



## Original article

## Improved surgical outcomes following radical cystectomy at high-volume centers influence overall survival

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## Abstract

**Objectives:** Positive surgical margins (PSM) and lymph node yield (LNY) following radical cystectomy (RC) for urothelial carcinoma of the bladder affect survival. Variations in PSM or LNY at different care facilities are poorly described. We evaluated the relationship between hospital surgical volume and academic hospital status with these surgical outcomes and overall survival (OS).

**Methods and materials:** Patients with nonmetastatic urothelial carcinoma of the bladder who underwent RC were identified from the National Cancer Database (2004–2013). Treatment centers were categorized as academic (ACC) and community cancer centers (CCC). Logistic regression was used to identify factors associated with PSM status and LNY, and a multivariate Cox proportional hazards model was used to determine factors associated with OS.

**Results:** In our cohort, 39,274 patients underwent RC. A lower proportion of PSMs (10% vs. 12%;  $P < 0.001$ ) and higher median LNY (14 vs. 8,  $P < 0.001$ ) was observed at ACCs compared to CCCs. On logistic regression, there were lower odds of PSM (OR = 0.89, 95% CI: 0.81–0.97) and higher odds of LNY  $\geq 10$  nodes (OR = 1.84, 95% CI: 1.74–1.96) among patients at ACCs compared to CCCs. Cox proportional hazards analysis demonstrated benefit to OS at high-volume centers (HR = 0.91, 95% CI: 0.87–0.95) but not based on ACC designation. The OS advantage at high-volume centers is attenuated (HR = 0.95, 95% CI: 0.91–0.99) by PSM status and LNY.

**Conclusions:** ACCs demonstrate improved surgical outcomes following RC, and a survival advantage attributable to high surgical volume is identified. Centralization of care may lead to improved outcomes in this lethal malignancy. © 2018 Elsevier Inc. All rights reserved.

**Keywords:** Volume; Outcomes; Cystectomy; Margins of excision; Regionalization

## 1. Introduction

Radical cystectomy (RC), with the intent of complete eradication of all loco-regional disease, is the standard of care for the management of patients with nonmetastatic, high-risk urothelial carcinoma of the bladder (UCB). RC

with concurrent pelvic lymph node dissection (PLND) cures the majority of patients with tumors confined to the bladder, with an increased risk to mortality when extravesical disease or positive lymph nodes are identified [1–3]. Positive surgical margins (PSM) and lymph node yield (LNY) have been shown to affect patient survival [4].

Increased hospital or surgeon experience with RC has been shown to improve in-hospital mortality and length of stay [5–9]. This raises a debate about whether UCB care should be centralized at high-volume centers, but the effect of volume on specific surgical factors, including margins,

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LNy, and long-term survival, has not been identified. Studies have shown an association with surgeon experience and surgical outcomes including positive margin rates in other urologic oncology operations [10,11].

Improved outcomes at high-volume institutions are inconsistently attributed to factors associated with surgeon experience, including improved surgical outcomes as a result of higher surgical volume or additional training, and factors associated with hospital experience, including enhanced hospital resources and experience of nonsurgical staff in managing cancer patients. We hypothesized that surgical margin rates and LNy varied between academic cancer centers (ACC) and community cancer centers (CCC) in the large National Cancer Data Base (NCDB) cohort, and that these differences were associated with hospital surgical volume and patient overall survival (OS).

## 2. Material and methods

### 2.1. Study population

The NCDB is a large, hospital-based cancer registry jointly sponsored by the American Cancer Society and the Commission on Cancer of the American College of Surgeons. After institutional review board approval, the NCDB patient population was identified, including patients aged 40 years and older with the primary diagnosis of UCB who underwent RC from years 2004 to 2013 ( $n = 42,020$ ). We excluded patients who had unknown cancer center type ( $n = 141$ ) or an unknown surgical margin status ( $n = 2,084$ ). Patients with evidence of metastatic (M1) disease before RC were excluded ( $n = 521$ ).

#### 2.1.1. Primary outcomes and patient and hospital covariates

The primary outcomes of this study were surgical margin status, LNy, and OS of UCB patients undergoing RC. Covariates used to test for associations include age at diagnosis, sex, race, Charlson-Deyo comorbidity score, disease stage, tumor grade, and tumor size. We also evaluated cancer center academic status, hospital RC volume, and use of neoadjuvant chemotherapy.

Classification of hospital academic status was made based on the cancer program category assigned by the Commission on Cancer for each facility. The NCDB designates treatment facilities as academic cancer centers if they provide postgraduate medical education in 4 specialties, including general surgery, and accession more than 500 newly diagnosed cancer cases each year. Community cancer centers have training of resident physicians as an optional criterion and were subcategorized as a Comprehensive Community Cancer Program, a Community Cancer Program, or an Integrated Network Cancer Program if they accession greater than 500 new cancer cases, greater than

100 but fewer than 500 new cancer cases, or no minimum case load designation, respectively.

Hospital volume was determined by assessing the number of RC procedures performed at each NCDB institution which performed at least 1 RC during the 10-year study period. Number of procedures was assessed before exclusion of patients with metastatic disease or with incomplete outcomes data. Institutions with an average RC volume  $>10$  per year were designated as high-volume.

Charlson-Deyo comorbidity score was calculated using the ICD-9-CM secondary diagnosis codes as designated by certified data extractors, with scores categorized as 0 (no comorbidities), 1, or  $>1$  (2 or more comorbidities). Surgical margin status is identified in the NCDB as no residual tumor (R0), microscopic residual tumor (R1), macroscopic residual tumor (R2), or residual tumor not otherwise specified, with the later 3 results classified together as a PSM. If a patient receives multimodal therapy with chemotherapy and surgery, the NCDB classifies the sequence of therapies administered. Use of neoadjuvant chemotherapy was designated if systemic therapy was administered before surgery or before and following surgery.

### 2.2. Statistical analysis

Patients were categorized into 2 comparison groups: patients with RC performed at an ACC or a CCC. Univariate associations of patient, facility, and cancer variables were tested by the Pearson chi-square and the 2-sided  $t$ -test, as appropriate. The Kaplan-Meier method was used to examine OS. We conducted a multivariate Cox proportional hazards model to evaluate associations between multiple clinical and pathologic variables to determine factors associated with variations in OS between ACCs and CCCs. Logistic regression was used for multivariate analysis to determine factors associated with a PSM and a LNy  $\geq 10$  lymph nodes. Stata SE, version 13.0 (StataCorp, College Station, TX) was used to perform all statistical analyses. A  $P < 0.05$  was used to determine statistical significance.

## 3. Results

A total of 39,274 RC patients met inclusion criteria. As seen in Table 1, 20,346 patients underwent RC at ACCs, whereas 18,928 were treated at CCCs. Patients at ACCs were younger (68 vs. 70 y,  $P < 0.001$ ) and more likely to have no comorbidities (71.6% vs. 68.9%,  $P < 0.001$ ). ACCs performed a median 6.4 cystectomies per year compared to 1.3 at CCCs ( $P < 0.001$ ). Of the 1,228 hospital included in the study, 97 hospitals (7.9%) have a RC volume  $>10$  per year.

ACC patients were less likely to have disease invading outside the bladder (45.0% vs. 47.7%,  $P < 0.001$ ) but more likely to have lymph node involvement (24.2 vs. 22.6%,

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