Title

Patterns of care in palliative radiotherapy: a population-based study.

Journal

Journal of oncology practice, 9(5)

ISSN

1554-7477

Authors

Murphy, James D
Nelson, Lorene M
Chang, Daniel T
et al.

Publication Date

2013-09-01

DOI

10.1200/jop.2012.000835

Peer reviewed

Original Contribution

Patterns of Care in Palliative Radiotherapy: A Population-Based Study

By James D. Murphy, MD, MS, Lorene M. Nelson, PhD, Daniel T. Chang, MD, Loren K. Mell, MD, and Quynh-Thu Le, MD

Stanford University School of Medicine, Stanford; and University of California, San Diego, La Jolla, CA

Abstract

Purpose: Approximately one half of the radiotherapy (RT) prescribed in the United States is delivered with palliative intent. The purpose of this study was to investigate the patterns of delivery of palliative RT across the United States.

Methods: Using the Surveillance, Epidemiology, and End Results–Medicare linked database, 51,610 patients were identified with incident stage IV breast, prostate, lung, or colorectal cancer diagnosed between 2000 and 2007 and observed through 2009. Multivariate logistic regression determined predictors of palliative RT.

Results: Forty-one percent of the study population received palliative RT, including 53% of patients with lung cancer, followed by those with breast (42%), prostate (40%), and colorectal cancers (12%). Multivariate analysis revealed that older patients ($P < .001$) and those with higher Charlson comorbidity scores ($P < .001$) were less likely to receive palliative RT. Black patients with prostate cancer were 20% less likely ($P < .001$), and black patients with colorectal cancer were 28% less likely ($P < .001$), than white patients to receive palliative RT. Among those treated with RT, 23% of patients with lung cancer died within 2 weeks of completing treatment, followed by those with colorectal (12%), breast (11%), and prostate cancers (8%). In addition to tumor site, significant predictors ($P < .05$) of death within 2 weeks of receiving RT included increased age, increased comorbidity, and male sex.

Conclusion: Inequality in the receipt of palliative RT exists among the elderly and patients with comorbid conditions and varies with race. In addition, a significant number of patients die shortly after receiving RT. Understanding these patterns of care, along with further research into the underlying causes, will improve access and quality of palliative RT.

INTRODUCTION

Across the United States, approximately one half of prescribed radiotherapy (RT) is delivered with palliative intent.[1,2] Palliative RT has numerous indications, including the treatment of painful bone metastases, symptomatic brain metastases, and spinal cord or nerve root compression. Palliative RT can diminish pain, preserve or improve neurologic function, and dramatically improve quality of life in patients with metastatic cancer.

Despite the significant benefit that palliative RT offers, few studies have evaluated this modality at a population level.[3-6] In addition, the benefit of palliative RT depends a great deal on timing. Patients who die shortly after receiving cancer therapy inherently stand to benefit less. Other studies have addressed chemotherapy use at the end of life,[7,8] and this question deserves further evaluation with palliative RT.

Our study used the Surveillance, Epidemiology, and End Results (SEER) –Medicare linked database to explore palliative RT across the four most common cancers in the United States[9]: breast, prostate, lung, and colorectal cancers. Specifically, the objectives of this study were: one, to identify factors that contribute to inequality in palliative RT; and two, to define the time-course of palliative RT with a focus on defining the population receiving treatment immediately before death.

METHODS

Data

This study used the SEER-Medicare linked database. The SEER program consists of cancer registries that cover approximately 28% of the US population. Medicare provides federally funded health insurance for people age ≥ 65 years. The SEER-Medicare linked database contains Medicare claims data for the Medicare-eligible patients in the SEER database. This data set allows a unique opportunity to evaluate patterns of health care delivery on a population-based level. This study was deemed exempt from institutional review board approval.

Population

This study evaluated the four most commonly diagnosed cancers in the United States: breast, prostate, non–small-cell lung, and colorectal cancers. We identified 90,563 patients age ≥ 66 years with an incident diagnosis of stage IV cancer between 2000 and 2007. Patients with multiple primary tumors were excluded (13%), as were patients who initially enrolled in Medicare because of end-stage renal disease or disability (0.3%). Finally, patients with incomplete Medicare claims data (continuous part A or part B, without part C enrollment) for 12 months before diagnosis (to calculate comorbidity) through death or last follow-up (December 2009) were excluded (34%), leaving 51,610 patients in the final study cohort.

Study End Points

The primary end point in this study was RT delivery in patients with metastatic disease, which was derived from SEER registry data and Medicare claims data. SEER collects information on RT within 1 year of diagnosis delivered as part of the initial course of treatment.[10] Medicare billing claims data allow the identification of RT delivered at any point in a patient's life. With Medicare, the following daily radiation treatment and weekly management Health Care Common Procedure Coding System codes were used to capture a course of RT: 77371 to 77373, 77417, 77419 to 77420, 77425, 77427, 77430 to 77432, 77435, 77401 to 77416, 77418, 77422 to 77423, 77470, 77499, 77520, 77522 to 77523, 77525, G0173 to G0174, G0243, G0251, and G0338 to G03340. Radioactive implants and radioisotopes, coded separately in SEER, were not counted as palliative RT. A course of radiation was defined as any group of codes within 14 days of one another. Because patients can receive multiple courses of radiation, we assumed that any break in radiation codes $\geq$ 14 days indicated a separate and additional course of radiation. The duration of a course of radiation was defined as the time between the first and last billing claims for that course.

We assessed RT agreement between SEER registry data and Medicare claims data within the first year of diagnosis, when both SEER and Medicare capture RT data simultaneously. When the SEER database scored patients as having received radiation, Medicare agreed 91% of the time. Similarly, when Medicare scored patients as having received radiation within 1 year of diagnosis, SEER agreed 90% of the time. This level of agreement is similar to what other investigators have found.[11]

Covariates Studied

Patient- and tumor-related variables obtained from SEER data included age, race, marital status, disease site, registry location, socioeconomic status, and year of diagnosis (2000 to 2007). Race was defined from SEER using descriptions from the 2000 US Census and Bureau of Vital Statistics.[12] Individual SEER cancer registries were reclassified into East (Connecticut and New Jersey), Midwest (Detroit and Iowa), South (Atlanta, rural Georgia, Kentucky, and Louisiana), and West (San Francisco, Hawaii, New Mexico, Seattle, Utah, San Jose, Los Angeles, and greater California). Socioeconomic status was estimated by median household income divided into quintiles. Median household income was determined from the 2000 census using census track data over zip code data and secondarily using race- and age-adjusted data over unadjusted data. Patients without household income data (1%) were grouped into the bottom quintile.[13] Comorbidity was assessed during the 12 months before diagnosis using inpatient and outpatient Medicare claims[14] with the Deyo adaptation[15] of the Charlson comorbidity index.[16] The distance from the patient to the nearest radiation oncologist was estimated from the number of radiation oncologists per 1,000 square miles in the county where the patient resided. These data were determined from the Area Resource File,[17] which collects data that include the number of radiation oncologists per county in the year 2005.

Statistical Analysis

Continuous covariates were divided into categorical covariates to assess for nonlinear trends. Univariate predictors of palliative RT were determined with χ^2 tests. Multivariate predictors of palliative RT were determined with logistic regression using relevant covariates (Table 1). Potential interactions between covariates were examined in the multivariate model, and among the covariates tested, we found a clinically and statistically significant interaction between tumor site and race. To account for this interaction, we stratified this multivariate model by tumor site.

Predictors of the duration of RT were determined with a multivariate linear regression model that included all covariates listed in Table 1. Time from the end of palliative RT to death was assessed with the Kaplan-Meier method.[18] Among patients who received multiple courses of RT, the last course was used to assess time from the end of treatment to death. Multivariate predictors of death within 2 weeks of irradiation were determined with logistic regression. The end of palliative RT was defined as the date of the last Medicare radiation claim, and therefore, the analysis of the timing of palliative RT excluded a small fraction of patients with a record of palliative RT in SEER only, without Medicare irradiation billing claims (6% of patients receiving RT). No interactions between covariates were discovered in the multivariate analyses of RT duration, and predictors of death within 2 weeks of RT; therefore, unstratified models are presented with these analyses. All analyses were conducted with SAS version 9.3 (SAS Institute, Cary, NC).

RESULTS

Of the 51,610 patients identified within the SEER-Medicare database, 21,279 (41%) received palliative RT. Fifty-three percent of patients with lung cancer received palliative RT, followed by those with breast (42%), prostate (40%), and colorectal cancers (12%). Table 1 lists additional demographic data for our study population. The majority of patients (78%) received only a single course of palliative RT, whereas 17% received two courses, and 5% received $\geq$ three separate courses. The median follow-up times from diagnosis to death were 4.0, 13, 29, and 6.6 months for lung, breast, prostate, and colorectal cancers, respectively.

Predictors of Palliative RT

Table 1 lists the univariate predictors of palliative RT, and Table 2 lists the multivariate predictors of palliative RT. After adjusting for other covariates, black patients with prostate cancer were 20% less likely to receive palliative RT compared with white patients with prostate cancer (relative risk [RR], 0.80; 95% CI, 0.71 to 0.91; $P < .001$). In addition, black patients with colorectal cancer were 28% less likely to receive palliative RT compared with white patients with colorectal cancer (RR, 0.72; 95% CI, 0.60 to 0.87; $P < .001$). We saw no significant differences between black and white patients with breast (RR, 0.91; 95% CI, 0.79 to 1.03; $P = .13$) or lung cancer (RR, 0.98; 95% CI, 0.94 to 1.01; $P = .16$). Across all disease sites, multi-

Table 1. Patient Characteristics and Univariate Predictors of Palliative RT

Variable	No. of Patients	Palliative RT (%)		P
		No	Yes	
All patients	51,610	59	41	—
Tumor site				< .001
Lung	29,316	47	53	
Colon/rectum	11,920	87	13	
Breast	3,811	58	42	
Prostate	6,563	60	40	
Sex				< .001
Male	28,031	58	42	
Female	23,579	60	40	
Race/ethnicity				< .001
White	42,903	58	42	
Black	5,231	64	36	
Asian	1,553	61	39	
Hispanic	798	62	38	
Other/unknown	1,125	58	42	
Age, years				< .001
66-69	10,315	48	52	
70-74	13,226	53	47	
75-79	12,867	59	41	
80-84	9,232	66	34	
≥ 85	5,970	78	22	
Marital status				< .001
Not married	25,689	63	37	
Married	25,921	55	45	
Year of diagnosis				.35
2000	5,942	58	42	
2001	6,167	58	42	
2002	6,332	59	41	
2003	6,673	58	42	
2004	6,859	58	42	
2005	6,750	59	41	
2006	6,651	60	40	
2007	6,236	59	41	
Charlson comorbidity score				< .001
0	30,228	57	43	
1	12,209	59	41	
2	5,113	63	37	
≥ 3	4,060	67	33	
SEER registry				< .001
Midwest	8,122	59	41	
East	12,342	58	42	
South	9,978	57	43	
West	21,168	60	40	
Geographic location				< .001
Metro area (≥ 1 million)	29,016	59	41	
Metro area (< 1 million)	14,455	57	43	
Urban area (≥ 20,000)	3,161	57	43	
Urban area (2,500 to 19,999)	4,014	60	40	
Rural area (< 2,500)	963	60	41	
Median household income, quintile				< .001
Bottom	10,329	62	38	
Second	10,323	59	41	
Third	10,315	59	41	
Fourth	10,324	57	43	
Top	10,319	57	43	
Physician density				.0034
< 1	11,096	59	41	
1-10	14,410	58	42	
11-20	5,581	57	43	
21-30	4,568	59	41	
31-40	5,543	61	39	
≥ 41	10,411	59	41	

Abbreviations: RT, radiotherapy; SEER, Surveillance, Epidemiology, and End Results.

variate analysis revealed that older patients ($P < .001$) and those with high comorbidity scores ($P < .001$) were less likely to receive palliative RT. Among those with lung, breast, or prostate cancer, there were higher rates of palliative RT in higher socioeconomic classes and among people who were married. The use of palliative RT decreased slightly over time for lung cancer and remained relatively stable for breast, prostate, and colorectal cancers.

Among the group of black patients with prostate or colorectal cancer, we searched for potential subgroups who may have been more or less likely to receive palliative RT. We observed that black patients were more likely to be younger, unmarried, have lower income, more comorbidity, reside in the South or Midwest, and live in urban areas compared with white patients. However, tests for statistical interaction failed to identify a particular subgroup of black patients who were more or less likely to receive palliative RT compared with the already decreased rates of palliative RT among the entire group of black patients with prostate or colorectal cancer ($P > .05$ for interaction).

Duration and Timing of Palliative RT

The median duration of palliative RT for the entire study population was 16 days. Patients with lung cancer had the shortest treatment duration, followed by those with breast (average 4 days longer), colorectal (6 days longer), and prostate cancers (8 days longer; all $P < .001$). Older patients had slightly shorter radiation courses (average 1.3 days shorter for every 10 years older; $P < .001$). Finally, patients treated in the West had slightly longer radiation courses (1.2 days longer; $P = .002$) compared with those in the Midwest. The duration of palliative RT did not vary by race, sex, comor-

Table 2. Multivariate Predictors of Palliative RT

	Colorectal Cancer			Lung Cancer			Breast Cancer			Prostate Cancer		
Variable	**OR***	**95% CI**	***P***	**OR***	**95% CI**	***P***	**OR***	**95% CI**	***P***	**OR***	**95% CI**	***P***
Race/ethnicity												
White	1		—	1		—	1		—	1		—
Black	0.67	0.54 to 0.84	< .001	0.94	0.85 to 1.03	.16	0.83	0.66 to 1.06	.13	0.71	0.59 to 0.85	< .001
Asian	1.35	0.99 to 1.84	.059	0.92	0.80 to 1.06	.26	0.90	0.53 to 1.54	.71	0.84	0.61 to 1.15	.27
Hispanic	1.36	0.89 to 2.09	.16	0.91	0.74 to 1.12	.37	0.80	0.41 to 1.57	.52	1.00	0.73 to 1.38	.98
Other/unknown	1.24	0.86 to 1.79	.25	0.92	0.78 to 1.08	.31	1.36	0.82 to 2.23	.23	0.87	0.63 to 1.19	.38
Age, years												
65-69	1		—	1		—	1		—	1		—
70-74	0.79	0.68 to 0.92	.0027	0.80	0.75 to 0.86	< .001	0.82	0.67 to 1.00	.053	0.93	0.81 to 1.08	.36
75-79	0.61	0.52 to 0.71	< .001	0.61	0.57 to 0.65	< .001	0.71	0.58 to 0.87	.0011	0.82	0.70 to 0.95	.001
80-84	0.47	0.39 to 0.56	< .001	0.50	0.46 to 0.54	< .001	0.47	0.38 to 0.58	< .001	0.57	0.48 to 0.67	< .001
≥ 85	0.27	0.22 to 0.34	< .001	0.32	0.29 to 0.36	< .001	0.32	0.25 to 0.41	< .001	0.35	0.29 to 0.42	< .001
Charlson comorbidity score												
0	1		—	1		—	1		—	1		—
1	0.86	0.75 to 0.99	.037	0.85	0.81 to 0.90	< .001	0.69	0.58 to 0.82	< .001	0.98	0.86 to 1.12	.81
2	0.67	0.54 to 0.83	< .001	0.70	0.64 to 0.75	< .001	0.74	0.58 to 0.95	.019	0.75	0.61 to 0.92	.0072
≥ 3	0.41	0.31 to 0.56	< .001	0.58	0.53 to 0.63	< .001	0.55	0.41 to 0.72	< .001	0.63	0.50 to 0.80	< .001
Sex												
Female	1		—	1		—	1		—	1		—
Male	1.05	0.99 to 1.11	.10	0.97	0.95 to 0.99	.018	—			—		
Marital status												
Not married	1		—	1		—	1		—	1		—
Married	1.06	0.94 to 1.19	.32	1.24	1.18 to 1.30	< .001	1.15	0.99 to 1.33	.06	1.37	1.23 to 1.53	< .001
Median household income, quintile												
Bottom	1		—	1		—	1		—	1		—
Second	0.91	0.76 to 1.09	.29	1.07	0.99 to 1.16	.09	1.29	1.03 to 1.61	.026	1.20	1.01 to 1.42	.036
Third	1.06	0.88 to 1.27	.53	1.06	0.98 to 1.15	.16	1.03	0.82 to 1.29	.82	1.32	1.11 to 1.58	.0019
Fourth	1.02	0.84 to 1.23	.86	1.17	1.08 to 1.27	< .001	1.24	0.98 to 1.58	.08	1.33	1.11 to 1.60	.0021
Top	0.97	0.80 to 1.19	.80	1.19	1.09 to 1.29	< .001	1.31	1.02 to 1.68	.033	1.50	1.24 to 1.81	< .001
Year of diagnosis												
2000	1		—	1		—	1		—	1		—
2001	1.06	0.85 to 1.33	.58	0.97	0.87 to 1.07	.51	1.06	0.81 to 1.38	.66	0.90	0.74 to 1.10	.32
2002	1.15	0.92 to 1.42	.22	0.88	0.79 to 0.97	.011	1.17	0.90 to 1.53	.24	0.91	0.75 to 1.11	.34
2003	1.03	0.82 to 1.28	.81	0.91	0.83 to 1.01	.07	1.08	0.82 to 1.41	.59	1.09	0.89 to 1.32	.42
2004	1.12	0.90 to 1.40	.29	0.87	0.79 to 0.96	< .001	1.11	0.85 to 1.43	.45	1.01	0.83 to 1.24	.90
2005	1.13	0.91 to 1.41	.28	0.82	0.74 to 0.90	< .001	1.06	0.82 to 1.38	.64	1.10	0.90 to 1.35	.34
2006	1.11	0.89 to 1.38	.37	0.80	0.73 to 0.88	< .001	0.91	0.70 to 1.18	.46	1.04	0.85 to 1.28	.69
2007	1.10	0.87 to 1.39	.41	0.85	0.77 to 0.94	< .001	0.93	0.71 to 1.20	.57	1.08	0.88 to 1.33	.45
Region												
Midwest	1		—	1		—	1		—	1		—
East	1.18	0.98 to 1.42	.08	1.02	0.94 to 1.10	.66	1.01	0.80 to 1.26	.96	0.89	0.75 to 1.07	.22
South	0.94	0.77 to 1.14	.53	1.11	1.02 to 1.20	.014	1.20	0.95 to 1.53	.13	0.94	0.78 to 1.13	.50
West	0.94	0.79 to 1.12	.51	0.88	0.82 to 0.95	.0015	1.01	0.81 to 1.27	.91	0.87	0.75 to 1.03	.10
Physician density												
< 1	1		—	1		—	1		—	1		—
1-10	0.97	0.82 to 1.14	.69	1.04	0.97 to 1.12	.28	1.09	0.88 to 1.35	.44	1.07	0.92 to 1.25	.36
11-20	0.97	0.78 to 1.20	.79	1.07	0.97 to 1.17	.16	1.16	0.89 to 1.52	.27	1.05	0.86 to 1.29	.60
21-30	0.89	0.70 to 1.13	.33	1.00	0.90 to 1.12	.94	1.07	0.80 to 1.43	.65	1.25	1.00 to 1.56	.051
31-40	0.92	0.74 to 1.15	.47	1.00	0.91 to 1.10	.99	1.15	0.88 to 1.51	.30	1.19	0.97 to 1.45	.09
≥ 40	0.87	0.72 to 1.05	.15	1.05	0.97 to 1.14	.21	1.11	0.88 to 1.40	.37	1.00	0.83 to 1.19	.97

Abbreviations: OR, odds ratio; RT, radiotherapy.
*Adjusted.

Table 3. Predictors of Death Within 1 Month of Completing Palliative RT

Variable	OR*	95% CI	*P*
Tumor site			
Prostate	1		—
Breast	1.72	1.37 to 2.17	< .001
Colorectal	1.81	1.46 to 2.25	< .001
Lung	3.81	3.26 to 4.45	< .001
Race/ethnicity			
White	1		—
Black	1.01	0.88 to 1.17	.84
Asian	0.93	0.74 to 1.17	.54
Hispanic	1.27	0.95 to 1.71	.10
Other/unknown	0.77	0.59 to 1.02	.07
Age, years			
66-69	1		—
70-74	1.07	0.97 to 1.18	.21
75-79	1.13	1.02 to 1.25	.021
80-84	1.29	1.15 to 1.45	< .001
≥ 85	1.42	1.21 to 1.67	< .001
Charlson comorbidity score			
0	1		—
1	1.06	0.97 to 1.15	.21
2	1.23	1.09 to 1.39	.001
≥ 3	1.38	1.20 to 1.59	< .001
Sex			
Female	1		—
Male	1.11	1.07 to 1.16	< .001
Marital status			
Not married	1		—
Married	0.94	0.87 to 1.01	.10
Median household income, quintile			
Bottom	1		—
Second	1.05	0.93 to .191	.41
Third	1.05	0.93 to .191	.40
Fourth	1.06	0.93 to 1.20	.38
Top	0.96	0.84 to 1.10	.55
Year of diagnosis			
2000	1		—
2001	0.91	0.79 to 1.05	.19
2002	0.93	0.81 to 1.07	.32
2003	0.79	0.68 to 0.91	.001
2004	0.85	0.74 to 0.98	.026
2005	0.80	0.69 to 0.92	.0018
2006	0.69	0.60 to 0.80	< .001
2007	0.73	0.63 to 0.85	< .001
Region			
Midwest	1		—
East	1.01	0.90 to 1.14	.83
South	0.97	0.86 to 1.10	.69
West	0.99	0.88 to 1.11	.88
Physician density			
< 1	1		—
1-10	1.07	0.96 to 1.19	.24
11-20	1.08	0.94 to 1.25	.26
21-30	0.99	0.84 to 1.17	.92
31-40	1.06	0.91 to 1.23	.46
≥ 40	1.07	0.94 to 1.21	.29

Abbreviations: OR, odds ratio; RT, radiotherapy.
*Adjusted.

bidity, marital status, income level, year of diagnosis, or density of radiation oncologists.

We next turned our attention to determining the timing of the delivery of palliative RT, focusing on the fraction of patients who received RT immediately preceding death. Survival after completing RT is shown in Appendix Figure A1 (online only), which highlights the observation that a significant proportion of patients received RT shortly before death. Specifically, 23% of patients with lung cancer died within 2 weeks of completing palliative RT, followed by those with colorectal (12%), breast (12%), and prostate cancers (8%).

Finally, we determined the patient characteristics of those who died within 2 weeks of receiving RT (Table 3). Multivariate analysis revealed site-specific differences, with patients with lung cancer the most likely to die shortly after RT, followed by those with colorectal, breast, and prostate cancers. Treatment year was a significant predictor, suggesting that the number of patients treated shortly before death decreased over the study period. Other predictors of death included increased age, increased comorbidity, and male sex.

DISCUSSION

This study characterizes the delivery of palliative RT among the four most common causes of cancer diagnosed in the United States.[9] Although palliative RT can act as a powerful tool to alleviate symptoms associated with advanced cancer, this study identified areas of disparity and potential inefficiency with respect to delivery of RT at the end of life. Identifying these problems and further research into their underlying causes will improve access and effectiveness of this important treatment modality.

A key finding of our study relates to tumor site–dependent racial disparity, with black patients with prostate cancer 20% less likely to receive palliative RT and black patients with colorectal cancer 28% less likely to receive palliative RT compared with white patients. Many factors could explain these observed differences, and although underlying causes of racial inequality have not been identified in palliative RT, they have been addressed in other areas of health care. Unconscious physician racial bias against black patients affects clinical recommendations for cardiac catheterization[19] and treatment decisions in patients with acute coronary syndrome.[20] Also, poor patient-

physician interaction contributes to the decision of black patients to reject the recommendation for the standard of care (surgery) in early-stage non–small-cell lung cancer.[21] Although this study found racial inequality with prostate and colorectal cancers, a natural question arises: Why was there no disparity in breast or lung cancer? This question is challenging to answer; however, understanding the difference could shed light on the underlying cause of racial disparity. Potential hypotheses include disease-specific biases or barriers somewhere from patient referral through radiation treatment, although race-based differences in tumor biology or disease trajectory should be explored as well. Unfortunately, the data used in this project lack the granularity required to answer several of these questions, and underlying causes of tumor site–specific racial disparity in the use of palliative RT remains unknown. Factors such as referring or treating physician biases, communication breakdowns, and race-based differences in tumor biology all warrant further study.

In addition to racial inequality, our study found that income level and age correlated independently with palliative RT. The correlation between estimated income level, age, and palliative RT is not unique to this study.[3,4] A SEER-Medicare study on non–small-cell lung cancer between 1991 and 1996 and a Canadian study evaluating the Ontario Cancer Registry between 1986 and 1995 both found that increased age and lower income level correlated inversely with the receipt of palliative RT. Of note, all participants in these studies had health insurance; however, one could hypothesize that lower socioeconomic status would affect a patient's ability to pay deductibles or copayments, which could affect his or her willingness to receive palliative RT. Although our study cannot address this hypothesis directly, increased copayments have been linked to a 15% decline in the use of emergency department services.[22] Another possibility would be that patients with a lower income level could have less access to transportation, which would limit their ability to get to and from a radiation oncology clinic.[23]

Aside from inequality, this study found that a considerable number of patients died soon after receiving RT. Chemotherapy delivered within 2 weeks of death is considered a metric for decreased quality of care at the end of life[24]; however, the same may not be true for palliative RT. Although chemotherapy can palliate, it is often delivered to induce a systemic response, decrease tumor burden, and prolong life. This stands in contrast with the principal goal of palliative RT: alleviating focal symptoms. Despite this, a German study found that among patients who died within 2 weeks of receiving palliative RT, only 26% had stable or improved symptoms.[25] Among patients receiving palliative RT in this study, 19% died within 2 weeks of completing treatment, and one of three died within 1 month. A separate recently reported SEER-Medicare study evaluating lung, breast, prostate, colorectal, and pancreatic cancers from 2000 to 2007 found that nearly one in five patients who received RT within the last 30 days of life spent $>$ 10 days receiving radiation treatment.[6] Identifying and understanding the underlying causes of this complex subject poses a challenge, given that the timing of RT depends on multiple factors. Although earlier patient identification and referral to a radiation oncologist could help, this approach may not be feasible in all patients, given their relatively short overall survival. Physicians consistently overestimate survival in patients with cancer at the end of life,[26,27] and improved prognostic tools or biomarkers[28] could lead to enhanced patient selection. In addition, improvements in the delivery of radiation therapy, such as faster times from referral to treatment[29] or shorter courses of palliative RT,[6,30,31] would effectively lengthen the interval between RT and death. Further research is desperately needed to better understand this complicated issue.

This study has limitations that are worth mentioning. The administrative data in this study do not contain information on radiation target or dose. Therefore, this study included patients treated with RT for bone metastases, brain metastases, and symptomatic local disease, as well as RT for several other indications. This heterogeneity precludes more-detailed subset analyses, and our results could theoretically differ between patients treated with brain metastases, bone metastases, and other palliative RT targets. Another limitation relates to the fact that this study included patients age $>$ 66 years with an incident diagnosis of metastatic cancer and did not include patients with localized malignancies who subsequently developed metastatic disease. Therefore, conclusions reached here may not be generalizable to younger patients or those with metastatic cancer initially presenting with local disease. Finally, this study can only infer palliative treatment intent, because neither SEER nor Medicare explicitly record intent. A large majority of patients with stage IV disease have incurable cancer; however, a small subset of patients with oligometastatic tumors could have potentially curable disease, and therefore, RT may be administered with curative intent in this subset. Although this could have potentially skewed our results, we estimate that the subset of patients treated with curative intent accounted for a small fraction of the study population and therefore should not jeopardize our conclusions.

Despite these limitations, this study demonstrates significant inequality in the delivery of palliative RT among the elderly, patients with comorbidity, and black patients with prostate and colorectal cancer. In addition, we show that a considerable proportion of patients die shortly after completing radiation treatment. Understanding these patterns of care and further research into the underlying causes will improve the effectiveness of palliative RT.

Acknowledgment

Supported an American Society of Clinical Oncology Young Investigator Award (J.D.M.) and Master Research Agreement from Varian Medical Systems (J.D.M., Q.-T.L.). This study used the linked Surveillance, Epidemiology, and End Results (SEER) –Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. We acknowledge the efforts of the Applied Research Program, National Cancer Institute; the Office of Research, Development, and Information, Centers for Medicare and Medicaid Services; Information Management Services; and the SEER program tumor registries in the creation of the SEER-Medicare database.

Authors' Disclosures of Potential Conflicts of Interest

Although all authors completed the disclosure declaration, the following author(s) and/or an author's immediate family member(s) indicated a financial or other interest that is relevant to the subject matter under consideration in this article. Certain relationships marked with a "U" are those for which no compensation was received; those relationships marked with a "C" were compensated. For a detailed description of the disclosure categories, or for more information about ASCO's conflict of interest policy, please refer to the Author Disclosure Declaration and the Disclosures of Potential Conflicts of Interest section in Information for Contributors.

Employment or Leadership Position: None **Consultant or Advisory Role:** None **Stock Ownership:** None **Honoraria:** None **Research Funding:** Quynh-Thu Le, Varian **Expert Testimony:** None **Other Remuneration:** None

Author Contributions

Conception and design: All authors

Financial support: James D. Murphy, Quynh-Thu Le

Administrative support: Quynh-Thu Le

Collection and assembly of data: James D. Murphy

Data analysis and interpretation: All authors

Manuscript writing: All authors

Final approval of manuscript: All authors

Corresponding author: James D. Murphy, MD, MS, University of California San Diego, Department of Radiation Medicine and Applied Sciences, 3960 Health Sciences Dr, La Jolla, CA 92093-0865; e-mail: j2murphy@ucsd.edu.

DOI: 10.1200/JOP.2012.000835; published online ahead of print at jop.ascopubs.org on April 16, 2013.

References

1. Janjan NA: An emerging respect for palliative care in radiation oncology. J Palliat Med 1:83-88, 1998

2. Richter MP, Coia LR: Palliative radiation therapy. Semin Oncol 12:375-383, 1985

3. Hayman JA, Abrahamse PH, Lakhani I, et al: Use of palliative radiotherapy among patients with metastatic non-small-cell lung cancer. Int J Radiat Oncol Biol Phys 69:1001-1007, 2007

4. Huang J, Zhou S, Groome P, et al: Factors affecting the use of palliative radiotherapy in Ontario. J Clin Oncol 19:137-144, 2001

5. Kapadia NS, Mamet R, Zornosa C, et al: Radiation therapy at the end of life in patients with incurable nonsmall cell lung cancer. Cancer 118:4339-4345, 2012

6. Guadagnolo BA, Liao KP, Elting L, et al: Use of radiation therapy in the last 30 days of life among a large population-based cohort of elderly patients in the United States. J Clin Oncol 31:80-87, 2013

7. Earle CC, Neville BA, Landrum MB, et al: Trends in the aggressiveness of cancer care near the end of life. J Clin Oncol 22:315-321, 2004

8. Ho TH, Barbera L, Saskin R, et al: Trends in the aggressiveness of end-of-life cancer care in the universal health care system of Ontario, Canada. J Clin Oncol 29:1587-1591, 2011

9. Siegel R, Naishadham D, Jemal A: Cancer statistics, 2012. CA Cancer J Clin 62:10-29, 2012

10. Adamo MB, Johnson CH, Ruhl JL, et al (eds): 2012 SEER Program Coding and Staging Manual. Bethesda, MD, National Cancer Institute, NIH publication 12-5581, 2012

11. Virnig BA, Warren JL, Cooper GS, et al: Studying radiation therapy using SEER-Medicare linked data. Med Care 40:IV49-IV54, 2002 (suppl)

12. Surveillance, Epidemiology, and End Results: Appendix D: Race and Nationality Descriptions From the 2000 Census and Bureau of Vital Statistics. http://seer.cancer.gov/manuals/2010/SPCSM_2010_AppendixD.pdf

13. Krieger N: Overcoming the absence of socioeconomic data in medical records: Validation and application of a census-based methodology. Am J Public Health 82:703-710, 1992

14. Klabunde CN, Potosky AL, Legler JM, et al: Development of a comorbidity index using physician claims data. J Clin Epidemiol 53:1258-1267, 2000

15. Deyo RA, Cherkin DC, Ciol MA: Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 45:613-619, 1992

16. Charlson ME, Pompei P, Ales KL, et al: A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 40:373-383, 1987

17. US Department of Health and Human Services: 2009-2010 Area Resource File. http://arf.hrsa.gov/index.htm

18. Kaplan EL, Meier P: Nonparametric estimation from incomplete observations. J Am Stat Assoc 53:457-481, 1958

19. Schulman KA, Berlin JA, Harless W, et al: The effect of race and sex on physicians' recommendations for cardiac catheterization. N Engl J Med 340:618-626, 1999

20. Green AR, Carney DR, Pallin DJ, et al: Implicit bias among physicians and its prediction of thrombolysis decisions for black and white patients. J Gen Intern Med 22:1231-1238, 2007

21. Cykert S, Dilworth-Anderson P, Monroe MH, et al: Factors associated with decisions to undergo surgery among patients with newly diagnosed early-stage lung cancer. JAMA 303:2368-2376, 2010

22. Selby JV, Fireman BH, Swain BE: Effect of a copayment on use of the emergency department in a health maintenance organization. N Engl J Med 334:635-641, 1996

23. Goodwin JS, Hunt WC, Samet JM: Determinants of cancer therapy in elderly patients. Cancer 72:594-601, 1993

24. American Society of Clinical Oncology: The Quality Oncology Practice Initiative: Summary of Measures, Spring 2012. http://qopi.asco.org/Documents/QOPISpring2012MeasuresSummary_003.pdf

25. Gripp S, Mjartan S, Boelke E, et al: Palliative radiotherapy tailored to life expectancy in end-stage cancer patients: Reality or myth? Cancer 116:3251-3256, 2010

26. Glare P, Virik K, Jones M, et al: A systematic review of physicians' survival predictions in terminally ill cancer patients. BMJ 327:195-198, 2003

27. Hartsell WF, Desilvio M, Bruner DW, et al: Can physicians accurately predict survival time in patients with metastatic cancer? Analysis of RTOG 97-14. J Palliat Med 11:723-728, 2008

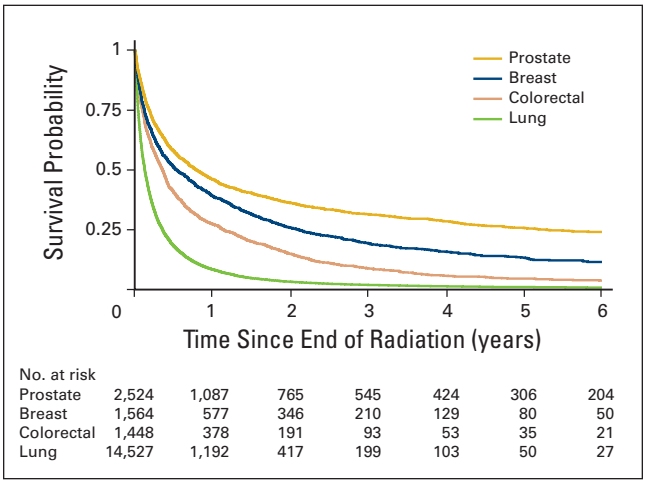
28. Feliu J, Jiménez-Gordo AM, Madero R, et al: Development and validation of a prognostic nomogram for terminally ill cancer patients. J Natl Cancer Inst 103:1613-1620, 2011

29. de Sa E, Sinclair E, Mitera G, et al: Continued success of the rapid response radiotherapy program: A review of 2004-2008. Support Care Cancer 17:757-762, 2009

30. Borgelt B, Gelber R, Kramer S, et al: The palliation of brain metastases: Final results of the first two studies by the Radiation Therapy Oncology Group. Int J Radiat Oncol Biol Phys 6:1-9, 1980

31. Hartsell WF, Scott CB, Bruner DW, et al: Randomized trial of short- versus long-course radiotherapy for palliation of painful bone metastases. J Natl Cancer Inst 97:798-804, 2005

Appendix



No. at risk							
Prostate	2,524	1,087	765	545	424	306	204
Breast	1,564	577	346	210	129	80	50
Colorectal	1,448	378	191	93	53	35	21
Lung	14,527	1,192	417	199	103	50	27

Figure A1. Time from end of palliative radiotherapy to death, stratified by tumor site.

Volume 9 Issue 5 September 2013

JOURNAL OF ONCOLOGY PRACTICE

The Authoritative Resource for Oncology Practices

CONTENTS

continued on following page

Journal of Oncology Practice (ISSN 1554-7477) is published bimonthly (January, March, May, July, September, November) by the American Society of Clinical Oncology, 2318 Mill Road, Suite 800, Alexandria, VA 22314. Periodicals postage is paid at Alexandria, VA, and at additional mailing offices. Publication Mail Agreement Number 273. Editorial correspondence should be addressed to John V. Cox, DO, *Journal of Oncology Practice*, 2318 Mill Road, Suite 800, Alexandria, VA 22314; phone: 703-797-1900; fax: 703-684-8720; e-mail: jopeditorsdesk@asco.org.

POSTMASTER: ASCO members should send changes of address to American Society of Clinical Oncology, 2318 Mill Road, Suite 800, Alexandria, VA 22314. Nonmembers should send changes of address to *Journal of Oncology Practice*, Customer Service, 2318 Mill Road, Suite 800, Alexandria, VA 22314. Annual subscription rates (effective through August 31, 2014): United States and possessions: ASCO active-allied, $50; ASCO international corresponding, $50; ASCO associate, $50; nonmember individual US, $125; nonmember individual international, $134; in-training US, $68; in-training international, $79; institutional US, $216; institutional international, $270; single issue US, $30; single issue international, $40. See jop.ascopubs.org/site/subscriptions/ for additional details.

To receive in-training rate, orders must be accompanied by name of affiliated institution, date of term, and the signature of program/residency coordinator on institution letterhead. Orders will be billed at individual rate until proof of status is received. Current prices are in effect for back volumes and back issues. Back issues are sold in conjunction with a subscription rate on a prorated basis. Subscriptions are accepted on a calendar-year basis. Prices are subject to change without notice. Single issues, both current and back, exist in limited quantities, and are offered for sale subject to availability.

continued on following page

HEALTH POLICY

Original Contirbutions

BUSINESS OF ONCOLOGY

Original Contribution

FOCUS ON QUALITY

Original Contributions

continued on following page

Also in This Issue

Editor Roster
Information for Contributors

Supplementary information available online

Web-exclusive content available

jop.ascopubs.org