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The Association of Hospital Volume With Conditional 90-day Mortality After Cystectomy: An Analysis of the National Cancer Database

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Abstract

OBJECTIVE—To examine the association of hospital volume and 90-day mortality after cystectomy, conditional on survival to 30 days

SUBJECTS AND METHODS—The National Cancer Database was used to evaluate 30- and 90-day mortality for 35,055 bladder cancer cases that received cystectomy at 1,118 hospitals. Patient data were aggregated into hospital volume categories based on average annual number of procedures [<10 low volume hospital (LVH), 10–19, ≥20 high volume (HVH)]. Associations between mortality and clinical, demographic and hospital characteristics were analyzed using hierarchical logistic regression models. To assess the association between hospital volume and 90-day mortality independent from shorter-term mortality, 90-day mortality conditional on 30-day survival was assessed in the multivariate modeling.

RESULTS—Unadjusted 30- and 90-day mortality rates were 2.7% and 7.2% overall, 1.9% and 5.7% among HVH, and 3.2% and 8.0% among LVH, respectively. Compared to HVH, the adjusted risks among LVH [OR (95% CI)] of 30- and 90-day mortality conditional on having survived through 30 days from the hierarchical models were 1.5 (1.3–1.9), and 1.2 (1.0–1.4), respectively.

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CONCLUSION—Low hospital volume was associated with increased 30- and 90-day mortality. These data support the need for further research to better understand the relatively high mortality rates seen between 30–90 days, which are high and less variable across hospital volume strata. The stronger association between volume and 30-day mortality suggests that quality-reporting efforts should focus on shorter term outcomes.

Keywords

Bladder cancer; cystectomy; volume-outcome; 90-day mortality; conditional survival

Introduction

Cystectomy is indicated for the potentially lethal phenotype of bladder cancer (1) and has been associated with overall survival benefit compared to less aggressive management approaches.(2) Along with other complex surgical procedures (3, 4), a strong and consistent inverse association between hospital volume and short-term, in-hospital and 30-day postoperative, mortality has been observed among patients receiving cystectomy. (5–10)

Given the magnitude of cystectomy in a population with a high burden of competing risks, data suggesting substantial additional postoperative mortality out to 90 days (11–13) raise the question of whether the typical reference period of 30 days adequately captures the short-term risks, or whether the 90-day outcome may be more meaningful. Furthermore, it has been suggested that the volume/outcome association for cystectomy may extend to 90-day survival,(14) raising the question of the extent to which hospital volume may impact intermediate-term outcomes, independent of the well-established association with mortality in the earlier postoperative period. We focus on 90-day mortality conditional on survival to 30 days to assess the association between hospital volume and 90-day mortality independent from shorter-term mortality.

Subjects and Methods

The National Cancer Data Base (NCDB), a joint project of the American Cancer Society and the Commission on Cancer of the American College of Surgeons, serves as a comprehensive surveillance resource for cancer care in the United States.(15) The NCDB currently captures approximately 70% of all bladder cancers in the US, from over 1,400 facility-based cancer registries. This study was approved by the Institutional Review Board (IRB) of the University of North Carolina.

Incident bladder cancer cases diagnosed from 2004 through 2011 were queried. Selection criteria included ages ≥ 18 years, non-metastatic disease, and cystectomy procedure in the reporting facility. Total and radical cystectomies only were included; partial cystectomy procedures were excluded. Overall 30- and 90-day mortality, defined as patients who died within 30 or 90 days of the definitive surgery date, were assessed for descriptive analyses. Average annual hospital volume was determined by summing the number of cystectomies in each hospital from 2004–2011, divided by the eight year time period, excluding hospitals not accredited and reporting cases in each year between 2004–2011. Volume was calculated for individual hospitals including hospitals that are part of a network. For merged hospitals, volume was calculated for the merged entity, not individual hospitals. Hospitals missing mortality rates for 40% or more of cystectomy cases were excluded. Individual providers' volumes could not be calculated since surgeon information is not included in the NCDB.

Co-morbidity information was derived from up to ten secondary diagnoses recorded for each patient, based on ICD-9-CM codes. The Elixhauser(16) classification, shown to be a better predictor of outcomes than the Charlson Comorbidity Index,(17, 18) was used. Reported secondary diagnoses were classified into 28 Elixhauser groups (excluding the two neoplasm groups).(19) Other measures include demographic and clinical variables, as well as median income and census region residence from 2000 U.S. Census data (based on zip codes of patient residence linked to census data). Case-mix for low versus high volume hospitals was also assessed for demographic and clinical variables.

Statistical Analysis

Thirty- and 90-day mortality was assessed overall and by hospital volume, categorized as low (<10), intermediate (10–19) and high (>20 cases/year). To examine factors associated with 90-day mortality independent of effects from shorter term mortality and to allow for between-model comparisons, conditional 90-day mortality was calculated for patients who survived beyond 30 days. For descriptive analyses, bivariate associations between 30-day and conditional 90-day mortality outcomes and demographic, clinical, and hospital variables were assessed using survey sampling methodology to account for clustering of patients within hospitals. Adjusted associations between 30- and 90-day conditional mortality and clinical, demographic, and hospital characteristics, including hospital cystectomy volume, were assessed using hierarchical logistic regression models fit using the SAS GLIMMIX procedure (SAS version 9.4, SAS Institute, Cary, NC). All models included random hospital effects to account for clustering of patients within hospitals. The model for each outcome simultaneously included all listed risk factors. Characteristics of patients in low volume hospitals (< 10 cases per year) compared to high volume hospitals (≥ 10 per year) were assessed using stepwise logistic regression. In reviewing the results, we focus on associations significant at the 0.05 level with no adjustments for multiple comparisons.

Results

In total, 38,917 patients received cystectomy in the five year period. After exclusions for incorrect hospital facility codes or hospitals not reporting cases for each of the eight years (n=1,136), cases with metastatic disease (n=1,103), and missing stage information (n=555), there were 36,123 analytic cases. In this preliminary analytic set, there were 5 hospitals with ≥40% of cases missing 30-day mortality, representing 47 cases, and 8 hospitals with ≥40% of cases missing 90-day mortality, representing 61 cases. After excluding these hospitals, all remaining hospitals had less than 40% of cases missing mortality status, with the majority of hospitals (93% and 88%, respectively, for 30-day and 90-day mortality) missing 10% or less. Excluding all other cases with missing 30- (n=1,042) or 90-day mortality (n=1,910), the final analytic cohort included 35,055 cases from 1,118 hospitals (30-day mortality) and 34,186 cases from 1,115 hospitals (cumulative 90-day mortality).

Demographic, clinical and hospital characteristics of all cases and by hospital volume are presented in Table 1. The mean age was 67.5 (interquartile range 60–76) years and 43 % were age 70 or older. The majority (51%) of procedures were performed in hospitals averaging fewer than 10 cases per year (representing 91% of hospitals), including 30% in hospitals averaging fewer than five cases per year. There were 37 hospitals with an annual volume of 20 or more, representing 32 % of all cystectomies. Lower volume hospitals had the lowest percent of cases with private health insurance (31%) and the higher percent of black cases (7%). High volume hospitals had the highest percentage of cases who received neoadjuvant chemotherapy (21%).

Overall unadjusted 30- and 90-day mortalities were 2.7% and 7.2%, respectively. Significant differences in 30- and cumulative 90-day mortality rates, including patients who died within 30 days, were found according to hospital volume, with decreases in mortality at both average volumes between 10–19 and 20 or higher relative to average volumes less than 10 (Figure 1). For cumulative 90-day mortality, the observed mortality rates and 95% confidence intervals were 8.0 (7.6–8.5), 7.5 (6.6–8.3) and 5.7 (5.0–6.4) for hospital volumes of less than 10, 10–19 and 20 or more, respectively ($p \leq 0.0001$). Among 33,250 patients who survived beyond 30 days and for whom longer follow-up data are available, 1,519 (4.6%) died between 31 and 90 days. The vast majority of these deaths (n=1,342) occurred post discharge. The results for conditional 90-day mortality rather than cumulative 90-day mortality (data not shown) are presented to eliminate the bias from shorter-term deaths included in the 90-day cumulative outcome.

Bivariate associations with 30-day and conditional 90-day mortality are presented in table 2. Volume was significantly associated with both 30-day mortality and conditional 90-day mortality although rates in the latter were similar in volumes under 20. Mortality rates increased with age, with a six percent 30-day mortality rate and a 10 percent 90-day mortality rate in patients aged 80 and over. Significantly higher 30 and 90-day mortality rates were found in blacks compared to whites, and in females compared to males for 90 day mortality only. Mortality rates were significantly higher among cases residing in lower income areas. There were no significant differences by census division, but residents in the East South Central Division had the highest rates for both 30 and 90 day mortality. Medicare recipients had higher 30- and 90-day mortality rates than cases with other insurance. Higher stage, tumor grade, and having a prior cancer were also associated with higher 30- and 90-day mortality rates. Cases diagnosed in 2008–2011 had somewhat lower 90 day mortality rates than cases diagnosed in 2004–2007. Receipt of neoadjuvant chemotherapy was associated with a lower mortality rate than no neoadjuvant chemotherapy. Mortality rates for 17 different Elixhauser comorbid conditions with significant differences are presented in table 2.

Results from the hierarchical models for 30- and 90-day mortality are included in Table 3. Adjusted odds ratios show that low volume hospitals had a significantly elevated odds ratio of 1.5 (95% CI 1.3–1.9) of 30-day mortality compared to high volume hospitals, but the association was attenuated for conditional 90-day mortality (estimated OR 1.2, 95% CI 1.0 – 1.4). Additionally, for both 30- and 90-day mortality, significant associations were observed for age, race, stage, insurance type, and income. Several comorbid conditions were also significantly associated with both 30 and 90 day mortality.

Table 4 presents results comparing patients in low- to intermediate and high-volume hospitals. Older patients, those of black race, and patients with non-private insurance were more likely to be seen in low volume hospitals than younger patients, non-black patients, and those with private insurance, respectively. Selected comorbid conditions were also more prevalent in low volume hospitals.

Discussion

Cystectomy is the reference standard for the management of muscle-invasive bladder cancer, a potentially lethal phenotype.(1) The demanding extirpative and reconstructive requirements classify this procedure, along with pancreatectomy and esophagectomy,(3, 4) among the high-risk, complex cancer operations, for which evidence supports an inverse association between facility volume and short-term mortality.(5–11) Recent reports suggest this phenomenon may also extend to longer term survival outcomes.(20, 21) Our analysis of a large, contemporary, multicenter cohort in the United States adds to the body of literature supporting an independent inverse association between facility-level cystectomy volume and 30-day postoperative mortality, and demonstrates a similar, albeit attenuated association with 90-day mortality. This study is the first to document a statistically significant association between hospital volume and cumulative 90-day mortality after cystectomy. However, recognizing the inherent potential bias of 90-day mortality rates from shorter-term deaths, we sought to examine the independent effect of hospital volume on intermediate-term mortality beyond the 30-day window by separately examining 90-day mortality conditional on survival beyond 30 days. Conditional survival estimates have been suggested to provide a more dynamic and clinically meaningful lens through which to examine long-term survival estimates(22); however, this approach has had limited application to shorter-term outcomes. Interestingly, the rates of conditional 90-day mortality so defined were relatively high, and, while associated with hospital volume, the magnitude of this association was somewhat less than that observed for the 30-day outcome. Though cystectomy has been associated with benefits in longer term overall survival relative to less aggressive treatments,(2) these data underscore the potential for substantial risks of short-term mortality, even among high-volume centers, which in turn provide potential targets for quality improvement efforts.

The first notable finding of this study is the relatively high (7.2%) overall 90-day postoperative mortality following cystectomy. This is in line with results (6.7–8.2%) from several recent studies (12–14) though greater than that reported in an analysis of SEER data (3.9%).(23) The discrepant results with the latter study may be accounted for by a higher proportion of partial cystectomy and lower proportions of patients in the oldest age groups as compared to the present cohort. In support of our findings, a previous examination reporting a non-significant association between hospital volume and 90-day cumulative mortality in a single U.S. state(14) reported similar unadjusted rates by high-, medium- and low-volume hospitals (5.4, 6.9, and 8.4%, respectively). In this context, it is noteworthy that approximately 51% of procedures in our nationally representative sample took place in low volume hospitals, representing approximately 91% of the facilities. Our findings underscore relatively high early-term mortality risks, particularly in certain subgroups of patients, including those receiving care at low volume centers. These data support further study of patient-level factors associated with short-term risks (24) of the different treatment options to enhance the informed consent process and shared decision making. The observation of poorer access to high volume hospitals and 90-day survival among low income patients, blacks, and the elderly raises concerns regarding racial and socioeconomic disparities in outcome consistent with previous findings (25) which warrant further study.

Our findings of substantial conditional 90 day mortality, even among the relatively higher hospital volume strata, underscore the need to elucidate the root causes of postoperative mortality in this time frame to inform the development of strategies to optimize outcomes. The concept of “failure to rescue” (i.e., case fatality among patients with complications) (26) has recently re-emerged as a stronger mediator of differences between low- and high-30-day-mortality hospitals as compared to differences in the absolute incidence of complications, which are in general comparatively small.(27) The relevance of this concept to cystectomy is supported by a study with similar findings for esophagectomy and pancreatectomy.(28) A more recent study examined this concept in the specific context of cystectomy, finding reduced odds of failure to rescue among higher volume hospitals.(29) Delayed complications are common after cystectomy, with one high volume center reporting 54% of patients experiencing grade 2–5 complications, 57% of which occurred between discharge and 90 days.(30) The high number of 30–90 day deaths in our data, even among high volume hospitals, warrants further investigation for potentially actionable targets for quality improvement.

An important overarching question relates to the mechanisms underlying the observed association between hospital volume and short-term mortality outcomes. Prior cystectomy studies demonstrated differences in hospital staffing and capacity,(31) including more intensive nurse staffing in particular,(9, 32) and utilization of specific processes of care (11) to be mediators of the volume effect with respect to 30-day mortality. These data are not currently available in the NCDB; however, future work in other datasets should examine the effects of these variables on 90-day mortality. Additional factors including coordination of care, access and/or distance to the treating facility and the management of late postoperative complications may be important possible mediators of 90-day mortality worthy of future study.

Although the volume-outcome phenomenon has been previously described for cystectomy, this has not been a target for volume-based referral by the Leapfrog Group or other policymakers, as have pancreatectomy and esophagectomy. Bladder cancer care has, however, been designated among Blue Cross’ Blue Distinction Centers’ “rare and complex cancers” initiative, distinguishing approximately 90 centers in the US on the basis of multidisciplinary management and minimum volume thresholds (11 cases per year for cystectomy).(33) Our threshold for low-volume hospitals is consistent with this policy. Additionally, our finding of the extension of the volume-outcome association to 90 days adds additional support to efforts assisting consumers in identifying higher volume centers. That said, the relatively wider variation in 30-day outcomes between hospital volume strata suggests that this earlier time point may represent a more meaningful and feasible target for performance feedback. Despite the lack of formal regulatory or legislative mandates, regionalization and concentration of cystectomy procedures to high volume centers is already underway.(4, 6, 34) Our results are consistent with this, with the proportion of cases occurring in very low volume (<5 cases per year) hospitals declining from 42% to 33% over the study period as well as the fact that 27/1178 hospitals accounted for over 20% of the procedures.

This study has several notable strengths. The NCDB provides a large sample with strong generalizability to the US population.(15) In contrast to prior literature describing volume-outcome relationships to in-hospital or 30-day postoperative mortality(3, 5–8, 10, 13), this dataset allowed us to ascertain 90-day mortality, which may more meaningfully capture the intermediate-term risks. This study also has several important limitations. The NCDB does not collect individual surgeon data so we are unable to draw inferences with regard to surgeon volume and the primary outcome—the importance of which, independent of facility volume, is somewhat unclear.(8, 20, 21, 35) ICD-9 coding for comorbidities provides no detail on illness severity, and we have no data on other nutritional and functional status variables that may contribute to short-term survival.(24) We do not have information on cause of death, limiting our ability to make inferences regarding the observed poorer 30- and 90-day survival among patients with advanced stage disease; while this may represent rapid disease progression, we believe this more likely reflects the complexity of surgery and potentially associated higher short-term risks in these cases. While improved 90-day survival among patients who received neoadjuvant chemotherapy, an underutilized (36) adjunct to cystectomy, obviously reflects selection bias, these findings may nevertheless assuage concerns regarding the potential for poorer short-term outcomes with chemotherapy.

Conclusions

Hospital volume is inversely associated with 90-day mortality after cystectomy; however this association is largely driven by variation in shorter-term outcomes. The results of this study point to the need for further study of potentially actionable root causes of mortality in the window from 30 to 90 days postoperative, where mortality rates are relatively high across hospital volume strata.

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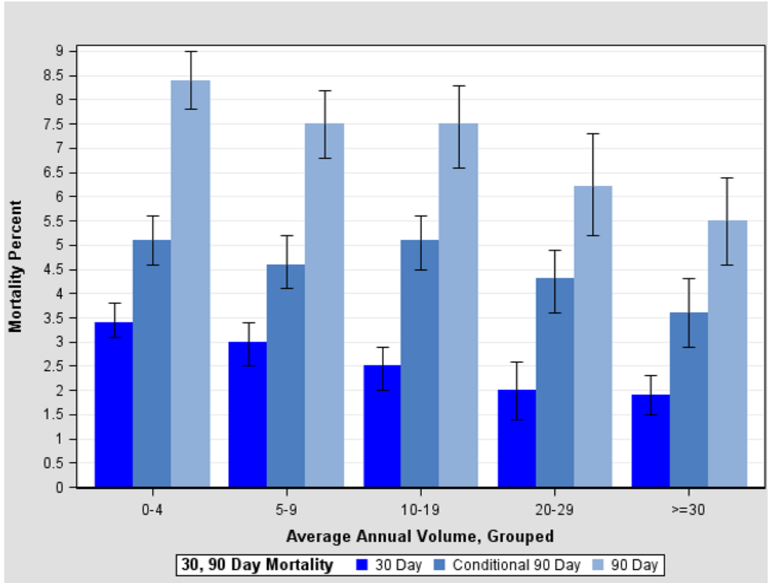

Figure 1.
Cystectomies, 2004–2008: Unadjusted 30- and 90-Day Mortality, by Average Annual Hospital Volume

Table 1

Radical Cystectomies, Patient Characteristics, 2004–2011 Patient Characteristics (N=35,055)

	Average Annual Hospital Volume, %			Patient Distributions % (n)
	0–9 (N=17,761)	**10–19 (N=5,965)**	**≥20 (N=11,329)**	**Total (N=35,055)**
Age				
18–49	4.9	5.9	6.6	5.6 (1,965)
50–59	16.3	17.7	18.1	17.1 (5,993)
60–69	30.5	30.5	32.0	31.0 (10,868)
70–79	34.4	32.8	32.1	33.4 (11,703)
>=80	13.9	13.1	11.3	12.9 (4,526)
Sex				
Male	75.0	75.0	76.0	75.3 (26,409)
Female	25.0	25.0	24.0	24.9 (8,646)
Race				
White	90.3	89.4	91.5	90.5 (31,728)
Black	7.0	5.6	4.6	6.0 (2,108)
Other	2.7	5.0	3.9	3.5 (1,219)
Diagnosis Years				
2004–2007	49.2	46.3	44.8	47.3 (16,574)
2008–2011	50.8	53.6	55.2	52.7 (18,481)
Insurance				
None, Medicaid	5.2	4.8	4.5	4.9 (1,730)
Private, Self Pay	30.7	37.4	36.7	33.8 (11,836)
Medicare	57.0	55.5	55.8	56.4 (19,755)
Other, Unknown	7.1	2.2	3.0	4.9 (1,339)
Median Income Quintiles[2]				
< $28,000	9.1	8.0	6.7	8.1 (2,684)
$28–32,000	14.0	12.7	15.4	14.2 (4,696)
$33–38,000	19.5	18.3	20.4	19.6 (6,475)
$39–48,000	26.5	23.5	24.1	25.2 (8,322)
>=$49,000	31.0	37.4	33.4	32.8 (10,841)
Census Region[3]				
New England	6.5	9.1	3.0	5.8 (2,043)
Middle Atlantic	11.7	19.0	18.1	15.0 (5,261)
South Atlantic	16.4	19.0	21.0	18.3 (6,428)
East North Central	21.6	15.0	22.7	20.8 (7,300)
East South Central	7.9	7.5	7.2	7.6 (2,665)
West North Central	10.0	4.8	9.1	8.8 (3,092)
West South Central	8.6	9.0	2.6	6.7 (2,352)

	Average Annual Hospital Volume, %			Patient Distributions % (n)
	0–9 (N=17,761)	**10–19 (N=5,965)**	**≥20 (N=11,329)**	**Total (N=35,055)**
Mountain	5.7	2.2	4.6	4.8 (1,675)
Pacific	11.4	14.2	11.2	11.8 (4,142)
Out of U.S.	0.2	0.1	0.5	0.3 (97)
Stage				
0–II	46.2	45.8	47.7	46.6 (16,352)
III, T4bN0M0/AnyTN+M0	53.8	54.2	52.3	53.4 (18,703)
Grade				
Well or moderately Differentiated	9.1	7.2	6.1	7.8 (2,735)
Poorly differentiated or Undifferentiated	83.5	84.1	86.7	84.6 (29,673)
Unknown	7.4	8.7	7.1	7.6 (2,647)
Cancer Sequence				
First Primary or Only primary	81.2	80.0	77.4	79.8 (27,970)
Other prior primary cancer	18.8	20.0	22.6	20.2 (7,085)
Neo-adjuvant chemotherapy				
No	88.5	84.8	79.3	84.9 (29,753
Yes	11.5	15.2	20.7	15.1 (5,302)

[1]Cases with valid 30 day mortality.

[2]Based on zip code level Income from 2000 Census. Excludes 2,037 cases with missing income.

[3]Patient residence. Census region states include: New England: (ME,VT,NH, MA, CT,RI); Middle Atlantic (NY, PA, NJ); South Atlantic (WV,MD,DE,DC,VA,NC,SC,GA,FL); East North Central (WI,IL,MI,IN,OH); East South Central (KY,TN,MS,AL); West North Central (ND,SD,NE,KS,MN,IA,MO); West South Central (OK,AR,LA,TX); Mountain (MT,ID,WY,NV,UT,CO,AZ,NM); Pacific (WA,OR,CA,HI).

Table 2

Unadjusted 30, 90 Day mortality Rates by selected demographic, hospital and clinical characteristics, and significant comorbid conditions

	30-Day Mortality (N=35,055)		90-Day Conditional Mortality[1] (N=33,250)	
	Mortality (%), 95% Confidence Intervals	**Number of Deaths/ N**	**Mortality (%), 95% Confidence Intervals**	**Number of Deaths/ N**
All Cases	2.7 (2.5–2.9)	936/35,055	4.6 (4.3–4.8)	1,519/33,250
Average Annual Volume[2,3]				
0–9	3.2 (3.0–3.5)	574/17,761	4.9 (4.6–5.3)	828/16,883
10–19	2.5 (2.0–2.9)	147/5,965	5.1 (4.5–5.6)	287/5,678
>=20	1.9 (1.6–2.2)	215/11,329	3.8 (3.3–4.3)	404/10,689
Diagnosis Years[3]				
2004–2007	2.7 (2.4–2.9)	444/16,574	4.8 (4.4–5.2)	771/16,031
2008–2011	2.7 (2.4–2.9)	492/18,481	4.3 (4.0–4.7)	748/17,219
Hospital Category[2,3]				
Community	3.4 (2.4–4.4)	57/1,674	5.2 (4.0–6.4)	83/1,601
Comprehensive Community	3.3 (3.0–3.6)	354/10,752	5.1 (4.6–5.5)	519/10,212
Academic	2.3 (2.0–2.6)	456/19,837	4.3 (3.9–4.7)	805/18,778
Other	2.5 (1.9–3.1)	69/2,792	4.2 (3.4–5.1)	112/2,659
Age[2,3]				
18–49	1.0 (0.6–1.5)	20/1,965	2.8 (2.1–3.5)	53/1,885
50–59	1.1 (0.8–1.3)	63/5,993	2.0 (1.6–2.4)	116/5,783
60–69	1.8 (1.5–2.0)	192/10,868	3.1 (2.7–3.5)	322/10,413
70–79	3.3 (2.9–3.6)	383/11,703	5.7 (5.2–6.2)	628/11,036
>=80	6.1 (5.4–6.9)	278/4,526	9.7 (8.8–10.6)	400/4,133
Sex[3]				
Male	2.7 (2.4–2.9)	702/26,409	4.3 (4.0–4.6)	1,079/25,031
Female	2.7 (2.3–3.1)	234/8,646	5.4 (4.8–6.0)	440/8,219
Race[2,3]				
White	2.6 (2.4–3.9)	840/31,728	4.6 (4.3–4.8)	1,374/30,133
Black	3.4 (2.6–4.2)	72/2,108	5.5 (4.4–6.6)	108/1,968
Other	2.0 (1.2–2.7)	24/1,219	3.2 (2.2–4.3)	37/1,149
Insurance[2,3]				
None/Medicaid	1.7 (1.1–2.3)	29/1,730	4.8 (3.7–5.9)	79/1,635
Private	1.3 (1.1–1.5)	154/11,836	2.8 (2.5–3.1)	317/11,381
Medicare	3.6 (3.3–3.9)	710/19,755	5.6 (5.3–6.0)	1,050/18,589
Other, Unknown	2.5 (1.8–3.2)	43/1,734	4.4 (3.3–5.6)	73/1,645
Median Income Quintiles[2,3,4]				
< $28,000 (Lowest Quintle)	3.6 (2.8–4.4)	96/2,684	5.4 (4.5–6.3)	136/2,517

	30-Day Mortality (N=35,055)		90-Day Conditional Mortality[1] (N=33,250)	
	Mortality (%), 95% Confidence Intervals	Number of Deaths/ N	Mortality (%), 95% Confidence Intervals	Number of Deaths/ N
>=$28,000	2.6 (2.4–2.8)	840/32,371	4.5 (4.2–4.8)	1,383/30,733
Census Region[5]				
New England	2.5 (1.8–3.2)	51/2,043	4.6 (3.7–5.6)	91/1,962
Middle Atlantic	2.5 (2.1–3.0)	133/5,261	4.7 (3.8–5.6)	234/4,985
South Atlantic	2.6 (2.1–3.1)	166/6,428	4.9 (4.3–5.5)	297/6,068
East North Central	3.3 (2.7–3.9)	240/7,300	4.2 (3.7–4.8)	291/6,894
East South Central	3.0 (2.4–3.6)	80/2,665	5.4 (4.6–6.2)	137/2,530
West North Central	2.4 (1.8–3.1)	75/3,092	4.1 (3.1–5.0)	120/2,951
West South Central	2.6 (1.8–3.4)	62/2,352	4.7 (3.7–5.7)	105/2,232
Mountain	2.5 (1.5–3.5)	42/1,675	4.3 (3.1–5.4)	68/1,592
Pacific	2.1 (1.7–2.5)	87/4,142	4.4 (3.6–5.2)	174/3,959
Stage[2,3]				
0–II	2.1 (1.8–2.3)	337/16,352	2.2 (2.0–2.5)	349/15,515
III,T4bN0M0/N+M0	3.2 (2.9–3.5)	599/18,703	6.6 (6.2–7.0)	1,170/17,735
Grade				
Well or moderately differentiated	2.5 (1.9–3.1)	69/2,735	3.8 (3.0–4.6)	100/2,618
Poorly differentiated or undifferentiated	2.7 (2.5–2.9)	805/29,673	4.7 (4.4–5.0)	1,320/28,140
Unknown	2.3 (1.8–2.9)	62/2,647	4.0 (3.1–4.8)	99/2,492
Prior Cancers[2,3]				
None	2.5 (2.3–2.7)	693/27,970	4.3 (4.0–4.6)	1,133/26,595
One or more	3.4 (3.0–3.9)	243/7,085	5.8 (5.2–6.4)	386/6,655
Cystectomy Type[3]				
Total	3.5 (2.5–4.6)	48/1,356	4.0 (2.8–5.1)	51/1,285
With reconstruction	2.6 (2.4–2.9)	698/26,384	4.4 (4.1–4.6)	1,094/25,075
With Pelvic exenteration	2.6 (2.2–3.0)	190/7,315	5.4 (4.8–6.1)	374/6,890
Neo-adjuvant Chemo[2,3]				
Yes	1.6 (1.2–2.0)	85/5,302	3.1 (2.6–3.7)	155/4,975
No	2.9 (2.6–3.1)	851/29,753	4.8 (4.5–5.1)	1,364/28,275
Elixhauser Comorbid conditions				
Congestive Heart Failure[2,3]				
No	2.5 (2.3–2.7)	861/34,071	4.4 (4.1–4.7)	1,417/32,351
Yes	7.6 (5.9–9.4)	75/984	11.3 (9.3–13.4)	102/899
Cardiac Arrythmias[2,3]				
No	2.5 (2.3–2.7)	805/32,288	4.3 (4.0–4.6)	1,324/30,685
Yes	4.7 (3.9–5.6)	131/2,767	7.6 (6.5–8.8)	195/2,565
Vascular Disease[2]				

	30-Day Mortality (N=35,055)		90-Day Conditional Mortality[1] (N=33,250)	
	Mortality (%), 95% Confidence Intervals	Number of Deaths/ N	Mortality (%), 95% Confidence Intervals	Number of Deaths/ N
No	2.7 (2.4–2.9)	928/34,938	4.6 (4.3–4.8)	1,512/33,148
Yes	6.8 (2.3–11.3)	8/117	6.9 (1.9–11.8)	7/102
Peripheral Vascular Disease[3]				
No	2.6 (2.4–2.9)	896/33,893	4.5 (4.2–4.8)	1,452/32,151
Yes	3.4 (2.3–4.6)	40/1,162	6.1 (4.7–7.5)	67/1,099
Hypertension[3]				
No	2.8 (2.6–3.1)	618/21,855	4.8 (4.5–5.1)	998/20,715
Yes	2.4 (2.1–2.7)	318/13,200	4.2 (3.7–4.6)	521/12,535
Other Neurologic Disorders[2,3]				
No	2.6 (2.4–2.8)	900/34,593	4.5 (4.2–4.8)	1,484/32,844
Yes	7.8 (5.3–10.2)	36/462	8.6 (5.8–11.4)	35/406
Chronic Pulmonary Disease[2,3]				
No	2.5 (2.3–2.7)	762/30,463	4.4 (4.1–4.7)	1,286/28,935
Yes	3.8 (3.2–4.3)	174/4,592	5.4 (4.8–6.0)	233/4,315
Diabetes, Uncomplicated[2,3]				
No	2.6 (2.4–2.8)	791/30,466	4.4 (4.1–5.7)	1,282/28,914
Yes	3.2 (2.7–3.6)	145/4,444	5.5 (4.8–6.1)	237/4,336
Diabetes, Complicated[2]				
No	2.6 (2.4–2.9)	920/34,746	4.6 (4.3–4.9)	1,507/32,694
Yes	5.2 (2.9–7.5)	16/309	4.2 (2.0–6.4)	12/286
Renal Failure[2,3]				
No	2.6 (2.4–2.8)	906/34,657	4.5 (4.2–4.8)	1,480/32,889
Yes	7.5 (4.9–10.1)	30/398	10.8 (7.6–14.0)	39/361
Liver Disease[2]				
No	2.7 (2.4–2.9)	926/34,870	4.6 (4.3–4.8)	1,508/33,079
Yes	5.4 (2.3–8.5)	10/185	6.4 (2.6–10.2)	11/171
Coagulopathy[2,3]				
No	2.6 (2.4–2.8)	905/34,566	4.5 (4.2–4.8)	1,485/32,808
Yes	6.3 (4.1–8.6)	31/489	7.7 (5.2–10.2)	34/442
Obesity[3]				
No	2.7 (2.5–2.9)	919/34,128	4.6 (4.3–4.9)	1,495/32,372
Yes	1.8 (0.9–2.7)	17/927	2.7 (1.8–3.7)	24/878
Weight Loss[2,3]				
No	2.6 (2.4–2.8)	884/34,086	4.7 (4.1–4.6)	1,415/32,357
Yes	5.4 (3.9–6.9)	52/964	11.6 (9.7–13.6)	104/893
Fluid, Electrolyte Disorders[2,3]				

	30-Day Mortality (N=35,055)		90-Day Conditional Mortality[1] (N=33,250)	
	Mortality (%), 95% Confidence Intervals	**Number of Deaths/ N**	**Mortality (%), 95% Confidence Intervals**	**Number of Deaths/ N**
No	2.5 (2.3–2.7)	792/31,978	4.3 (4.1–4.6)	1,315/30,380
Yes	4.7 (3.9–5.5)	144/3,077	7.1 (6.2–8.0)	204/2,870
Blood Loss Anemias[2]				
No	2.6 (2.4–2.9)	916/34,578	4.6 (4.3–4.8)	1,498/32,800
Yes	4.2 (2.4–6.0)	20/477	4.7 (2.8–6.5)	21/450
Psychoses[3]				
No	2.7 (2.5–2.9)	931/34,740	4.5 (4.3–4.8)	1,497/32,945
Yes	1.6 (0.2–3.0)	5/315	7.2 (4.1–10.3)	22/305

[1]90-day mortality excludes deaths within first 30 days.

[2]$p < =.05$, 30-day mortality

[3]$p < =.05$, 90-day mortality.

[4]Based on 2000 Census data income of patient zip code. 2,037 cases with missing income classifed included in top quartile group.

[5]Excludes 97 cases living outside the U.S. Census region states include: New England: (ME,VT,NH, MA, CT,RI); Middle Atlantic (NY, PA, NJ); South Atlantic (WV,MD,DE,DC,VA,NC,SC,GA,FL); East North Central (WI,IL,MI,IN,OH); East South Central (KY,TN,MS,AL); West North Central (ND,SD,NE,KS,MN,IA,MO); West South Central (OK,AR,LA,TX); Mountain (MT,ID,WY,NV,UT,CO,AZ,NM); Pacific (WA,OR,CA,HI).

Table 3

Adjusted Odds Ratios[1] for 30- and 90-Day Mortality

	30-day Mortality[2]	90-day Conditional Mortality[3]
	Odds Ratio, 95% Confidence Limits	**Odds Ratio, 95% Confidence Limits**
Hospital Average Annual Volume		
>= 20	1.0 (Reference)	1.0 (Reference)
10–19	1.2 (1.0–1.6)	1.3 (1.1–1.5)
0–9	1.5 (1.3–1.9)	1.2 (1.0–1.4)
Elixhauser Group		
Congestive Heart Failure	1.8 (1.4–2.3)	1.7 (1.4–2.1)
Cardiac Arrhythmias	1.3 (1.1–1.6)	1.3 (1.1–1.6)
Hypertension	0.7 (0.6–0.9)	0.8 (0.7–0.9)
Other Neurologic Disorders	2.5 (1.8–3.6)	1.6 (1.1–2.3)
Chronic Pulmonary Disease[5]	1.3 (1.1–1.6)	1.1 (0.9–1.3)
Diabetes, Uncomplicated[4]	1.2 (1.0–1.4)	1.2 (1.1–1.4)
Renal Failure	1.8 (1.2–2.7)	1.7 (1.2–2.4)
Liver Disease[5]	3.0 (1.6–5.9)	1.8 (1.0–3.5)
Coagulopathy[5]	1.8 (1.2–2.7)	1.3 (0.9–1.9)
Weight Loss	1.4 (1.0–1.9)	2.1 (1.7–2.7)
Fluid and Electrolyte Disorders	1.4 (1.1–1.7)	1.2 (1.0–1.4)
Age Group		
18–49 (Reference)	1.0 (Reference)	1.0 (Reference)
50–59	1.0 (0.6–1.7)	0.8 (0.6–1.1)
60–69	1.5 (0.9–2.4)	1.2 (0.9–1.6)
70–79	2.3 (1.4–3.8)	2.1 (1.5–2.8)
>=80	4.1 (2.6–6.7)	3.4 (2.4–4.7)
Race		
White	1.0 (Reference)	1.0 (Reference)
Black	1.4 (1.1–1.8)	1.2 (1.0–1.5)
Other/Unknown	0.9 (0.6–1.3)	0.7 (0.5–1.0)
Median Income[5]		
>=$28,000	1.0 (Reference)	1.0 (Reference)
<$28,000	1.3 (1.0–1.6)	1.1 (0.9–1.4)
Insurance		
Private	1.0 (Reference)	1.0 (Reference)
None, Medicaid	1.2 (0.8–1.8)	1.7 (1.3–2.2)
Medicare	1.5 (1.2–1.9)	1.1 (0.9–1.3)
Other, Unknown	1.5 (1.0–2.1)	1.3 (1.0–1.7)

	30-day Mortality[2]	**90-day Conditional Mortality[3]**
	Odds Ratio, 95% Confidence Limits	**Odds Ratio, 95% Confidence Limits**
Stage[1]		
0–II	1.0 (Reference)	1.0 (Reference)
III,T4bN0M0/N+M0	1.4 (1.2–1.6)	2.8 (2.5–3.2)
Prior Cancers[4]		
None	1.0 (Reference)	1.0 (Reference)
One or more	1.1 (1.0–1.3)	1.1 (1.0–1.3)
Neoadjuvant Chemotherapy[5]		
Yes	1.0 (Reference)	1.0 (Reference)
No	1.3 (1.0–1.6)	1.1 (0.9–1.3)
Diagnosis Years[4]		
2008–2011	1.0 (Reference)	1.0 (Reference)
2004–2007	1.0 (0.9–1.1)	1.1 (1.0–1.3)

[1]Variables significant at p <= .05, unless otherwise indicated. Non-significant variables also included in the model: sex, tumor grade.

[2]N=35, 055, 936 deaths

[3]Conditional on having survived through 30 days; N=33,250, 1,519 Deaths, excludes 936 cases who died within 30 days,

[4]Not significant 30 day mortality (p> .05).

[5]Not significant 90 day conditional mortality (p>.05).

[6]Based on 2000 Census data income of patient zip code. 2,037 cases with missing income classifed included in top quartile groups.

Table 4

Variables[1] Associated with having cystectomy in a low volume[2] compared to intermediate and high volume hospitals

	Odds Ratio (95% Confidence Interval)[3]
Age Group	
18–49	1.00 (Reference)
50–59	1.2 (1.1–1.4)
60–69	1.3 (1.2–1.5)
70–79	1.5 (1.3–1.6)
>=80	1.6 (1.4–1.8)
Race	
White	1.0 (Reference)
Black	1.3 (1.2–1.5)
Other/UK	0.6 (0.5–0.7)
Insurance	
Private	1.00 (Reference)
None, Medicaid	1.3 (1.2–1.5)
Medicare	1.0 (1.0–1.1)
Other, Unknown	3.0 (2.7–3.4)
Neoadjuvant Chemotherapy	
No	1.0 (Reference)
Yes	0.6 (0.5–0.6)
Cancer Sequence	
First Primary or Only Primary	
Other Primary Prior Cancer	0.8 (0.7–0.8)
Grade	
Low	1.0 (Reference)
High	0.7 (0.7–0.8)
Missing	0.7 (0.7–0.8)
Elixhauser Comorbid Conditions[4]	
Congestive Heart Failure	1.3 (1.1–1.4)
Cardiac Arrthymias	0.9 (0.8–0.9)
Chronic Pulmonary Disease	1.2 (1.2–1.3)
Diabetes, Uncomplicated	1.1 (1.0–1.2)
Renal Failure	1.4 (1.1–1.7)
Obesity	0.9 (0.8–1.0)
Fluid, Electrolyte Disorders	1.2 (1.1–1.3)
Blood Loss Anemia	2.1 (1.7–2.5)
Deficiency Anemias	1.5 (1.4–1.7)

	Odds Ratio (95% Confidence Interval)[3]
Alcohol Abuse	1.3 (1.1–1.6)
Depression	0.9(0.8–1.0)

[1]Variables significant at $p < .05$ in a stepwise logistic regression model.

[2]Low volume defined as less than 10 cystectomies per year.

[3]N=35,055;17,761 cases in low volume hospitals.

[4]Condition present compared to absence of condition.