Longitudinal Trends in Costs of Palliative Radiation for Metastatic Prostate Cancer

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Abstract

Background: In recent years, palliative treatment of prostate cancer metastases has been characterized by the use of more complex radiation treatment, despite a lack of evidence demonstrating a clinical benefit of these technologies in the palliative setting. The impact of adoption of these technologies on the costs of palliative radiation treatment in patients with metastatic prostate cancer remains poorly understood in the general patient population.

Methods: The study was a retrospective analysis of Surveillance, Epidemiology and End Results (SEER) Medicare data of men aged 66 and older who died from metastatic prostate cancer between 2000 and 2007 and received radiation therapy for bony metastases in the last year of life. Direct costs were obtained from Medicare carrier and outpatient facility payments for all radiation treatment claims and adjusted to 2008 dollars.

Results: A total of 1705 men met study inclusion criteria. Total Medicare payments for radiation therapy for bony metastases in the last year of life increased by 44.4% from an average of \$2,763 in 2000 to \$3,989 in 2007, with the proportion of all payments accrued within hospital-based settings increasing from 48% to 57%. Complexity of radiation therapy techniques over the same period was characterized by use of less simple (30.1% to 23.3%) and more complex (59.9% versus 66.7%) radiation therapy. From 2000–2003 to 2004–2007, the use of shorter treatment courses (≤ 5 fractions) decreased from 22% to 14%, and the use of single fraction treatment courses decreased by half (6.3% to 2.9%; $P \leq .001$).

Conclusions: Between 2000 and 2007, palliative radiation therapy for bony prostate cancer metastases was characterized by the use of more advanced treatment technologies and prolonged radiation treatment courses. Further research investigating barriers to cost-effective palliation is warranted.

Introduction

PROSTATE CANCER IS A LEADING CONTRIBUTOR to cancer health care costs.¹ Among patients with cancer, costs of care are often greatest near the end of life. Among men with prostate cancer, overall costs of medical care in the last year of life are on average three times higher than in the initial year after diagnosis, with total costs in the last year of life estimated at \$34,000 for patients diagnosed in 2004.¹ Radiation therapy, with or without supportive bisphosphonate therapy or additional supportive therapy, remains at the forefront of recommended care for patients with bony metastases.²

In recent years, palliative treatment for metastases has been characterized by the use of more complex radiation planning and delivery systems. Therapeutic radiation can be targeted using two-dimensional (2D) radiation therapy, three-dimensional (3D)

radiation therapy, or intensity-modulated radiation therapy (IMRT), along with image guidance and stereotactic localization systems. Expenditures attributed to radiation oncology are outpacing other areas of Medicare spending.³ Shifts toward more advanced radiation therapy techniques have been observed in the initial treatment of prostate cancer, which underwent a switch from 3D conformal treatment to IMRT between 2002 and 2007.⁴ A study of utilization patterns of radiation therapy at the end of life suggested a trend toward the use of more advanced techniques in palliative end-of-life care of prostate and other metastatic disease.⁵

In this study we performed a retrospective analysis to assess changes in costs, radiation delivery technique, and number of fractions per treatment course of palliative radiation therapy of prostate cancer bony metastases among men 66 years and older who died from prostate cancer between 2000 and 2007.

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Methods

Data source

Data were from the Surveillance, Epidemiology and End Results (SEER) and Medicare linked data. SEER-Medicare is a collaborative effort of the National Cancer Institute and the Centers for Medicare & Medicaid Services that links routinely collected, population-based data from SEER cancer registries to Medicare administrative claims. The data have been used to examine cancer treatment, costs, and outcomes⁶⁻⁸. We used SEER data from 1992 through 2007 to define diagnosis of prostate cancer, disease stage, patient demographic characteristics, and cause of death. We used linked Medicare claims from 1991 through 2007 to confirm Medicare enrollment and capture Medicare payments associated with planning and administration of radiation therapy. The institutional review board of the Duke University Health System approved the study.

Study population

From the 12 SEER registries that were continuously active from 1992 onward, we identified all patients who were diagnosed with prostate cancer between 1992 and 2007 and who died from prostate cancer between 2000 and 2007 according to the cause of death recorded in the SEER data. To identify patients likely to have complete Medicare claims related to prostate cancer management, we required that patients have a claim associated with a primary diagnosis of prostate cancer within two months of the SEER-reported diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] code 185). We limited the study to men who were 66 years or older at the time of diagnosis and who died between 2000 and 2007.

We excluded patients who were diagnosed at autopsy or death or had another diagnosis of malignancy in the year before the diagnosis of prostate cancer. We also excluded patients who had a diagnosis of one or more malignancies in the two years before death and patients who had discontinuous Medicare Part A and Part B coverage from the year before diagnosis through death.

The presence of a bone metastases ICD-9 diagnosis (198.5) on a claim submitted in the last year of life was required to maximize the specificity of our cohort, but should not be interpreted as an accurate assessment of the overall number of men with bone metastases. We identified receipt of radiation therapy within the last year of life using Current Procedural Terminology (CPT)/Healthcare Common Procedure Coding System (HCPCS) codes on outpatient and carrier claims. (See online supplementary Table S1 at www.liebertpub.com/jpm and at www.liebertonline.com.) The final patient cohort consisted of men with bony metastases who received palliative radiation therapy in the last year of life.

Outcomes

Primary outcomes included Medicare payments in the last year of life for all claims associated with radiation therapy following an initial claim for radiation treatment for bony metastases. We categorized treatment delivery modality as simple (codes 77401–77406), intermediate (codes 77407–77411), complex (codes 77412–77416), IMRT (code 77418), or as stereotactic radiosurgery (codes G0339 and G0340). We calculated direct costs to Medicare by summing Medicare

carrier and outpatient facility payments starting with an initial radiation claim with an ICD-9-CM code for bony metastases (code 198.5). Outpatient and carrier file claims were used to identify treatment within a hospital outpatient department and freestanding facility, respectively. We adjusted costs for inflation to 2008 U.S. dollars using the U.S. Consumer Price Index for medical care.⁹

To calculate the number of fractions received during the initial course of therapy, we counted all fractions delivered within 30 days after an initial claim for radiation delivery. We excluded patients who received additional fractions between days 31 and 60 to avoid analyzing prolonged courses of treatment that were unlikely to reflect palliative treatment for single bony metastases.¹¹ We defined retreatment as radiation therapy that resumed after a break in treatment was observed between 31 to 60 days after the initial treatment course. We performed a sensitivity analysis that included all treatments within 60 days after the initial treatment claim.

Other variables

We obtained demographic variables from the SEER Patient Entitlement and Diagnosis Summary File, including age at diagnosis, age at death, time from diagnosis to death, race, ethnicity, marital status, and local census tract characteristics (i.e., metropolitan urban or rural status, proportion of the population not finishing high school, proportion below the poverty line, and proportion reporting black race). We assessed National Cancer Institute (NCI)-established comorbid conditions using inpatient, outpatient, and carrier Medicare claims¹⁰ from the year before diagnosis and one year before death. Baseline clinical characteristics included disease stage at diagnosis and receipt of surgery or radiation.

Statistical analysis

We assessed general trends in categorical variables over time using Cochran-Mantel-Haenszel tests. We modeled costs over time using a generalized linear model of costs with a gamma error distribution and a log link as a function of year of death. We analyzed other continuous variables including age at diagnosis and time from diagnosis to death using linear regression applied to each variable as a function of year of death. In addition to assessing general trends over time, we compared the number of fractions administered during the initial course of radiation therapy in 2000–2003 versus 2004–2007 using a Wilcoxon rank sum test and the proportion of patients receiving each type of radiation therapy in 2000–2003 versus 2004–2007 using χ^2 tests for homogeneity. We used the same approach to compare between time periods the proportions of patients who received a single fraction, 2 to 5 fractions, 6 to 10 fractions, and 11 or more fractions. We set the significance level at $P \leq .001$ to address multiple hypothesis testing. We used statistical software SAS (SAS version 9.2; SAS Institute Inc., Cary, NC) for all analyses.

Results

A total of 4954 patients died from prostate cancer between 2000 and 2007 and received a diagnosis of bony metastases within the last year of life. Of these patients, 1705 patients (34.4%) received radiation therapy within the last year of life during the study period. The proportion of patients who

received any radiation therapy did not change significantly between 2000 (173/538 [32%]) and 2007 (207/642 [32%]; $P = .42$ from Cochran-Mantel-Haenszel test for difference in row means) and remained between 32% and 36% throughout the study period.

Table 1 shows the characteristics of the study population. Among the 1705 patients who received radiation therapy for bony metastases, patient characteristics remained similar from 2000 through 2007. In the overall study population, mean age at diagnosis was 75.0 years (SD, 6.0) and did not change during the study period ($P = 0.6$). Overall mean age at death was 79.7 years (SD, 5.9) and increased from 79.1 years in 2000 to 80.3 years in 2007 ($P = .003$). Mean time from diagnosis to death was 56.8 months (SD, 42.1) and increased during the study period from 46.9 to 68.3 months ($P < .001$). On average, patients had claims for 1.1 noncancer-related comorbid condition in the year before death. Among the overall study population, 7% were black, 73% were married, and most patients came from the Midwest (35%) or West (44%), with relatively few patients represented from the South (5%). Over the study period, 37% of men had distant metastatic disease confirmed at the time of diagnosis. The proportion of black, married, and patients represented within each geographic region all remained similar over the study period (all $P > .001$).

One-quarter of the study population underwent simple radiation therapy, 10.6% underwent intermediate therapy, and 63.4% underwent complex therapy (see Table 2). Nineteen patients (1.1%) underwent IMRT or stereotactic radiosurgery. Comparisons of patients treated in 2000–2003 to patients treated in 2004–2007 revealed a significant shift toward more complex treatments ($P = .003$) and IMRT ($P = .003$) over simple ($P = .002$) and intermediate ($P < .001$) treatment, though the number of patients undergoing IMRT (<11) remained too small to report.

To examine the mean number of fractions delivered during the initial course of treatment, we summed the number of treatments administered within 30 days after the initial radiation treatment delivery claim ($n = 1423$) and excluded patients who received any treatment between 31 and 60 days after the initial treatment claim. Few of the remaining 1278 patients received single fraction treatment ($n = 58$; 4.5%), and the large majority (82.2%) received six fractions or more within 30 days. Comparison of the number of fractions received by patients who died in 2000–2003 and those who died in 2004–2007 demonstrated that the use of shorter treatment courses (≤ 5 fractions) decreased from 22% to 14%. The use of single fraction treatment decreased from 6.3% to 2.9% from 2004 to 2007 ($P \leq .001$; see Table 3). Retreatment after the initial course was defined as receipt of any radiation therapy after day 60, following a break in treatments between days 31 and 60, and was observed in 221 (17.3%) patients. Sensitivity analyses that considered all 1423 patients, including those who were treated between day 31 and day 60 after the initial treatment, confirmed a similar trend toward higher numbers of treatments per initial treatment course ($P < .001$).

Total Medicare payments for radiation therapy for bony metastases in the year before death increased by 44.4% from a mean of \$2,763 in 2000 to \$3,989 in 2007 (see Table 4; $P < .001$). Payments for outpatient claims, representing radiation therapy provided at hospital-affiliated outpatient

TABLE 1. PATIENT CHARACTERISTICS BY YEAR OF DEATH

Characteristic	All years (N = 1705)	2000 (n = 173)	2001 (n = 198)	2002 (n = 230)	2003 (n = 221)	2004 (n = 224)	2005 (n = 243)	2006 (n = 209)	2007 (n = 207)	P value ^a
Age at death, mean (SD), y	79.7 (5.9)	79.1 (5.9)	79.4 (5.5)	79.0 (5.8)	79.5 (5.5)	80.1 (5.9)	80.4 (5.7)	79.9 (6.1)	80.3 (6.3)	0.003
Diagnosis to death, mean (SD), mo	56.8 (42.1)	46.9 (31.1)	51.0 (34.1)	53.8 (36.6)	54.6 (39.1)	55.8 (40.7)	58.8 (44.8)	63.6 (51.2)	68.3 (50.1)	<0.001
Comorbid conditions in the last year of life, mean (SD)	1.1 (1.2)	1.0 (1.2)	1.0 (1.1)	1.1 (1.1)	1.0 (1.2)	1.0 (1.2)	1.1 (1.3)	1.2 (1.3)	1.2 (1.2)	0.01
Black race, no. (%)	117 (6.9)	14 (8.1)	20 (10.1)	<10 (<4)	13 (5.9)	13 (5.8)	22 (9.1)	12 (5.7)	14 (6.8)	0.16
U.S. geographic region										0.28
Midwest	593 (34.8)	63 (36.4)	72 (36.4)	84 (36.5)	83 (37.6)	73 (32.6)	75 (30.9)	72 (34.5)	71 (34.3)	
Northeast	285 (16.7)	30 (17.3)	35 (17.7)	49 (21.3)	28 (12.7)	36 (16.1)	46 (18.9)	31 (14.8)	30 (14.5)	
South	81 (4.8)	<10 (<5.8)	14 (7.1)	<10 (<4.3)	16 (7.2)	10 (4.5)	13 (5.4)	11 (5.3)	<10 (<4.8)	
West	746 (43.8)	74 (42.8)	77 (38.9)	94 (40.9)	94 (42.5)	105 (46.9)	109 (44.9)	95 (45.5)	98 (47.3)	
Disease stage at diagnosis										0.002
Localized	722 (42.4)	47 (27.2)	66 (33.3)	89 (38.7)	98 (44.3)	100 (44.6)	123 (50.6)	97 (46.4)	102 (49.3)	
Distant	626 (36.7)	61 (35.3)	67 (33.8)	87 (37.8)	79 (35.8)	81 (36.2)	91 (37.5)	84 (40.2)	76 (36.7)	
Unstaged or missing	357 (20.9)	65 (37.6)	65 (32.8)	54 (23.5)	44 (19.9)	43 (19.2)	29 (11.9)	28 (13.4)	29 (14.0)	

^aP values for categorical variables were calculated from Cochran-Mantel-Haenszel tests for differences in row means. P values for continuous variables were calculated from linear regression of the continuous variable as a function of the year of death.

TABLE 2. PATIENTS RECEIVING ONE OR MORE OF EACH TREATMENT TYPE IN THE LAST YEAR OF LIFE

Treatment type, ^a no. (%)	All years (n=1705)	2000–2003 (n=822)	2004–2007 (n=883)	P value ^b
Simple radiation therapy	453 (26.6)	247 (30.1)	206 (23.3)	0.002
Intermediate	181 (10.6)	115 (14.0)	66 (7.5)	<0.001
Complex	1081 (63.4)	492 (59.9)	589 (66.7)	0.003
Port films	1272 (74.6)	609 (74.1)	663 (75.1)	0.64

^aSimple radiation therapy included single or parallel ports and no device or simple devices. Intermediate radiation therapy included two separate treatment areas, three or more ports to a single area, and/or multiple noncomplex devices. Complex radiation therapy included three or more treatment areas, custom devices, rotational beam radiation therapy, compensators, electron beam therapy, and/or tangential ports. Use of intensity-modulated radiation therapy (IMRT) increased over the study period, but was used in only 17 (1%) of patients over the whole study period ($P=0.003$). Stereotactic radiosurgery was used in less than 10 patients and is not reported.

^bP values were calculated from χ^2 tests for homogeneity.

^cData are not shown for cells with fewer than 10 observations.

facilities, increased significantly from 48% of all Medicare payments for radiation therapy in 2000 to 57% in 2007 ($P<.001$). In contrast, mean payments for carrier claims, representing radiation therapy provided at freestanding treatment centers, increased marginally ($P=.03$).

Discussion

Between 2000 and 2007, palliative radiation therapy for bony prostate metastases was characterized by the use of more advanced treatment technologies and the use of prolonged radiation courses despite an absence of clinical data to suggest that either approach to palliation improves clinical efficacy. Not surprisingly, we observed that mean Medicare payments for palliative radiation therapy for bony prostate cancer metastases increased by almost one-half over this same period. The majority of the increase in costs occurred within hospital-affiliated outpatient treatment centers, as opposed to free-standing radiation facilities. Use of IMRT and SBRT also

increased but remained a small proportion of treatments (less than 2%) as of 2007. Meta-analyses comparing overall and complete response rates in pain control provided by single versus multiple fraction treatments have shown no benefit in palliation, and there is no randomized trial evidence to support increased clinical efficacy with more advanced treatment techniques in the palliative setting.^{10,11} Overall, our observations provide further support to the concern that the use of increasingly costly approaches to palliation have occurred without any evidence of improved outcomes.

Our study provides a nationally representative perspective on trends in palliative radiation therapy for bony metastases between 2000 and 2007, and is consistent with previous observational analyses of palliative radiation treatment patterns. A claims-based analysis of 213 patients with bony metastases associated with prostate cancer evaluated treatment patterns in the second half of 2008 and through 2009 across 98 U.S. radiation treatment centers.¹³ This analysis differed from ours in that their study examined a much smaller patient

TABLE 3. FRACTIONS RECEIVED DURING THE INITIAL TREATMENT COURSE IN 2000–2003 VERSUS 2004–2007

Treatment	All years	2000–2003	2004–2007	P value
Within 30 days of the initial radiation claim ^a				
No. of patients	1278	620	658	
Fractions per treatment course				0.001 ^b
1 fraction, no. (%)	58 (4.5)	39 (6.3)	19 (2.9)	
2–5 fractions, no. (%)	170 (13.3)	97 (15.7)	73 (11.1)	
6–10 fractions, no. (%)	479 (37.5)	215 (34.7)	264 (40.1)	
≥ 11 fractions, no. (%)	571 (44.7)	269 (43.4)	302 (45.9)	
Mean (SD)	11.0 (5.6)	10.6 (6.0)	11.3 (5.3)	0.02 ^c
Median (interquartile range)	10 (8–14)	10 (7–14)	10 (9–15)	
Within 60 days of the initial radiation claim ^d				
No. of patients	1423	682	741	
Fractions per treatment course				<0.001 ^b
1 fraction, no. (%)	58 (4.1)	39 (5.7)	19 (2.6)	
2–5 fractions, no. (%)	174 (12.2)	100 (14.7)	74 (10.0)	
6–10 fractions, no. (%)	486 (32.2)	219 (32.1)	267 (46.0)	
≥ 11 fractions, no. (%)	705 (49.5)	324 (47.5)	381 (51.4)	
Mean (SD)	12.2 (7.0)	11.6 (7.0)	12.7 (7.0)	0.002 ^c
Median (interquartile range)	10 (9–15)	10 (7–15)	11 (9–15)	

^aThe main analysis was limited to patients who did not receive any radiation treatment delivery between days 31 and 60 after their initial treatment.

^bP values were calculated from χ^2 tests for homogeneity of the number of fractions during the initial treatment course in 2000–2003 versus 2004–2007.

^cP values were calculated from Wilcoxon rank-sum tests of the number of fractions received during the initial treatment course in 2000–2003 versus 2004–2007.

^dThe sensitivity analysis did not exclude patients treated between days 31 and 60 after their initial treatment.

TABLE 4. MEDICARE PAYMENTS BY YEAR OF DEATH

<i>Medicare payments^b</i>	<i>All years</i> (n = 1705)	2000 (n = 173)	2001 (n = 198)	2002 (n = 230)	2003 (n = 221)	2004 (n = 224)	2005 (n = 243)	2006 (n = 209)	2007 (n = 207)	<i>P value^a</i>
Carrier claims, mean (SD), \$	1667 (2147)	1447 (1520)	1568 (1749)	1672 (2026)	1600 (1370)	1849 (3086)	1602 (1595)	1842 (2982)	1714 (2072)	0.03
Outpatient claims, mean (SD), \$	1797 (2486)	1316 (1848)	1097 (1552)	1496 (2009)	1699 (2271)	2105 (2828)	2079 (2954)	2157 (2970)	2276 (2613)	<0.001
Total claims, mean (SD), \$	3464 (3255)	2763 (2412)	2666 (2362)	3168 (2961)	3300 (2706)	3955 (4113)	3681 (3302)	3999 (4113)	3989 (3108)	<0.001

^aP values were calculated from a generalized linear model of costs with a gamma error distribution and a log link as a function of year of death.

^bMedicare payments adjusted to 2008 dollars using the Consumer Price Index for medical care.

cohort over a shorter period of time at select radiation treatment centers, of which only four were hospital based. And because their study was not limited to Medicare beneficiaries, 15% of their study cohort was younger than 65 years old. Nevertheless, the authors reported similar fractionation schedules, with a mean of 10 fractions per treatment course and only 2.3% of patients receiving single fraction treatment courses. They examined mean payments from third-party payers and/or patients for radiation administration and estimated a cost of \$4,950 per treatment course. This analysis did not explicitly examine the treatment delivery method; and the higher costs compared to our \$3,989 in 2007 may be explained by increased use of IMRT, higher payments by private insurers, inclusion of patient cost-sharing, and increased reimbursement rates over time.

Another contemporary SEER-Medicare based study of utilization patterns of radiation therapy at the end of life observed findings similar to those from our analysis over the same time period from 2000 to 2007 among patient with terminal lung, breast, prostate, colorectal, and pancreatic cancer. Specifically, they observed a trend toward the use of more advanced radiation techniques and the use of more than 10 fractions in 18% of patients undergoing palliative end-of-life radiation therapy. This study suggests that these trends in palliative radiation therapy are not limited to our cohort, which was limited to men with prostate cancer treated for bone metastases.⁵

Total costs of radiation therapy are driven by treatment delivery method, number of fractions per treatment course, and rates of subsequent retreatment. Treatment delivery techniques can influence total costs due to increased payments per treatment and a requirement for additional planning and quality assurance procedures. Randomized trials have not been used to compare the clinical effectiveness of more versus less advanced treatment approaches in palliative settings. However, modeling studies have compared the cost-effectiveness of stereotactic body radiotherapy (SBRT) to conventional single fraction radiation to treat patients with spinal metastases and found that the direct costs of SBRT were roughly nine times higher than single fraction radiation therapy (\$9,000 versus \$1,087) and that the use of SBRT in the palliative setting was unlikely to be cost-effective.¹⁴ Total costs of palliative radiation may also be influenced by retreatment rates, as observed in a cost analysis bone metastases trial in the Netherlands, which found a 25% reduction in cost with single fraction therapy versus six fraction treatment, but only an 8% reduction when considering the effect of higher retreatment rates among patients who received single fraction therapy.¹⁵ Our analysis of treatment patterns within the United States were remarkably similar, in that only 17% of patients in our study underwent retreatment (versus 16% within the Dutch trial). We were unable to differentiate between retreatment and treatment of a new, previously untreated site of bony metastases.

We found in our study that Medicare payments increased almost exclusively for outpatient facility claims, in contrast to a slight increase for carrier claims. Medicare outpatient facility claims are submitted by hospital-affiliated outpatient radiation treatment centers and include fees for all technical services (e.g., radiation treatment delivery, computed tomography simulation, imaging guidance) provided at these centers. In contrast, carrier claims are submitted for technical services provided at freestanding radiation facilities, as well as

professional services provided by physicians at freestanding and hospital-affiliated facilities. Because mean payments for carrier claims did not change appreciably during the study period, the relative increase in payments for outpatient claims likely represents a shift from freestanding clinics to hospital-affiliated outpatient radiation oncology departments. The increase in costs observed in our study was not fully accounted for by the increase in the number of fractions delivered during the initial course of treatment and suggests that payments may have increased either as a result of increased reimbursement rates or because of the type of therapy delivered.

Although cost incentives are frequently suggested as an underlying reason for the high frequency of relatively extended fractions, this is not a pattern unique to the fee-for-service system in the United States. Although somewhat dated and based on survey responses, a survey of radiation oncologists in the United Kingdom in 1989 suggested that two-thirds of the physicians typically gave multiple fractions for palliative therapy, despite the lack of payment incentives, citing training and concern for acute toxicities as the primary reasons for extended treatment.¹⁶ Although we observed increased costs over the study period, these costs would have reflected payments to the hospital, and would not directly affect physician reimbursement in the absence of an explicit or departmental cost-sharing incentive. Changes in reimbursement in the context of palliative radiation therapy would certainly impact treatment costs, but whether such changes would impact current treatment practices and overall end-of-life costs remains an important area of future research.

Guidelines emphasizing the use of single fraction radiation treatments in the palliation of painful bone metastases have been in place since 2004, and have been based on a body of literature that now dates back several decades that has consistently shown equivalent pain relief with single fraction palliation.¹¹ A meta-analysis by Chow¹⁰ examined a total of 16 randomized trials published between 1986 and 2005 that included a total of nearly 2500 patients. Overall response rates, defined as patient-reported improvement in pain scores, were nearly identical between treatment arms at 58% versus 59%. Complete response rates, or complete resolution of patient pain, were reported as 23% versus 24%. Of the 16 trials examined, not a single one reported a significant advantage of multifractionated versus single fraction radiation therapy, with the overall relative benefit of multiple versus single fraction treatment estimated at OR 0.99 (0.95–1.03). Of the patients considered in this meta-analysis, 75% had already been reported within individual trials by 2000 and were available to impact practice during our observed study period from 2000 to 2007.

Our study was a retrospective, claims-based analysis, and therefore may not have captured payments for treatment made by a non-Medicare payer, including out-of-pocket and third-party (e.g., supplemental insurance) expenditures. Overall costs of treatment in this study were limited to direct delivery of radiation therapy, radiation planning, and weekly management. Therefore, the results likely reflect a lower estimate of the total costs associated with receipt of radiation therapy and do not include additional costs of initial consultation, antiemetic medication, supportive care, costs related to complications or additional imaging or other diagnostic procedures that were performed to assist with treatment planning or subsequent monitoring. Cost of image guidance was captured as a part of the total radiation-related

costs; however, we did not separately examine the costs of image guidance over the study period. Although it does not exclude the possibility of increased frequency or costs of image guidance during treatment, we did not observe a change in the proportion of patients undergoing one or more port films during the study period (see Table 2).

It should be noted that the body of evidence supporting single fraction palliative radiation therapy has grown over the years. In the United States, RTOG 9714 was a pivotal trial that showed equivalent pain relief and narcotic reduction at three months following a single fraction of 8 Gy versus 10 fractions of 3 Gy for painful bone metastases, but was not published until 2005 and would have had limited potential to influence the practice patterns observed during much of the study period.¹⁷ Patients in this study died from prostate cancer; therefore, the study population reflects a clinical subgroup of patients that cannot be prospectively defined in clinical practice.

Our study cohort was selected to provide a highly specific set of patients undergoing radiation therapy for bone metastases. It is important to note that the use of claims data for detecting the overall incidence or prevalence of recurrent or metastatic disease are not sensitive or specific, and are particularly insensitive in older patients due to the lack of additional aggressive treatment in these patients.^{18–22} In this study we selected a cohort of men who actively underwent treatment with radiation therapy, which we believe represents a highly specific patient population of men who were palliated for their prostate cancer bone metastases using radiation therapy. In support of the specificity of our cohort, previous work examining claims-based treatment for patients undergoing radiation therapy for brain metastases appear to have sensitivities approaching 100%.²³ The overall incidence of bone metastases in this population was not a primary outcome of this study and should be interpreted with caution.

Conclusions

In this study, we showed that between 2000 and 2007, palliative radiation therapy for bony prostate metastases was characterized by the use of more advanced treatment technologies, prolonged radiation treatment courses, and higher costs to Medicare. Mean Medicare payments for palliative radiation therapy for bone prostate cancer metastases increased by almost one-half over this period and occurred predominantly within hospital affiliated outpatient treatment centers. These costs increased prior to any significant use of SBRT and IMRT, each of which may further impact the costs of palliative radiation therapy in the future. Extended fractionation up to 10 fractions is often clinically reasonable for high risk treatment locations or complex situations. However, the clinical justification for more extended treatment courses seen in roughly half of all patients treated remains unclear. Further research to understand barriers to providing equally effective, more cost-effective palliation is warranted.

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Author Disclosure Statement

No competing financial interests exist.

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