outcomes compared to lower volume providers.[1-3] However, the relationship between cystectomy hospital and surgeon volume and operative mortality is not completely clear. With few exceptions,[4,5] all studies were conducted in the United States.[6,7] Furthermore, the databases used in these analyses were subsets of population samples and their composition may have been prone to selection biases. For example, Medicare is restricted to patients aged 65 and older,[8] the Surveillance, Epidemiology and End Results (SEER) database is based on samples from SEER areas and captures 26% of the American population,[9] and the Nationwide Inpatient Sample (NIS) represents a 20% stratified sample of US community hospitals.[10] Therefore, the potential for selection bias exists, and additional whole-population studies outside the US healthcare setting are required to demonstrate the generalizability of the volume-outcome phenomenon.

Therefore, we investigated the impact of both hospital and surgeon cystectomy volume on postoperative mortality rates in a publicly-funded (Canadian) healthcare setting.

Methods

Cohort identification

Patients undergoing radical cystectomy in the province of Ontario, between 1992 and 2004, were identified from the Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD) (Canadian Classification of Diagnostic, Therapeutic and Surgical Procedure code 69.51 and Canadian Classification of Health Interventions codes 1.PM.91 and 1.PM.92). The CIHI DAD contains information on all inpatient hospital admissions in Ontario and was used to identify cystectomy patients. Information about age, sex, comorbidity, urgency of admission, region of residence, and vital status for each cystectomy patient was obtained from either the CIHI DAD or the provincial Registered Person's Database. The Charlson Comorbidity Index was derived from CIHI DAD International Classification of Diseases (ICD) diagnostic codes from each patient's index admission and from any hospital admissions in the year prior to cystectomy.[11-13]

Because radical cystectomy can be performed for both bladder cancer and for non-bladder malignancies (e.g., as part of larger exenterative procedures for colorectal, prostate or gynecological malignancies), we linked the CIHI data to the Ontario Cancer Registry (OCR) to select only those cystectomy patients with a diagnosis of bladder cancer. The OCR contains information on all incident cancers detected in the province of Ontario with 97% capture of incident cases of bladder cancer.[14] A total of 3296 patients undergoing cystectomy for bladder cancer were identified.

Outcomes

The primary outcome was operative mortality defined as death prior to discharge or within 30 days of cystectomy.

Volume definitions

Hospital volume was defined as the average annual number of cystectomy cases performed at an institution during the study time period. In situations where a hospital closed or newly opened, only the years of the hospital's existence during the study span were used for volume calculations.[15] Hospitals were identified using CIHI DAD institution unique identifiers.

Surgeon volume was defined as the average annual number of cystectomy cases performed by a surgeon during his/her active years of clinical activity. Surgeons were identified using Ontario Health Insurance Plan (OHIP) unique identifiers. Each cystectomy identified in CIHI is linkable by a combination of unique identifier and procedure type and date to an OHIP billing fee-code (S484, S485, S453, S440) and thus a specific surgeon. A minority of Ontario physicians are salaried and do not submit billing codes. Consequently, 160 (4.9%) cystectomy cases were missing surgeon identifiers.

Potential confounding variables

Multivariable analyses were risk-adjusted for age, sex, admission status (urgent/emergent vs. elective), Charlson comorbidity score, and socioeconomic status. Socioeconomic status was derived from Canadian Census neighbourhood-specific quintiles of income.

Statistical analyses

The program MLwiN v2.02 (Centre for Multilevel Modeling, Bristol, UK) was used to fit multivariable multilevel (random effects or hierarchical) logistic regression models. All remaining statistical analyses were performed using SAS version 9.1.3 (SAS Institute, Cary, North Carolina). A 2-sided p value of 0.05 was defined as statistically significant. For descriptive statistics, the data were divided into quartiles of hospital volume and surgeon volume. Multicollinearity, defined as a variance inflation factor (VIF) >10, was determined for all variables to ensure the fitted regression model did not suffer from multicollinearity.[16] The effect of hospital or surgeon volume on operative mortality was determined using fully adjusted, random intercept models accounting for clustering of data at both the surgeon and hospital levels. In all analyses, volume was modelled as a continuous variable. We performed sensitivity analyses to determine whether our operationalization of operative mortality (outcome) or volume (exposure) affected the results. Multivariable analyses were repeated with outcome defined as death within 30 days of cystectomy (30-day mortality) and with volume categorized into quartiles. In another sensitivity analysis, we accounted for local tumour stage in the 2535 (77%) patients in whom pathology data were available for review in the OCR. We hypothesized that complex resections (i.e., higher stage tumours) would selectively be performed by high volume centres, which in turn could affect short-term mortality outcomes. Pathologic staging was based on the 2002 American Joint Committee on Cancer system.[17]

Results

Patient demographics

From 1992 to 2004, radical cystectomy was performed by 199 surgeons in 90 hospitals across Ontario. We breakdown the number of cases, hospitals, physicians, and volume cutpoints by quartile of hospital and surgeon volume (Table 1).

Baseline information for the entire cohort, divided into quartiles of hospital volume and surgeon volume, are presented in Table 2 and Table 3, respectively. Higher volume providers tended to treat younger patients with a higher socioeconomic status. Significant differences in patient region of residence also existed. A trend towards higher stage lesions being resected by higher volume hospitals and surgeons was also noted.

Table 1. Cohort characteristics according to annual volume quartiles

Volume measure	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Hospital volume				
No. patients	830	794	823	849
No. hospitals	58	17	11	4
Volume cut-points	0.77–3.22	3.23–5.85	6.00–17.00	19.43–32.63
Surgeon volume				
No. patients	811	749	793	783
No. surgeons	128	42	21	8
Volume cut-points	0.77–1.54	1.67–2.54	2.63–8.08	8.11–16.71

Increasing quartile indicates increasing annual cystectomy volume.

Table 2. Patient level and pathologic variables by hospital volume quartile

Variable	Hospital volume				*p* value
	Quartile 1 (n=830)	Quartile 2 (n=794)	Quartile 3 (n=823)	Quartile 4 (n=849)	
Age	68.4 (9.4)	67.5 (10.0)	68.0 (9.6)	66.5 (10.7)	0.006
Sex					0.816
Males	677 (81.6%)	636 (80.1%)	665 (80.8%)	678 (79.9%)	
Comorbidity†					
None	282 (34.0%)	266 (33.5%)	276 (33.5%)	247 (29.1%)	
Mild	79 (9.5%)	77 (9.7%)	73 (8.9%)	69 (8.1%)	0.087
Moderate	197 (23.7%)	184 (23.2%)	195 (23.7%)	189 (22.3%)	
Severe	272 (32.8%)	267 (33.6%)	279 (33.9%)	344 (40.5%)	
Socioeconomic status*					
Quintile 1	156 (18.8%)	104 (13.1%)	172 (20.9%)	147 (17.3%)	
Quintile 2	168 (20.2%)	185 (23.3%)	186 (22.6%)	168 (19.8%)	<0.001
Quintile 3	169 (20.4%)	158 (19.9%)	167 (20.3%)	137 (16.1%)	
Quintile 4	142 (17.1%)	156 (19.7%)	157 (19.1%)	154 (18.1%)	
Quintile 5	171 (20.6%)	173 (21.8%)	122 (14.8%)	219 (25.8%)	
Admission status					0.216
Urgent/Emergent	102 (12.3%)	104 (13.1%)	127 (15.4%)	126 (14.8%)	
LHIN**	(see footnote)	(see footnote)	(see footnote)	(see footnote)	<0.001
Tumour Stage#					
Tx	3 (0.5%)	1 (0.2%)	4 (0.7%)	0 (0%)	
T0	13 (2.0%)	7 (1.2%)	13 (2.2%)	14 (2.0%)	
Ta	13 (2.0%)	13 (2.2%)	13 (2.2%)	12 (1.7%)	
Tis	28 (4.4%)	38 (6.3%)	37 (6.2%)	24 (3.5%)	0.054
T1	65 (10.2%)	47 (7.8%)	58 (9.7%)	68 (9.8%)	
T2	163 (25.5%)	165 (27.3%)	147 (24.6%)	171 (24.6%)	
T3	237 (37.1%)	228 (37.8%)	197 (32.9%)	234 (33.7%)	
T4	117 (18.3%)	105 (17.4%)	129 (21.6%)	171 (24.6%)	

Hospital volume increases with quartiles. Values listed are counts (percentages) or means (standard deviations).
†Comorbidity scale based on charlson scores: None = Charlson 0; Mild = Charlson 1; Moderate = Charlson 2 and Severe = Charlson >2. *Quintile 5 refers to the highest socioeconomic (neighbourhood income) status whereas quintile 1 is the lowest. **LHIN (Local Health Integration Network) refers to a patient's region of residence modeled as a 14 level categorical variable. Patient allocation by LHIN not shown for space considerations. #Tumour stage only assessable in 2535 patients. Percentages may not add to 100 due to rounding.

Operative mortality

A total of 126 (3.8%) patients experienced operative mortality. The operative mortality rates across hospital and surgeon volume quartiles were as follows: 4.3%, 3.7%, 4.4% and 2.9% for hospital volume quartiles 1 (lowest volume quartile) to 4 (highest volume quartile), respectively and 4.3%, 5.1%, 3.3% and 2.9% for surgeon volume quartiles 1 to 4, respectively. Table 4 lists the multivariable random effects logistic regression results. The odds ratios depicted in Table 4 represent the change in odds for a single cystectomy rise in annual provider volume. In both crude (unadjusted) and adjusted analyses, neither hospital volume nor surgeon volume were statistically significantly associated with operative mortality, although there was a trend towards improved outcomes at higher volume centres and with higher volume surgeons. None of the results were altered in sensitivity analyses that accounted for local tumour stage or which modified how volume or outcome were operationalized (data not shown).

Discussion

Using a dataset with full population coverage from a publicly funded healthcare system, we demonstrated that neither hospital nor surgeon volume were significantly associated with operative mortality, although there was a trend to higher volumes of both being associated with lower mortality.

Contrary to the work of others, our data did not support an association between hospital or surgeon volume and operative mortality. One potential explanation for our results could lie in the differences between the healthcare systems in Canada and the United States. For example, Urbach and colleagues observed that Canadian volume-outcome studies were significantly less likely to report statistically significant associations than US-based studies.[18] They hypothesized that less inter-hospital competition and the potential for coordinated health services in a public, single-payer healthcare system may decrease variability in the quality of care compared to a market-based model where competition could potentially exacerbate such differences. Indirect evidence supporting this claim comes from the Veterans' Administration system in the United States, which operates

Table 3. Patient level and pathologic variables by surgeon volume quartile

Variable	Surgeon volume Quartile 1 (n=811)	Quartile 2 (n=749)	Quartile 3 (n=793)	Quartile 4 (n=783)	*p* value
Age	68.22 (9.3)	67.83 (9.8)	68.08 (9.9)	66.61 (10.6)	0.021
Sex					
Males	659 (81.3%)	586 (78.2%)	644 (81.2%)	637 (81.4%)	0.339
Comorbidity†					
None	281 (34.7%)	246 (32.8%)	251 (31.7%)	237 (30.3%)	0.391
Mild	85 (10.5%)	70 (9.4%)	67 (8.5%)	68 (8.7%)	
Moderate	187 (23.1%)	166 (22.2%)	181 (22.8%)	186 (23.8%)	
Severe	258 (31.8%)	267 (35.7%)	294 (37.1%)	292 (37.3%)	
Socioeconomic status*					
Quintile 1	131 (16.2%)	138 (18.4%)	150 (18.9%)	129 (16.5%)	0.058
Quintile 2	192 (23.7%)	154 (20.6%)	172 (21.7%)	155 (19.8%)	
Quintile 3	178 (22.0%)	135 (18.0%)	141 (17.8%)	146 (18.7%)	
Quintile 4	127 (15.7%)	156 (20.8%)	139 (17.5%)	158 (20.2%)	
Quintile 5	162 (20.0%)	145 (19.4%)	167 (21.1%)	182 (23.2%)	
Admission status					
Urgent/emergent	105 (13.0%)	103 (13.8%)	96 (12.1%)	130 (16.6%)	0.056
LHIN**	(see footnote)	(see footnote)	(see footnote)	(see footnote)	<0.001
Tumour Stage#					
Tx	0 (0%)	3 (0.5%)	3 (0.5%)	0 (0%)	0.197
T0	9 (1.4%)	13 (2.3%)	9 (1.5%)	15 (2.6%)	
Ta	9 (1.4%)	12 (2.1%)	15 (2.5%)	15 (2.6%)	
Tis	32 (5.0%)	25 (4.5%)	26 (4.4%)	33 (5.7%)	
T1	58 (9.1%)	54 (9.6%)	62 (10.4%)	55 (9.5%)	
T2	181 (28.3%)	138 (24.6%)	145 (24.4%)	141 (24.3%)	
T3	234 (36.6%)	214 (38.2%)	205 (34.5%)	186 (32.0%)	
T4	117 (18.3%)	101 (18.0%)	129 (21.7%)	136 (23.4%)	

†Comorbidity scale based on Charlson scores: None = Charlson 0; Mild = Charlson 1; Moderate = Charlson 2 and Severe = Charlson >2. *Quintile 5 refers to the highest socioeconomic (neighbourhood income) status whereas 1 is the lowest. **LHIN (Local Health Integration Network) refers to a patient's region of residence modeled as a 14 level categorical variable. Patient allocation by LHIN not shown for space considerations. # Tumour stage only assessable in 2535 patients. Percentages may not add to 100 due to rounding. Surgeon volume increases with quartiles. Values listed are counts (percentages) or means (standard deviations).

as a publicly funded system in a private healthcare environment.[19] Few volume-outcome studies from the Veterans' Administration system have been positive.[20] Another possible reason for a non-significant volume-operative mortality finding in Ontario is that the data in this study represent an entire population of cystectomy cases. Since many positive volume-outcome studies use databases of population samples, it is possible that selection bias in the derivation of these samples may have contributed to the significant results from these studies. Variations in the results of volume outcome studies based on samples of populations compared to complete datasets have been reported by others.[8]

The absence of a strong volume-outcome association for radical cystectomy operative mortality in Canada provides a potential model with which to improve the quality of cystectomy care. Increasingly, evidence suggests that volume is actually a surrogate for underlying structures and/or processes of care which, in turn, affect quality of care.[21] Identifying relevant structure/process measures and then implementing them in the form of best practice guidelines could ultimately improve the outcomes associated with low-volume service providers. Comparing settings in which significant volume-outcome associations exist to those in which they do not, such as in Canada, may help identify the important structures and/or processes responsible for volume-related disparities in care.

Our study has limitations. First, the lack of a significant volume-outcome association for operative mortality may have been secondary to decreased statistical power. Power calcu-

Table 4. Effect of hospital and surgeon volume on postoperative mortality

Variable	Odds ratio	95% CI	*p* value
Hospital volume			
Unadjusted	0.974	(0.943, 1.005)	0.091
Adjusted*	0.975	(0.947, 1.003)	0.074
Surgeon volume			
Unadjusted	0.958	(0.899, 1.020)	0.170
Adjusted*	0.956	(0.899, 1.017)	0.143

P values derived from a multilevel random effects logistic regression model. *Adjusted for age, sex, Charlson comorbidity score, socioeconomic status and admission status. CI: confidence interval.

lations with our data suggest that large mortality differences with changes in hospital or surgeon volume would have been required to detect a statistically significant difference (data not shown). Nevertheless, other investigators have been able to detect significant differences in similar analyses with far fewer patients,[22] implying larger quality gaps in their patient populations. Furthermore, a future analysis using a time frame longer than our 13-year period (to derive a larger patient cohort) may overcome any possible power limitation, but a finding of statistical significance may not necessarily translate into a clinically meaningful difference. Second, we chose to define provider volume as the average annual case volume (number of cases for a provider during their period of clinical activity divided by the duration of their clinical activity). While we may be criticized for not using another definition of volume (e.g., annual case volume for each given year, case volume in the preceding year), we have demonstrated that the method by which volume is defined does not alter the final conclusions of volume-outcome analyses.[23] Third, while we were able to assess the effect of volume on operative mortality, our administrative data precluded assessment of other outcome measures, such as disease-specific or recurrence-free survival.[24] Finally, our study does not identify structures or processes of care that may be responsible for the volume-based variations in outcomes identified by others.

Conclusion

In Ontario, there was no statistically significant association between surgeon or hospital volume and operative mortality in patients undergoing radical cystectomy. Ongoing research into the structures and processes of care underlying the volume-outcome relationship may help reduce disparities in outcomes after cystectomy present in privately funded healthcare systems.

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This paper has been peer-reviewed.

References

1. Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med* 2002;346:1128-37. http://dx.doi.org/10.1056/NEJMsa012337
2. Birkmeyer JD, Stukel TA, Siewers AE, et al. Surgeon volume and operative mortality in the United States. *N Engl J Med* 2003;349:2117-27. http://dx.doi.org/10.1056/NEJMsa035205
3. Konety BR, Dhawan V, Allareddy V, et al. Impact of hospital and surgeon volume on in-hospital mortality from radical cystectomy: data from the health care utilization project. *J Urol* 2005;173:1695-700. http://dx.doi.org/10.1097/01.ju.0000154638.61621.03
4. McCabe JE, Jibawi A, Javle P. Defining the minimum hospital case-load to achieve optimum outcomes in radical cystectomy. *BJU Int* 2005;96:806-10. http://dx.doi.org/10.1111/j.1464-410X.2005.05717.x
5. McCabe JE, Jibawi A, Javle PM. Radical cystectomy: defining the threshold for a surgeon to achieve optimum outcomes. *Postgrad Med J* 2007;83:556-60. http://dx.doi.org/10.1136/pgmj.2007.058214
6. Black PC, Brown GA, Dinney CP. Should cystectomy only be performed at high-volume hospitals by high-volume surgeons? *Curr Opin Urol* 2006;16:344-9. http://dx.doi.org/10.1097/01.mou.0000240307.85829.7a
7. Joudi FN, Konety BR. The impact of provider volume on outcomes from urological cancer therapy. *J Urol* 2005;174:432-8. http://dx.doi.org/10.1097/01.ju.0000165340.53381.48
8. Baxter NN, Urbach DR. Misclassification of hospital volume in surgical volume-outcome analyses of persons aged 65 years or older: potential limitations of Medicare data. *Evidence-based Surgery* 2003;1:49-55.
9. Overview of the SEER program. Surveillance Research Program NCI. http://seer.cancer.gov/about/overview.html. Accessed November 13, 2013.
10. Overview of the Nationwide Inpatient Sample (NIS). Health Care Cost and Utilization Project Databases. http://www.hcup-us.ahrq.gov/nisoverview.jsp. Accessed November 13, 2013.
11. Quan H, Parsons GA, Ghali WA. Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. *Med Care* 2004;42:801-9. http://dx.doi.org/10.1097/01.mlr.0000132391.59713.0d
12. Preen DB, Holman CD, Spilsbury K, et al. Length of comorbidity lookback period affected regression model performance of administrative health data. *J Clin Epidemiol* 2006;59:940-6. http://dx.doi.org/10.1016/j.jclinepi.2005.12.013
13. Nuttall M, van der Meulen J, Emberton M. Charlson scores based on ICD-10 administrative data were valid in assessing comorbidity in patients undergoing urological cancer surgery. *J Clin Epidemiol* 2006;59:265-73. http://dx.doi.org/10.1016/j.jclinepi.2005.07.015
14. Cancer Care Ontario; Ontario Cancer Registry. Bladder Cancer ICD9 (188). Internal communication.
15. Kulkarni GS, Laupacis A, Urbach DR, et al. Varied definitions of hospital volume did not alter the conclusions of volume-outcome analyses. *J Clin Epidemiol* 2009;62:400-7. http://dx.doi.org/10.1016/j.jclinepi.2008.07.008
16. Christensen LA: Introduction to building a linear regression model. Proceedings of the Twenty-Second Annual SAS Users Group International Conference; 1997. http://www2.sas.com/proceedings/sugi22/STATS/PAPER267.PDF. Accessed November 13, 2013.
17. American Joint Committee on Cancer: AJCC Cancer Staging Manual, 6th edition; 2002.
18. Urbach DR, Croxford R, MacCallum NL, et al. How are volume-outcome associations related to models of health care funding and delivery? A comparison of the United States and Canada. *World J Surg* 2005;29:1230-3. http://dx.doi.org/10.1007/s00268-005-7994-7
19. Fooks C, Decter M. The transformation experience of the Veterans Health Administration and its relevance to Canada. *Healthc Pap* 2005;5:60.
20. Khuri SF, Henderson WG. The case against volume as a measure of quality of surgical care. *World J Surg* 2005;29:1222-9. http://dx.doi.org/10.1007/s00268-005-7987-6
21. Urbach DR, Baxter NN. Does it matter what a hospital is "high volume" for? Specificity of hospital volume-outcome associations for surgical procedures: analysis of administrative data. *Qual Saf Health Care* 2004;13:379-83. http://dx.doi.org/10.1136/qhc.13.5.379
22. Elting LS, Pettaway C, Bekele BN, et al. Correlation between annual volume of cystectomy, professional staffing, and outcomes: a statewide, population-based study. *Cancer* 2005;104:975-84. http://dx.doi.org/10.1002/cncr.21273
23. Hall S, Schulze K, Groome P, et al. Using cancer registry data for survival studies: the example of the Ontario Cancer Registry. *J Clin Epidemiol* 2006;59:67-76. http://dx.doi.org/10.1016/j.jclinepi.2005.05.001
24. Kulkarni GS, Laupacis A, Urbach DR, et al. Varied definitions of hospital volume did not alter the conclusions of volume-outcome analyses. *J Clin Epidemiol* 2009;62:400-7. http://dx.doi.org/10.1016/j.jclinepi.2008.07.008

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