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Practice Patterns and Impact of Postchemotherapy Retroperitoneal Lymph Node Dissection on Testicular Cancer Outcomes

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Abstract

Background: Owing to surgical complexity and controversy regarding indications, there are wide practice variations in the use of postchemotherapy retroperitoneal lymph node dissection (PC-RPLND).

Objective: To evaluate patterns of PC-RPLND use in the USA and evaluate the association between PC-RPLND and survival in advanced nonseminomatous germ cell tumors (NSGCTs).

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Design, setting, and participants: A retrospective, observational study using National Cancer Data Base (NCDB) data from 2004–2014 for 5062 men diagnosed with stage II/III NSGCT.

Outcome measurements and statistical analysis: In a comparative analysis based on receipt of PC-RPLND, the primary outcome of interest was factors associated with omission of PC-RPLND as explored via logistic regression. As a secondary outcome, we evaluated the association between PC-RPLND and overall survival (OS) via multivariable Cox regression and propensity score matching (PSM).

Results and limitations: Patients undergoing PC-RPLND were more likely to be younger, white, privately insured, and reside in more educated/wealthier regions ($p < 0.001$). Insurance status was independently associated with receipt of PC-RPLND; compared to patients with private insurance, those without insurance were significantly less likely to receive PC-RPLND (odds ratio 0.49; $p < 0.001$). After multivariate adjustment, age, comorbidity, non-private insurance, distance from hospital, clinical stage, and risk group were independently associated with all-cause mortality. In addition, omission of PC-RPLND remained associated with all-cause mortality (hazard ratio 1.98; $p < 0.001$). After PSM, the 5-yr OS was significantly lower among those not undergoing PC-RPLND (72% vs 77%; $p = 0.007$).

Conclusions: PC-RPLND represents a critical part of the multidisciplinary management of NSGCT. Patients with non-private insurance are less likely to undergo PC-RPLND, and omission of PC-RPLND is associated with lower OS.

Patient summary: We evaluated the practice patterns for advanced testicular cancer management and found that patients who did not undergo a postchemotherapy retroperitoneal lymph node dissection were more likely to have worse survival outcomes. Patients with unfavorable insurance were less likely to receive this surgical treatment.

Keywords

Testis cancer; Germ cell tumor; Surgery; Retroperitoneal lymph node dissection

1. Introduction

Primary metastatic or relapsed advanced nonseminomatous germ cell tumors (NSGCTs) are typically managed with upfront platinum-based chemotherapy followed by assessment of radiographic response to chemotherapy and measurement of serum tumor markers (STMs). For many patients, the next step in management is a postchemotherapy retroperitoneal lymph node dissection (PC-RPLND), which has the potential to be diagnostic of residual retroperitoneal mass, to treat residual disease, and is the only treatment for chemoresistant teratoma. For patients with residual masses >1 cm and normal STMs, the standard of care is PC-RPLND. Although advocated by many centers as a standard of care following chemotherapy, the indications for PC-RPLND are controversial in certain cases, in particular in cases with a complete response (CR), subcentimeter residual masses, or resistance to chemotherapy [1]. Furthermore, there is wide practice pattern variation in the use of PC-RPLND. We previously found that lower-volume hospitals are significantly less likely to perform PC-RPLND, and postulated that some of the variability may be because of concerns

about the complexity of the operation and morbidity, as well as a lack of understanding regarding the biology of NSGCT [2].

Given the rarity of the disease, most publications on testicular germ cell tumor (TGCT) are single-center retrospective reviews, which are not necessarily reflective of nationwide practice patterns or socioeconomic factors that play a role in disease management. We used the National Cancer Data Base (NCDB) to study factors associated with the performance of PC-RPLND and the association between performance of PC-RPLND and survival in NSGCT.

2. Patients and methods

2.1. Data source

The NCDB is a national cancer registry sponsored by the American College of Surgeons (ACS) and the American Cancer Society that collects data on malignancies from ACS-Commission on Cancer (CoC) accredited facilities. It includes approximately 70% of all malignant cancers diagnosed in the USA from more than 1500 facilities [3]. The NCDB was queried for patients with TGCT diagnosed from 2004 to 2014.

2.2. Study population

There were 62 727 reported cases of testis cancer screened for inclusion. Figure 1 illustrates the case selection process. The International Classification of Disease for Oncology (3rd edition) was used to identify men diagnosed with NSGCT. Patients with non-testicular cancers, spermatocytic seminoma, sex cord/stromal tumors, seminoma, or unspecified germ cell tumors were excluded. Patients with unspecified American Joint Committee on Cancer (AJCC) clinical staging or stage 0–I disease were excluded. The CoC classifies patients according to the facility at which the malignancy was diagnosed and where the first-line treatment was provided. Patients who were not treated at the reporting facility (class of case “00”) were excluded. For patients treated at multiple CoC facilities, the NCDB reports the most recent treatment facility and/or the facility with the most complete records. Further information on CoC case classification and comparison of baseline demographics between patients included and those excluded because of missing or unknown selection parameters is provided in Supplementary Tables 1 and 2.

2.3. Definition of PC-RPLND

Receipt of PC-RPLND is not explicitly listed in the NCDB, but it can be inferred. Patients with nonlocalized disease are typically managed with upfront chemotherapy. Patients given chemotherapy within 60 d of NSGCT diagnosis were categorized as having received primary chemotherapy. Within this group, patients recorded as having undergone regional lymph node surgery (RPLND) after chemotherapy were classified as having undergone PC-RPLND.

2.4. Covariates

Covariates included age, AJCC clinical stage, Charlson-Deyo comorbidity index, race/ethnicity, insurance coverage, distance from hospital, socioeconomic factors in the form of

income and education in the patient's region and a measure of urban versus rural geography [4], and International Germ Cell Cancer Collaborative Group (IGCCCG) risk classification [5]. The IGCCCG risk group was calculated by assessing metastatic location and postorchietomy tumor marker status [5]. The CoC classifies hospitals according to facility type (eg, academic vs community) and geographic region; however, these variables are censored for patients younger than 39 yr. Given the young age at presentation of most men with testicular cancers, these variables were not included in the analysis.

2.5. Outcome

The primary outcome of interest was the association of PC-RPLND with overall survival (OS) measured from the time of diagnosis. As secondary outcomes, we analyzed patient and tumor factors associated with performance of PC-RPLND. In addition, we assessed the impact of PC-RPLND pathologic nodal staging on OS.

2.6. Statistical analysis

The mean $\pm$ standard deviation (SD) and median and interquartile range (IQR) are reported for normally and non-normally distributed continuous variables, respectively. Categorical and ordinal variables are presented as proportions. Baseline covariates were compared using the χ^2 test for categorical variables and the Mann-Whitney *U* test for continuous and ordinal variables. A binomial logistic regression analysis was performed to ascertain the effects of covariates on the likelihood that PC-RPLND would be performed on a patient. Patients in the last year of the study (2014) were excluded from survival analysis, as directed by the NCDB. Survival was estimated using univariate analysis according to the Kaplan-Meier method, and comparisons were performed using the log-rank test and unadjusted Cox regression analysis. To minimize selection bias, we performed propensity score matching (PSM) to account for differences in covariates between patients who received PC-RPLND and those who did not. Matching was performed in a nearest 1:1 fashion according to the propensity to receive PC-RPLND according to multivariate logistic regression analysis of all observed covariates used in the multivariate analysis. The goal of this technique is to balance the covariates between those who did and did not receive PC-RPLND. Survival analysis was performed using Kaplan-Meier estimates of OS between the groups and univariate Cox regression analysis. Landmark analysis was performed at 6 mo after the time of diagnosis to account for the potential effect of immortal time bias, which may favor patients who went on to receive PC-RPLND.

Statistical analysis was performed using SPSS 22.0 (IBM, Armonk, NY, USA) and the MatchIt R package was used to perform PSM [6]. Bonferroni correction was applied for multiple comparison testing. Two-sided statistical significance was defined as $p < 0.05$.

3. Results

After applying the exclusion criteria, we identified 5062 patients for analysis. Table 1 describes the baseline patient characteristics. The mean $\pm$ SD patient age was 29.8 ± 10.1 yr. The majority of patients were non-Hispanic white (77.4%), and privately insured (62.2%). Clinical stage grouping was stage II for 1684 patients (32.9%) and stage III for 3439 patients

(67.1%). The median follow-up from diagnosis was 41.6 mo (IQR 21.4–68.6). Of the overall cohort, 1230 (24.3%) underwent PC-RPLND and 3832 (75.7%) did not undergo PC-RPLND. Patients who underwent PC-RPLND were more likely to be younger (29.3 ± 9.5 vs 30.0 ± 10.3 yr; $p = 0.015$), white (81.6% vs 76.2%; $p < 0.001$), privately insured (72.6% vs 59.0%; $p < 0.001$), and to come from more highly educated/wealthier regions ($p < 0.001$). Patients who underwent PC-RPLND were also more likely to live further from their treating facility (median 17.8 miles, IQR 6.5–63.6 vs 9.7 miles, IQR 4.4–22.0; $p < 0.001$) and were less likely to have clinical stage III compared to stage II disease (61.5% vs 68.6%; $p < 0.001$).

On multivariate logistic regression, patients with clinical stage III disease were less likely to receive PC-RPLND (odds ratio [OR] 0.74, 95% confidence interval [CI] 0.63–0.88; $p = 0.001$). Compared to patients with good risk, those with intermediate-risk disease were more likely to undergo PC-RPLND (OR 1.74, 95% CI 1.17–2.59; $p = 0.006$). In addition, distance from a patient's residence to the hospital location was significantly associated with receiving PC-RPLND (OR 1.55, 95% CI 1.46–1.65; $p < 0.001$). Patient insurance status was independently associated with receipt of PC-RPLND; compared to patients with private insurance, those with Medicaid (OR 0.72, 95% CI 0.58–0.90; $p = 0.003$) or no insurance (OR 0.49, 95% CI 0.38–0.63; $p < 0.001$) were significantly less likely to receive PC-RPLND. After adjusting for other variables, patient race/ethnicity, comorbidity score, age, and zip-code income and education level were not associated with receipt of PC-RPLND (Table 2). All-cause mortality was reported for 725 patients. Table 3 lists results for univariate and multivariate survival analyses. On unadjusted univariate Cox regression analysis, patient age, higher comorbidity, minority race/ethnicity, non-private insurance coverage, lower median household income and education level, distance from hospital, clinical stage III (vs stage II), IGCCCG risk group other than good risk, and omission of PC-RPLND were significantly associated with higher risk of all-cause mortality. The 5-yr OS was 90% for those who underwent PC-RPLND versus 79% for those who did not ($p < 0.001$; Fig. 2A). After multivariate adjustment; age, comorbidity status, non-private insurance, distance from hospital, clinical stage, and IGCCCG risk group remained independently associated with all-cause mortality. In addition, omission of PC-RPLND remained significantly associated with all-cause mortality with (hazard ratio [HR] 1.98, 95% CI 1.56–2.51; $p < 0.001$).

Of the 1230 patients who underwent PC-RPLND, pathologic nodal stage was not recorded for 360 patients (29.3%), with pN0 in 300 patients (24.4%), pN1 in 153 patients (12.4%), pN2 in 192 patients (15.6%), and pN3 in 215 patients (17.5%). Among patients with available pathologic data, 65.1% had positive nodes on PC-RPLND. When assessing OS by pathologic nodal stage, those who did not undergo PC-RPLND had significantly worse OS (HR for all-cause mortality 1.68, 95% CI 1.30–2.16; $p < 0.001$) compared to pN0 patients (Fig. 3). All-cause mortality did not differ significantly between patients with pathologically positive nodes (pN1–3) and those with negative nodes (pN0) following PC-RPLND (HR 1.05, 95% CI 0.79–1.41; $p = 0.732$).

After PSM, there were 2278 patients in the analysis evenly split between those who underwent PC-RPLND ($n = 1139$) and those who did not ($n = 1139$). Table 4 demonstrates

that the baseline characteristics between the groups after PSM were evenly distributed, with the exception of distance from hospital. The 5-yr OS was 77% for those who underwent PC-RPLND versus 72% for those who did not ($p = 0.007$; Fig. 2B).

In a landmark analysis performed at 6 mo after NSGCT diagnosis in the PSM cohort, the survival difference between PC-RPLND and no PC-RPLND remained unchanged relative to the “naïve” analysis. A total of 398 patients (17.5%) were excluded from the landmark analysis because of <6 mo of follow-up due to death or censoring, leaving 1880 patients for analysis ($n = 935$ for no PC-RPLND, $n = 945$ for PC-RPLND). The 5-yr OS was 88% for the PC-RPLND group versus 82% for the no PC-RPLND group ($p < 0.001$; Fig. 2C).

4. Discussion

PC-RPLND plays a critical role in the multidisciplinary approach to patients with advanced testicular cancer. The rationale for PC-RPLND is to remove persistent lymph nodes that may contain mature teratoma in 30–40% or viable tumor in 10–20% of patients [7–10]. PC-RPLND not only provides crucial diagnostic information on the residual mass but can also have therapeutic benefit, and is the only definitive way of treating teratoma [11,12]. Approximately 70% of patients who present with metastatic NSGCT to the retroperitoneum achieve CR to chemotherapy, defined as normalization of STMs and radiographic resolution of the retroperitoneal mass [13]. Regarding the remaining 30% of patients with persistent radiographic masses and negative STMs, there is universal agreement that PC-RPLND is the treatment of choice because these masses can harbor viable GCT or teratoma. However, there is considerable debate regarding the definition of a persistent radiographic mass and the management of patients who achieve CR. Several groups reported that even with complete radiographic response to chemotherapy, 20–30% of patients had residual teratoma and 1–9% had viable GCT, demonstrating that the retroperitoneum remains difficult to accurately stage in the postchemotherapy setting [10,14–16]. Thus, several groups have attempted to develop preoperative clinical tools to predict the histology of postchemotherapy residual masses; however, these attempts have had limited success because of high false-negative rates [8,17–20]. Given the unpredictable behavior of subcentimeter residual masses, some centers recommend PC-RPLND even for patients who achieve CR [10,16]. Despite guidelines to standardize the treatment of NSGCT, institutional treatment variations continue to occur [2]. Our study sought to analyze factors associated with the performance of PC-RPLND and the association between PC-RPLND and survival. After multivariable adjustment, lack of private insurance remained significantly associated with omission of PC-RPLND. This is troubling, as it is unlikely that patients without insurance have any biologic differences in chemoresponsiveness to explain differences in PC-RPLND use. In addition, we found that patients with clinical stage III and IGCCCG poor risk were less likely to receive PC-RPLND. We speculate this may be because these patients have higher rates of platinum-resistant disease, necessitating salvage chemotherapy rather than PC-RPLND. Patients who underwent PC-RPLND were more likely to travel further to seek care, supporting centralization of TGCT management.

A concerning finding is that patients who did not undergo PC-RPLND had a twofold higher risk of all-cause mortality (HR 1.98; $p < 0.001$). This is consistent with a report by Fosså et

al [21], who described significantly higher mortality among NSGCT patients who did not undergo RPLND. Unfortunately, the NCDB does not allow determination of response to chemotherapy; therefore, no conclusions can be made regarding use of PC-RPLND among patients who achieved CR to chemotherapy, nor were we able to stratify patients according to residual mass size. Nevertheless, even among patients with CR observed by Ehrlich et al [22], the relapse rate in the retroperitoneum was 4%, and ultimately one-third of those who experienced relapse died of their disease. To take this one step further, if we assume that a significant proportion of patients had CR and PC-RPLND was intentionally omitted after shared decision-making that considered the risks and benefits of PC-RPLND, we still observed a dramatic effect on OS in the subgroup/minority of patients with residual disease who would have most likely benefited from PC-RPLND.

Recent data show that 17% of the young population in the USA remain uninsured [23]. Consistent with previous reports on socioeconomic disparities in testicular cancer [21,24,25], we find that unfavorable insurance status is an important determinant of survival. While some of this effect may be explained by delayed presentation and patient willingness to accept intensive treatment or monitoring, it is likely that there are also differences in how physicians approach management for insured versus uninsured patients. It is an unfortunate reality in our society that uninsured patients are more likely to present with metastatic disease, be undertreated, and die after a diagnosis of cancer [26]. These are especially alarming findings with respect to testicular cancer given its success story and potential for high cure rates. Ultimately, reductions in insurance gaps are needed to improve TGCT outcomes.

There are several limitations to the study that should be acknowledged. The NCDB does not provide information on response to chemotherapy, recurrence, or RPLND histology. In addition, performance of PC-RPLND is not specifically coded, but can rather be inferred from performance of regional lymph node surgery following chemotherapy. As mentioned previously, facility location and type were not analyzed as variables in our analysis as these are censored for patients younger than 39 yr because of privacy concerns. The NCDB does not allow for assessment of cancer-specific mortality; however, in TGCT this is less of a concern as the vast majority of patients are young and healthy, with few competing causes of mortality.

5. Conclusions

Our results suggest that unfavorable insurance status is independently associated with omission of PC-RPLND. In addition, we found that patients who do not undergo PC-RPLND have a higher risk of mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Postchemotherapy retroperitoneal lymph node dissection (PC-RPLND) is an integral part of nonseminomatous germ cell tumor management. We found that patients with unfavorable insurance were less likely to receive PC-RPLND and omission of this surgical treatment was independently associated with worse survival.

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Fig. 1 –.

Patient selection flow chart. NSGCT = nonseminomatous germ cell tumor; NOS = not otherwise specified; AJCC = American Joint Committee on Cancer; PC-RPLND = postchemotherapy retroperitoneal lymph node dissection.

Fig. 2 –.
Overall survival (OS) stratified by receipt of postchemotherapy retroperitoneal lymph node dissection (PC-RPLND) for (A) the unmatched cohort; (B) the propensity score–matched cohort; and (C) the propensity score–matched cohort with 6-mo landmark analysis.

Number at Risk

pN0	576	412	255	124	57	15
pN1-3	1050	805	483	249	114	36
No PC-RPLND	2500	1698	1033	543	255	69
Month	0	24	48	72	96	120

Fig. 3 –.

Overall survival (OS) stratified by pathologic nodal status. PC-RPLND = postchemotherapy retroperitoneal lymph node dissection.

Table 1 –

Patient characteristics for the unmatched cohort

Characteristic	Overall	PC-RPLND		<i>p</i> value
		No	Yes	
Patients (<i>n</i>)	5062	3832	1230	–
Patient age (yr)				
Mean ± standard deviation	29.8 ± 10.1	30.0 ± 10.3	29.3 ± 9.5	0.015
Median (IQR)	28.0 (22.0–35.0)	28.0 (23.0–35.0)	27.0 (22.0–34.0)	0.108
Charlson-Deyo comorbidity score, <i>n</i> (%)				
0	4752 (92.8)	3541 (92.4)	1153 (93.7)	0.273
1	323 (6.3)	252 (6.6)	68 (5.5)	
2	48 (0.9)	39 (1.0)	9 (0.7)	
Race/ethnicity, <i>n</i> (%)				
White (non-Hispanic)	3929 (77.4)	2894 (76.2)	992 (81.6)	<0.001
Black	177 (3.5)	148 (3.9)	28 (2.3)	
Hispanic	795 (15.7)	625 (16.5)	155 (12.8)	
Other	173 (3.4)	131 (3.4)	40 (3.3)	
Insurance status, <i>n</i> (%)				
Private insurance	3133 (62.2)	2222 (59.0)	879 (72.6)	<0.001
Not insured	138 (2.7)	114 (3.0)	22 (1.8)	
Other government	73 (1.4)	58 (1.5)	14 (1.2)	
Medicaid	927 (18.4)	737 (19.6)	182 (15.0)	
Medicare	765 (15.2)	635 (16.9)	113 (9.3)	
Zip-code education level, <i>n</i> (%)				
21% NGHS	934 (18.4)	731 (19.3)	184 (15.0)	<0.001
13–20.9% NGHS	1200 (23.6)	929 (24.5)	262 (21.4)	
7–12.9% NGHS	1670 (32.9)	1207 (31.9)	446 (36.4)	
<than 7% NGHS	1270 (25.0)	922 (24.3)	332 (27.1)	
Zip-code median household income, <i>n</i> (%)				
<\$38 000	830 (16.4)	655 (17.3)	160 (13.1)	<0.001
\$38 000–\$47 999	1208 (23.8)	913 (24.1)	277 (22.6)	
\$48 000–\$62 999	1420 (28.0)	1070 (28.3)	341 (27.9)	
\$63 000	1613 (31.8)	1148 (30.3)	446 (36.4)	
Distance from hospital (miles)				
Mean ± standard deviation	41.6 ± 144.6	26.9 ± 101.1	87.0 ± 227.5	<0.001
Median (IQR)	10.9 (4.7–27.2)	9.7 (4.4–22.0)	17.8 (6.5–63.6)	<0.001
Household location, <i>n</i> (%)				
Metropolitan	4240 (85.5)	3154 (85.1)	1032 (86.6)	0.190
Urban	639 (12.9)	497 (13.4)	138 (11.6)	
Rural	79 (1.6)	55 (1.5)	22 (1.8)	
AJCC clinical nodal stage, <i>n</i> (%)				
cN0	708 (14.0)	620 (16.3)	76 (6.2)	

Characteristic	Overall	PC-RPLND		
		No	Yes	<i>p</i> value
cN1–3	3856 (76.0)	2759 (72.7)	1066 (87.3)	<0.001
cN1	1368 (27.0)	1087 (28.7)	269 (22.0)	
cN2	1410 (27.8)	1012 (26.7)	390 (31.9)	
cN3	1078 (21.2)	660 (17.4)	407 (33.3)	
cNX	509 (10.0)	414 (10.9)	79 (6.5)	
AJCC clinical metastasis stage, <i>n</i> (%)				
cM0	2906 (57.6)	2131 (56.5)	751 (61.9)	0.001
cM1	2140 (42.4)	1643 (43.5)	463 (38.1)	
cM1 (NOS)	745 (14.8)	589 (15.6)	141 (11.6)	
cM1a	877 (17.4)	653 (17.3)	211 (17.4)	
cM1b	518 (10.3)	401 (10.6)	111 (9.1)	
AJCC clinical stage, <i>n</i> (%)				
Stage II	1684 (32.9)	1203 (31.4)	474 (38.5)	<0.001
Stage III	3439 (67.1)	2629 (68.6)	756 (61.5)	
IGCCCG risk group, <i>n</i> (%)				
Good risk	779 (15.2)	547 (14.3)	231 (18.8)	<0.001
Intermediate risk	232 (4.5)	152 (4.0)	76 (6.2)	
Poor risk	677 (13.2)	523 (13.6)	146 (11.9)	
Unable to determine	3435 (67.1)	2610 (68.1)	777 (63.2)	

SD = standard deviation; IQR = interquartile range; NGHS = not graduating high school; AJCC = American Joint Committee on Cancer; IGCCCG = International Germ Cell Collaborative Group.

Table 2 –

Factors associated with receipt of postchemotherapy retractoritoneal lymph node dissection

Characteristic	OR (95% CI)	p value
Patient age in years ^a	0.95 (0.74–1.20)	0.649
Charlson-Deyo comorbidity score		
0	Reference	–
1	0.78 (0.56–1.09)	0.149
2	0.98 (0.43–2.23)	0.967
Race/ethnicity		
White (non-Hispanic)	Reference	–
Black	0.73 (0.44–1.20)	0.215
Hispanic	0.96 (0.75–1.23)	0.759
Other	0.90 (0.58–1.41)	0.646
Insurance status		
Private	Reference	–
Medicare	0.70 (0.41–1.19)	0.192
Other government	0.44 (0.21–0.94)	0.034
Medicaid	0.72 (0.58–0.90)	0.003
Not insured	0.49 (0.38–0.63)	<0.001
Zip-code median household income		
<\$38 000	Reference	–
\$38 000–\$47 999	1.02 (0.78–1.33)	0.883
\$48 000–\$62 999	0.97 (0.73–1.28)	0.811
\$63 000	1.16 (0.85–1.59)	0.342
Zip-code education level		
21% not graduating high school	Reference	–
13–20.9% not graduating high school	0.90 (0.69–1.18)	0.446
7–12.9% not graduating high school	1.09 (0.83–1.43)	0.523
<7% not graduating high school	0.94 (0.69–1.30)	0.720
Distance from hospital in miles ^a	1.55 (1.46–1.65)	<0.001
Household location		
Metropolitan	Reference	–
Urban	0.53 (0.41–0.68)	<0.001
Rural	0.60 (0.33–1.07)	0.083
American Joint Committee on Cancer clinical stage		
Stage II	Reference	–
Stage III	0.74 (0.63–0.88)	0.001
IGCCCG risk group		
Good risk	Reference	–
Intermediate risk	1.74 (1.17–2.59)	0.006
Poor risk	0.75 (0.55–1.03)	0.076
Unable to determine	0.87 (0.70–1.07)	0.192

OR = odds ratio; CI = confidence interval; IGCCCG = International Germ Cell Collaborative Group.

^aNatural log-transformed.

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Table 3 –

Factors associated with all-cause mortality

Characteristic	Univariate analysis		Multivariate analysis	
	HR (95% CI)	p value	HR (95% CI)	p value
Patient age (years)	1.034 (1.028–1.041)	<0.001	1.03 (1.02–1.04)	<0.001
Charlson-Deyo comorbidity score				
0	Reference	–	Reference	–
1	1.977 (1.551–2.519)	<0.001	1.43 (1.10–1.85)	0.007
2	3.643 (2.250–5.898)	<0.001	3.25 (1.98–5.32)	<0.001
Race/ethnicity				
White (non-Hispanic)	Reference	–	Reference	–
Black	2.247 (1.657–3.047)	<0.001	1.37 (0.97–1.92)	0.072
Hispanic	1.325 (1.088–1.614)	0.005	0.97 (0.77–1.23)	0.821
Other	1.732 (1.224–2.450)	0.002	1.56 (1.08–2.25)	0.017
Insurance status				
Private insurance	Reference	–	Reference	–
Medicaid	2.650 (1.842–3.812)	<0.001	1.52 (1.02–2.26)	0.037
Medicare	2.218 (1.299–3.790)	0.004	1.53 (0.87–2.70)	0.141
Other government	2.357 (1.971–2.818)	<0.001	1.86 (1.53–2.26)	<0.001
Not insured	2.151 (1.772–2.611)	<0.001	1.74 (1.41–2.15)	<0.001
Zip-code median household income				
<\$38 000	Reference	–	Reference	–
\$38 000–\$47 999	0.784 (0.631–0.972)	0.027	1.05 (0.82–1.33)	0.719
\$48 000–\$62 999	0.699 (0.565–0.864)	0.001	1.10 (0.85–1.43)	0.470
\$63 000	0.564 (0.454–0.700)	<0.001	0.96 (0.71–1.31)	0.803
Zip-code education level				
21% NGHS	Reference	–	Reference	–
13–20.9% NGHS	0.81 (0.66–1.00)	0.048	1.04 (0.82–1.31)	0.774
7–12.9% NGHS	0.65 (0.53–0.79)	<0.001	0.88 (0.68–1.15)	0.349
<7% NGHS	0.54 (0.54–0.68)	<0.001	0.82 (0.60–1.13)	0.233
Distance from hospital in miles	1.000 (1.000–1.001)	0.042	1.00 (1.00–1.00)	0.001
Household location				
Metropolitan	Reference	–	Reference	–
Urban	1.15 (0.93–1.42)	0.181	1.08 (0.86–1.36)	0.513
Rural	1.25 (0.72–2.17)	0.441	0.76 (0.40–1.44)	0.400
AJCC clinical stage				
Stage II	Reference	–	Reference	–
Stage III	6.312 (4.836–8.238)	<0.001	4.17 (3.13–5.54)	<0.001
IGCCCG risk group				
Good risk	Reference	–	Reference	–
Intermediate risk	2.92 (1.55–5.50)	0.001	1.51 (0.77–2.96)	0.229
Poor risk	11.69 (7.51–18.21)	<0.001	5.51 (3.51–8.66)	0.000

Characteristic	Univariate analysis		Multivariate analysis	
	HR (95% CI)	<i>p</i> value	HR (95% CI)	<i>p</i> value
Unknown	3.97 (2.59–6.08)	<0.001	2.61 (1.69–4.01)	0.000
Performance of PC-RPLND				
Yes	Reference	–	Reference	–
No	2.492 (1.985–3.130)	<0.001	1.98 (1.56–2.51)	<0.001

HR = hazard ratio; CI = confidence interval; NGHS = not graduating high school; AJCC = American Joint Committee on Cancer; IGCCCG = International Germ Cell Collaborative Group, PC-RPLND = post-chemotherapy retroperitoneal lymph node dissection

Table 4 –
Patient characteristics for the propensity score–matched cohort

Characteristic	Overall	PC-RPLND		
		No	Yes	<i>p</i> value
Patients (<i>n</i>)	2278	1139	1139	–
Mean age ± SD (yr)	29.3 ± 9.6	29.3 ± 9.7	29.3 ± 9.6	0.73
Charlson-Deyo comorbidity score				
0	2133 (93.6)	1067 (93.7)	1066 (93.6)	0.958
1	126 (5.5)	62 (5.4)	64 (5.6)	
2	19 (0.8)	10 (0.9)	9 (0.8)	
Race/ethnicity				
White (non-Hispanic)	2133 (93.6)	928 (81.5)	935 (82.1)	0.908
Black	126 (5.5)	22 (1.9)	25 (2.2)	
Hispanic	19 (0.8)	156 (13.7)	146 (12.8)	
Other	2133 (93.6)	33 (2.9)	33 (2.9)	
Insurance status, <i>n</i> (%)				
Private insurance	1616 (70.9)	782 (68.7)	834 (73.2)	0.188 ^c
Not insured	44 (1.9)	24 (2.1)	20 (1.8)	
Other government	25 (1.1)	12 (1.1)	13 (1.1)	
Medicaid	366 (16.1)	199 (17.5)	167 (14.7)	
Medicare	227 (10.0)	122 (10.7)	105 (9.2)	
Zip-code education level, <i>n</i> (%)				
21% NGHS	359 (15.8)	187 (16.4)	172 (15.1)	0.786
13–20.9% NGHS	468 (20.5)	227 (19.9)	241 (21.2)	
7–12.9% NGHS	838 (36.8)	420 (36.9)	418 (36.7)	
<7% NGHS	613 (26.9)	305 (26.8)	308 (27.0)	
Zip-code median household income, <i>n</i> (%)				
<\$38 000	304 (13.3)	155 (13.6)	149 (13.1)	0.577
\$38 000–\$47 999	532 (23.4)	273 (24.0)	259 (22.7)	
\$48 000–\$62 999	603 (26.5)	287 (25.2)	316 (27.7)	
\$63000	839 (36.8)	424 (37.2)	415 (36.4)	
Mean distance from hospital ± SD (miles)	2.9 ± 1.5	2.8 ± 1.3	3.0 ± 1.6	<0.001
Household location, <i>n</i> (%)				
Metropolitan	1967 (86.3)	978 (85.9)	989 (86.8)	0.795
Urban	268 (11.8)	139 (12.2)	129 (11.3)	
Rural	43 (1.9)	22 (1.9)	21 (1.8)	
AJCC clinical nodal stage, <i>n</i> (%)				
cN0	153 (6.7)	81 (7.1)	72 (6.3)	0.479
cN1	519 (22.8)	271 (23.8)	248 (21.8)	
cN2	745 (32.7)	375 (32.9)	370 (32.5)	
cN3	723 (31.7)	349 (30.6)	374 (32.8)	
cNX	138 (6.1)	63 (5.5)	75 (6.6)	

Characteristic	Overall	PC-RPLND		
		No	Yes	<i>p</i> value
AJCC clinical metastasis stage, <i>n</i> (%)				
cM0	1413 (62.0)	701 (61.5)	712 (62.5)	0.814
cM1	865 (38.0)			
cM1 (NOS)	270 (11.9)	142 (12.5)	128 (11.2)	–
cM1a	386 (16.9)	190 (16.7)	196 (17.2)	–
cM1b	209 (9.2)	106 (9.3)	103 (9.0)	–
AJCC clinical stage				
Stage II	849 (37.3)	411 (36.1)	438 (38.5)	0.242
Stage III	1429 (62.7)	728 (63.9)	701 (61.5)	
IGCCCG risk group, <i>n</i> (%)				
Good risk	410 (18.0)	195 (17.1)	215 (18.9)	0.719
Intermediate risk	149 (6.5)	73 (6.4)	76 (6.7)	
Poor risk	266 (11.7)	135 (11.9)	131 (11.5)	
Unknown	1453 (63.8)	736 (64.6)	717 (62.9)	

SD = standard deviation; NGHS = not graduating high school; AJCC = American Joint Committee on Cancer; IGCCCG = International Germ Cell Collaborative Group; PC-RPLND = postchemotherapy retroperitoneal lymph node dissection.