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Single-fraction vs Multifraction Radiation Therapy for Palliative Bone Metastases

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Purpose To evaluate the treatment fractionation schedule of people who have bone metastases based on outpatient Medicare billing data.

Methods The retrospective study is based on billing data obtained from the Research Data Assistance Center on Medicare beneficiaries in 2014. A random sample was selected to include individuals who received Medicare payments for outpatient services. The factors investigated included overall number of single- vs multifraction treatments, primary malignancy, age, sex, race, and geographical region.

Results The chi-square analysis and Fisher exact test showed no significant association among fractionation schedule and sex ($P = .91$), primary malignancy ($P = .08$), race ($P = .67$), region ($P = .82$), or age ($P = .37$). Two chi-square analyses were performed for men ($P = .57$) and women ($P = .50$) to further analyze the relationship between fractionation and primary malignancy.

Discussion The research question addressed factors that could influence physicians in their palliative radiation therapy prescription habits, and the results of the study show no statistically significant evidence that the proportion of single-fraction treatments differs among primary malignancy, age, sex, race, or region in which beneficiaries live.

Conclusion Although the study reveals no significant results, the findings provide evidence related to the prescribing habits of physicians. Further studies could provide a more comprehensive comparison between single-fraction and multifraction treatments, as beneficiaries studied had extensive lengths of treatment.

Keywords | bone metastases, Medicare, single-fraction treatment, cancer treatment, palliative radiation, ICD-9/CPT codes

Bone metastases occur in 30% to 70% of cancer patients with metastatic cancer, depending on the primary site of disease, and can cause severe pain, spinal cord compression, hypercalcemia, and pathologic fracture.^{1,2} In this subset of cancer patients, the goals of treatment are to relieve symptoms caused by the metastases and to control their growth. However, the clinically relevant outcome is to control pain, which improves the patient's quality of life, an important factor for patients who have poor prognoses.³ Median survival time of patients who have bone metastasis typically is less than 1 year, depending on the site of the disease.³ Management options for bone metastases include pharmacological interventions, cytotoxic therapy, surgical management, vertebroplasty,

kyphoplasty, chemotherapy, external-beam radiation therapy, and radiopharmaceuticals.³

External-beam radiation therapy is an effective palliative treatment option for patients who have localized symptoms.⁴ The main symptom of bone metastases is pain, and untreated bone metastases can result in fractures and cord compressions. An average of 50% to 80% of patients experience pain relief within 1 to 4 weeks of receiving radiation treatment for bone metastases.⁴⁻¹¹ The most common fractionation schemes for palliation of bone metastases are 30 Gy in 10 fractions (2-week treatment), 20 Gy in 5 fractions (1-week treatment), and 8 Gy in 1 fraction (1-day treatment).^{1,2,4,5,7,10,11} A radiation treatment that is delivered in 1 fraction is called a *single-fraction treatment* (ie, 8 Gy in 1 fraction), and

a treatment that is delivered in more than 1 fraction is called a *multifraction treatment* (ie, 30 Gy in 10 fractions or 20 Gy in 5 fractions).

In 2011, the American Society for Radiation Oncology (ASTRO) released guidelines, based on published evidence, about using radiation therapy in palliative care for bone metastases.² The ASTRO subcommittee performed a systemic literature review between 1998 and 2009 involving 4287 original research articles that included 25 randomized clinical trials, 20 prospective single-arm studies, and 4 meta-analysis reviews.² The guidelines addressed questions related to fractionation schemes for²:

- Peripheral and spinal metastases.
- Possible long-term adverse effect risks of single-fraction therapy.
- Re-treatment.
- Highly conformal radiation therapy.
- Spinal cord compressions.
- Radiopharmaceuticals.
- Bisphosphonates.
- Kyphoplasty.
- Vertebroplasty.

The ASTRO guideline authors concluded that 8 Gy delivered in 1 fraction is a safe and effective treatment for uncomplicated bone metastases and offers a shorter duration of acute radiation adverse effects compared with multifraction treatment. Adverse effects start to resolve at the conclusion of treatment, making the duration of the effects from single-fraction treatment shorter.² The single-fraction approach also optimizes patient and caregiver convenience and is more cost-effective.^{2,12}

Situations in which patients who have bone metastases might benefit from multifraction treatment include^{2,7}:

- Compression (ie, cord or cauda equina).
- Radicular nerve pain.
- Previous treatment to the spine.
- Femoral axial cortical involvement greater than 3 cm.
- History of a surgical stabilization procedure.

Challenges of multifraction treatment include^{2,7,12-14}:

- Increased amount of travel, especially for those residing a long distance from services.
- Transportation limitations.

- Increased cost.
- Loss of time.
- Decreased convenience.
- Increased duration of adverse effects.
- Increased overall time on the treatment table, which can cause discomfort.
- Potential delay for hospice care due to radiation therapy expense and reimbursement (per diem of approximately \$120 per day).

The toxicity of single-fraction treatment is cited by many radiation oncologists as a concern and a reason to recommend multifraction treatments.¹⁵ A subset retrospective analysis of Radiation Therapy Oncology Group Trial 97-14 evaluated the efficacy and toxicity of 8 Gy in 1 fraction vs 30 Gy in 10 fractions for painful vertebral bone metastases.¹⁵ The study found no statistically significant difference in pain relief or freedom from narcotic use following radiation therapy but found a significant difference in acute grade 2 through 4 toxicities, with lower toxicities in the group receiving 8 Gy in 1 fraction and no recordings of myelopathy in either fractionation scheme.¹⁵ The study concluded that single-fraction treatment for vertebral bone metastasis generates less-acute adverse effects, produces no difference in late effects compared with multifraction treatments, and is safe.¹⁵

A radiation oncologist can re-treat patients who received single-fraction treatment if pain returns to the previously irradiated area. Single-fraction treatments are associated with a 20% re-treatment rate, and multifraction treatments are associated with an 8% re-treatment rate.² The higher re-treatment rate appears to be the only major disadvantage of single-fraction treatments compared with multifraction treatment; as the pain relief effect is similar (ie, 50%-80% of patients experience pain relief with both single-fraction and multifraction treatments), and the adverse effects are short-lived and less severe for patients who receive single-fraction treatment.²

The ASTRO guidelines show that the United States has been slow to adopt the single-fraction treatment dose and suggested that the dose regimen be changed.² Possible reasons for the delay include lack of understanding of single-fraction treatment effectiveness, fear of long-term adverse risk, and monetary considerations.⁷

The intent of this study is to analyze radiation oncology treatment fractionation schedules based on Medicare billing data pertaining to the patient population who has bone metastases. Using descriptive summaries and statistical analysis, the study aims to discover the differences in patients who are treated with single fractions and those who are treated with multiple fractions. The research question for the study addresses identification of factors influencing physicians in their prescription of palliative care for patients who have bone metastasis.

Methods

This study used billing data obtained from the Research Data Assistance Center (ResDAC) on outpatient Medicare beneficiaries in 2014. The database is maintained by the Centers for Medicare and Medicaid Services, specifically using the outpatient limited data sets and the denominator file (which includes the demographic data), carrier standard analytic file, and outpatient standard analytic file. The sample population is a random 5% selection from the total Medicare population in 2014. This 5% selection included roughly 2.8 million beneficiaries randomly chosen from the roughly 55 million Medicare participants. Medicare eligibility includes beneficiaries aged 65 years or older and those who are permanently disabled or have end-stage renal disease or amyotrophic lateral sclerosis (Lou Gehrig disease).¹⁶

According to ResDAC, “The Outpatient file contains final action, fee-for-service claims data submitted by institutional outpatient providers.”¹⁷ Medicare institutional provider numbers are not encrypted; however, physician identifiers (eg, national provider identifiers or unique physician identification numbers) are encrypted. Examples of outpatient providers include¹⁸:

- Hospital outpatient departments.
- Rural health centers.
- Renal dialysis facilities.
- Outpatient rehabilitation centers.
- Comprehensive outpatient rehabilitation facilities.
- Community mental health centers.

The outpatient files include the International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes, Healthcare Common Procedure Coding System (HCPCS) codes, and Current

Procedural Terminology (CPT) codes, along with dates of service, reimbursement amount, outpatient provider number, revenue center codes, and beneficiary demographic information.¹⁷

Access to the ResDAC Medicare limited data set outpatient billing and demographic data from 2014 requires a data use agreement that outlines the purpose, project methods, data management safeguards, key personnel, and dissemination of the data by potential users. Access does not go through a privacy board review.¹⁸ The data use agreement was submitted and accepted. The factors investigated are the overall number of single-fraction vs multifraction treatments, primary malignancy, age, sex, race, and region in which beneficiaries live.

Ethical Considerations

The files purchased from ResDAC partially were paid for through a university grant. The files include beneficiary-level protected health information and exclude specified direct identifiers. Some variables are encrypted, blanked, or ranged to ensure privacy. Institutional review board approval was not required.

Sample Population

Radiation oncology CPT codes were used to determine the patient population. Using Statistical Analysis System (SAS Institute) software, beneficiaries were extracted from the roughly 2.8 million beneficiaries by using diagnosis and billing codes related to radiation therapy.^{19,20} The following is the process used to extract the final sample population in order of operation:

- Data on beneficiaries with ICD-9 diagnosis code 198.5 (secondary malignant neoplasm of bone and bone marrow) were extracted. A total of 5987 unique beneficiaries had this diagnosis code.
- Data on beneficiaries with radiation delivery CPT codes ranging from 77401 to 77416 billed under a 198.5 diagnosis code were extracted. A total of 392 beneficiaries had radiation therapy.
- Exclusion criteria (see **Box**) were applied to remove data on beneficiaries who had intensity-modulated radiation therapy; respiratory management; intraoperative radiation therapy; brachytherapy; proton, neutron, or stereotactic radiosurgery; stereotactic body radiation therapy; and

Box

Inclusion and Exclusion Criteria**Inclusion (mandatory):**

ICD-9, code 198.5 – Secondary neoplasm of bone metastases
 Radiation treatment delivery: conventional external beam:
 77401-77416 (counted for fractionation)

Inclusion (if available):

CPT 77431 is billable 1 time for external beam therapy courses of 1 or 2 fractions only.
 (77431 – Physician treatment management for complete course of therapy consisting of 1 or 2 fractions)
 Simulation: 77280-77290
 Clinical treatment planning services: 77261-77263
 3-D radiation therapy plan, including dose volume: 77295
 Basic dosimetry: 77300
 Isodose plans: 77305-77315
 Port films: 77417

Exclusion:

IMRT: 77301, 77418, 0073T, 77338
 Respiratory management: 77293
 Proton treatment delivery: 77520-77525
 Neutron beam treatment delivery: 77422, 77423
 SRS (freestanding): 77371-77372, G0339, G0340
 SBRT (freestanding): 77373, G0339, G0340
 SBRT (hospital outpatient): G0251, G0339, G0340
 SBRT: 77435
 SRS (hospital outpatient): 77371, G0173, G0251, G0339, G0340
 SRS: 77432, 77435
 Hyperthermia: 77600-77620
 Brachytherapy: 77776-77778, 77789, 77750, 77799
 LDR and HDR brachytherapy: 77776-77778, 77785-77787
 Electronic brachytherapy: 0182T
 Isodose plan for LDR: 77326-77328
 IORT: 77424, 77425
 Radiation source: 77790

Abbreviations: CPT, Current Procedural Terminology; HDR, high-dose rate; ICD, International Classification of Diseases; IMRT, intensity-modulated radiation therapy; IORT, intraoperative radiation therapy; LDR, low-dose rate; SBRT, stereotactic body radiation therapy; SRS, stereotactic radiosurgery.

The material in this box is for informational purposes only and is not meant as coding advice. Radiation oncology providers should consult or employ professional coders and check with local Medicare carriers or third-party payers to ensure all coding and documentation requirements are met.

hyperthermia therapy, which resulted in exclusion of 25 beneficiaries, for a total of 367 beneficiaries remaining.

- Each beneficiary's radiation therapy CPT codes were examined to determine whether the patient received multiple courses of treatment. Indications of multiple courses were numerous elapsed days between billing of CPT 77261 to 77263 codes. Elapsed days between treatments ranged from 3 days to 297 days, with a median break of 76 days. Beneficiaries with multiple courses of treatment were excluded from the study.
- Beneficiaries with 16 fractions or more were excluded because this high number of fractions increased the likelihood that the treatment was to soft tissue instead of to bone and had been billed incorrectly.
- For the remaining 303 beneficiaries, CPT codes 77401 through 77416 were counted (1 per day) to determine the number of fractions delivered.

Excluding intensity-modulated radiation therapy, respiratory management, intraoperative radiation therapy, and brachytherapy removed beneficiaries who had received complex treatments. Beneficiaries with multiple courses of treatment were excluded to avoid counting the same person multiple times in the statistical analysis, which would multiply demographic and primary malignancy data and distort the results. Not removing these beneficiaries would have violated the assumption that each observation is independent from one another. It was determined that these beneficiaries should be excluded since the number of those who had more than 1 course of treatment was small.

Data Analysis

For primary malignancy, the "other or multiple" category includes all other primary diagnosis codes, beneficiaries who have 2 or more primary diagnosis codes, and the 50 beneficiaries who were missing a primary malignancy diagnosis code. In the "other or multiple" category, 14 beneficiaries had multiple diagnoses and the remaining had a primary diagnosis code other than a neoplasm diagnosis (ICD-9 codes 140-239). Only 253 of the 303 beneficiaries were included in the statistical analysis for primary malignancy.

The age ranges were based on the Medicare eligibility age of 65 years; however, because Medicare also covers people who have qualifying disabilities or end-stage renal disease, the age category of “under 65” was included. The geographic categories divide the United States into 5 regions. The regions are Northeast, Southeast, Midwest, Southwest, and West (see **Table 1**). The race classifications followed the labeling from ResDAC. To determine whether a statistically significant association existed between demographic data or primary malignancy and the delivered fractionation schedule of single-fraction or multifraction treatment, a chi-square test was conducted for each variable (primary malignancy, sex, race, region, and age). Assumptions were checked and when assumptions of the chi-square test were not met, a Fisher exact test was conducted. A significance level of .05 was used. Both the sample population extraction and statistical analysis were completed using Statistical Analysis System version 9.4.

Results

The final sample population of 303 beneficiaries received palliative radiation treatment for bone metastases in 2014. Of those beneficiaries, 24 (7.92%) had single-fraction treatments, and 279 beneficiaries (92.1%) had multifraction treatments. Most were aged 65 to 75 years ($n = 129$; 42.6%) and 76 to 85 years ($n = 106$; 35%). The mean age was 73.3 years, and most beneficiaries were identified in ResDAC as white ($n = 276$; 91.1%) or black ($n = 16$; 5.3%). The majority of palliative radiation treatments were delivered in the Southeast ($n = 123$; 40.6%) and Midwest ($n = 52$; 17.2%) regions, and sex was mostly balanced, with slightly more men

($n = 161$; 53.1%) than women ($n = 142$; 46.9%).

Overall, the most common type of cancer to lead to radiation for bone metastases was a primary diagnosis of lung cancer ($n = 67$; 26.5%), followed by the category of other or multiple ($n = 61$; 24.1%). See **Table 2** for additional information.

Of the 24 beneficiaries who received a single-fraction course of treatment, the mean age was 74.5 years and most were aged 76 to 85 years ($n = 12$; 50%), followed by 65 to 75 years ($n = 8$; 33.3%). All the beneficiaries who received single-fraction treatment were white ($n = 24$; 100%), and most were from the Southeast ($n = 12$; 50%) and Southwest ($n = 4$; 16.7%) regions. Sex was evenly divided between men ($n = 12$; 50%) and women ($n = 12$; 50%). The most common site of primary diagnosis was the lungs ($n = 10$; 55.6%) followed by the prostate ($n = 3$; 16.7%).

Of the 279 beneficiaries who received multifraction courses of treatment, the mean age was 73.6 years, with most beneficiaries aged 65 to 75 years ($n = 121$; 43.4%), followed by 76 to 85 years ($n = 94$; 33.7%). The majority were white ($n = 252$; 90.3%) or black ($n = 16$; 5.8%). Most of the beneficiaries who received multifraction treatment were from the Southeast region ($n = 111$; 39.8%), followed by the Midwest ($n = 49$; 17.6%) region. Slightly more beneficiaries were men ($n = 149$; 53.4%) than women ($n = 130$; 46.6%). The most common primary diagnosis was divided across 4 categories: other or multiple ($n = 59$; 25.1%), lung ($n = 57$; 24.3%), prostate ($n = 52$; 22.1%), and breast ($n = 48$; 20.4%).

Table 3 provides chi-square *P* values unless at least 25% of the expected counts were less than 5; for those variables, a Fisher exact test was used. The

Table 1

Grouping of the United States Into 5 Regions

Region	States
Northeast	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
Southeast	Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia
Midwest	Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio, Nebraska, North Dakota, South Dakota, Wisconsin
Southwest	Arizona, New Mexico, Oklahoma, Texas
West	Alaska, California, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

data did not provide sufficient evidence of an association between fractionation schedule and sex ($P = .91$), race ($P = .67$, Fisher), region ($P = .82$, Fisher), and age group ($P = .37$, Fisher). The data provided marginally

sufficient evidence of an association between fractionation schedule and primary malignancy ($P = .08$, Fisher).

Since the association between fractionation schedule and primary malignancy was marginally significant,

Table 2

Demographics and Primary Malignancy Characteristics			
Demographics	Single Fraction (n = 24)	Multifraction (n = 279)	Total (n = 303)
Mean age, years (SD)	74.5 (8.3)	73.6 (9.7)	73.3 (9.5)
Age group, n (%)			
< 65	3 (12.5)	33 (11.9)	36 (11.9)
65-75	8 (33.3)	121 (43.4)	129 (42.6)
76-85	12 (50)	94 (33.7)	106 (35)
> 85	1 (4.2)	31 (11.1)	32 (10.6)
Sex, n (%)			
Male	12 (50)	149 (53.4)	161 (53.1)
Female	12 (50)	130 (46.6)	142 (46.9)
Race, n (%)			
White	24 (100)	252 (90.3)	276 (91.1)
Black	0 (0)	16 (5.8)	16 (5.3)
Asian	0 (0)	7 (2.5)	7 (2.3)
Hispanic	0 (0)	1 (0.4)	1 (0.3)
Native American	0 (0)	2 (0.7)	2 (0.7)
Other	0 (0)	0 (0)	0 (0)
Unknown	0 (0)	1 (0.4)	1 (0.3)
Geographic region, n (%)			
Northeast	2 (8.3)	32 (11.5)	34 (11.2)
Southeast	12 (50)	111 (39.8)	123 (40.6)
Midwest	3 (12.5)	49 (17.6)	52 (17.2)
Southwest	4 (16.7)	41 (14.7)	45 (14.9)
West	3 (12)	46 (16.5)	49 (16.2)
Primary malignancy, n (%)			
Breast	1 (5.6)	48 (20.4)	49 (19.4)
Prostate	3 (16.7)	52 (22.1)	55 (21.7)
Lung	10 (55.6)	57 (24.3)	67 (26.5)
Kidney	2 (11.1)	17 (7.2)	19 (7.5)
Thyroid	0 (0)	0 (0)	0 (0)
Melanoma	0 (0)	2 (0.9)	2 (0.8)
Other or multiple	2 (11.1)	59 (25.1)	61 (24.1)

Abbreviation: SD, standard deviation.

and to further evaluate the role of sex, 2 additional chi-square analyses were performed between primary malignancy (breast, kidney, prostate, lung) and number of fractions treated (< 10 fractions, 10 fractions, > 10 fractions), separated by sex. The data did not provide evidence of association between primary malignancy (breast, kidney, lung) and number of fractions ($P = .50$) in women who received multifraction treatment. The data also did not provide evidence of an association between primary malignancy (prostate, kidney, lung) and number of fractions ($P = .57$) in men. The Fisher exact test was used for male and female beneficiary comparisons (see **Table 4**).

Discussion

The research question addressed factors that could influence physicians in their palliative radiation therapy prescription habits, and the results of the study show no statistically significant evidence that the proportion of single-fraction treatments differs among primary malignancy, age, sex, race, or region in which beneficiaries live. The descriptive statistics showed that the population that received a single fraction of therapy was older than the average multifraction population and most had a primary diagnosis of lung cancer.

Two hypothesis were drawn before the results of the study were found. The hypothesis that age would be a significant and associating factor for single-fraction treatment was proven incorrect ($P = .37$). The hypothesis was drawn because older patients are more likely to have comorbidities and difficulty traveling; therefore, it was theorized that physicians would be more likely to prescribe a single fraction. Davis et al reported that 83% of Medicare beneficiaries have at least 1 chronic condition, such as hypertension, dyslipidemia, diabetes, or heart disease.²¹ It is possible that in a population sample including younger patients, the age-related hypothesis might have proved correct because the population in this study consisted mostly of Medicare beneficiaries aged 65 to 75 years ($n = 129$; 42.6%). In a Canadian systematic review, the most cited barriers to accessing radiation therapy were age, distance to treatment center, wait times, and lack of physician understanding about the use of radiation therapy.²²

Table 3

Chi-square and Fisher Exact Test		
Variable ^a	Test Statistic	P Value
Sex	0.0141	.91
Primary malignancy	–	.08
Race	–	.67
Region	–	.82
Age group	–	.37

^aThe significance level was set at .05. No demographic data showed an association with fractionation (single fraction vs multifraction).

Table 4

Fisher Exact Test Separated by Sex for Primary Malignancy ^a				
Sex	Primary Malignancy	Fractions		
		< 10 (n %)	10 (n %)	> 10 (n %)
Male	Kidney	4 (33.3)	5 (41.7)	3 (25)
	Lung	18 (50)	10 (27.8)	8 (22.2)
	Prostate	20 (36.4)	16 (29.1)	19 (34.6)
Female	Kidney	2 (28.6)	3 (42.9)	2 (28.6)
	Lung	17 (54.8)	10 (32.3)	4 (12.9)
	Breast	19 (38.8)	18 (36.7)	12 (24.5)

^aFisher exact test was performed for primary malignancy and fractionation separated by sex. The significance level was set at .05. No primary malignancy showed an association with fractionation (ie, < 10 fractions, 10 fractions, > 10 fractions).

The second hypothesis involved the relationship of primary malignancy to prescribing habits. It was theorized that more aggressive cancer types with worse prognoses would be associated with single-fraction treatments. Specifically, lung cancer was thought to be significant because the prognosis for patients with bone metastasis typically is 6 to 10 months of life.²³ This hypothesis also was incorrect ($P = .08$), yet marginally significant. The results of the study show that even with grouped fractionations (ie, < 10 fractions, 10 fractions, > 10 fractions), there was not a significant result for men ($P = .57$) or women ($P = .50$). The sample size and rarity of single-fraction treatment for bone metastases made it difficult to identify significant differences between groups within each categorical

variable. A larger sample size might find a significant association between primary malignancy and fractionation schedule, but with this data set the association was inconclusive.

The single-fraction rates in the study are consistent with other data. The single-fraction rate of 7.92% aligns with results from other studies conducted in the United States. In 2008 to 2009, Hess found 8.1% of patients who had a primary cancer of the prostate or breast received a single-fraction irradiation to bone metastases.¹³ Using the National Cancer Database, Rutter et al found that 4.7% patients who underwent therapy between 2005 and 2011 for breast, prostate, and lung cancer received 8 Gy in 1 fraction to nonspinal/vertebral sites.²⁴ The difference in single-fraction rates could be attributed to the National Cancer Database capturing only the first course of radiation therapy.²⁴ The comparison appears to demonstrate no significant changes in prescribing habits since the ASTRO recommendations were published in 2011.

The results of this study differ from the Rutter et al study, which found age and facility location (ie, Northeast, South Atlantic, Midwest, South, West) to be significantly associated with single-fraction treatment, along with increased travel distance for therapy, provision of services in an academic treatment facility, and nonprivate health insurance coverage.²⁴ The conflicting results could be attributed to the difference in patient populations and how they appear in the National Cancer Database vs the Medicare database.

The top 3 primary diagnoses—excluding the “other” category—associated with palliative radiation to the bone in the study were lung ($n = 67$; 26.5%), prostate ($n = 55$; 21.7%), and breast ($n = 49$; 19.4%). This finding coincides with the Piccioli et al finding of breast, prostate, lung, and thyroid cancers representing the main sites of primary cancer that metastasize to bone.²⁵ The exception was thyroid cancer because no beneficiaries in this study had a primary diagnosis of thyroid cancer. A larger sample population might have returned more beneficiaries who had primary thyroid malignancy. Piccioli et al also reported that up to 30% of patients who had bone metastases have cancers of an unknown origin, which could explain the 50 beneficiaries in this study who did not have a primary neoplasm diagnosis.²⁵

Race was included in the statistical analysis despite the unbalanced distribution. According to 2014 Kaiser Family Foundation data, 76% of Medicare beneficiaries were white, 10% were black, 8% were Hispanic, and 5% were identified as other.²⁶ In this study, 91.1% of those who received radiation were white, which is 15.1% higher than the overall distribution of beneficiaries. A more in-depth review would be required to determine a pattern of racial inequality in use of radiation therapy.

The number of treatments beneficiaries received ranged from 1 to 15 in the study, with most receiving 10 ($n = 99$; 32.6%). More beneficiaries received fewer than 10 fractions ($n = 130$; 43%) compared with more than 10 fractions ($n = 74$; 24.3%). The **Figure** displays the distribution of the various numbers of fractions beneficiaries received. Those who received what seems to be an unusual number of fractions (eg, 2-4, 6-9, or 11-13) could have been beneficiaries who did not complete their therapy, services that were billed incorrectly, or patients who were prescribed unusual fractionation schemes. Because the data does not include prescription information, specifics of the original prescriptions are unknown.

Although no significant results confirmed the research question, the results provide evidence of the prescribing habits of physicians. These findings are important in 2 respects. First, the data was 3 years after the ASTRO guidelines were published, which allows for comparison of pre-recommendation and post-recommendation single fraction use by using data from other articles. Second, the study reviewed physician variation in prescribing fractionation schemes for palliative bone metastases, and further interventions can be made by understanding prescribing patterns. Lipitz-Snyderman et al studied whether physicians are consistent in their patterns of behavior in prescribing services known to be overused in cancer care.²⁷ The authors found significant and unexplained variation in service use of extended fractionation schemes (ie, > 10 fractions) by physicians for palliation of bone metastases in prostate cancer patients between 2004 and 2011. More research is needed to test factors that could influence physicians' choices to adhere more closely to the standard of care.

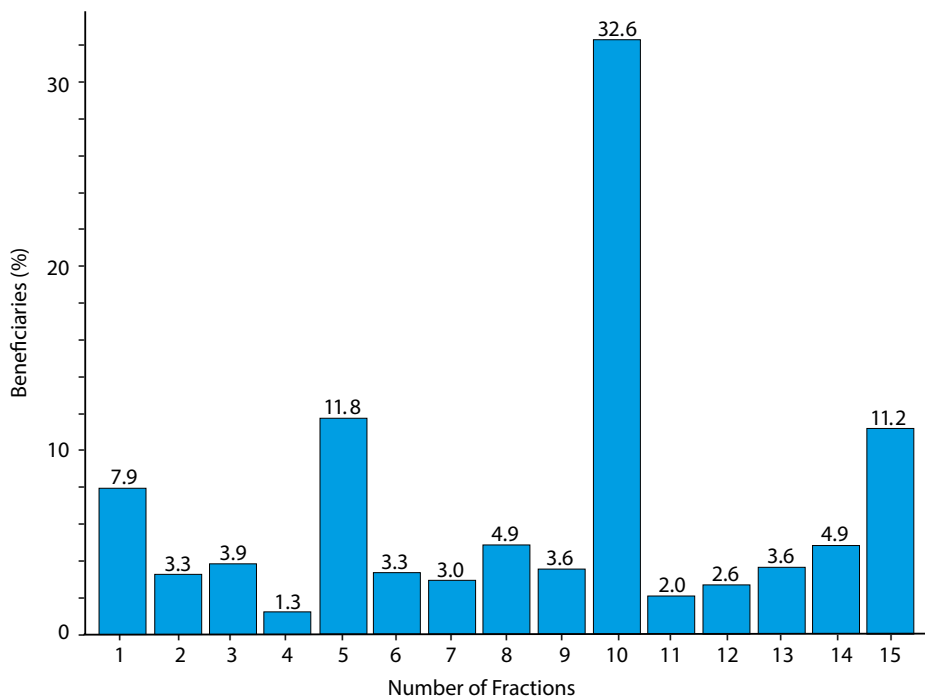


Figure. Distribution of fractions that beneficiaries received during treatment. The fractions ranged from 1 to 15, with the majority (32.6%) receiving 10 fractions. Image courtesy of the author.

Limitations

Limitations of this study include incomplete patient information, limited generalizability, and lack of prescription information. The ResDAC data did not include information to help determine the subset of patients who would benefit from a longer therapy course (ie, cord compression, cauda equina compression, radicular nerve pain, previous treatment to the spine, femoral axial cortical involvement longer than 3 cm, and history of a surgical stabilization procedure) who should not have received a single-fraction treatment.^{2,7} The sample population consisted of outpatient Medicare beneficiaries; therefore, these results are not generalizable to all bone metastasis patients. Because data pertaining to Medicaid beneficiaries or those covered by private insurance were not included in the study, it cannot be determined whether the prescribing habits are similar. In addition, no radiation prescription information was provided; all fractionation schedules were inferred from the billing data. The study is only as accurate as the billing data that was submitted.

Conclusion

The results of the study did not show an association between demographic characteristic or primary malignancy with the prescribing habits of radiation oncologists. However, the study highlights the importance of treatment options for palliation of bone metastases in patients and prescribing practices. Overall, the study results show that single-fraction treatments are not being used to their full capacity and that further studies are needed to investigate other factors that might influence physicians' prescribing habits. Studying prognosis and actual mortality of patients who had bone metastases could determine how long patients typically live after treatment and which subset of patients would benefit most from shorter therapy courses. A more robust study on days elapsed between the radiation oncology consultation and the end of therapy should be compared with those patients who received single-fraction and multifraction treatments, because many of the beneficiaries in the study had extensive lengths of therapy.

Furthermore, research should be conducted regarding the education of patients about the safe and effective

fractionation treatment options available. In addition, physicians should consider the values and treatment preferences of the patient and his or her family members as part of the prescribing decision.

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