THERAPEUTIC ADVANCES in
Urology

Original Research

Preoperative predictors of prolonged length of stay in radical cystectomy: a retrospective study using the American College of Surgeons-National Surgical Quality Improvement Program Dataset

Ther Adv Urol

2023, Vol. 15: 1–11

DOI: 10.1177/
17562872231191654

Elia Abou Chawareb*, **Christian Habib Ayoub***, **Jad Najdi, Joseph Ghoubaira and Albert El-Hajj**

Abstract

Background: Radical cystectomy (RC) is considered a complex procedure that entails significant morbidity and mortality.

Objectives: We aimed to determine pre-operative patient characteristics that help predict a prolonged length of hospital stay (PLOS) following RC.

Design and Methods: The American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database was used to select patients who underwent RC between the years 2011 and 2020. Prolonged length of stay was defined as a hospital stay ⩾9 days. We compared patient demographics, pre-operative labs, surgical characteristics, and medical history between patients with or without PLOS. Multivariable logistic regression models controlling for pre-operative characteristics and propensity score matching for post-operative complications were conducted to control for possible confounders.

Results: The analysis yielded details of 19,158 RC patients of which 6007 (31%) patients had a PLOS. Patients with PLOS were more likely to have post-operative complications that could serve as predictors for the PLOS rather than their pre-operative characteristics. Hence, we matched our cohort for these complications. After matching, patient pre-operative characteristics that predict PLOS included female gender (Odds Ratio (OR) = 5.91), 10-year increase in age (OR = 1.15), non-White race (OR = 1.98), partially or totally dependent functional health status (OR = 2.86), bleeding disorders (OR = 4.67), congestive heart failure (OR = 1.59), pre-operative transfusion (OR = 3.03), and a 20-min increase in operative time (OR = 1.01) ($p < 0.046$).

Conclusion: Patient demographics and pre-operative factors can help predict PLOS in RC patients. These predictors could serve as tools for patient counseling and risk stratification.

Keywords: hospital stay, morbidity, urinary bladder, urologic neoplasms, urologic surgical procedures

Received: 5 April 2023; revised manuscript accepted: 14 July 2023.

Correspondence to:
Albert El-Hajj
Division of Urology, Department of Surgery, American University of Beirut Medical Center, PO Box 11-0236, Riad El Solh, Beirut 1107 2020, Lebanon
ae67@aub.edu.lb

Elia Abou Chawareb
Christian Habib Ayoub
Jad Najdi
Division of Urology, Department of Surgery, American University of Beirut Medical Center, Beirut, Lebanon

Joseph Ghoubaira
Department of Radiology Oncology, University of Pittsburgh Medical Center, Pittsburgh, PA, USA

*These authors have contributed equally to this work and share first authorship.

Introduction

Bladder cancer (BCa) is a common malignancy causing approximately 3% of all new cancer diagnosis and 2.1% of all cancer deaths in 2020.[1] BCa consists of an array of presentations, ranging from non-invasive tumors that require long-term surveillance, to aggressive and invasive tumors that require radical treatment.[2] Overall prevalence of localized, regional, and distant BCa are 76.5%, 17.5%, and 2.7%, respectively.[3] Furthermore, overall survival for localized disease is 90.8% and decreases to 8% in distant disease.[3]

Radical cystectomy (RC) is the gold-standard treatment for muscle-invasive BCa T2–T4a and high-grade non-invasive BCa that is unresponsive to intravesical therapy or cannot be controlled by transurethral resection of bladder tumor.[4] However, RC is a complex procedure that is associated with significant morbidity and mortality and often performed in old and frail patients.[5] Therefore, many studies have aimed to identify pre-operative predictors of morbidity and mortality after RC in an attempt to better risk stratify patients and optimize counseling.[6,7]

Length of stay has been previously used as an indicator of proper hospital management and a quality measure.[8,9] A PLOS is associated with increased odds of nosocomial infections, elevated morbidity, and mortality rates.[9,10] Furthermore, a prolonged length of stay is also associated with increased complications and increased hospital costs which significantly burden RC patients.[11,12] It is imperative that length of stay remains at a minimum; hence, the importance of understanding preoperative predictors of PLOS.

Many studies have investigated peri and post-operative risk factors that affect Length of Stay (LOS).[13,14] However, a gap still exists when specifying pre-operative factors that prolong LOS in RC patients. As a fact, PLOS could be affected by pre-, intra-, and post-operative factors, as these factors intertwine, hence making it difficult to determine pre-operative factors that prolong LOS.[15] Determining pre-operative predictors of PLOS is essential in risk stratifying patients pre-operatively and in guiding post-operative follow up care. Thus, in this study, we aimed to determine pre-operative factors that are independent predictors of PLOS in RC using the American College of Surgeons-National Surgical Quality Improvement Program Dataset (ACS-NSQIP).

Methods

Study design

The ACS-NSQIP database was used to collect data on patients who underwent RC between the years 2011 and 2020. Corresponding procedural terminology codes 51,570, 51,575, 51,580, 51,585, 51,590, 51,595, and 51,596 were used to select RC patients. Patients with disseminated cancer ($N = 1178$) were excluded from the analysis. The dataset does not differentiate between open and minimally invasive (MIS) RC. The ACS-NSQIP database is a nationally validated, risk-adjusted, and outcomes-based program. It encompasses 719 centers both inside and outside the United States. Data is collected by surgical clinical reviewers that receive intensive training and follow-up support; in addition, data quality is ensured by an Intra-Rater Reliability Audit of participating sites.

Patients, variables, and outcome of interest

In our study, PLOS was defined as a hospital stay ≥ 9 days. The 75th percentile of LOS in our cohort was 10 days and most studies in the literature defined PLOS in cystectomy as a range between 7 and 11 days.[7,16,17] Hence, 9 days was used as an average between possible values. We compared patient demographics, laboratory values, medical comorbidities, and surgical characteristics between patients with or without PLOS. Patient demographics included age, gender, smoking status, race, body mass index (BMI), American Society of Anesthesiologists' (ASA) class, and functional health status. Laboratory values included abnormal creatinine defined as serum creatinine ≥ 1.5 mg/dL, leukocytosis defined as WBC $> 11 \times 10^9$ cells/L, thrombocytopenia defined as platelet count $< 150 \times 10^3$, and anemia defined as hematocrit $< 36\%$. Medical comorbidities included diabetes (insulin and non-insulin dependent), hypertension, pre-operative renal failure, history of chronic obstructive pulmonary disease, bleeding disorder, congestive heart failure (CHF), chronic steroid use defined as regular oral or parenteral corticosteroids or immunosuppressant medication use for a chronic condition within 30 days of procedure, weight loss defined as $\geq 10\%$ weight loss over 6 months, dyspnea, dialysis, and bleeding transfusion defined as transfusion > 4 units packed red blood cells (pRBCs) 72 h before surgery. Surgical characteristics included diversion type (neobladder *versus* ileal conduit) and operative time (OT). We also compared 30-day post-operative mortality and morbidity including urinary tract infection, superficial surgical site infection (SSI), deep incisional SSI, wound disrupt, pneumonia, pulmonary embolism, renal failure, cerebrovascular accident (CVA), cardiac arrest requiring cardiopulmonary resuscitation (CPR), bleeding transfusions, deep vein thrombosis (DVT), sepsis, septic shock, and death between patients with or without PLOS.

Statistical analysis

First, we compared demographics, laboratory values, medical comorbidities, and surgical characteristics between patients with or without PLOS. Categorical variables were compared using Chi-square test and presented as count and percentages while continuous variables were analyzed using independent *t*-test and presented as mean and standard error of the mean. Next, a multivariable logistic regression was performed using LOS < 9 days as a reference and adjusting for all patient demographics, laboratory values, medical comorbidities, and surgical characteristics. Missing values were not imputed since the percentage of missing values was less than 10%. However, post-operative complications could act as essential confounders and predictors of PLOS and in order to control for such complications, a sensitivity analysis was performed by propensity score matching. We matched patients with or without PLOS on all post-operative complications and looked at pre-operative characteristics that remained significant as predictors of PLOS. These complications are urinary tract infection, superficial SSI, deep incisional SSI, wound disruption, pneumonia, pulmonary embolism, renal failure, CVA or stroke, cardiac arrest requiring CPR, bleeding that require transfusion, DVT, sepsis, septic shock and death. IBM SPSS Statistics version 28 (Armonk, NY: IBM Corp) was used for the statistical analysis and two-sided significance was set at 0.05.

Results

Our analysis yielded data on 19,158 patients who underwent RC between the years 2011 and 2020. In our cohort of 13,151 patients (69%) of patients had LOS <9 days whereas 6007 patients (31%) of patients had a LOS ⩾ 9 days. Patients with PLOS were more likely to be older, females, with higher BMI, higher ASA score, and with a totally or partially dependent functional health status ($p < 0.001$). Patients with PLOS were also more likely to have abnormal creatinine, leukocytosis, and anemia ($p < 0.001$). Furthermore, patients with PLOS were also more likely to have any medical comorbidity and longer OTs ($p < 0.001$) (Table 1).

After multivariable analysis using LOS < 9 days as a reference, every 10-year increase in age was associated with an increased odds of PLOS (OR = 1.21, $p < 0.001$). Furthermore, female gender (OR = 1.16), smoker (OR = 1.10), non-White race (OR = 2.08), BMI ⩾ 40 (OR = 1.36), ASA score >2 (OR = 1.20), and partially or totally dependent functional health status (OR = 3.04) were predictors of PLOS ($p < 0.026$). In addition, leukocytosis (OR = 1.27), anemia (OR = 1.14), and any medical comorbidity were also predictors of PLOS ($p < 0.007$). Presence of bleeding disorders (OR = 2.04), acute renal failure (OR = 2.76), and pre-operative transfusion (OR = 3.40) were the most significant predictors of PLOS ($p < 0.001$). Diversion type of neobladder (OR = 1.13) was also found to be a predictor of PLOS. A 20-min increase in OT was also associated with a PLOS (OR = 1.01, $p < 0.001$) (Table 2).

Patients with PLOS were also found to have higher rates of all 30-day post-operative complications (Table 3). To control for these possible confounders in increasing LOS we developed a matched cohort of 10,222 patients that were matched on all post-operative complications and hence diluting their confounding effects on predictors of PLOS (Table 3). After matching, variables that remained independent predictors of PLOS included a 10-year increase in age (OR = 1.15), female gender (OR = 5.91), non-White race (OR = 1.98), and partially or totally dependent functional health status (OR = 2.86), bleeding disorder (OR = 4.67), CHF (OR = 1.59), pre-operative transfusion (OR = 3.03), and a 20-min increase in OT (OR = 1.01) ($p < 0.046$) (Table 2).

Discussion

Hospital length of stay is an important measure of a hospital's quality, competency, and efficiency; unfortunately, it also accounts for a considerable fraction of healthcare costs. Furthermore, healthcare officials have been looking at safe and efficient ways to reduce post-operative hospital length of stay without undermining the quality of care nor increasing readmission rates.[18] In this study, we showed that an increase in age, female gender, smoking status, non-White race, dependent functional health status, bleeding disorder, pre-operative transfusion, and an increase in OT were all associated with a PLOS in RC patients.

In our study, 31% of RC patients were found to have PLOS, a similar rate as reported by others.[16,19] To our knowledge, this is the first study

Table 1. Patient pre-operative demographics, laboratory values, medical history, and surgical characteristics between length of stay <9 and ⩾9 days.

N **= 19,158 cystectomy**	**Length of stay**		***p*-Value**
	<9 days, *N* = 13,151	**⩾9 days, *N* = 6007**	
	***N* (%) or Mean ± SD**	***N* (%) or Mean ± SD**	
Demographics			
Age	67.7 ± 0.9	68.9 ± 0.14	<0.001*
Gender			
Female	2520 (19.2)	1358 (22.6)	<0.001*
Male	10,631 (80.8)	4649 (77.4)	
Smoker	2879 (21.9)	1340 (22.3)	0.520
Race			
Black	548 (4.2)	325 (5.4)	<0.001*
White	10,375 (78.9)	4045 (67.3)	
Other	2228 (16.9)	1637 (27.3)	
BMI categories			
<25	3487 (26.5)	1686 (28.1)	<0.001*
25–29.9	5225 (39.7)	2155 (35.9)	
30–34.9	2905 (22.1)	1356 (22.6)	
35–39.9	1059 (8.1)	506 (8.4)	
⩾40	475 (3.6)	304 (5.1)	
ASA score >2	9939 (75.6)	4870 (81.1)	<0.001*
Functional health status prior to surgery			
Independent	12,910 (98.2)	5730 (95.4)	<0.001*
Partial or totally dependent	241 (1.8)	277 (4.6)	
Lab values			
Abnormal creatinine	2026 (15.4)	1096 (18.2)	<0.001*
Leukocytosis	1128 (8.6)	715 (11.9)	<0.001*
Thrombocytopenia	1276 (9.7)	563 (9.4)	0.472
Anemia	4496 (34.2)	2448 (40.8)	<0.001*
Comorbidities			
Diabetes	2496 (19)	1293 (21.5)	<0.001*
Insulin dependent diabetes	811 (6.2)	452 (7.5)	<0.001*

(Continued)

Table 1. (Continued)

N **= 19,158 cystectomy**	**Length of stay**		***p*-Value**
	<9 days, *N* = 13,151	**⩾9 days, *N* = 6007**	
	N **(%) or Mean ± SD**	***N*** **(%) or Mean ± SD**	
Hypertension	7650 (58.2)	3685 (61.3)	<0.001*
Acute renal failure	18 (0.1)	37 (0.6)	<0.001*
History of severe COPD	805 (6.1)	555 (9.2)	<0.001*
Bleeding disorders	98 (0.7)	88 (1.5)	<0.001*
CHF	69 (0.5)	62 (1)	<0.001*
Steroid use for chronic condition	410 (3.1)	231 (3.8)	0.009*
Weight loss	306 (2.3)	217 (3.6)	<0.001*
Dyspnea	899 (6.8)	572 (9.5)	<0.001*
Dialysis	95 (0.7)	60 (1)	<0.048*
Pre-operative transfusion	99 (0.8)	188 (3.1)	<0.001*
Surgical characteristics			
Diversion type			
Neobladder	2079 (16.9)	917 (16.2)	0.280
Ileal conduit	10,257 (83.1)	4741 (83.8)	
Operative time	335 ± 117	350 ± 131	<0.001*

Smoker is a current smoker within 1 year; Abnormal creatinine is serum creatinine ⩾1.5 mg/dL; Leukocytosis is WBC > 11 × 109 cells/L; Thrombocytopenia is platelet count <150 × 103; Anemia is defined as hematocrit <36%; Hypertension indicates hypertension requiring medication; Weight loss is >10% loss body weight in the last 6 months; Blood transfusion is receiving packed red blood cells 72 h before surgery.
*Significant $p < 0.05$.
ASA, American Society of Anesthesiologists; BMI, body mass index (kg/m^2); CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

focusing on PLOS after RC that matched patients on all post-operative complications, that increase the patient's hospital stay for management, to eliminate the confounding effect of perioperative complications on pre-operative determinants of PLOS.

Female gender in our analysis was found to be an independent predictor of PLOS. We postulate that this can be explained by the different surgical approach that is used for women during RC. RC in females involves the dissection of the anterior vaginal wall, removal of the uterus, ovaries, fallopian tubes, and part of the vagina; hence, Lee *et al.*[20] found that females have increased blood loss and were 1.5 times more likely to require a transfusion following RC when compared to males. Moreover, females presented at admission with a lower pre-operative hematocrit, and required intensive care following RC more often than men did; thus, females had a longer hospital stay.[20,21]

Older patients with a partially or fully dependent functional health status were at a higher risk of PLOS after RC. This has also been reported by Cárdenas-Turanzas *et al.*[21] who demonstrated that an increase in age was associated with an increase in hospital length of stay in RC. This subset of patients may require additional

Table 2. Odds ratio of patient pre-operative demographics, laboratory values, medical history, and surgical characteristics between length of stay <9 and ⩾9 days before and after propensity score.

Radical cystectomy		**Before match, *N* = 19,158**		**After match, *N* = 10,222**	
		LOS < 9 days, odds ratio (CI)	***p*-Value**	**LOS ⩾ 9 days, odds ratio (CI)**	***p*-Value**
Demographics					
Age[a]		1.21 (1.17–1.25)	<0.001*	1.15 (1.10, 1.21)	<0.001*
Gender	Male (Reference)	–	<0.001*	–	<0.001*
	Female	1.16 (1.06–1.25)		5.91 (5.01, 6.98)	
Smoker		1.1 (1.01–1.20)	0.026*	–	
Race	White (Reference)	–	<0.001*	–	<0.001*
	Non-White	2.08 (1.93–2.24)		1.98 (1.79, 2.19)	
BMI categories	<25 (Reference)	–		–	
	25–29.9	0.91 (0.84–0.99)	0.032*	–	
	30–34.9	1.06 (0.96–1.17)	0.248	–	
	35–39.9	1.04 (0.91–1.18)	0.615	–	
	⩾40	1.36 (1.15–1.61)	<0.001*	–	
ASA score >2		1.20 (1.11–1.31)	<0.001*	–	–
Functional health status prior to surgery	Independent (Reference)	–	<0.001*	–	<0.001*
	Partial or totally dependent	3.04 (2.50–3.71)		2.86 (2.15, 3.80)	
Laboratory values					
Leukocytosis		1.27 (1.14–1.42)	<0.001*	–	
Anemia		1.14 (1.06–1.22)	<0.001*	–	
Medical history					
Acute renal failure		2.76 (1.48–5.01)	<0.001*	–	
History of severe COPD		1.43 (1.25–1.62)	<0.001*	–	
Bleeding disorders		2.04 (1.50–2.77)	<0.001*	4.67 (2.60, 8.39)	<0.001*
CHF		1.66 (1.15–2.40)	0.007*	1.59 (1.01, 2.51)	0.046*
Weight loss		1.40 (1.16–1.70)	<0.001*	–	
Dyspnea		1.20 (1.06–1.36)	0.004*	–	
Pre-operative transfusion		3.40 (2.60–4.43)	<0.001*	3.03 (2.15, 4.28)	<0.001*

(Continued)

Table 2. (Continued)

Radical cystectomy		Before match, *N* = 19,158		After match, *N* = 10,222	
		LOS < 9 days, odds ratio (CI)	*p*-Value	LOS ⩾ 9 days, odds ratio (CI)	*p*-Value
Surgical characteristics					
Diversion type	Ileal conduit (Reference)	–	0.008*	–	
	Neobladder	1.13 (1.03–1.24)		–	
Operative time[b]		1.01 (1.007–1.01)	<0.001*	1.01 (1.004, 1.007)	<0.001*

Smoker is a current smoker within 1 year; Abnormal creatinine is serum creatinine ⩾1.5 mg/dL; Leukocytosis is WBC > 11×10^9 cells/L; Thrombocytopenia is platelet count < 150×10^3; Anemia is defined as hematocrit <36%; Hypertension indicates hypertension requiring medication; Weight loss is >10% loss body weight in the last 6 months; Blood Transfusion is receiving packed red blood cells 72 h before surgery.
[a]10-year increase in age.
[b]20-min increase in operative time.
*Significant $p < 0.05$.
ASA, American Society of Anesthesiologists; BMI, body mass index (kg/m^2); CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

assistance in activities of daily living and may also lack social support at home; thereby, encouraging an extended hospital stay. In fact, lack of social support has been previously shown to be a significant determinant of PLOS whereby married patients were less likely to have a PLOS as compared to single patients.[22] Moreover, patients lacking social support may find it difficult to return for ureteral stent removal or Foley catheter irrigation, in the case of neobladder or continent diversion, and thus may elect to stay longer in hospital. In addition, increased age is also associated with increased morbidity that leads to an increased length of stay.[23] As age increases, physiological reserves in patients decrease; hence impairing a patient's surgical recovery process.[24]

Smoking status was also found to cause an increased risk of PLOS. In a recent meta-analysis by Tellini *et al.*,[25] smokers undergoing RC were at an increased risk for major post-operative complications and infections, that eventually would lead to a prolonged length of hospital stay. This can be related to the immunosuppressive effect of tobacco smoking which leads to delayed wound healing and impaired respiratory function.[26] In addition, smokers may face withdrawal symptoms after performing surgery ranging from anxiety, irritability, and anhedonia to depression[27]; all of which can contribute to PLOS. Moreover, Kanova *et al.*[28] observed that Nicotine Replacement therapy during hospitalization of surgical patients didn't reduce the incidence of delirium nor the length of stay.[28]

Interestingly, non-White patients witnessed a two-fold increase in the odds of PLOS as compared to White patients in our study. These findings were similar to Gild *et al.*[29] results that demonstrated that non-White patients had higher odds of PLOS following RC when compared to White patients.[29] These findings can be attributed to confounding variables that are not accounted for in the NSQIP database, such as education level, economic status, income level, access to health care and rehabilitation services, stable housing, and cultural considerations. Racial disparities, which may stem from unequal access to nursing care outside the hospital, as well as various socio-economic factors hinder patients from being discharged earlier and receiving adequate stoma care or neobladder care outside the hospital setting. The discrepancy in education and socioeconomic level between White and non-White patients, the significant treatment delay in Black patients, and the racial disparity in care may contribute to the longer hospital stay in non-White patients.[29]

Furthermore, having a bleeding disorder, requiring pre-operative transfusion, and prolonged OT were all found to be independent predictors of PLOS. We could hypothesize that patients with a known bleeding disorder and those who required

Table 3. Patient 30-day complications between length of stay <9 and ⩾9 days before and after propensity score matching.

Radical cystectomy	Before match, N = 19,158			After match, N = 10,222		
	Length of stay		p-Value	Length of stay		p-Value
	<9 days, N = 13,151	⩾9 days, N = 6007		<9 days, N = 5111	⩾9 days, N = 5111	
	N (%) or Mean ± SD	N (%) or Mean ± SD		N (%) or Mean ± SD	N (%) or Mean ± SD	
Urinary tract infection	995 (7.6)	614 (10.2)	<0.001*	456 (8.9)	454 (8.9)	0.945
Superficial SSI	535 (4.1)	483 (8)	<0.001*	346 (6.8)	346 (6.8)	0.99
Deep incisional SSI	88 (0.7)	143 (2.4)	<0.001*	64 (1.3)	65 (1.3)	0.929
Wound disrupt	196 (1.5)	291 (4.8)	<0.001*	127 (2.5)	127 (2.5)	0.99
Pneumonia	170 (1.3)	383 (6.4)	<0.001*	90 (1.8)	90 (1.8)	0.99
Pulmonary embolism	141 (1.1)	167 (2.8)	<0.001*	74 (1.4)	74 (1.4)	0.99
Renal failure	86 (0.7)	146 (2.4)	<0.001*	36 (0.7)	36 (0.7)	0.99
CVA/stroke	37 (0.3)	56 (0.9)	<0.001*	15 (0.3)	16 (0.3)	0.857
Cardiac arrest requiring CPR	107 (0.8)	77 (1.3)	<0.001*	19 (0.4)	19 (0.4)	0.99
Bleeding transfusions	3779 (28.7)	2533 (42.2)	<0.001*	2055 (40.2)	2055 (40.2)	0.99
DVT/thrombosis	226 (1.7)	240 (4)	<0.001*	119 (2.3)	121 (2.4)	0.896
Sepsis	894 (6.8)	762 (12.7)	<0.001*	534 (10.4)	531 (10.4)	0.923
Septic shock	229 (1.7)	274 (4.6)	<0.001*	77 (1.5)	79 (1.5)	0.872
Death	183 (1.4)	211 (3.5)	<0.001*	56 (1.1)	56 (1.1)	0.99

*Significant $p < 0.05$.
CPR, cardiopulmonary resuscitation; CVA, cerebrovascular accident; DVT, deep vein thrombosis; SSI, surgical site infection.

transfusion would be kept for a longer hospital stay for close monitoring. Furthermore, an increase in OT translates into a more complex procedure that requires a longer post-operative course. This was also shown by Faraj *et al.*[30] who observed that increase in OT was associated with a significant increase in LOS. Moreover, OT and complication rates are two potentially modifiable variables that could shorten hospital stay duration. According to Judge *et al.*,[31] high-volume hospitals with experienced surgeons witness lower complication rates and OTs and thus a shorter hospital stay.

In conclusion, identifying patients at-risk for PLOS could aid in patient counseling, identification of better interventions to shorten hospital stay, improvement of quality of care, decrease of overall hospital costs, and fairer distribution of healthcare resources. Patient pre-operative counseling for PLOS can better prepare patients, surgeons, and surgical care teams for what to expect and plan accordingly for a smoother and shorter hospital stay.

Our study is not without limitations. First, the NSQIP database is limited to post-operative events occurring within 30 days after surgery, and thus data on patients with LOS > 30 days is not available. Furthermore, pre-operative oncologic parameters that include tumor grade and stage and the use of neoadjuvant chemotherapy, all of which could influence the LOS, are not recorded in the database. The NSQIP database lacks a specific variable for sarcopenia, which has been demonstrated as an independent predictor of both mortality and complications in RC; thus increasing the length of hospital stay.[32,33] Moreover, subjective factors such as patient preference or physician preference, in addition to socioeconomic factors including marital status, disposition after discharge, and type of guarantor were not captured in our study; all of which could be important factors that influence LOS. Lastly, the NSQIP dataset does not report on surgical approach (open *versus* MIS).

Conclusion

As a conclusion, our study showed that patient demographics and medical history can help predict PLOS for RC patients. These predictors could serve as tools for pre-operative patient counseling and risk stratification.

Declarations

Ethics approval and consent to participate

The de-identified database (ACS-NSQIP) does not constitute human subject research; therefore, no consent to participate or institutional review board (IRB) approval was required or attained.

Consent for publication

Not applicable.

Author contributions

Elia Abou Chawareb: Conceptualization; Data curation; Formal analysis; Project administration; Writing – original draft; Writing – review & editing.

Christian Habib Ayoub: Conceptualization; Data curation; Formal analysis; Project administration; Writing – original draft; Writing – review & editing.

Jad Najdi: Conceptualization; Writing – original draft; Writing – review & editing.

Joseph Ghoubaira: Writing – original draft; Writing – review & editing.

Albert El-Hajj: Conceptualization; Supervision; Writing – original draft; Writing – review & editing.

Acknowledgements

None.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Competing interests

The authors declare that there is no conflict of interest.

Availability of data and materials

The (ACS-NSQIP) data is subject to a data use agreement. To access the dataset a request to the ACS-NSQIP participant use form should be placed at the following link (https://www.facs.org/quality-programs/acs-nsqip/participant-use). The American University of Beirut Medical Center is enrolled in ACS-NSQIP as a participating center. As such the data was made available by the ACS-NSQIP center and the AUBMC Department of Surgery after signing the data use agreement.

ORCID iDs

Elia Abou Chawareb https://orcid.org/0000-0002-0757-896X

Christian Habib Ayoub https://orcid.org/0000-0003-2475-4256

References

1. Sung H, Ferlay J, Siegel RL, *et al*. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2021; 71: 209–249.
2. Lenis AT, Lec PM, Chamie K, *et al*. Bladder cancer: a review. *JAMA* 2020; 324: 1980–1991.
3. Abdollah F, Gandaglia G, Thuret R, *et al*. Incidence, survival, and mortality rates of stage-specific bladder cancer in United States: a trend analysis. *Cancer Epidemiol* 2013; 37: 219–225.
4. Witjes JA, Bruins HM, Cathomas R, *et al*. European association of urology guidelines on muscle-invasive and metastatic bladder cancer: summary of the 2020 guidelines. *Eur Urol* 2020; 79: 82–104.
5. Nasrallah AA, Mansour M, Abou Heidar NF, *et al*. Risk factors for wound dehiscence following radical cystectomy: a prediction model. *Ther Adv Urol* 2021; 13: 17562872211060570.
6. Ayoub CH, Dakroub A, El-Asmar JM, *et al*. Preoperative MELD score predicts mortality and adverse outcomes following radical cystectomy: analysis of American College of Surgeons National Surgical Quality Improvement Program. *Ther Adv Urol* 2022; 14: 17562872221135944.
7. Shabsigh A, Korets R, Vora KC, *et al*. Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized

reporting methodology. *Eur Urol* 2009; 55: 164–174.

8. Moore L, Stelfox HT, Turgeon AF, *et al*. Derivation and validation of a quality indicator of acute care length of stay to evaluate trauma care. *Ann Surg* 2014; 260: 1121–1127.
9. Baek H, Cho M, Kim S, *et al*. Analysis of length of hospital stay using electronic health records: a statistical and data mining approach. *PLoS One* 2018; 13: e0195901.
10. Hajj AE, Labban M, Ploussard G, *et al*. Patient characteristics predicting prolonged length of hospital stay following robotic-assisted radical prostatectomy. *Ther Adv Urol* 2022; 14: 17562872221080737.
11. Khan NA, Quan H, Bugar JM, *et al*. Association of postoperative complications with hospital costs and length of stay in a tertiary care center. *J Gen Intern Med* 2006; 21: 177–180.
12. Kim SP, Shah ND, Karnes RJ, *et al*. The implications of hospital acquired adverse events on mortality, length of stay and costs for patients undergoing radical cystectomy for bladder cancer. *J Urol* 2012; 187(6): 2011–2017.
13. Sathianathen NJ, Jarosek S, Lawrentschuk N, *et al*. A simplified frailty index to predict outcomes after radical cystectomy. *Eur Urol Focus* 2019; 5: 658–663.
14. Jensen BT, Lauridsen SV and Jensen JB. Optimal delivery of follow-up care after radical cystectomy for bladder cancer. *Res Rep Urol* 2020; 12: 471–486.
15. Collins TC, Daley J, Henderson WH, *et al*. Risk factors for prolonged length of stay after major elective surgery. *Ann Surg* 1999; 230: 251–259.
16. Chang SS, Baumgartner RG, Wells N, *et al*. Causes of increased hospital stay after radical cystectomy in a clinical pathway setting. *J Urol* 2002; 167: 208–211.
17. Taub DA, Dunn RL, Miller DC, *et al*. Discharge practice patterns following cystectomy for bladder cancer: evidence for the shifting of the burden of care. *J Urol* 2006; 176: 2612–2617.
18. Trinh QD, Bianchi M, Sun M, *et al*. Discharge patterns after radical prostatectomy in the United States of America. *Urol Oncol* 2013; 31: 1022–1032.
19. Pietzak EJ, Hwang WT, Malkowicz SB, *et al*. Factors influencing the length of stay after radical cystectomy: implications for cancer care and perioperative management. *Ann Surg Oncol* 2014; 21: 4383–4389.
20. Lee KL, Freiha F, Presti JC Jr, *et al*. Gender differences in radical cystectomy: complications and blood loss. *Urology* 2004; 63: 1095–1099.
21. Cárdenas-Turanzas M, Cooksley C, Kamat AM, *et al*. Gender and age differences in blood utilization and length of stay in radical cystectomy: a population-based study. *Int Urol Nephrol* 2008; 40: 893–899.
22. Ray-Zack MD, Shan Y, Mehta HB, *et al*. Hospital length of stay following radical cystectomy for muscle-invasive bladder cancer: development and validation of a population-based prediction model. *Urol Oncol* 2019; 37: 837–843.
23. Cole KL, Kazim SF, Thommen R, *et al*. Association of baseline frailty status and age with outcomes in patients undergoing intracranial meningioma surgery: results of a nationwide analysis of 5818 patients from the National Surgical Quality Improvement Program (NSQIP) 2015–2019. *Eur J Surg Oncol* 2022; 48: 1671–1677.
24. Massarweh NN, Legner VJ, Symons RG, *et al*. Impact of advancing age on abdominal surgical outcomes. *Arch Surg* 2009; 144: 1108–1114.
25. Tellini R, Mari A, Muto G, *et al*. Impact of smoking habit on perioperative morbidity in patients treated with radical cystectomy for urothelial bladder cancer: a systematic review and meta-analysis. *Eur Urol Oncol* 2021; 4: 580–593.
26. Sopori M. Effects of cigarette smoke on the immune system. *Nat Rev Immunol* 2002; 2: 372–377.
27. Benowitz NL. Nicotine addiction. *N Engl J Med* 2010; 362: 2295–2303.
28. Kanova M, Tejkalova K, Neiser J, *et al*. Nicotine replacement therapy in surgical patients. *Neuro Endocrinol Lett* 2021; 42: 305–311.
29. Gild P, Wankowicz SA, Sood A, *et al*. Racial disparity in quality of care and overall survival among black *versus* white patients with muscle-invasive bladder cancer treated with radical cystectomy: a national cancer database analysis. *Urol Oncol* 2018; 36: 469.e1–469.e11.
30. Faraj KS, Judge N, Blodgett G, *et al*. Relationship between operative duration and perioperative outcomes after radical cystectomy. *Can J Urol* 2021; 28: 10603–10609.
31. Judge A, Evans S, Gunnell DJ, *et al*. Patient outcomes and length of hospital stay after radical prostatectomy for prostate cancer: analysis of hospital episodes statistics for England. *BJU Int* 2007; 100: 1040–1049.

32. Mayr R, Gierth M, Zeman F, *et al*. Sarcopenia as a comorbidity-independent predictor of survival following radical cystectomy for bladder cancer. *J Cachexia Sarcopenia Muscle* 2018; 9: 505–513.

33. Mayr R, Fritsche HM, Zeman F, *et al*. Sarcopenia predicts 90-day mortality and postoperative complications after radical cystectomy for bladder cancer. *World J Urol* 2018; 36: 1201–1207.

Visit Sage journals online journals.sagepub.com/home/tau

Sage journals