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Overall Survival Trends and Clinical Characteristics of Plasmacytoma in the United States, a National Cancer Database Analysis

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Abstract

Background: Given the rarity of plasmacytoma, large-scale database analysis can provide useful information regarding the clinical presentation and patient related factors impacting overall survival.

Materials and Methods: The National Cancer Data Base was queried for patients with plasmacytoma between 2004-2013, excluding patients with systemic disease. Plasmacytomas were classified as originating in bone (P-bone), in extramedullary tissue (P-EM), or unspecified. Survival was estimated using the Kaplan-Meier and log-rank test method. We used Cox regression to determine specific outcomes adjusting for demographic, socioeconomic, geographic, facility type, year of diagnosis, and comorbid factors.

Results: In total, 6,225 patients were identified, of which 61.5% were men. The median age at diagnosis was 64 (range 18-90), and median follow up was 58 months. The primary site of disease was: P-bone in 4,056 (65.1%) patients, P-EM in 1468 (23.6 %), and remaining 701 patients were P-unspecified. The unadjusted median survival for solitary P-bone was 89 months (95%CI, 82.9 to 95.0), and for solitary P-EM was 117.3 months (95%CI 108.8 to NR). Factors associated with improved OS include younger age, private insurance, higher income, solitary lesion, and lower comorbidity score. P-bone patients treated at academic facilities had improved OS. Only 65% of patients with solitary plasmacytoma lesions received radiation treatment. Age greater than 75 and increased distance to treatment facility was associated with decreased likelihood of receiving radiation.

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Conflict of Interest Statement:

The authors have no conflicts of interest to disclose.

Conclusions: This is the largest study examining outcomes of patients with plasmacytoma using a large database analysis, revealing unique aspects of P-EM vs. P-bone and underutilization of radiation treatment.

Microabstract:

This is the largest study examining outcomes of patients with plasmacytoma using the National Cancer Data Base. Clinical and patient related factors impacting OS were studied for both bone (P-bone) and extramedullary (P-EM) plasmacytoma. P-bone patients who were treated at academic facilities had improved OS. Surprisingly, we found radiation treatment was underutilized in patients with solitary lesions especially in those older than 75 and with increasing distance from treatment facility.

INTRODUCTION

Plasma cell neoplasms can have varying clinical presentations. Most commonly they present as disseminated bone marrow based neoplasm with heterogeneous clinical presentation. Infrequently, the plasma cell neoplasm can be seen localized to a bony or extra medullary site with essentially normal bone marrow examination. Furthermore clinical or laboratory findings, required for the diagnosis of multiple myeloma are not seen in patients with plasmacytoma. Plasmacytomas represent approximately 3% of plasma cell disorders, and can present with either solitary or multiple lesions.

A recent single institution retrospective analysis of outcomes and prognostic factors after definitive radiation in patients with solitary plasmacytoma was based on 84 cases.¹ Large-scale population-based data on plasmacytomas are rare, but a previous SEER analysis describes incidence and survival patterns among 1500 patients with plasmacytoma.²

We aimed to further understand the epidemiological features of plasmacytoma according to primary site as well as number of lesions. In this population-based analysis, we analyzed the National Cancer Data Base (NCDB) to evaluate the prognostic patient and demographic features that impact overall survival in patients with plasmacytoma, according to primary site and extent of disease.

METHODS

Data Source:

We used de-identified patient level data from the National Cancer Database (NCDB) Participant-User File. NCDB is a joint endeavor by the American College of Surgeons and the American Cancer Society. It is a nationwide, hospital-based registry which compiles data from more than 1,500 Commission on Cancer (CoC)-accredited facilities, and captures more than 70% of all cancer cases in the United States.³ The data elements are prospectively collected using standardized coding definitions.⁴ The American College of Surgeons and the Commission on Cancer have not verified and are not responsible for the statistical validity or conclusions derived from these data. The study was deemed exempt from review by Mount Sinai Hospital Institutional Review Board.

Patient Selection

Patients with Plasmacytoma diagnosed between 2004 and 2013 (N= 10,613) were identified using the International Classification of Disease for Oncology-3 codes 9731 and 9734. We excluded patients who were not treated at the reporting facility (N= 1,912). Using the CS-Extension variable we omitted patients who were coded as systemic disease or unknown extension (N=1,688). Patients with incomplete radiation parameters (N=700), unclear chemotherapy status (N = 82) and follow up dates unavailable (N = 6) were also excluded. Our final study population was 6,225.

Patient Demographics and Treatment Variables

We included patient level data pertaining to diagnosis year, socio-demographics, comorbidity score, Facility type, as well as time from diagnosis to last contact. Age was analyzed categorically as <54, 55-64, 65-74 and ≥75. Race was categorized as white, black, Hispanic and other. Institution type was classified as community cancer program, comprehensive community cancer program, academic/research program (Including National Cancer Institute – designated comprehensive cancer centers) and integrated network cancer program. Insurance status was defined as private, government (including Medicare, Medicaid, and other government insurance) and uninsured. Median household income was assessed based on 2012 U.S. Census data and grouped as < \$38,000, \$38,000 - \$47,999, \$48,000 - \$62,999, \$63,000 +. Distance from facility was categorized as <12.5, 12.5 – 50 and ≥ 50 miles. Patients' residential area was coded as metropolitan, urban and rural. RT was coded as external beam radiation. Chemotherapy was analyzed categorically (yes or no). Clinical variables such as Charlson/Deyo Comorbidity Index (truncated by NCDB into 0, 1, and 2) and year of diagnosis were also included. Primary site codes were used to classify plasmacytomas as bone (P-bone), extra medullary (P-EM) or unspecified location (P-unspecified). P-bone was identified using primary site codes C400-C403, C408-414, C418-419. Primary site codes C 420-424, C760-765, C767 and C809 were coded as P-unspecified location. Remaining patients were coded as P-EM. Primary site codes were also used to categorize primary bone sites as well as extra medullary site groupings. Using the CS_extension variable, patients were divided into solitary lesion, or multiple lesions.

Missing data

Missing data for prognostic covariates outlined above were handled by multiple imputation using chained equations. Among these covariates, lesion numbers have the most missing values at 4.2%, followed by facility type at 4.1% and residential status at 3.3%. Other variables with missing data include insurance status (1.9%), household median income (1.4%), distance from facility (1.3%) and race (1.2%). This sequential regression imputation method was implemented using the IVEware software system with SAS. (<https://www.src.isr.umich.edu/software/>).⁵ We performed 10 repetitions to generate 50 imputed datasets to achieve balanced results, which were later combined to summarize the effect estimates using Rubin's rules executed by MIANALYZE procedure in SAS in subsequent analysis. This method is shown better than its alternatives, e.g. complete case analysis, as far as analytic bias is concerned, when the assumption that data is missing at random holds.⁶

Statistical Analysis

Prognostic covariates outlined above were summarized as n (%) by plasmacytoma sites and compared among these three sites using chi-square test. A multivariable logistic regression model was used for each of the receipt of chemotherapy and RT to estimate adjusted odds ratios (OR) and 95% confidence intervals (95% CI) to evaluate the association between each variable and treatment utilization.

The primary objectives of this study were to identify factors associated with survival from 2004 to 2013 in this NCDB plasmacytoma cohort. Univariable and multivariable logistic regression models were constructed to estimate crude and adjusted hazard ratios (HR) and 95% CI to evaluate the association between each variable and overall survival stratified by P-bone and P-EM site.

All statistical analyses were performed using SAS Version 9.4 (SAS Institute, Cary, NC). Hypothesis testing was two-sided and conducted at the 5% level of significance.

RESULTS

Patient Characteristics

Patient and treatment characteristics have been summarized in Table 1. Overall 6,225 patients with plasmacytoma were included. The median age at diagnosis was 65 years (range 18-90), and the median follow-up was 58 months (95% CI 56.3, 59.4). Our patient cohort was 61.5% male, and predominantly Caucasian (75.6%), followed by black (15.3%). Briefly, 4056 (65.1%) patients had P-bone and 1468 (23.6 %) P-EM. The primary location of the plasmacytoma was classified as unspecified in 701 patients. Overall 5,722 (91.9%) of patients had solitary lesions. Details of primary site of tumor involvement and 5-year OS can be found in Table 2. Most common location for a P-bone was vertebral bodies (40.7%), and for P-EM was the head and neck region (37.3%). A total of 4055 (65.1%) patients were treated with external beam radiation. Patients were documented as receiving chemotherapy in 1113 (17.9%) of cases.

Predictors for OS—The unadjusted median OS rate for P-bone was lower than for P-EM (Fig. 1A). The unadjusted Kaplan Meier survival curves are also depicted separately by number of lesions for P-bone and P-EM (Fig. 1B&1C). Median OS for solitary P-bone was 89.0 months (95% CI, 82.9 to 95.1), and for multiple P-bone lesions was 48.6 months (95% CI, 42.0 to 75.6). Median OS for solitary P-EM was 117.3 months (95% CI, 108.8 to NR), and for multiple P-bone lesions was 37.1 months (95% CI, 18.8 to 64.6).

Among the P-bone, those with disease in the vertebral bodies had the best 5-year OS at 61.5% (95% CI, 58.7% to 64.2%). In the P-EM cohort, endocrine and head and neck subsites had the best 5-year OS at and 81.8% (95% CI, 61.7% to 92.0%) and 80.8% (95% CI, 76.6% to 84.4%) respectively. Details of disease distribution and OS according to primary tumor site can be found in Table 2.

Employing UVA and MVA demographic and clinical factors associated with improved overall survival were identified for P-bone, and P-EM and outlined separately in Tables 3 & 4.

For both P-bone and P-EM, patients younger than 54 had the highest survival, and those >75 years of age had the most unfavorable results. On univariate analysis, male gender had a positive effect on OS in the P-bone cohort, which did not remain significant on multivariate analysis. No gender-based differences were observed for outcomes of P-EM. Among the P-bone patients, Hispanic patients had improved overall survival compared to Caucasians, HR 0.66 (95% CI 0.5-0.86; $p=0.002$). Of the P-EM patients, black race was associated with decreased overall survival compared to Caucasians, HR 1.5 (95% CI 1.15-1.95; $p=0.0027$). Treatment at an academic facility was associated with improved outcomes for P-bone patients, HR 0.76 (95% CI 0.62-0.92; $p=0.0065$), while type of treatment facility had no bearing on outcomes for P-EM patients. Those with private insurance had improved outcomes in both the P-bone and P-EM cohorts. P-bone patients treated after 2008 had improved outcomes, but no association was found between diagnosis year and outcome for P-EM patients. Patient's residence and distance to treatment facility did not affect patient outcomes. Higher median household income improved P-bone patient outcomes, but not those with P-EM. Higher Charlson-Deyo comorbidity scores were also associated with worse overall survival. Not-surprisingly, multiple lesions were associated with worse survival in both P-bone and P-EM groups.

Factors influencing receipt of radiation treatment and chemotherapy are summarized in Table 5. Radiation utilization rates were 65% among all plasmacytomas, and 66.5% among those with solitary lesions. Male patients, and those treated at academic or comprehensive facilities were more likely to receive RT. Patients older than 75 years were less likely to receive radiation (OR 0.75, $p<0.0001$), and chemo (OR 0.87, $p=0.042$). Patients living >50 miles from treatment facility (OR 0.5, $p<0.0001$) were also less likely to receive RT. As expected, patients with multiple lesions were less likely to receive radiation treatment, but more likely to receive chemotherapy. Race, insurance status, median household income, and CDCC score did not impact receipt of radiation.

DISCUSSION

To our knowledge, this is the largest epidemiologic study of patients with plasmacytoma to date. Previous information on this topic were limited to small single institution series or SEER database analyses,^{2,7} which were on smaller cohorts largest of which included 1691 patients.

A previous multi-institutional study of plasmacytoma showed more favorable overall survival for P-EM than P-bone.⁸ Other studies have also demonstrated similar survival trends.^{9,10} In a single institution series on solitary plasmacytoma from MD Anderson Cancer Center, primary bone site was associated with a higher risk of progression to Multiple Myeloma.¹ Our study confirms an unfavorable prognosis for P-bone in a large patient cohort, and suggests these patients behave very differently from P-EM.

Radiation utilization rates were low at 65% among all plasmacytomas, and 66.5% among those with solitary lesions. This may in part be explained by accessibility of radiation facilities, as those patients living greater than 50 miles from the treatment facility were half as likely to receive RT. However, as only 10% of patients live greater than 50 miles from the treatment facility, there are clearly other contributing factors that are difficult to elucidate from the database. There was also decreased RT utilization among the population older than 75, without correlation between CDCC score and receipt of radiation. So despite not having higher comorbidity score, elderly patients are not receiving a non-invasive treatment modality, which is typically well tolerated. We are unable to elucidate the exact reasons why elderly patients did not receive radiation treatment based on the information available in the database. It is important to individually assess elderly patients with a comprehensive decision-making framework,¹¹ prior to making radiation treatment recommendations.

Although prior work has revealed there may be racial differences in the incidence of plasmacytoma,^{2,12} it is controversial whether race has an effect on survival. Our study demonstrates that patient race may be associated with varying survival in P-bone and P-EM cohorts. The racial based differences of survival did not appear to stem from disparities in receipt of treatment, and may rather point to inherent differences in disease biology among the race groups. Future studies and molecular advances will provide insight into the mechanism behind these varying outcomes.

We found improved outcomes for P-bone patients treated at academic facilities. These patients were also more likely to receive radiation treatment, which is the standard of care for these patients. A recent analysis of multiple myeloma outcomes revealed a lower risk of mortality for those treated at higher-volume facilities.¹³ Considering the rapid pace of advances in MM treatment, this observation is not a surprise. Plasmacytomas are even less common than MM, and clinician experience would also be expected to significantly impact outcomes.

There are several limitations of this investigation that must be noted to provide context and applicability of the analysis. While large databases are a valuable resource in highlighting survival trends and associations that may not be apparent in smaller cohorts, absence of certain clinical parameters limits the impact of any conclusions. Most notably, NCDB does not provide information on disease recurrence or progression to MM. As such, we were unable to determine any endpoint other than overall survival. Many patients with plasmacytoma especially those with osseous disease progress to MM, and ultimately succumb to the disease. We are unable to tease out the cause of death in our study.

Given the retrospective nature of the study, we cannot exclude the possibility that some MM patients were incorrectly coded as plasmacytoma. However, our study period ranged from 2004 to 2013, when sensitive diagnostic testing such as MRI and monoclonal paraproteins were widely adopted, making this possibility less likely. Moreover, patients with tumors coded to bone marrow or unspecified sites were separated into a P-unspecified category.

Conclusions:

This is the largest study examining outcomes of patients with plasmacytoma using a large database analysis, revealing unique aspects of P-EM vs. P-bone and underutilization of radiation treatment.

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A.

B.

C.

Figure 1. Unadjusted Kaplan Meier curves comparing overall survival outcomes for P-Bone versus P-EM (A); separated by solitary versus multiple lesions for P-Bone (B) and P-EM (C).

Table 1.

Baseline Patient, and Facility Characteristics by Plasmacytoma Site

	Overall (N = 6225) No. (%) [*]	Plasmacytoma Site			p [†]
		P-Bone (N=4056) No. (%) [*]	P-EM (N=1468) No. (%) [*]	P-unspecified (N=701) No. % [*]	
Age group					
<54	1358 (21.8)	892 (22.0)	350 (23.8)	116 (16.5)	0.0014
55-64	1554 (25.0)	1032 (25.4)	335 (22.8)	187 (26.7)	
65-74	1637 (26.3)	1053 (26.0)	403 (27.5)	181 (25.8)	
>75	1676 (26.9)	1079 (26.6)	380 (25.9)	217 (31.0)	
SEX					
Female	2396 (38.5)	1575 (38.8)	530 (36.1)	291 (41.5)	0.0401
Male	3829 (61.5)	2481 (61.2)	938 (63.9)	410 (58.5)	
RACE					
White	4705 (75.6)	3083 (76.0)	1102 (75.1)	520 (74.2)	0.0007
Black	951 (15.3)	616 (15.2)	200 (13.6)	135 (19.3)	
Hispanic	411 (6.6)	257 (6.3)	120 (8.2)	34 (4.8)	
Other	158 (2.5)	100 (2.5)	46 (3.1)	12 (1.7)	
FACILITY TYPE					
Community	569 (9.1)	337 (8.3)	146 (10.0)	86 (12.3)	0.0015
Comprehensive	2825 (45.4)	1839 (45.3)	653 (44.5)	333 (47.5)	
Academic/Research	2163 (34.8)	1452 (35.8)	509 (34.7)	202 (28.8)	
Integrated	668 (10.7)	428 (10.6)	160 (10.9)	80 (11.4)	
Insurance Status					
Not Insured	225 (3.6)	148 (3.7)	57 (3.9)	20 (2.8)	0.6082
Private	2672 (42.9)	1753 (43.2)	629 (42.8)	290 (41.4)	
Government	3328 (53.5)	2155 (53.1)	782 (53.3)	391 (55.8)	
Residence					
Metropolitan	5128 (82.4)	3338 (82.3)	1228 (83.7)	562 (80.2)	0.0689
Urban	981 (15.8)	640 (15.8)	222 (15.1)	119 (17.0)	
Rural	116 (1.8)	78 (1.9)	18 (1.2)	20 (2.8)	
Distance					
12.5 miles	3618 (58.1)	2354 (58.0)	847 (57.7)	417 (59.5)	0.9266
12.6 – 50 miles	1936 (31.1)	1269 (31.3)	458 (31.2)	209 (29.8)	
>50 miles	671 (10.8)	433 (10.7)	163 (11.1)	75 (10.7)	
Median Income Quartiles (%)					
< \$38,000	1157 (18.6)	763 (18.8)	240 (16.3)	154 (22.0)	0.1136
\$38,000 - \$47,999	1448 (23.3)	952 (23.5)	346 (23.6)	150 (21.4)	

	Overall (N = 6225) No. (%) [*]	Plasmacytoma Site			p [†]
		P-Bone (N=4056) No. (%) [*]	P-EM (N=1468) No. (%) [*]	P-unspecified (N=701) No. % [*]	
\$48,000 - \$62,999	1662 (26.7)	1074 (26.5)	406 (27.7)	182 (25.9)	
\$63,000 +	1958 (31.4)	1267 (31.2)	476 (32.4)	215 (30.7)	
CDCC_TOTAL					
0	4964 (79.7)	3239 (79.9)	1183 (80.6)	542 (77.3)	0.4201
1	906 (14.6)	589 (14.5)	200 (13.6)	117 (16.7)	
2+	355 (5.7)	228 (5.6)	85 (5.8)	42 (6.0)	
Chemotherapy					
No	5112 (82.1)	3344 (82.4)	1260 (85.8)	508 (72.5)	<.0001
Yes	1113 (17.9)	712 (17.6)	208 (14.2)	193 (27.5)	
Radiation Therapy					
No	2170 (34.9)	1231 (30.4)	627 (42.7)	312 (44.5)	<.0001
Yes	4055 (65.1)	2825 (69.6)	841 (57.3)	389 (55.5)	
Year of Diagnosis					
2004-2007	1928 (31.0)	1113 (27.4)	432 (29.4)	383 (54.7)	<.0001
2008-2010	1909 (30.7)	1224 (30.2)	452 (30.8)	233 (33.2)	
2011-2013	2388 (38.3)	1719 (42.4)	584 (39.8)	85 (12.1)	
Lesion number					
Solitary	5722 (91.9)	3717 (91.6)	1353 (92.2)	652 (93.0)	0.4350
Multiple	503 (8.1)	339 (8.4)	115 (7.8)	49 (7.0)	

Abbreviations: EM: Extramedullary;

^{*} Row percentages may not sum to 100% as a result of rounding.

[†] p-value obtained from chi-square test.

Table 2.

Distribution and OS According to Primary Tumor Site

Site	No. (%)	5-yr OS (%)
Bone		
Vertebrae	1649 (40.7)	61.5% (58.7%, 64.2%)
Pelvis	734 (18.1)	60.7% (56.4%, 64.7%)
Ribs/Sternum/Clavicle	684 (16.8)	57.6% (52.9%, 61.9%)
Extremities	637 (15.7)	53.4% (48.6%, 57.9%)
Facial/Skull Bone	352 (8.7)	57.3% (50.7%, 63.4%)
Total	N= 4056	
Extramedullary		
Head & Neck	547 (37.3)	80.8% (76.6%, 84.4%)
Connective/Soft tissue	358 (24.4)	50.6% (44.4%, 56.4%)
GI	160 (10.9)	56.5% (47.6%, 64.5%)
Pulmonary	103 (7.0)	56.6% (44.8%, 66.7%)
Nervous System	82 (5.6)	52.4% (39.4%, 63.8%)
Lymph Nodes	67 (4.6)	69.3% (53.2%, 80.8%)
GU	53 (3.6)	35.7% (20.6%, 51.0%)
Cardiac/Mediastinum	33 (2.2)	46.0% (27.5%, 62.6%)
Endocrine	28 (1.9)	81.8% (61.7%, 92.0%)
Breast/GYN	23 (1.6)	65.2% (39.5%, 82.2%)
Eye/Orbit	14 (1.0)	55.0% (25.8%, 76.8%)
Total	N=1468	

Table 3.

Association Between Baseline Characteristics and Overall Mortality for P-Bone (N = 4056)

	Univariable		Multivariable	
	Hazard Ratio (95% CI) [†]	p-value	Hazard Ratio (95% CI) [†]	p-value
Age group				
<54	Ref		Ref	
55-64	1.66 (1.35, 2.04)	<.0001	1.61 (1.31, 1.98)	<.0001
65-74	3.15 (2.60, 3.82)	<.0001	2.44 (1.97, 3.02)	<.0001
>75	7.69 (6.41, 9.22)	<.0001	5.68 (4.60, 7.02)	<.0001
Sex				
Female	Ref		Ref	
Male	0.87 (0.78, 0.96)	0.0066	0.97 (0.88, 1.08)	0.5856
Race				
White	Ref		Ref	
Black	0.87 (0.76, 1.01)	0.0713	0.99 (0.84, 1.16)	0.8851
Hispanic	0.59 (0.45, 0.76)	<.0001	0.66 (0.50, 0.86)	0.0025
Other	0.75 (0.51, 1.10)	0.1416	0.82 (0.56, 1.20)	0.2997
Facility Type				
Community	Ref		Ref	
Comprehensive	0.99 (0.83, 1.20)	0.9498	0.95 (0.79, 1.15)	0.6254
Academic/Research	0.70 (0.57, 0.85)	0.0004	0.76 (0.62, 0.92)	0.0065
Integrated	0.94 (0.75, 1.18)	0.5850	0.97 (0.77, 1.22)	0.7638
Insurance Status				
Not Insured	Ref		Ref	
Private	0.74 (0.52, 1.04)	0.0833	0.70 (0.48, 0.98)	0.0362
Government	2.32 (1.66, 3.25)	<.0001	1.02 (0.72, 1.46)	0.9091
Year of Diagnosis				
2004-2007	Ref		Ref	
2008-2010	0.87 (0.77, 0.99)	0.0351	0.83 (0.73, 0.94)	0.0037
2011-2013	1.00 (0.88, 1.14)	0.9999	0.86 (0.75, 0.99)	0.0370
Residence				
Metropolitan	Ref		Ref	
Urban	1.10 (0.96, 1.26)	0.1688	1.02 (0.87, 1.21)	0.7727
Rural	1.16 (0.82, 1.63)	0.4116	0.91 (0.63, 1.31)	0.6137
Distance (%)				
12.5 miles	Ref		Ref	
12.6 – 50 miles	0.85 (0.76, 0.95)	0.0050	0.91 (0.81, 1.03)	0.1548

	Univariable		Multivariable	
	Hazard Ratio (95% CI) [†]	p-value	Hazard Ratio (95% CI) [†]	p-value
>50 miles	0.87 (0.73, 1.04)	0.1236	0.97 (0.79, 1.18)	0.7422
Median Income Quartiles				
< \$38,000	Ref		Ref	
\$38,000 - \$47,999	0.94 (0.81, 1.09)	0.4039	0.78 (0.67, 0.92)	0.0021
\$48,000 - \$62,999	0.82 (0.71, 0.95)	0.0093	0.77 (0.65, 0.89)	0.0008
\$63,000 +	0.74 (0.64, 0.86)	<.0001	0.72 (0.61, 0.85)	<.0001
Charlson-Deyo Score				
0	Ref		Ref	
1	1.55 (1.36, 1.76)	<.0001	1.29 (1.13, 1.48)	0.0001
2	2.39 (2.00, 2.87)	<.0001	2.03 (1.68, 2.44)	<.0001
Lesion number				
Solitary	Ref		Ref	
Multiple	1.68 (1.39, 2.02)	<.0001	1.61 (1.32, 1.97)	<.0001

Abbreviations: CI, confidence interval.

[†] Hazard Ratios (95% Confidence Intervals and P-values) computed from standard Cox regression model adjusted for all covariates shown in table.

Table 4.

Association Between Baseline Characteristics and Overall Mortality for P-EM (N = 1468)

	Univariable		Multivariable	
	Hazard Ratio (95% CI) †	p-value	Hazard Ratio (95% CI) †	p-value
Age group				
<54	Ref		Ref	
55-64	1.74 (1.24, 2.43)	0.0012	1.77 (1.26, 2.49)	0.0010
65-74	2.65 (1.95, 3.60)	<.0001	2.24 (1.59, 3.14)	<.0001
>75	4.87 (3.63, 6.54)	<.0001	4.05 (2.87, 5.71)	<.0001
Sex				
Female	Ref		Ref	
Male	0.88 (0.73, 1.05)	0.1534	1.02 (0.85, 1.22)	0.8556
Race				
White	Ref		Ref	
Black	1.41 (1.11, 1.79)	0.0051	1.50 (1.15, 1.95)	0.0027
Hispanic	0.84 (0.59, 1.21)	0.3605	0.89 (0.61, 1.29)	0.5334
Other	0.76 (0.44, 1.32)	0.3332	1.03 (0.58, 1.83)	0.9126
Facility Type				
Community	Ref		Ref	
Comprehensive	1.31 (0.94, 1.83)	0.1102	1.38 (0.98, 1.93)	0.0628
Academic/Research	1.08 (0.76, 1.52)	0.6821	1.29 (0.90, 1.84)	0.1675
Integrated	1.29 (0.86, 1.95)	0.2189	1.48 (0.98, 2.24)	0.0635
Insurance Status				
Not Insured	Ref		Ref	
Private	0.48 (0.29, 0.79)	0.0036	0.44 (0.26, 0.73)	0.0016
Government	1.26 (0.78, 2.02)	0.3466	0.64 (0.37, 1.09)	0.1032
Year of Diagnosis				
2004-2007	Ref		Ref	
2008-2010	1.13 (0.91, 1.41)	0.2776	1.08 (0.86, 1.35)	0.5118
2011-2013	1.49 (1.18, 1.87)	0.0008	1.17 (0.92, 1.50)	0.2069
Residence				
Metropolitan	Ref		Ref	
Urban	1.02 (0.80, 1.30)	0.8800	0.96 (0.71, 1.28)	0.7670
Rural	1.51 (0.78, 2.92)	0.2169	1.67 (0.82, 3.37)	0.1543
Distance to Facility				
12.5 miles	Ref		Ref	
12.6 – 50 miles	0.96 (0.79, 1.26)	0.6569	0.98 (0.79, 1.21)	0.8429

	Univariable		Multivariable	
	Hazard Ratio (95% CI) [†]	p-value	Hazard Ratio (95% CI) [†]	p-value
>50 miles	0.79 (0.58, 1.09)	0.1495	0.93 (0.66, 1.32)	0.6909
Median Income Quartiles				
< \$38,000	Ref		Ref	
\$38,000 - \$47,999	0.85 (0.65, 1.11)	0.2372	0.94 (0.71, 1.25)	0.6914
\$48,000 - \$62,999	0.77 (0.59, 1.01)	0.0557	0.84 (0.63, 1.12)	0.2355
\$63,000 +	0.76 (0.58, 0.98)	0.0348	0.84 (0.63, 1.13)	0.2544
Charlson-Deyo Score				
0	Ref		Ref	
1	1.72 (1.36, 2.17)	<. 0001	1.36 (1.07, 1.72)	0.0119
2+	1.57 (1.10, 2.25)	0.0130	1.15 (0.80, 1.66)	0.4464
Lesion number				
Solitary	Ref		Ref	
Multiple	2.57 (1.94, 3.41)	<.0001	2.43 (1.79, 3.28)	<.0001

Abbreviations: CI, confidence interval.

[†] Hazard Ratios (95% Confidence Intervals and P-values) computed from standard Cox regression model adjusted for all covariates shown in table.

Table 5.

Factors Influencing Receipt of Chemotherapy and Radiation

	Chemo		RT	
	Odds Ratio (95% CI)	p-value [†]	Odds Ratio (95% CI)	p-value [†]
Age group				
<54	Ref		Ref	
55-64	1.11 (0.98, 1.26)	0.1051	1.12 (1.01, 1.24)	0.0340
65-74	1.09 (0.97, 1.23)	0.1657	1.02 (0.92, 1.13)	0.6943
>75	0.87 (0.76, 1.00)	0.0429	0.75 (0.67, 0.83)	<.0001
Sex				
Female	Ref		Ref	
Male	0.96 (0.89, 1.02)	0.1973	1.08 (1.03, 1.15)	0.0041
Race				
White	Ref		Ref	Ref
Black	1.18 (0.98, 1.42)	0.0852	0.92 (0.80, 1.07)	0.2892
Hispanic	0.96 (0.75, 1.22)	0.7231	1.02 (0.85, 1.22)	0.8390
Other	0.81 (0.56, 1.15)	0.2384	0.98 (0.76, 1.26)	0.9054
Facility Type				
Community	Ref		Ref	
Comprehensive	0.90 (0.81, 1.01)	0.0796	1.17 (1.07, 1.28)	0.0005
Academic/Research	0.95 (0.85, 1.07)	0.4158	1.12 (1.01, 1.24)	0.0245
Integrated	1.04 (0.88, 1.23)	0.6638	0.86 (0.75, 0.98)	0.0226
Insurance Status				
Not Insured	Ref		Ref	
Private	0.92 (0.80, 1.06)	0.2460	1.06 (0.94, 1.19)	0.3730
Government	0.98 (0.84, 1.15)	0.8067	1.09 (0.96, 1.24)	0.1790
Year of Diagnosis				
2004-2007	Ref		Ref	
2008-2010	1.01 (0.92, 1.12)	0.8232	0.99 (0.92, 1.07)	0.8457
2011-2013	1.13 (1.02, 1.25)	0.0156	0.90 (0.83, 0.97)	0.0094
Residence				
Metropolitan	Ref		Ref	
Urban	1.04 (0.84, 1.29)	0.7084	1.20 (1.02, 1.42)	0.0313
Rural	0.80 (0.56, 1.16)	0.2458	1.17 (0.89, 1.55)	0.2582
Distance to Facility				
12.5 miles	Ref		Ref	
12.6 – 50 miles	1.06 (0.95, 1.19)	0.2964	1.30 (1.19, 1.42)	<.0001

	Chemo		RT	
	Odds Ratio (95% CI)	p-value [†]	Odds Ratio (95% CI)	p-value [†]
>50 miles	0.96 (0.82, 1.13)	0.6483	0.50 (0.44, 0.56)	<.0001
Median Income Quartiles				
< \$38,000	Ref		Ref	
\$38,000 - \$47,999	0.96 (0.84, 1.08)	0.4770	0.97 (0.88, 1.07)	0.5966
\$48,000 - \$62,999	1.05 (0.93, 1.18)	0.4317	1.07 (0.97, 1.17)	0.1619
\$63,000 +	0.98 (0.87, 1.11)	0.7652	1.05 (0.96, 1.16)	0.3096
Charlson-Deyo Score				
0	Ref		Ref	
1	1.13 (0.98, 1.31)	0.0980	0.94 (0.83, 1.06)	0.3022
2+	0.94 (0.77, 1.14)	0.5182	0.96 (0.82, 1.12)	0.5692
Lesion number				
Solitary	Ref		Ref	
Multiple	2.02 (1.82, 2.25)	<.0001	0.73 (0.66, 0.80)	<.0001
Site				
Bone site	Ref		Ref	
Extramed site	0.67 (0.60, 0.76)	<.0001	0.86 (0.78, 0.94)	0.0011
Unspecified site	1.73 (1.51, 1.97)	<.0001	0.77 (0.69, 0.86)	<.0001

[†]Odds Ratios (95% Confidence intervals and P-values) computed from multivariable logistic regression model adjusted for all covariates shown in table.