Published in final edited form as:

J Urol. 2011 January ; 185(1): 90–96. doi:10.1016/j.juro.2010.09.021.

EFFECT OF PRE-OPERATIVE NUTRITIONAL DEFICIENCY ON MORTALITY AFTER RADICAL CYSTECTOMY FOR BLADDER CANCER

Justin R. Gregg¹, Michael S. Cookson¹, Sharon Phillips², Shady Salem¹, Sam S. Chang¹, Peter E. Clark¹, Rodney Davis¹, C.J. Stimson Jr.¹, Monty Aghazadeh¹, Joseph A. Smith Jr.¹, and Daniel A. Barocas^{1,3}

¹Vanderbilt University Medical Center, Department of Urologic Surgery, Nashville, TN

²Vanderbilt University Medical Center, Department of Biostatistics, Nashville, TN

³Vanderbilt University Medical Center, Center for Surgical Quality and Outcomes Research, Nashville, TN

Abstract

Introduction and Objectives—Poor preoperative nutritional status is a risk factor for adverse outcomes after major surgery. We evaluated the effect of preoperative nutritional deficiency (ND) on peri-operative mortality and overall survival in patients undergoing radical cystectomy (RC) for bladder cancer.

Methods—538 patients underwent RC for urothelial carcinoma (UC) between January 2000 and June 2008 and had nutritional parameters documented. Patients with preoperative albumin <3.5 g/dL, BMI <18.5 or pre-surgical weight loss >5% of body weight were considered ND. Primary outcomes were 90-day mortality and overall survival. Survival was estimated using Kaplan–Meier analysis and compared using the log-rank test. Cox proportion hazards models were used for multivariate survival analysis.

Results—103 of 538 patients (19%) met criteria for ND. 90-day mortality was 7.3% overall (39 deaths); 16.5% in patients with ND and 5.1% in the others, $p < 0.01$. ND was a strong predictor of death within 90 days on multivariate analysis (HR 2.91, 95% CI [1.36, 6.23], $p < 0.01$). Overall survival at 3 years was 44.5% (33.5, 54.9) for ND patients and 67.6% (62.4, 72.2) for nutritionally normal patients, $p < 0.01$. On multivariate analysis, ND patients had significantly higher risk of all-cause mortality (HR 1.82, 95% CI [1.25, 2.65], $p < 0.01$).

Conclusions—Nutritional deficiency, as measured by preoperative weight loss, BMI and serum albumin, is a strong predictor of 90-day mortality and poor overall survival. Prospective studies are needed to demonstrate the best indices of preoperative nutritional status and whether nutritional intervention can alter the poor prognosis for RC patients with nutritional deficiencies.

Keywords

Bladder Cancer; Cystectomy; Nutritional Status; Albumin; Outcome

Introduction

There are approximately 70,980 new cases of bladder cancer (BC) annually in the United States, about 25% of which involved muscle-invasive disease¹. Radical cystectomy (RC) remains the standard treatment for muscle invasive BC² and also has a role in treating non-muscle invasive BC. RC is associated with excellent 5-year recurrence-free survival in lymph-node negative (78%) and even lymph-node positive (35%) patients³. However, as many as two thirds of patients suffer one or more complications within 90 days of surgery⁴. The 30-day perioperative mortality in patients having undergone RC is estimated at between 1 and 3%, but it may be as high as 7% within 90 days of surgery^{4, 6, 7}. Known risk factors for peri-operative death and other severe complications include age, estimated blood loss (EBL), prior abdominal/pelvic surgery and ASA score >2 ⁴. Risks for overall mortality include preoperative stage, tumor size, margin status, extravesical involvement, margin status and older age^{3, 8}.

In general surgical patients, nutritional deficiency is a well known risk factor for complications, such as infection and poor wound healing, and may influence perioperative mortality and overall survival⁹. However, the role of nutritional deficiency in the outcomes of BC patients undergoing RC has been incompletely explored.

No standardized method exists to evaluate patients for nutritional risk preoperatively¹⁰. Serum albumin is often part of a nutritional evaluation and low preoperative serum albumin predicts mortality in various groups of surgical patients including those undergoing RC¹¹⁻¹³. Preoperative BMI <18.5 , the World Health Organization definition of “underweight”¹⁴, is associated with increased peri-operative mortality in patients who have undergone surgery for intra-abdominal cancers¹⁵. Weight loss has also been associated with decreased survival in advanced stage cancer patients¹⁶.

In RC patients, studies suggest that complications and mortality after RC may be associated with each of these nutritional parameters^{13, 17, 18}. Thus, our aim was to explore the effect of preoperative nutritional status, as measured by pre-operative body mass index (BMI), weight loss and serum albumin, on 90-day mortality and overall survival in a large cohort of BC patients undergoing RC.

Methods

Patient Selection and Exclusion Criteria

We performed a retrospective cohort study of 905 consecutive patients who underwent RC at Vanderbilt University Medical Center (VUMC) between January 2000 and June 2008. RC was performed and post-operative care administered as previously described by Lowrance et al.⁷. Pathologic specimens were evaluated by a staff surgical pathologist and staged according to American Joint Committee on Cancer guidelines¹⁹.

Institutional Review Board approval was obtained for the creation of a prospective database and for this study in particular. Clinical, pathological and outcome data were collected prospectively and were supplemented by review of the medical records. We excluded patients who underwent cystectomy for non-urothelial carcinoma, such as pure squamous or adenocarcinoma (n=80) or for salvage therapy after radiation therapy or chemo-radiation therapy with curative intent (n=24). Out of this potential cohort of 801, we were able to categorize 538 (67.2%) with respect to nutritional status.

In 335/538 patients (62.3%), information related to nutrition status was gathered from structured dietary evaluation by a registered dietician. In the remainder (203/538 patients

[37.7%]), nutritional status information was gathered through review of the electronic medical records. Patients were classified into two groups: “Nutritionally Normal” and “Nutritionally Deficient” (ND). ND was defined as the presence of one or more of the following factors: pre-operative albumin lower than the lower bound of VUMC normal values (3.5-5 g/dL), unintentional pre-operative weight loss of greater than or equal to 5% of body weight, or pre-operative BMI under 18.5 (Table 1).

Covariates including age, sex, race, smoking status, preoperative hematocrit, ASA classification, Charlson Comorbidity Index (CCI), neoadjuvant chemotherapy, diversion type, peri-operative complications, transfusion rate, pathologic stage, pathologic cell type, and lymph node status were obtained through patient charts. Vital status was ascertained through the VUMC cancer registry, the Social Security Death Index and patient charts. Patients were censored at the date of last follow-up or date of death up to August 1, 2009.

Our objective was to investigate and model the relationship between ND and survival after RC. The primary outcomes measured were mortality within 90 days of surgery mortality after 90 days, and overall survival. Clinical variables, including demographic information, procedural details and disease characteristics, were investigated as potential confounders of the relationship of interest. These characteristics were compared across groups using Kruskal-Wallis tests and Wilcoxon rank-sum tests for continuous variables and Fisher’s exact tests for categorical variables. 90-day and overall survival were evaluated with Kaplan-Meier curves and log-rank tests. Cox proportional hazards models for 90-day, post 90-day and overall survival were constructed. Variables included in these models were age-adjusted Charlson Comorbidity Index, transfusion, complications, lymph node density, and pathologic stage. The additional number of events in the overall survival model enabled us to add age, race, sex, smoking status and histology (pure urothelial carcinoma vs. mixed) as covariates.

The predictive value of the ND composite variable was compared with all of its components and with preoperative serum albumin alone in separate models. Bootstrap validation with 200 model repetitions was performed in order to determine the bias in these models. Models with the least amount of bias are considered strongest.

All tests of significance were two-tailed. A p value <0.05 was considered significant. Scaled Schoenfeld residuals were computed separately for each predictor to test the Proportional Hazards (PH) assumption using the “correlation with time” test. Plots of the residuals were also examined in testing the PH assumption. Statistical analyses were performed using Stata 10.0 software (Stata Corporation, College Station, TX, USA) and R version 2.10.1 (R Development Core Team, 2008).

Results

Out of 538 patients, 103 (19%) had one or more of the following: preoperative albumin <3.5 g/dL (29 patients [6%]), BMI <18.5 (18 patients [3%]) and weight loss ≥5% (71 patients [13%]) (Table 1).

Table 2 shows characteristics of the cohort with respect to ND. Mean age was 68.3 years (SD 10.0 years); 79% of the population was male and 94% were white. Median follow-up of patients alive at last visit was 31.3 months and 181/538 (34.6%) patients had died. We found no differences in baseline characteristics, peri-operative and pathologic outcomes, 90-day mortality, post 90-day mortality and overall survival between included and excluded patients (n=367 [40.6%]).

Patients in the nutritionally deficient and nutritionally normal groups differed with respect to a number of baseline variables (Table 2). The ND patients were older, more commonly female, non-white, had higher ASA and Charlson Comorbidity Index ($p < 0.05$ for each).

90-day mortality was 7.3% overall (39 deaths in 534 patients with follow up); 16.5% (17/103) in patients with ND and 5.1% (22/431) in the nutritionally normal patients. Kaplan-Meier estimated 90-day survival was 84.2% (95% CI [75.5, 90.0]) for ND patients vs. 94.9% (92.3, 96.6) for others, $p < 0.01$ (Figure 1a). ND was a strong predictor of death within 90 days on Cox proportional hazard model (HR 2.91, 95% CI [1.36, 6.23], $p = 0.01$) after controlling for age-adjusted CCI, transfusion rate, complications, lymph node density and pathologic stage (Table 3).

The same model was used to identify predictors of overall survival *after* 90 days. ND was also a significant predictor of death after 90 days (HR 1.55, 95% CI [1.01, 2.38], $p = 0.04$) (Table 3).

Overall survival at 3 years was 44.5% (33.5, 54.9) for patients with ND and 67.6% (62.4, 72.2) for other patients, $p < 0.01$. Kaplan-Meier survival curve is shown in Figure 1b. Cox proportional hazards model showed that patients with ND had a significantly higher risk of death (HR 1.82, 95% CI [1.25, 2.65], $p < 0.01$), after controlling for age, sex, race, smoking status, Age-Adjusted CCI, preoperative hematocrit, transfusion, cell type, lymph node density, and pathologic stage (Table 4).

A multivariable model for all cause mortality was run with preoperative albumin, BMI, and weight loss (the three risk factors used to determine ND) along with all covariates used in the previous multivariate model. Of the ND components, only preoperative albumin (75th percentile vs. 25th percentile) was significantly associated with all cause mortality (HR 0.52, 95% CI [0.39, 0.69], $p < 0.01$). Omitting BMI and weight loss from the model had little effect on the hazard ratio or that of the covariates in the model, nor did it significantly change the likelihood ratio of the model, suggesting that BMI and weight loss do not add significantly to the prediction of all-cause mortality.

Bootstrap validation demonstrated that the model with the least bias was the one using preoperative albumin alone as the exposure variable. Addition of BMI and weight loss did not reduce the bias of the model, and replacing albumin with the nutritional deficiency composite measure was worse. Again, albumin alone seemed to be at least as strong of a predictor of all-cause mortality as all nutritional factors individually or the composite measure.

Discussion

In this study, we found that preoperative ND (measured by low BMI, low serum albumin and/or preoperative weight loss) is predictive of increased 90-day mortality and poor overall survival after RC. Secondary analyses using albumin level alone demonstrated that albumin level may be a sufficient index of preoperative nutritional status.

The quantification of nutritional status is controversial. While albumin may be a suitable marker of nutrition status on its own, it may be an index of disease severity, rather than an objective marker of nutrition status^{10, 20}. Given albumin's 20-day half-life, it is not an accurate measure of *acute* nutritional depletion, though it is useful when considering protein synthesis in chronic illness²¹. Suggested alternatives to albumin include pre-albumin and transferrin, proteins with shorter half-lives. However, all of these visceral proteins are affected by the acute phase response, which can complicate interpretation¹⁰. In our study, albumin was a strong predictor of mortality individually, though the number of patients with

a sub-normal albumin alone was quite low (6%). From this study, it is difficult to tell whether albumin alone or as part of the ND composite measure is the best way to evaluate preoperative RC patients, though the latter is much more inclusive.

A number of composite measures of nutritional status have been proposed, though no standardized method of nutrition evaluation exists¹⁰. In patients undergoing gastrointestinal surgery, measurements such as the Nutritional Risk Index (NRI), which uses preoperative albumin and weight loss to calculate risk, and the more subjective Nutritional Risk Score (NRS), which uses BMI, weight loss, appetite, dysphagia and disease severity to determine risk, have been shown to predict the incidence and severity of post-operative complications²². Using a version of the NRS designed specifically for urologic patients, up to 16% of urologic patients were deemed at severe risk of malnutrition²³. While the NRS is a validated index, its reliance on subjective information could limit its applicability. The components we selected to define ND (serum albumin level < 3.5, BMI < 18.5 and unintentional weight loss > 5% of body weight) are easily obtained by clinicians as part of the standard preoperative evaluation. Furthermore, studies have previously suggested that each component may be associated with mortality after RC^{13, 17, 18}. Poor nutritional status has been associated with adverse health outcomes in a number of other settings. In a prospective study of 54,215 surgical patients at 14 academically-affiliated Veterans Affairs centers, patients with a 1.0g/dL decrease in serum albumin level had a 2-fold increased risk of 30-day mortality¹¹. Similarly, Beghetto et al evaluated 434 medical and surgical inpatients to determine whether nutritional parameters (albumin < 3.5, weight loss > 5%, BMI < 18.5, lymphocyte count < 1500, and Subjective Global Assessment score indicating severe malnutrition) were predictive of in-hospital death and other adverse outcomes. Multivariate analysis revealed that albumin was the only nutritional parameter predictive of in-hospital mortality²⁴. In a multi-center prospective cohort of 2258 patients who underwent major intra-abdominal cancer surgery, patients with a preoperative BMI < 18.5 had greater than a 5-fold increased risk of peri-operative mortality¹⁵.

As demonstrated in this study, up to 19% of RC patients present with poor nutritional status. For the first several weeks after surgery, many RC patients have sub-optimal enteral nutrition, which can be exacerbated by common complications, such as ileus and infection^{4, 5}. Moreover, the protein and energy requirements increase after surgery,²⁵ thus elevating the importance of a patient's nutritional reserve. However, few studies have attempted to identify nutritional factors predictive of post-operative mortality in patients undergoing RC. Notably, Hollenbeck et al. recently demonstrated in a cohort of over 2,500 patients who had undergone RC that low preoperative serum albumin was associated with increased peri-operative mortality¹³. Studies in smaller BC cohorts have also suggested that, preoperative weight loss and height/weight ratios were predictive of complications and mortality after RC^{17, 18}. These studies were limited, however, by sample size (n≤69).

Ultimately, the importance of preoperative nutritional assessment will be determined by its ability to risk stratify RC patients and predict whether individual patients may benefit from preoperative intervention. Individual studies have shown that peri-operative nutritional intervention in malnourished surgical patients reduces the rate of complications and mortality, while meta-analyses suggest the benefit may be limited to reduction in complication rates^{26, 27}. Despite the promise of nutritional intervention, no large studies exist evaluating the role of nutrition supplementation in RC patients.

A recent prospective analysis of 28 RC patients demonstrated that the use of a combination protocol of TPN and enteral nutrition was not effective at reducing post-operative ileus and did not prevent the decline of serum chemistry markers such as serum albumin²⁸. However, this study's power to detect a difference in complication rates or surrogate markers may be

limited because the researchers did not target an at-risk population and because of the small sample size. Larger-scale prospective studies are needed to determine what the best markers are for nutritional status and whether nutritional intervention benefits nutritionally deficient patients undergoing RC.

Our study has important limitations as well as strengths. The small proportion of patients undergoing neoadjuvant chemotherapy made it impossible for us to determine the interaction between neoadjuvant chemotherapy and ND. In addition, there are no established criteria to evaluate preoperative nutritional status before undergoing RC and we were limited to a restricted range of nutritional parameters. On the other hand, despite the retrospective nature of the data collection, more than 2/3 of patients in our database had preoperative nutritional data available and more than 60% of these patients had undergone a structured nutritional evaluation with a registered dietician. A prospective study design with scheduled ascertainment of a variety of nutritional parameters and patient outcomes would address many of these limitations.

Conclusion

This study showed that nutritional deficiency in BC patients undergoing RC is associated with increased 90-day mortality and poor overall survival. These findings better equip physicians and patients to discuss the risks associated with this procedure. Prospective studies are needed to identify the most important components of a preoperative nutritional evaluation and to determine the potential impact of nutritional intervention in nutritionally deficient patients undergoing RC.

Acknowledgments

Funding: Supported in part by NIH/NIEHS K12 ES15855 (DAB K-12 Scholar).

References

1. Jemal A, Siegel R, Ward E, et al. Cancer statistics, 2009. *CA Cancer J Clin* 2009;59:225. [PubMed: 19474385]
2. Bischoff CJ, Clark PE. Bladder cancer. *Curr Opin Oncol* 2009;21:272. [PubMed: 19370808]
3. Stein JP, Lieskovsky G, Cote R, et al. Radical cystectomy in the treatment of invasive bladder cancer: long-term results in 1,054 patients. *J Clin Oncol* 2001;19:666. [PubMed: 11157016]
4. 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. [PubMed: 18675501]
5. Chang SS, K. M. The metabolic complications of urinary diversion. *Urologic Oncology* 2000;5:60–70. [PubMed: 21227290]
6. Konety BR, Dhawan V, Allareddy V, et al. Impact of hospital and surgeon volume on in-hospital mortality from radical cystectomy: data from the health care utilization project. *J Urol* 2005;173:1695. [PubMed: 15821560]
7. Lowrance WT, Rumohr JA, Chang SS, et al. Contemporary open radical cystectomy: analysis of perioperative outcomes. *J Urol* 2008;179:1313. [PubMed: 18289578]
8. Shariat SF, Karakiewicz PI, Palapattu GS, et al. Outcomes of radical cystectomy for transitional cell carcinoma of the bladder: a contemporary series from the Bladder Cancer Research Consortium. *J Urol* 2006;176:2414. [PubMed: 17085118]
9. Mainous MR, Deitch EA. Nutrition and infection. *Surg Clin North Am* 1994;74:659. [PubMed: 8197536]
10. Barbosa-Silva MC. Subjective and objective nutritional assessment methods: what do they really assess? *Curr Opin Clin Nutr Metab Care* 2008;11:248. [PubMed: 18403920]

11. Gibbs J, Cull W, Henderson W, et al. 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. [PubMed: 9927128]
12. Rady MY, Ryan T, Starr NJ. Clinical characteristics of preoperative hypoalbuminemia predict outcome of cardiovascular surgery. *JPEN J Parenter Enteral Nutr* 1997;21:81. [PubMed: 9084010]
13. Hollenbeck BK, Miller DC, Taub DA, et al. The effects of adjusting for case mix on mortality and length of stay following radical cystectomy. *J Urol* 2006;176:1363. [PubMed: 16952633]
14. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser* 2000;894:i. [PubMed: 11234459]
15. Mullen JT, Davenport DL, Hutter MM, et al. Impact of body mass index on perioperative outcomes in patients undergoing major intra-abdominal cancer surgery. *Ann Surg Oncol* 2008;15:2164. [PubMed: 18548313]
16. Dewys WD, Begg C, Lavin PT, et al. Eastern Cooperative Oncology Group. Prognostic effect of weight loss prior to chemotherapy in cancer patients. *Am J Med* 1980;69:491. [PubMed: 7424938]
17. Enig B, Winther E, Hessov I. Nutritional status of patients with cancer of the bladder before and during radiation therapy. Influence on survival? *Radiother Oncol* 1986;5:277. [PubMed: 3726166]
18. Terry WJ, Bueschen AJ. Complications of radical cystectomy and correlation with nutritional assessment. *Urology* 1986;27:229. [PubMed: 3952912]
19. Page, DL.; F., I.; Fritz, A.; Balch, CM.; Haller, DG.; Morrow, M. *AJCC Cancer Staging Manual*. 6th ed. Springer; 2002.
20. Seres DS. Surrogate nutrition markers, malnutrition, and adequacy of nutrition support. *Nutr Clin Pract* 2005;20:308. [PubMed: 16207668]
21. Fazio, VW.; C., J.; Delaney, CP. *Current Therapy in Colon and Rectal Surgery*. 2nd ed.. Elsevier Mosby; Philadelphia, PA: 2005. Serum Albumin Level.
22. Schiesser M, Kirchhoff P, Muller MK, et al. The correlation of nutrition risk index, nutrition risk score, and bioimpedance analysis with postoperative complications in patients undergoing gastrointestinal surgery. *Surgery* 2009;145:519. [PubMed: 19375611]
23. Karl A, Rittler P, Buchner A, et al. Prospective assessment of malnutrition in urologic patients. *Urology* 2009;73:1072. [PubMed: 19232689]
24. Beghetto MG, Luft VC, Mello ED, et al. Accuracy of nutritional assessment tools for predicting adverse hospital outcomes. *Nutr Hosp* 2009;24:56. [PubMed: 19266114]
25. Kiyama T, Witte MB, Thornton FJ, et al. The route of nutrition support affects the early phase of wound healing. *JPEN J Parenter Enteral Nutr* 1998;22:276. [PubMed: 9739029]
26. Bozzetti F, Gavazzi C, Miceli R, et al. Perioperative total parenteral nutrition in malnourished, gastrointestinal cancer patients: a randomized, clinical trial. *JPEN J Parenter Enteral Nutr* 2000;24:7. [PubMed: 10638466]
27. Heyland DK, Montalvo M, MacDonald S, et al. Total parenteral nutrition in the surgical patient: a meta-analysis. *Can J Surg* 2001;44:102. [PubMed: 11308231]
28. Maffezzini M, Gerbi G, Campodonico F, et al. A multimodal perioperative plan for radical cystectomy and urinary intestinal diversion: effects, limits and complications of early artificial nutrition. *J Urol* 2006;176:945. [PubMed: 16890663]

Figure 1. Kaplan-Meier estimated survival in Nutritionally Deficient patients compared to Not Nutritionally Deficient controls: A. 90-Day Mortality (Log-rank $p < 0.01$). B. Overall Survival (Log-rank $p < 0.01$).

Table 1

Cohort Nutritional Status

Characteristic	Strata	Number (percentage)
Albumin	<3.5g/L	29 (6%)
	≥3.5g/L	493 (94%)
BMI	<18.5	18 (3%)
	≥18.5 & <25	168 (32%)
	≥25 & <30	200 (38%)
	≥30 & <40	125 (24%)
	≥40	11 (2%)
Weight Loss	>10%	33 (6%)
	5-10%	38 (7%)
	None-<5%	467 (87%)
Normal Nutrition Status		435 (81%)
Nutritionally Deficient		103 (19%)

BMI = Body Mass Index; Nutritionally deficient was defined as having one or more of the following: preoperative serum albumin level below 3.5g/L, preoperative BMI of less than 18.5, and weight loss greater than or equal to 5% of previous body weight.

Table 2

Patient Characteristics and Nutritional Deficiency

Characteristic	Whole Cohort	Nutritionally Deficient	Nutritionally Normal	P Value
Patient Age (mean (SD))	68.3 (10.0)	71.2 (10.0)	67.6 (10.0)	<0.01 *
<u>Sex (N)</u>				<0.01 †
Male	420 (79%)	68 (67%)	352 (81%)	
Female	115 (21%)	34 (33%)	81 (19%)	
<u>Race</u>				0.03 †
White	505 (94%)	92 (89%)	413 (95%)	
Non-white	33 (6%)	11 (11%)	22 (5%)	
<u>Smoking Status</u>				0.83 †
Smoked in Past	440 (82%)	85 (83%)	355 (82%)	
Never smoked	98 (18%)	18 (17%)	80 (18%)	
Preoperative Hematocrit (mean (SD))	41.27 (5.0)	39.0 (6.0)	41.8 (5.0)	<0.01 *
<u>ASA Class</u>				0.03 †
1	2 (0%)	0 (0%)	2 (0%)	
2	133 (25%)	19 (18%)	114 (26%)	
3	371 (69%)	74 (72%)	297 (68%)	
4	32 (6%)	10 (10%)	22 (5%)	
Age-adjusted Charlson Comorbidity Index (mean (SD))	3.9 (2.0)	4.41 (2.0)	3.78 (2.0)	<0.01 *
<u>Diversion Type</u>				<0.01 †
Neobladder/Continent Cutaneous	165 (31%)	16 (16%)	149 (34%)	
Ileal Conduit	370 (69%)	87 (84%)	283 (66%)	
<u>Neoadjuvant Chemotherapy</u>				0.60 †
Received	17 (3%)	3 (3%)	14 (3%)	
Did Not Receive	521 (97%)	100 (97%)	421 (97%)	
<u>Transfusion</u>				0.06 †
Received	221 (42%)	51 (50%)	170 (40%)	
Did Not Receive	309 (58%)	51 (50%)	258 (60%)	
<u>Presence of Any Complication</u>				0.07 †
Yes	146 (30%)	20 (22%)	126 (32%)	
No	345 (70%)	71 (78%)	274 (68%)	
<u>Histology</u>				<0.01 †
Pure Urothelial Carcinoma	505 (94%)	87 (84%)	418 (96%)	
Mixed	33 (6%)	16 (16%)	17 (4%)	

Characteristic	Whole Cohort	Nutritionally Deficient	Nutritionally Normal	P Value
<u>Nodal Status</u>				0.21 [†]
Positive	123 (23%)	28 (28%)	95 (22%)	
Negative	411 (77%)	73 (72%)	338 (78%)	
Node Density (mean (SD))	0.10 (<0.001)	0.15 (<0.001)	0.09 (<0.001)	0.02*
<u>Pathologic Stage</u>				0.01 [†]
T0-T2b	302 (56%)	47 (46%)	255 (59%)	
T3a-T4	234 (44%)	56 (54%)	178 (41%)	

ASA = American Society of Anesthesiologists

* Wilcoxon rank-sum test

[†] Fisher's exact test

Table 3

Cox Proportional Hazards Model of 90-day and Post-90-day Mortality

Patient Characteristic	90-Day Mortality			Post-90-Day Mortality		
	Hazard Ratio	95% CI	P Value	Hazard Ratio	95% CI	P Value
Nutritionally Normal (ref.)	1					
Nutritionally Deficient	2.91	1.36-6.23	<0.01	1.55	1.01-2.38	0.04
AA CCI (cont.)	1.12	0.95-1.31	0.19	1.14	1.03-1.26	0.01
No Perioperative Transfusion (ref.)	1					
Perioperative Transfusion	2.59	1.17-5.74	0.02	1.36	0.94-1.96	0.10
No Complication Present (ref.)	1					
One or more complications	2.81	1.33-5.94	0.01	0.85	0.55-1.32	0.47
Lymph Node Density (cont.)	1.56	0.89-2.75	0.12	1.80	1.29-2.52	<0.01
Pathologic Stage 2b or Lower (ref.)	1					
Pathologic Stage 3a or Higher	2.28	1.03-5.06	0.04	2.59	1.76-3.81	<0.01

AA CCI = Age-adjusted Charlson Comorbidity Index ; ref. = referent ; cont. = continuous

Table 4

Cox Proportional Hazards Model of Overall Survival

Patient Characteristic	Hazard Ratio	95% CI	P Value
Nutritionally Normal (ref.)	1		
Nutritionally Deficient	1.82	1.25-2.65	<0.01
Age (cont.)	0.92	0.72-1.18	0.19
Female Sex (ref.)	1		
Male Sex	1.05	0.71-1.56	0.80
White Race (ref.)	1		
Non-White Race	1.02	0.53-1.94	0.96
Never Smoked (ref.)	1		
Current or Past Smoker	1.14	0.75-1.74	0.54
AA CCI (cont.)	1.08	0.96-1.20	0.20
Preoperative Hematocrit (cont.)	0.80	0.63-1.01	0.06
No Perioperative Transfusion (ref.)	1		
Perioperative Transfusion	1.32	0.92-1.90	0.13
Pure Urothelial Carcinoma (ref.)	1		
Mixed histology	1.62	0.93-2.83	0.09
Lymph Node Density (cont.)	1.84	1.39-2.43	<0.01
Pathologic Stage 2b or Lower (ref.)	1		
Pathologic Stage 3a or Higher	2.32	1.65-3.27	<0.01

AA CCI = Age-adjusted Charlson Comorbidity Index ; ref. = referent ; cont. = continuous