Published in final edited form as:
Cancer. 2010 January 15; 116(2): 331–339. doi:10.1002/cncr.24763.

Urinary Diversion and Morbidity After Radical Cystectomy for Bladder Cancer

John L. Gore, MD[1,2], **Hua-Yin Yu, MD**[3], **Claude Setodji, PhD**[4], **Jan M. Hanley, MS**[4], **Mark S. Litwin, MD, MPH**[3,4,5,6], **Christopher S. Saigal, MD, MPH**[3,4,5], and **the Urologic Diseases in America Project**

[1] Department of Urology, University of Washington School of Medicine, Seattle, Washington

[2] Robert Wood Johnson Clinical Scholars Program, David Geffen School of Medicine at University of California at Los Angeles, Los Angeles, California

[3] Department of Urology, David Geffen School of Medicine at University of California at Los Angeles, Los Angeles, California

[4] RAND Corporation, Santa Monica, California

[5] Jonsson Comprehensive Cancer Center, David Geffen School of Medicine at University of California at Los Angeles, Los Angeles, California

[6] Department of Health Services, University of California at Los Angeles School of Public Health, Los Angeles, California

Abstract

BACKGROUND—The rate of continent urinary diversion after radical cystectomy for bladder cancer varies by patient and provider characteristics. Demonstration of equivalent complication rates, independent of diversion type, may decrease provider reluctance to perform continent reconstructions. The authors sought to determine whether continent reconstructions confer increased complication rates after radical cystectomy.

METHODS—From the Nationwide Inpatient Sample, the authors used International Classification of Disease (ICD-9) codes to identify subjects who underwent radical cystectomy for bladder cancer during 2001–2005. They determined acute postoperative medical and surgical complications from ICD-9 codes and compared complication rates by reconstruction type using the nearest neighbor propensity score matching method and multivariate logistic regression models.

RESULTS—Adjusting for case-mix differences between reconstructive groups, continent diversions conferred a lower risk of medical, surgical, and disposition-related complications that was statistically significant for bowel (3.1% lower risk; 95% confidence interval [95% CI], −6.8% to −0.1%), urinary (1.2% lower risk; 95% CI, −2.3%, to −0.4%), and other surgical complications (3.0% lower risk; 95% CI, −6.2% to −0.4%), and discharge other than home (8.2% lower risk; 95% CI, −12.1% to −4.6%) compared with ileal conduit subjects. Older age and certain comorbid

Corresponding author: John L. Gore, MD, University of Washington School of Medicine, 1959 NE Pacific, Box 356510, Seattle, WA 98195; Fax: (206) 543–3272; jlgore@u.washington.edu.

Portions of this research study were presented at the American Urological Association Annual Meeting, Orlando, Florida, May 17–22, 2008.

CONFLICT OF INTEREST DISCLOSURES

Supported by National Institute of Diabetes and Digestive and Kidney Diseases grant N01-DK-7-0003.

conditions, including congestive heart failure and preoperative weight loss, were associated with significantly increased odds of postoperative medical and surgical complications in all subjects.

CONCLUSIONS—Mode of urinary diversion after radical cystectomy for bladder cancer is not associated with increased risk of immediate postoperative complications. These results may encourage broader consideration of continent urinary diversion without concern for increased complication rates.

Keywords

bladder cancer; radical cystectomy; morbidity; urinary diversion

Removal of the bladder for bladder cancer, or radical cystectomy, is a complex, potentially morbid procedure. Unlike most cancer-directed surgeries, the extirpation is followed by a reconstruction. Historically, the overwhelming majority of patients received an ileal conduit, in which a tube of ileum connects the urine draining from the kidneys to a cutaneous stoma, and the urine collects in an external bag. Over the last 2 decades, techniques designed to improve the quality of life of patients after radical cystectomy have obviated the need for external appliances. These continent urinary tract reconstructions involve creation of a spherical neobladder from bowel that is connected either to the urethra to replicate volitional voiding, or to a small skin opening that requires intermittent catheterization to empty the reservoir. Advantages of the ileal conduit include a shorter operative time and relative ease of the surgical technique. Advantages of the neobladder include continence and preserved body image.

Despite the presumed benefits inherent in a continent urinary diversion, analysis of nationally representative data reveals significant disparities in the utilization of continent reconstructions.[1,2] Among patients who underwent radical cystectomy for bladder cancer between 1992 and 2001, <20% received a continent diversion. Most pronounced was the effect of provider on diversion type: those undergoing surgery at high-volume or teaching hospitals had 50% higher odds of continent reconstruction than those treated elsewhere.

From these data, we presumed that provider reluctance to perform continent diversions may relate to a perceived increase in morbidity and mortality outcomes secondary to the increased complexity and magnitude of these operations. Confronting this perception may decrease provider reluctance to advocate for continent diversions when counseling bladder cancer patients about reconstructive options. Herein, we sought to determine whether continent urinary diversion is associated with an increased risk of medical or surgical postoperative complications after radical cystectomy.

MATERIALS AND METHODS

Identification of Study Subjects

Subjects were identified from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample, a stratified random sample of US hospitals sponsored by the Agency for Healthcare Research and Quality. The most recent iteration of the Nationwide Inpatient Sample captures >8 million patient discharges annually and generalizes to the US population.

We examined Nationwide Inpatient Sample data for admissions from 2001 to 2005. We identified study subjects with a primary diagnosis of bladder cancer who underwent radical cystectomy as the primary admission procedure (International Classification of Diseases, ninth revision [ICD-9] code 57.71) for whom codes representative of the type of urinary diversion performed were available (84% of radical cystectomy subjects). We classified the

type of reconstruction as continent (orthotopic neo-bladder or continent cutaneous reservoir, ICD-9 code 57.87) or incontinent (ileal urinary conduit, ICD-9 code 56.51) based on secondary procedure codes for the index admission.

Covariates

We examined patient and provider variables thought to correlate with the risk of postoperative adverse events. Patient-level variables examined included age, sex, race/ethnicity, income, primary payer, comorbid conditions, and the type of urinary diversion. With so few subjects of nonwhite race/ethnicity in the sample, we dichotomized race into white and nonwhite categories. Primary payer was collapsed into fewer categories and includes subjects with private insurance, Medicare, and Medicaid or other payer coverage. We analyzed subject comorbidity with the Elixhauser method, which permits adjustment for individual comorbid conditions rather than a count of the number of comorbidities.[3]

Provider-level variables examined included hospital location and teaching status, hospital region, and hospital cystectomy volume. We categorized hospital type as rural, urban nonteaching, or urban teaching. Hospital region conformed to US Census regions. We dichotomized hospital volume according to its 90th percentile for the sample and categorized hospitals with a cystectomy volume greater than the 90th percentile (14 cases during the study period) as high-volume hospitals.

Outcomes

Medical complications were subdivided into cardiovascular, respiratory, and other medical events. We focused on acute diagnoses to eliminate confounding from diagnoses that may represent acute or chronic conditions. We consolidated the occurrence of any of the medical complication categories above into a measure of any postoperative medical complication.

Surgical complications were subdivided into bowel, urinary, wound, and other surgical events. Definition of adverse surgical events used diagnosis and procedure codes. Procedure codes specific for surgical complication categories were identified from known complications of radical cystectomy and urinary diversion and from classification of observed secondary procedure codes for the study sample. We consolidated the occurrence of any of the adverse surgical events above into a measure of any postoperative surgical complication. The complications codes used represent an expansion of ICD-9 codes used in the Complications Screening Program to reflect the adverse outcomes that may result after an operation of the magnitude of a radical cystectomy.[4] We estimated the effect of continent diversion on postoperative wound complications as determined by the Complications Screening Program and our expanded ICD-9 coding algorithm and found no difference in either the treatment effect or the significance level.

Other outcomes evaluated included subject disposition, death during the admission, and length of stay. We dichotomized disposition to compare those discharged home unassisted with all other disposition categories. Postoperative death referred to death during the index admission regardless of subject length of stay. We dichotomized length of stay according to its 90th percentile for the sample and categorized those with a length of stay greater than the 90th percentile (17 days) as having a prolonged length of stay. The Nationwide Inpatient Sample contains information on the index admission only and precludes examination of events that occur after discharge, such as readmissions and follow-up surgeries.

Statistical Methods

All statistics were performed using SAS statistical software (version 9.02; SAS Institute, Inc, Cary, NC) and Stata statistical software (version 10.0;StataCorp LP, College Station,

Tex). Data were analyzed as pooled observations, and survey weights were used according to the sampling design of the Nationwide Inpatient Sample to account for the clustering of cystectomy subjects and their outcomes within hospitals. Categoric variables were compared on bivariate analysis by diversion type using chi-square analysis. Continuous variables were compared by reconstruction modality using independent–samples Student *t* tests. Bivariate analysis of the association between patient and provider characteristics and complications outcomes determined covariates to be included in each respective multivariate complication model. Variables that were significant at an α level of .15 were included. Age and hospital type were a priori included in the multivariate models regardless of significance level on univariate analysis.

To attempt to adjust for the selection bias inherent in an analysis of outcomes stratified by diversion type, we used propensity scores methodology.[5–8] Propensity scores attempt to statistically reproduce randomized trials by balancing the characteristics of different treatment groups. The propensity to undergo continent urinary diversion was calculated from unconditional logistic regression models using patient and provider level covariates associated with continent reconstruction. We used nearest neighbor propensity score matching to determine, for each complication category, the average treatment effect on the treated.[5] For each subject who underwent continent urinary diversion, the algorithm identifies ileal conduit subjects with the closest propensity score and calculates the difference between the outcome predictions. Thus, the subjects matched and compared had nearly identical patient and provider characteristics. The algorithm then averages the difference across all matched pairs in the sample to yield the average treatment effect on the treated. We bootstrapped with 1000 repetitions to obtain 95% confidence intervals for the average treatment effect on the treated. The matching method identifies individual subjects for calculation of the average treatment effect on the treated and thus, the unweighted sample was used. Propensity score methodology has been used previously to study the effects of arthritis treatment and to compare renal and cardiovascular outcomes after partial and radical nephrectomy.[9,10]

The propensity score matching method balances the analytic sample on the covariates to compare complication risk by diversion type, but we are also interested in estimating the effect of the covariates on the postoperative outcomes. Thus, we composed additional multivariate logistic regression models to determine the impact of covariates on the odds of postoperative complications. We accounted for the clustering of subjects within hospitals to adjust the standard errors in these estimates. The weighted study sample used for our bivariate statistics and for the logistic regression models that determine covariate associations with postoperative outcomes permits correspondence of our estimates to all US discharges for a primary procedure of radical cystectomy over the study period.

RESULTS

From our weighted sample, we identified 27,494 bladder cancer subjects from the Nationwide Inpatient Sample who underwent radical cystectomy with urinary diversion between 2001 and 2005. Of those, 4539 (16.5%) underwent a continent diversion, and 22,955 (83.5%) underwent an ileal conduit. Table 1 displays the characteristics of the study sample stratified by urinary diversion. Subjects who received a continent reconstruction were younger than those who received a conduit. Continent diversion was more prevalent among males and less common among subjects with Medicare as their primary payer. A trend was observed toward increased comorbidity among recipients of incontinent diversions, which was significant for valvular disease, hypothyroidism, and obesity (Table 2).

Propensity scores for our matched unweighted sample ranged from 0.031 to 0.297 for ileal conduit subjects and from 0.059 to 0.297 for continent diversion subjects. Within propensity score quartiles, subject demographic and clinical characteristics and hospital type were similar between reconstruction groups (Table 3). Examination of the propensity score quartiles allowed us to verify that the treatment groups were balanced. Quartile 1 contains subjects with the lowest likelihood of continent diversion; quartile 4 contains those with the highest likelihood. The highest propensity score quartile contained 1601 (23.3%) continent diversion subjects and 5272 (76.7%) ileal conduit subjects; the lowest quartile contained 818 (11.9%) continent diversion subjects and 7802 (88.1%) ileal conduit subjects.

Table 4 displays the unadjusted risk differences and average treatment effect on the treated from propensity score matching of the postoperative complications categories analyzed. From the unadjusted analyses, ileal conduit subjects had a similar risk of adverse events as continent diversion subjects for most complications categories. Ileal conduit subjects were more likely to have a medical or surgical complication and were 10% less likely to be discharged home after surgery.

The propensity score algorithm using the un-weighted sample matched all 921 continent diversion subjects with 3646 to 3653 ileal conduit subjects. Univariate differences in complication risk were rendered nonsignificant for the medical complications analyzed. For all medical complications, continent diversion subjects averaged a 2.8% lower risk of an adverse event than ileal conduit subjects. Recipients of continent reconstructions had a lower risk of adverse surgical outcomes overall and in all categories of surgical complications with the exception of wound complications, in which no difference was noted ($P = .98$). The effect ranged from a 1.2% lower risk of urinary complications ($P = .01$) to a 3% reduced risk of bowel and other surgical complications ($P = .04$ for both). Overall, continent diversion subjects had a 5.0% reduced risk of any surgical complication compared with recipients of ileal conduits ($P = .01$). Length of stay and death during the hospitalization did not vary by reconstructive modality. Disposition, however, yielded the largest treatment effect of any complication category analyzed. Continent diversion subjects were 8.2% more likely to be discharged home unassisted ($P < .001$).

Table 5 displays the results of weighted multivariate logistic regression models of factors associated with postoperative complications. Among all subjects, older age was associated with increased odds of cardiovascular complications, any medical event, and alternative disposition. Subjects treated at urban nonteaching hospitals had higher odds of urinary complications and any surgical event than subjects treated at urban teaching hospitals; those treated at high-volume hospitals had lower odds of postoperative death than their lower-volume counterparts.

Individual comorbid conditions were commonly associated with increased odds of postoperative medical, surgical, and disposition complications. Subject congestive heart failure increased the odds of all medical and disposition complications categories as well as increasing odds of any surgical event, with >4-fold increased odds of cardiovascular events and postoperative death. Comorbid chronic pulmonary disease significantly increased the odds of postoperative cardiovascular and respiratory events, wound complications, alternate discharge disposition including postoperative death, and the consolidated measure of any medical complication. Preoperative weight loss increased the odds of adverse medical and surgical events, with >4-fold increased odds of bowel complications and any medical or surgical complication.

DISCUSSION

We demonstrated that continent diversion does not increase complication risk after radical cystectomy for bladder cancer. Given the higher preponderance of comorbid conditions among ileal conduit subjects, the finding of increased medical complications among these subjects on unadjusted analyses is not surprising. Accounting for case-mix differences with propensity scores techniques, these differences persisted, albeit with a smaller effect size.

Despite increased technical complexity and incorporation of a larger bowel segment into continent urinary tract reconstructions, the rate of surgical complications was not higher among these subjects. The lower risk of medical and surgical complications likely produced the differential disposition outcomes seen for continent diversion subjects. Those reconstructed with a continent diversion had an 8% lower risk of discharge to a subacute facility. At least 1 postoperative complication was shown to increase admission charges by $15,000 and length of stay by 4 additional days.[11] Complications may increase the likelihood of postoperative disability requiring nursing care and thus, alternate disposition.

Retrospective series from high-volume academic centers corroborate our results.[12–14] Compared with these series from high-volume tertiary referral centers, our analysis attempts to minimize selection bias and examines complications outcomes broadly through inclusion of small practices that may perform few cystectomies. Tertiary referral centers likely have dedicated surgeons, nursing care, and ancillary support to facilitate efficient delivery of care for recipients of orthotopic or cutaneous neobladders. Our results offer more generalizable estimates of complications after cystectomy and urinary diversion.

Among covariates, age and comorbidity were associated with postoperative medical and surgical complications. Older patients had a higher risk of cardiovascular events and any medical complication, as well as increased odds of discharge to a subacute facility. Age confers a stepwise increase in postoperative cardiovascular events regardless of the surgery performed.[15] Age also correlates with functional status, known to correlate with occurrence of any postoperative complication and a risk factor for postoperative disability.[16] Yet age alone should not affect the consideration of radical cystectomy, as elderly patients derive a survival benefit from extirpative treatment compared with those managed conservatively.[17] Rather, advanced age mandates more diligent attention to preoperative medical optimization.

Similarly, certain comorbid conditions were associated with dramatically increased odds of postoperative medical and surgical complications. A medical history of congestive heart failure immediately attunes a surgical provider to the increased risk of perioperative adverse events; however, beyond intuitive promotion of cardiovascular and respiratory events, heart failure patients suffer worse bowel and urinary outcomes and have higher odds of any surgical complication. Preoperative weight loss likewise impacts medical and surgical complications. Impaired wound healing imposed by poor nutrition likely mediates the increased surgical risk. Among cystectomy patients, preoperative serum albumin inversely correlates with risk of 1 or more postoperative complications.[16] Among a cohort of veterans, preoperative serum albumin was a more powerful correlate of postoperative events than age or comorbidity.[18] Attention to nutritional interventions among those with preoperative weight loss may improve postoperative outcomes.

Our results may decrease provider reluctance to consider continent urinary diversion when counseling patients about reconstructive options after radical cystectomy for invasive bladder cancer. Patient-related concerns regarding consideration of continent reconstruction often relate to the aggressiveness of the cancer, the presence of comorbid chronic kidney disease, their functional status and ability to perform self-catheterization, if needed, and the

overall health status of the patient and ability to withstand longer anesthetics. Provider-specific concerns relate to the increased operative time because of the technical complexity of continent diversions, the possibility of increased morbidity and mortality, and the increased nursing care in the convalescent period. Demonstration of the safety of continent urinary diversion may mitigate these surgical concerns.

Regionalization of care for complex surgical procedures has been proposed as a solution to operations with defined volume-outcome relations. For these operations, high-volume providers have lower mortality rates than low-volume providers. Cancer operations with significant mortality rate differentials include pancreatectomy and esophagectomy.[19] A similar volume-outcome relation was not identified for radical cystectomy.[20] However, the benefits of regionalization extend beyond survival benefits; patients treated by high-volume cystectomy providers are more likely to undergo continent diversions.[1] These high-volume surgeons may have a level of expertise with continent diversions such that they can offer this reconstruction solely on the basis of patient clinical characteristics. At the same time, patients may be unwilling to travel long distances to high-volume surgeons and may face longer wait times for surgery if they do. Delays in definitive extirpation >3 months have been associated with decreased bladder cancer-specific survival.[21] More feasibly, we must disseminate those processes affiliated with utilization of continent urinary diversion. Although volume and academic affiliation correlate with use of continent reconstruction,[1] mean cystectomy volume at hospitals in which >40% of diversions were continent was 0.8 cystectomies annually in a nationally representative cohort.[22] Beyond academic centers, in which 35% to 52 % of cystectomies are followed by continent reconstructions,[23–25] some low-volume providers prioritize continent reconstruction. The differences between these and providers who eschew consideration of continent techniques must be better understood to increase rates of continent reconstruction from the low rate of 16.5% documented in this study.

The current study is confounded by several limitations. First, we were unable to account for cancer-specific characteristics and patient surgical history in our complications outcomes. The inability to stratify utilization of differing reconstruction types by stage or grade or to examine complications outcomes by those same pathologic parameters may have affected our analyses. More aggressive cancers require more extensive dissection that can predispose patients to adverse postoperative events. These patients more commonly undergo ileal conduit diversion. Failure to account for cancer characteristics may bias the ileal conduit group toward worse complications outcomes. Similarly, those undergoing neoadjuvant chemotherapy may have different tendencies toward certain diversions and, possibly, varying complications outcomes. Those with an extensive history of prior abdominal surgery are predisposed to adverse surgical events. The increased difficulty of the surgery likely predisposes these patients to ileal conduit diversion as well, further biasing these subjects to worse outcomes.

We were also restricted to assessing complication outcomes that occurred during the index admission. Adverse postoperative events that postdated the index admission and that are common after radical cystectomy and urinary diversion may include readmissions for infections, bowel obstructions and other gastrointestinal complications, stoma complications, stones, and metabolic consequences of bowel reconstructions.[26] These may increase the burden of care on recipients of continent diversions if they are predisposed to higher rates of these adverse events. Future work should examine long-term sequelae of urinary diversion after radical cystectomy.

In using propensity score methods, we assume that the patient- and hospital-level covariates are balanced between subjects with similar propensity scores. If unobserved characteristics

determined diversion type, our results would be confounded by persistent selection bias. For this analysis, several unmeasured variables may have influenced the type of reconstruction performed, including patient preferences and self-efficacy, body habitus, performance status, social support, and cancer severity. Unmeasured variables may likewise affect our complications outcomes, such as the use of clinical care pathways, surgeon training, and hospital nursing magnet status. Hospital characteristics associated with use of continent urinary diversion are likely associated with many of these unmeasured variables, such as use of clinical care pathways, which may be associated with reduced complication rates among continent diversion patients. We assume, however, that the observed characteristics of our sample—patient sociodemographics, patient comorbidity, hospital type—are associated with those unobserved characteristics such that balance is maintained between continent diversion subjects and those diverted with an ileal conduit. Lastly, we assessed morbidity in the immediate postoperative period. Given the data source, we were unable to compare morbidity incurred beyond the index admission, and thus were unable to represent long-term outcomes including readmissions and reoperations.

Despite these limitations, we demonstrated that the type of urinary diversion after radical cystectomy for bladder cancer is not associated with the risk of immediate postoperative complications. These results may decrease provider reluctance to consider a more complex diversion when counseling patients with invasive bladder cancer about reconstruction options after radical cystectomy.

References

1. Gore JL, Saigal CS, Hanley JM, Schonlau M, Litwin MS. Variations in reconstruction after radical cystectomy. Cancer 2006;107:729–737. [PubMed: 16826589]
2. Hautmann RE, Paiss T. Does the option of the ileal neo-bladder stimulate patient and physician decision toward earlier cystectomy? J Urol 1998;159:1845–1850. [PubMed: 9598473]
3. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care 1998;36:8–27. [PubMed: 9431328]
4. Iezzoni LI, Daley J, Heeren T, et al. Identifying complications of care using administrative data. Med Care 1994;32:700–715. [PubMed: 8028405]
5. Becker SO, Ichino A. Estimation of average treatment effects based on propensity scores. Stata J 2002;2:358–377.
6. D'Agostino RB Jr, D'Agostino RB Sr. Estimating treatment effects using observational data. JAMA 2007;297:314–316. [PubMed: 17227985]
7. Dehejia R, Wahba S. Propensity score matching methods for non-experimental causal studies. Rev Econ Statist 2002;84:151–161.
8. Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika 1983;70:41–55.
9. Miller DC, Taub DA, Dunn RL, Montie JE, Wei JT. The impact of comorbid disease on cancer control and survival following radical cystectomy. J Urol 2003;169:105–109. [PubMed: 12478114]
10. Wiles NJ, Lunt M, Barrett EM, et al. Reduced disability at 5 years with early treatment of inflammatory polyarthritis: results from a large observational cohort, using propensity models to adjust for disease severity. Arthritis Rheum 2001;44:1033–1042. [PubMed: 11352234]
11. Konety BR, Allareddy V. Influence of post-cystectomy complications on cost and subsequent outcome. J Urol 2007;177:280–287. discussion 287. [PubMed: 17162064]
12. Benson MC, Slawin KM, Wechsler MH, Olsson CA. Analysis of continent versus standard urinary diversion. Br J Urol 1992;69:156–162. [PubMed: 1537028]
13. Gburek BM, Lieber MM, Blute ML. Comparison of studer ileal neobladder and ileal conduit urinary diversion with respect to perioperative outcome and late complications. J Urol 1998;160(3 pt 1):721–723. [PubMed: 9720530]

14. Parekh DJ, Gilbert WB, Koch MO, Smith JA Jr. Continent urinary reconstruction versus ileal conduit: a contemporary single-institution comparison of perioperative morbidity and mortality. Urology 2000;55:852–855. [PubMed: 10840090]
15. Polanczyk CA, Marcantonio E, Goldman L, et al. Impact of age on perioperative complications and length of stay in patients undergoing noncardiac surgery. Ann Intern Med 2001;134:637–643. [PubMed: 11304103]
16. Hollenbeck BK, Miller DC, Taub D, et al. Identifying risk factors for potentially avoidable complications following radical cystectomy. J Urol 2005;174(4 pt 1):1231–1237. discussion 1237. [PubMed: 16145376]
17. Clark PE, Stein JP, Groshen SG, et al. Radical cystectomy in the elderly: comparison of clinical outcomes between younger and older patients. Cancer 2005;104:36–43. [PubMed: 15912515]
18. Gibbs J, Cull W, Henderson W, Daley J, Hur K, Khuri SF. Preoperative serum albumin level as a predictor of operative mortality and morbidity: results from the National VA Surgical Risk Study. Arch Surg 1999;134:36–42. [PubMed: 9927128]
19. Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. N Engl J Med 2002;346:1128–1137. [PubMed: 11948273]
20. Hollenbeck BK, Taub DA, Miller DC, Dunn RL, Montie JE, Wei JT. Regionalization of radical cystectomy [abstract]. J Urol 2004;171(4 suppl):36. Abstract 137.
21. Gore JL, Lai J, Setodji CM, Litwin MS, Saigal CS. Mortality increases when radical cystectomy is delayed more than 12 weeks: results from a Surveillance, Epidemiology, and End Results-Medicare analysis. Cancer 2009;115:988–996. [PubMed: 19142878]
22. Gore JL, Litwin MS. Quality of care in bladder cancer: trends in urinary diversion following radical cystectomy. World J Urol 2009;27:45–50. [PubMed: 19020881]
23. Cookson MS, Chang SS, Wells N, Parekh DJ, Smith JA Jr. Complications of radical cystectomy for nonmuscle invasive disease: comparison with muscle invasive disease. J Urol 2003;169:101–104. [PubMed: 12478113]
24. Gilbert SM, Wood DP, Dunn RL, et al. Measuring health-related quality of life outcomes in bladder cancer patients using the Bladder Cancer Index (BCI). Cancer 2007;109:1756–1762. [PubMed: 17366596]
25. Lowrance WT, Rumohr JA, Chang SS, Clark PE, Smith JA Jr, Cookson MS. Contemporary open radical cystectomy: analysis of perioperative outcomes. J Urol 2008;179:1313–1318. discussion 1318. [PubMed: 18289578]
26. Stein, JP.; Skinner, DG. Orthotopic urinary diversion. In: Walsh, PC.; Retik, AB.; Vaughan, ED.; Wein, AJ., editors. Campbell's Urology. 8. Philadelphia, PA: WB Saunders; 2002. p. 3835-3867.

Table 1

Characteristics of the Study Sample (Weighted)

Characteristic	Urinary Diversion, No. (%)		*P*
	Continent	Ileal Conduit	
Total	4539 (16.5)	22,955 (83.5)	
Mean age, y	65.9	68.8	<.001
<55	740 (16.3)	2321 (10.1)	<.001
55–64	1195 (26.3)	4744 (20.7)	
65–74	1500 (33.1)	8340 (36.3)	
≥75	1104 (24.3)	7550 (32.9)	
Sex			
Male	3935 (79.7)	19,077 (83.1)	.02
Female	605 (20.3)	3878 (16.9)	
Race/ethnicity			
White	2778 (61.2)	14,756 (64.3)	.18
Nonwhite	391 (8.6)	1655 (7.2)	
Missing	1370 (30.2)	6544 (28.5)	
Primary payer			
Private	1920 (42.3)	7421 (32.4)	<.001
Medicare	2374 (52.3)	14,471 (63.1)	
Medicaid/other	245 (5.4)	1034 (4.5)	
ZIP code income quartile			
1 (lowest income quartile)	955 (21.0)	4524 (19.7)	.13
2	1215 (26.7)	5734 (25.0)	
3	684 (15.1)	4061 (17.7)	
4 (highest income quartile)	697 (15.4)	3897 (17.0)	
Missing	989 (21.8)	4739 (20.6)	
Hospital type			
Urban teaching	3067 (67.6)	14,309 (62.4)	.07
Urban nonteaching	1181 (26.0)	7194 (31.3)	
Rural	291 (6.4)	1452 (6.3)	
Hospital volume, mean	26.9	23.9	.08
High volume hospital[a]	2191 (48.3)	10,491 (45.7)	.36
Hospital region			
Northeast	818 (18.0)	4883 (21.3)	.30
Midwest	1189 (26.2)	5973 (26.0)	
South	1756 (38.7)	7943 (34.6)	
West	776 (17.1)	4157 (18.1)	

[a] Based on 90th percentile hospital volume or >14 cases over the study period.

Table 2

Comorbid Conditions by Urinary Diversion (Weighted)

Comorbid Condition	Urinary Diversion, No. (%)		*P*
	Continent	Ileal Conduit	
Congestive heart failure	186 (4.1)	1239 (5.4)	.11
Valvular disease	100 (2.2)	840 (3.7)	.02
Pulmonary circulation disease	19 (0.4)	142 (0.6)	.48
Peripheral vascular disease	154 (3.4)	1002 (4.4)	.22
Paralysis	46 (1.0)	269 (1.2)	.69
Other neurologic disorders	45 (1.0)	428 (1.9)	.05
Chronic pulmonary disease	912 (20.1)	4612 (20.1)	.99
Uncomplicated diabetes	587 (12.9)	3300 (14.4)	.29
Complicated diabetes	28 (0.6)	253 (1.1)	.17
Hypothyroidism	140 (3.1)	1055 (4.6)	.03
Renal failure	20 (0.4)	107 (0.5)	.92
Liver disease	24 (0.5)	88 (0.4)	.51
Lymphoma	24 (0.5)	84 (0.4)	.46
Rheumatoid arthritis/CVD	52 (1.2)	260 (1.1)	.96
Coagulopathy	103 (2.3)	457 (2.0)	.58
Obesity	74 (1.6)	731 (3.2)	.02
Weight loss	122 (2.7)	816 (3.6)	.19
Deficiency anemia	437 (9.6)	2366 (10.3)	.56
Alcohol abuse	83 (1.8)	392 (1.7)	.81
Psychoses	25 (0.6)	296 (1.3)	.06
Depression	154 (3.4)	643 (2.8)	.36
Hypertension	1898 (41.8)	10,141 (44.2)	.26

CVD indicates collagen vascular disease.

Table 3

Covariate Balance by Quartiles of the Calculated Propensity to Receive a Continent Urinary Diversion[a]

Characteristic	Propensity Score Quartile[b]			
	1	2	3	4
Proportion continent diversions	11.9%	13.6%	17.1%	23.3%
Age, *P*	.85	.93	.20	.08
Sex, *P*	.27	.17	.23	.36
Race/ethnicity, *P*	.67	.83	.45	.48
Primary payer, *P*	.65	.42	.99	.96
Subject comorbid condition, *P*				
Congestive heart failure	.98	.95	.47	.51
Valvular disease	.62	.93	.11	.66
Other neurologic disorders	.30	.26	.36	*c*
Chronic pulmonary disease	.84	.43	.81	.61
Uncomplicated diabetes	.72	.12	.63	.99
Complicated diabetes	.15	10	.52	*c*
Hypothyroidism	.16	.70	.39	.63
Obesity	.36	.40	*c*	*c*
Weight loss	.34	.93	.30	.72
Psychoses	.37	.49	*c*	*c*
Hospital type, *P*	.37	.83	.42	.38

[a] For each quartile, the number displayed represents the significance test for chi-square analysis comparing the proportion of each patient- and provider-level covariate by type of urinary diversion.

[b] Propensity score quartile 1 contains subjects with the lowest likelihood of receiving a continent diversion, and quartile 4 contains those with the highest likelihood.

[c] Within this propensity score quartile, no subject had a history of this comorbid condition.

Table 4

Unadjusted and Propensity Score Matching Method Determination of the Risk Difference of Having a Complication for Subjects Who Underwent Continent Diversion Compared With Those Who Underwent Ileal Conduit Urinary Diversion

Complication	Unadjusted Risk Difference (*P*)	Propensity Score Matched ATT (95% CI)
Medical complications		
Any medical complication	−0.058 (.002)	−0.028 (−0.070 to 0.005)
Cardiovascular complications	−0.014 (.26)	0.012 (−0.012 to 0.038)
Respiratory complications	−0.025 (.08)	−0.015 (−0.044 to 0.012)
Other medical complications	−0.045 (.004)	−0.031 (−0.061 to 0.001)
Surgical complications		
Any surgical complication	−0.063 (.001)	−0.050 (−0.090 to 0.011)
Bowel complications	−0.037 (.04)	−0.031 (−0.068 to 0.001)
Urinary complications	−0.009 (.03)	−0.012 (−0.023 to −0.004)
Wound complications	−0.001 (.82)	0.001 (−0.014 to 0.015)
Other surgical complications	−0.033 (.02)	−0.030 (−0.062 to −0.004)
Disposition complications		
Disposition other than home	−0.100 (<.001)	−0.082 (−0.121 to −0.046)
Prolonged length of stay[a]	−0.012 (.36)	−0.005 (−0.027 to 0.018)
Death during hospitalization	0.003 (.96)	0.008 (−0.002 to 0.020)

ATT indicates average treatment effect in the treated from the propensity score matching algorithm (analogous to the risk difference comparing the likelihood of each complication outcome among continent diversion subjects compared with those who underwent ileal conduit urinary diversions); 95% CI, 95% confidence interval.

[a] Based on 90th percentile length of stay or >17 days.

Table 5

Survey-Weighted Logistic Regression Models to Examine Correlates of Complication Outcomes Among Patient- and Provider-Level Covariates (Adjusted for Diversion Type)

Characteristics	Medical Complications, OR (95% CI)			Surgical Complications, OR (95% CI)				Disposition Other Than Home, OR (95% CI)	Postoperative Death, OR (95% CI)
	Any	Cardiovascular	Respiratory	Any	Bowel	Urinary	Wound		
Patient characteristics									
Age, y [vs <55]									
55–64	1.25 (0.99–1.58)	3.71 (1.81–7.62)	1.34 (0.97–1.86)	0.98 (0.79–1.23)	1.07 (0.82–1.39)	1.32 (0.57–3.06)	1.08 (0.60–1.97)	1.14 (0.92–1.41)	2.54 (0.54–12.0)
65–74	1.54 (1.18–2.01)	7.86 (4.01–15.9)	1.13 (0.78–1.64)	1.02 (0.81–1.29)	1.04 (0.78–1.37)	1.23 (0.56–2.73)	1.41 (0.68–2.93)	1.55 (1.23–1.96)	3.68 (0.82–16.5)
≥75	2.24 (1.69–2.97)	12.9 (6.53–25.5)	1.31 (0.89–1.94)	1.08 (0.85–1.37)	1.16 (0.86–1.56)	1.18 (0.53–2.61)	1.34 (0.61–2.95)	2.64 (1.99–3.40)	7.86 (1.75–35.4)
Female sex	1.20 (1.03–1.40)				0.69 (0.58–0.83)			1.31 (1.11–1.55)	
Nonwhite race	0.92 (0.73–1.17)	0.60 (0.39–0.92)	0.83 (0.61–1.12)					0.88 (0.69–1.12)	
Insurer [vs private]									
Medicare	1.08 (0.93–1.26)	1.08 (0.84–1.39)	1.39 (1.06–1.84)	1.26 (1.05–1.53)	1.20 (0.97–1.48)		1.20 (0.71–2.01)	1.19 (0.98–1.44)	2.24 (1.04–4.81)
Medicaid/other	1.03 (0.77–1.38)	1.07 (0.64–1.79)	1.16 (0.79–1.68)	0.87 (0.65–1.17)	0.93 (0.67–1.29)		1.29 (0.58–2.86)	1.03 (0.79–1.36)	0.98 (0.20–4.82)
Comorbid conditions									
Congestive heart failure	4.77 (3.54–6.45)	4.30 (3.27–5.66)	2.88 (2.16–3.83)	1.35 (1.06–1.72)	1.16 (0.89–1.50)	1.60 (0.76–3.38)	1.15 (0.64–2.04)	1.67 (1.20–2.31)	5.08 (3.20–8.05)
Valvular disease	1.51 (1.09–2.09)	2.40 (1.68–3.44)	1.25 (0.85–1.83)					1.31 (0.91–1.89)	
Pulmonary circulation disease	1.65 (0.68–3.97)	2.33 (0.95–5.71)			1.52 (0.72–3.24)				
Peripheral vascular disease		1.33 (0.92–1.91)			0.76 (0.54–1.06)				0.17 (0.02–1.23)
Paralysis	1.95 (1.13–3.35)			1.48 (0.87–2.52)					
Chronic pulmonary disease	1.65 (1.43–1.90)	1.34 (1.10–1.64)	2.62 (2.21–3.11)	1.17 (1.02–1.35)	1.16 (0.98–1.36)		1.56 (1.12–2.18)	1.33 (1.13–1.57)	1.87 (1.21–2.88)
Hypothyroidism				0.82 (0.61–1.12)	0.62 (0.44–0.89)			0.94 (0.70–1.27)	
Renal failure	2.15 (0.78–5.94)	1.56 (0.57–3.92)						2.50 (0.96–6.53)	1.30 (0.26–6.40)
Liver disease			3.28 (1.38–7.78)						5.67 (0.91–35.2)
Rheumatoid arthritis/CVD		1.48 (0.78–2.80)	0.38 (0.13–1.12)	0.54 (0.31–0.92)	0.55 (0.28–1.08)				
Coagulopathy	2.57 (1.67–3.94)	2.25 (1.38–3.65)	1.98 (1.25–3.14)	2.50 (1.69–3.70)	1.28 (0.85–1.93)				
Obesity	1.57 (1.05–2.34)	0.79 (0.44–1.41)	2.05 (1.18–3.57)	0.86 (0.60–1.24)	0.79 (0.52–1.21)		1.31 (0.59–2.93)		
Weight loss	5.57 (3.86–8.04)	1.80 (1.15–2.82)	2.96 (2.04–4.29)	5.40 (3.68–7.95)	4.75 (3.35–6.73)	2.00 (0.93–4.30)	3.30 (2.00–5.46)	1.76 (1.18–2.62)	2.12 (1.05–4.25)
Deficiency anemia	1.57 (1.23–1.83)			0.69 (0.56–0.85)		1.75 (1.01–3.05)	0.49 (0.26–0.92)	1.26 (1.02–1.55)	0.40 (0.15–1.10)
Alcohol abuse	1.53 (1.01–2.32)								2.86 (0.89–9.20)

Characteristics	Medical Complications, OR (95% CI)			Surgical Complications, OR (95% CI)				Disposition Other Than Home, OR (95% CI)	Postoperative Death, OR (95% CI)
	Any	Cardiovascular	Respiratory	Any	Bowel	Urinary	Wound		
Psychoses			1.34 (0.66–2.71)					2.10 (1.09–4.07)	
Depression	12.9 (8.15–20.5)		20.1 (5.75–42.5)		0.77 (0.51–1.16)				
Provider characteristics									
Hospital type [vs urban teaching]									
Urban nonteaching	1.11 (0.95–1.30)	0.91 (0.75–1.11)	1.12 (0.91–1.38)	1.23 (1.03–1.48)	1.14 (0.94–1.38)	1.59 (1.02–2.49)	1.33 (0.97–1.82)	1.18 (0.93–1.50)	0.84 (0.51–1.40)
Rural	0.94 (0.69–1.29)	0.88 (0.63–1.24)	0.83 (0.55–1.22)	1.11 (0.87–1.43)	0.91 (0.66–1.27)	2.04 (0.89–4.67)	1.29 (0.74–2.11)	0.98 (0.72–1.34)	1.33 (0.68–2.61)
High-volume hospital[a]	0.98 (0.82–1.16)		0.85 (0.69–1.05)	1.01 (0.84–1.22)					0.59 (0.37–0.97)

OR indicates odds ratio; 95% CI, 95% confidence interval; CVD, collagen vascular disease.

[a] Based on 90th percentile hospital volume or >14 cases over the study period.

Cancer. Author manuscript; available in PMC 2011 March 15.