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Bladder Cancer

Variations in the Costs of Radical Cystectomy for Bladder Cancer in the USA

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Abstract

Background: Radical cystectomy (RC) for muscle-invasive bladder cancer (BCa) has potential for serious complications, prolonged length of stay and readmissions—all of which may increase costs. Although variations in outcomes are well described, less is known about determinants driving variation in costs.
Objective: To assess surgeon- and hospital-level variations in costs and predictors of high- and low-cost RC.
Design, setting, and participants: Cohort study of 23 173 patients who underwent RC for BCa in 208 hospitals in the USA from 2003 to 2015 in the Premier Healthcare Database.
Outcome measurements and statistical analysis: Ninety-day direct hospital costs; multilevel hierarchal linear models were constructed to evaluate contributions of each variable to costs.
Results and limitations: Mean 90-d direct hospital costs per RC was $39 651 (standard deviation $34 427), of which index hospitalization accounted for 87.8% ($34 803) and postdischarge readmission(s) accounted for 12.2% ($4847). Postoperative complications contributed most to cost variations (84.5%), followed by patient (49.8%; eg, Charlson Comorbidity Index [CCI], 40.5%), surgical (33.2%; eg, year of surgery [25.0%]), and hospital characteristics (8.0%). Patients who suffered minor complications (odds ratio [OR] 2.63, 95% confidence interval [CI]: 2.03–3.40), nonfatal major complications (OR 12.7, 95% CI: 9.63–16.8), and mortality (OR 13.5, 95% CI: 9.35–19.4, all $p < 0.001$) were significantly associated with high costs. As for low-cost surgery, sicker patients (CCI = 2: OR 0.41, 95% CI: 0.29–0.59; CCI = 1: OR 0.58, 95% CI: 0.46–0.75, both $p < 0.001$), those who underwent continent diversion (vs incontinent diversion: OR 0.29, 95% CI: 0.16–0.53, $p < 0.001$), and earlier period of surgery were inversely associated with low costs.
Conclusions: This study provides insight into the determinants of costs for RC. Postoperative morbidity, patient comorbidities, and year of surgery contributed most to observed variations in costs, while other hospital- and surgical-related characteristics such as volume, use of robot assistance, and type of urinary diversion contribute less to outlier costs.
Patient summary: Efforts to address high surgical cost must be tailored to specific determinants of high and low costs for each operation. In contrast to robot-assisted radical prostatectomy where surgeon factors predominate, high costs in radical cystectomy were primarily determined by postoperative complication and patient comorbidities.

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1. Introduction

Bladder cancer (BCa) costs approximately $3 billion in the USA and €4.9 billion in European Union annually [1,2], and incurs the highest lifetime treatment cost per patient among all types of cancers [2,3]. Despite high complication rates, radical cystectomy (RC) remains the gold standard treatment for nonmetastatic muscle-invasive BCa [4]. Recently, there has been a gradual rise in the adoption of robot-assisted RC (RARC), a potentially costlier approach to surgical extirpation of the bladder [5–7]. Given RC's morbidity and substantial economic impact, questions have been raised about variations in care and outcomes. High-volume centers may perform better with process measures and cancer outcomes [8,9] but factors such as postsurgical follow-up vary, with better survival seen in those with excellent postoperative follow-up [10]. Additionally, there are variations in surgical technique, volume, processes of care, and outcomes [11]; it is unknown whether such variations translate into cost differences. A population-based study examining insurance claims found that RC itself accounted for 69% of all charges, while postoperative consultations (7.8%) and complications (6%) accounted for the rest [9], therefore suggesting a possible role of the surgeon to influence costs. Despite the costs of the surgical procedure, a thorough assessment of cost variations and predictors of high costs for RC has not yet been performed. Therefore, we performed a study of costs following RC, hypothesizing that there exists substantial cost variation across surgeons and hospitals. We further hypothesized that the least costly providers would be those with a high annual surgical volume.

2. Patients and methods

2.1. Data source

The Premier Healthcare Database (Premier, Inc., Charlotte, NC, USA) is a nationally representative all-payer database capturing >75 million hospital inpatient discharges. Apart from *International Classification of Diseases, Ninth Revision* (*ICD-9*) and Current Procedural Terminology (CPT) codes, this claims-based database also provides standardized billing items including direct item costs (eg, medications, laboratory services, room and board, etc.). ICD-9 and CPT codes are used to identify patient diagnoses and characteristics of patient encounters (eg, procedures). This database has been featured in prior landmark studies [12,13]. Hospital-specific projection weights are applied to each discharge to project the sample to a national estimate of inpatient discharges. All numbers reported herein refer to the weighted estimates. Given our use of anonymized data, we obtained institutional review board waiver.

2.2. Study population

Using *ICD-9* codes, we identified individuals diagnosed with BCa (188.x, 233.7, 236.7) discharged following RC (57.71) between 2003 and 2015. We excluded those with metastatic disease (196.x, 197.x, 198.x) or other malignancies (140.x–209.79). In our weighted cohort of 53 473 individuals who received RC, we identified 2317 surgeons who performed the surgery in 425 unique hospitals. In our main cohort, we excluded surgeons with annual surgical volume ≤2/yr, which is likely too low to perform a meaningful analysis (median annual surgeon volume 3/yr; 75th percentile: 6; 90th percentile: 11), resulting in a cohort of 23 173 patients operated by 515 unique surgeons at 208 different hospitals in the USA.

2.3. Study variables

Our outcome of interest was direct hospital costs, which included the cost of the entire procedure, inpatient stay, and any inpatient encounters up to 90 d postprocedure. All costs were adjusted to 2016 US dollars using the medical component of the consumer price index.

We examined relevant patient, hospital, and surgeon characteristics. Patient characteristics included age, race, marital status, insurance status, and Charlson Comorbidity Index (CCI). Hospital characteristics included teaching status, urbanicity, size, hospital annual RC volume (low and high defined as >75th percentile; >22/yr), and US geographic region. Surgeon characteristics included annual RC volume (low and high defined as >75th percentile; >10/yr), type of urinary diversion, lymphadenectomy, surgical approach (open vs robot assisted as previously described [14]), and year of surgery (Table 1).

2.4. Statistical analyses

First, we sought to identify the scale of variation in nonadjusted direct hospital costs for all attending surgeons who performed ≥3 RCs/yr. We generated a ranked list of the 515 surgeons ordered by 90-d total direct hospital costs post-RC. To calculate mean costs per surgeon, we divided total direct hospital costs by the number of RCs performed by each surgeon during the study period. This yielded each surgeon's mean direct hospital cost per RC, along with 95% confidence intervals (CIs). We then plotted the distribution of mean direct hospital costs along with 95% CIs for all surgeons from the least costly to the costliest surgeon/hospital. Each data point on the horizontal axis represents an individual attending surgeon/hospital (Fig. 1 and 2).

Second, to assess for the relative contribution of patient-, hospital-, and surgical-level variables, as well as morbidity outcomes on costs, we constructed a multilevel hierarchical linear regression model and calculated the pseudo-R^2 of each variable, which translates to a percentage representing the variability contributed by that variable to 90-d direct hospital costs [15,16].

Finally, we assessed patient-, hospital-, surgical-, and morbidity-related predictors of high- and low-cost RC. Specifically, we determined the dollar thresholds corresponding to the least costly and costliest deciles, which were $18 600 and $68 166 per RC, respectively. We then examined characteristics associated with high- and low-cost RC. Summary statistics were constructed using frequencies and proportions for categorical variables, as well as means and standard deviations (s.d.) for continuous variables. Next, we constructed a multivariable logistic regression model controlling for all aforementioned covariates in order to assess for independent predictors of high- and low-cost surgery. We chose each variable's reference group to be that with the highest frequency. We accounted for clustering by hospitals. There was no significant collinearity across patient, hospital, and surgical covariates used.

2.5. Sensitivity analyses

We performed several sensitivity analyses to determine if our findings were robust and consistent across various study populations. First, we included all surgeons regardless of annual surgeon caseload. Second, we evaluated patients who had prolonged hospital length of stay (pLOS), defined by >75th percentile of 11 d; this was done in order to evaluate if there was still substantial variation in a group of patients whose outcomes were considered "poor." Third, we evaluated patients who did

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