Considerations for Quality Improvement in Radiation Oncology Therapy for Patients with Uncomplicated Painful Bone Metastases

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Abstract

Background: There is an increasing need for evidence-based efficiency in providing a growing amount of cancer care. One example of a quality gap is the use of multiple-fraction palliative radiation for patients with advanced cancer who have uncomplicated bone metastases; evidence suggests similar pain outcomes for treatment regimens with a lower burden of treatments.

Methods: During the first phase of quality improvement work, we used RAND/UCLA appropriateness methodology to understand how radiation oncologists at one academic medical center rate the appropriateness of different treatment regimens for painful uncomplicated bone metastases. We compared radiation oncologist appropriateness ratings for radiation treatments with radiation therapy provided by these oncologists to patients with painful bone metastases between July 2012 and June 2013.

Results: Appropriateness ratings showed that single-fraction (8 Gy) treatment (a low burden treatment) was consistently considered an appropriate option to treat a variety of uncomplicated bone metastases. The use of >10 fractions was consistently rated as inappropriate regardless of other factors. Eighty-one patients receiving radiation therapy for painful bone metastases during the study period had an available medical record for chart abstraction. Almost one-third of metastases were considered complicated because of a concern of spinal cord compression, a history of prior irradiation, or an associated pathological fracture. Among uncomplicated bone metastases, 25% were treated with stereotactic body radiation treatment (SBRT). Among the 54 uncomplicated bone metastases treated with conformal radiation, only one was treated with single-fraction treatment and 32% were treated with greater than 10 fractions.

Conclusions: Treatment at the study site demonstrates room for improvement in providing low-burden radiation oncology treatments for patients with painful bone metastases. Choosing a radiation treatment schedule for patients with advanced cancer and painful bone metastases requires consideration of many medical and patient-centered factors. Our experience suggests that it will take more than the existence of guidelines to change practice in this area.

Keywords: advanced cancer; bone metastases; palliative care; quality of care; radiation oncology

Introduction

ALTHOUGH THE NEED for cancer care continues to rise, supporting evidence now exists for many specific care processes that can improve quality of life, particularly for

advanced disease, while also reducing costs.¹⁻⁷ Unfortunately, quality measurement studies identify performance gaps for such patient-centered care.⁸⁻¹⁰

One example of a quality gap is the use of multiple-fraction palliative radiation for patients with advanced

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TABLE 1. SUBJECT INCLUSION AND EXCLUSION CRITERIA AMONG STUDIES SUPPORTING 2011 ASTRO GUIDELINES FOR RADIATION TREATMENT OF PAINFUL BONE METASTASES

<i>Reference</i>	<i>Inclusion</i>	<i>Exclusion</i>
Jeremic et al. ³¹	<ul style="list-style-type: none"> • Metastatic bone pain • Proven malignant disease • Pain history could be evaluated 	<ul style="list-style-type: none"> • Life expectancy less than eight weeks • Existing pathological fracture • Treated at same site with surgery or radiation
Bone Pain Trial Working Party ³²	<ul style="list-style-type: none"> • Histological or cytological diagnosis of malignant disease • Age older than 18 years • Clinical diagnosis of skeletal pain due to malignant disease • Patient's willingness to complete a pain questionnaire for 12 months 	<ul style="list-style-type: none"> • Pain due to pathological fracture of a long bone • Previous radiotherapy to the index site • Prior entry into the same trial for pain at a different site
Roos et al. ³³	<ul style="list-style-type: none"> • Pathologically confirmed malignancy • Plain X-ray or bone scan evidence of bone metastasis at the index site. • Pain or dysesthesia, predominantly of a neuropathic nature • Life expectancy of at least six weeks • Able to complete the pain assessments 	<ul style="list-style-type: none"> • Metastasis within the distribution of the neuropathic pain (e.g., shaft of femur metastasis with L2 neuropathic pain) • Prior radiotherapy to the index site • Clinical or radiological evidence of compression of the spinal cord or cauda equina • Pathological fracture of long bone(s) at index site • Change in systemic therapy within six weeks before, or anticipated within four weeks after, commencing radiotherapy • Neuropathic pain due primarily to extra-skeletal tumor (e.g., presacral recurrence of rectal carcinoma)
Hartsell et al. ³⁴	<ul style="list-style-type: none"> • Age 18 years or older • Histologically proven primary malignancy of breast or prostate • Radiographic evidence of bone metastasis, pain corresponding to the area of bone metastasis • Karnofsky performance status of at least 40, and an estimated life expectancy of at least three months. • Eligible treatment sites were classified as weight-bearing sites (i.e., pelvis [excluding pubis], femur, tibia, sacrum, and/or sacroiliac joints) or nonweight-bearing sites. • Patients with as many as three separate sites of painful metastases were eligible for the study. 	<ul style="list-style-type: none"> • Painful area had received prior radiation therapy or palliative surgery, if there was a pathological fracture or an impending fracture of the treatment site, or if there was planned surgical fixation of the bone. • Clinical or radiographic evidence of spinal cord or cauda equina compression and/or effacement • Introduction of any systemic therapy (hormonal therapy, chemotherapy, immunotherapy, or systemic radioisotope therapy) within the 30 days before entry into the study
Kaasa et al. ²¹	<ul style="list-style-type: none"> • Bone metastases resulting in clinically important pain, judged by the physician and the patient • Biopsy- or cytology-proven malignant disease, bone metastasis (at any site) verified by bone X-ray, bone scan, computed tomography, or magnetic resonance imaging • Karnofsky performance status above 40 • Patient able to complete the quality-of-life assessment tools 	<ul style="list-style-type: none"> • Previous irradiation to the present symptom site • Spinal cord compression • Patients in need of bone surgery • Life expectancy of less than six weeks
Foro et al. ³⁵	<ul style="list-style-type: none"> • Age 18 years or older 	<ul style="list-style-type: none"> • Pain due to a pathological fracture or an impending fracture • Clinical or radiographic evidence of spinal cord compression • Pain at more than one site • Prior radiotherapy at the same site • Patients whose pain could not be assessed either because of an overall poor state of health or due to difficulties in applying the ordinal pain scale • Estimated life expectancy of <1 month

(continued)

TABLE 1. (CONTINUED)

Reference	Inclusion	Exclusion
Sande et al. ³⁶ Nielsen et al. ³⁷	Same as Kaasa et al. ²¹ <ul style="list-style-type: none"> • Painful bone metastases localized to a single region that could be encompassed within a single radiation field • Malignant disease was histopathologically or cytologically confirmed, and the metastases were radiologically verified. • Patients able to complete a pain evaluation form 	<ul style="list-style-type: none"> • Previous radiotherapy to the concerned region • Pathological fractures except compression fractures of the vertebral spinal column and suspicion of spinal cord compression • Life expectancy <6 weeks
Steenland et al. ³⁸	<ul style="list-style-type: none"> • Patients with painful bone metastases from a solid tumor • Pain score of at least 2 on an 11-point scale from 0 (no pain at all) to 10 (worst imaginable pain) 	<ul style="list-style-type: none"> • Painful bone metastases not treatable in one target volume • Previously irradiated • Pathological fracture that needed surgical fixation or a spinal cord compression • Patients with metastases of malignant melanoma or renal cell carcinoma • Patients with metastases in the cervical spine

ASTRO, American Society of Radiation Oncology.

cancer and painful bone metastasis, despite evidence suggesting similar pain outcomes for lower burden treatment regimens. This area for quality improvement is discussed in the Choosing Wisely Guidelines of both the American Society of Radiation Oncology (ASTRO) and the American Academy of Hospice and Palliative Medicine (AAHPM). However, there are differences in the treatment recommendations between these two specialty societies: ASTRO recommends regimens of 10 or fewer fractions for patients with advanced cancer and painful uncomplicated bone metastases, whereas AAHPM recommends a single-fraction regimen for these patients.¹¹

A recent international survey of radiation oncologists showed that physicians in the United States have been slower to adopt single-fraction therapy compared with clinicians in other countries, even among patients who meet criteria of those included in the clinical trials demonstrating similar outcomes with abbreviated therapy.^{12–15} Although the evidence has grown for the use of fewer fractions in palliation of painful bone metastases in advanced cancer, there are several potential reasons that practice has not followed. First, the evidence for fewer fractions for uncomplicated metastases is not absolute for all patients. Despite the fact that there have been several randomized controlled trials (RCTs) and systematic reviews that conclude similar pain outcomes, there are higher retreatment rates (8% vs. 20%).¹⁶ Most of these studies have not considered quality of life as an outcome,^{12,13,15,17–22} and fee-for-service medicine incentivizes more treatments. Further complicating the issue, hypofractionated radiotherapy to the spinal region for metastatic disease (stereotactic body radiation treatment [SBRT]) is a new technology that appears to be at least as effective as standard multiple-fraction therapy, but it requires special training and preparation.²³

To design an intervention to decrease fractionation schedules for appropriate patients presenting with painful bone metastases, we studied the range of practices considered appropriate for these patients by radiation oncologists at one academic medical center and evaluated current practices at the same institution.

Methods

Defining uncomplicated bone metastases

To define uncomplicated bone metastases for this quality improvement project, the randomized clinical trials identified as informative by the ASTRO literature review were evaluated for their inclusion and exclusion criteria¹⁶ (Table 1). Based on these criteria, we preliminarily defined an uncomplicated bone metastases as one without pathological fracture, prior radiotherapy, or suspicion of spinal cord compression. Because there was no mention of tumor size or location in most studies, the working definition of uncomplicated metastases does not rely on these factors.

Appropriateness of treatment plans

Similar to the approach used to determine the American College of Radiology (ACR) appropriateness criteria,^{24,25} we used the modified RAND/UCLA appropriateness methodology to understand how radiation oncologists make decisions about single-fraction treatment.²⁶ We constructed a survey instrument to elicit radiation oncologist practice patterns that included cases with uncomplicated bone metastases at four different locations (spine, humeral head, femur, rib) (Supplementary Data; Supplementary Data are available online at www.liebertpub.com/jpm). Eight radiation oncologists with varying sub-specialties were provided ASTRO guidelines, a summary table of the findings from RCTs referenced in the guidelines, and recent research on current practices. They rated the appropriateness of 8 Gy single-fraction treatment and four alternative regimens for the clinical case scenarios before and after a panel discussion that also included three palliative care physicians. Clinical cases varied by location of metastases, size of metastases, patient prognosis, travel distance to treatment site, and patient age. We also explored how treatment varied based on whether the patient had oligometastases. We report final median appropriateness ratings and a qualitative evaluation of discussion.

TABLE 2. MEDIAN APPROPRIATENESS RATINGS OF RADIATION ONCOLOGY TREATMENT PLANS

Case	8 Gy × 1 fraction (Single fraction)	SRS with ablative dose	10 fractions of 3 Gy = 30 Gy	Between 1 and 10 fractions (4 or 5 fractions = 20 Gy)	>10 fractions
Spine					
General ^a	7	8	8	8.5	3
Large	4	5	8	8	7
<6 months	9	5.5	5	7.5	1
Lives >2 hours away	8	8	4.5	7.5	1
Patient is 83 years old, not 63	8	7.5	6.5	7.5	1.5
Patient is 43 years old, not 63	7.5	8.5	7.5	8	5
Left humeral head (oligometastatic)					
General ^a	8	2	8	8	4
Large	7	1	8	8	3
<6 months	N/A	N/A	N/A	N/A	N/A
Lives >2 hours away	8.5	1.5	4	8	1
Patient is 83, not 63	8	1.5	6	7.5	1.5
Patient is 43, not 63	7.5	5	7.5	8	3
Left humeral head (widely metastatic)					
General ^a	8.5	1	7	8	2
Large	8	1	8	8	1.5
<6 months	9	1	4.5	8	1
Lives >2 hours away	9	1	3	8	1
Patient is 83, not 63	9	1	5	8	1
Patient is 43, not 63	8	1	7	8	2
Left femur (oligometastatic)					
General ^a	7	6	7.5	7.5	3
Large	6	2	8	8	3
<6 months	N/A	N/A	N/A	N/A	N/A
Lives >2 hours away	8	3.5	5	8	1
Patient is 83, not 63	8	1	7	8	2.5
Patient is 43, not 63	7.5	6	7	8	3
Left femur (widely metastatic)					
General ^a	8.5	1	7	8	2
Large	8	1	7.5	8	2.5
<6 months	8.5	1	6.5	8	1.5
Lives >2 hours away	9	1	3.5	8	1
Patient is 83, not 63	9	1	6.5	8	1
Patient is 43, not 63	7.5	1	6	8	2
Right rib (oligometastatic)					
General ^a	7	7	7.5	8	3
Large	6	3.5	8	8	2.5
<6 months	N/A	N/A	N/A	N/A	N/A
Lives >2 hours away	8	7	6.5	8	2
Patient is 83, not 63	8	6.5	6	8	3
Patient is 43, not 63	7.5	6.5	7	7.5	2
Right rib (widely metastatic)					
General ^a	8.5	1.5	7	8	2
Large	7	1	7	8	2
<6 months	8.5	1	5.5	8	1
Lives >2 hours away	8	1	4	8	1.5
Patient is 83, not 63	8	2	5.5	8	1
Patient is 43, not 63	7.5	2.5	7	8	1

Appropriateness ratings as follows: 1–3 inappropriate, 4–6 equivocal, 7–9 appropriate.

^aFor general case, raters asked to assume that patient has a Karnofsky performance status of at least 80 and a prognosis of greater than six months. For all cases, raters asked to assume that there is no spinal cord compression (if spinal lesion), no prior irradiation, and no associated pathological fracture.

SRS, stereotactic radiosurgery.

Understanding current patterns of practice

We conducted chart reviews for all patients seen by radiation oncology at one academic medical center between July 2012 and June 2013 with a visit ICD-9 diagnosis code of 198.5 to identify all patients seen during this period for an initial consult to treat painful bone metastases. We did not conduct chart abstractions on cases in which the patient did not receive radiation therapy after initial evaluation (due to either provider not recommending or patient declining/lack of follow-up/treatment elsewhere), only a follow-up visit for previous treatment fell within the study period, the lesion treated was not primarily a bone metastases (but may have involved bone), or there was no documentation of pain and the patient was treated for another reason (for example, disease control or to prevent fracture). The abstraction window began one year before the initial radiation consult and continued up to one year after the initial consult. Trained nurse abstractors used a detailed chart abstraction tool and guidelines to collect information about location of bone metastases, whether the metastases were complicated, and treatment regimens prescribed and received. They also collected patient demographics and documentation about prognosis and treatment preferences. We conducted dual chart abstraction for six of the charts and found 100% agreement for the reliability of abstraction of prior radiation, spinal cord compression, history of pathological fracture, number of fractions prescribed and completed, and type of radiation provided for each metastasis.

Results

Appropriateness of treatment plans

The panel demonstrated general agreement on the definition of an uncomplicated bone metastases as one without pathological fracture, prior radiotherapy, or suspicion of spinal cord compression. Radiation oncologist ratings of appropriateness of various treatment regimens for painful uncomplicated bone metastases varied by tumor site, tumor size, patient prognosis, patient age, and for nonspinal lesions whether the patient had oligometastases (Table 2). Single-fraction treatment (8 Gy) was rated as the most appropriate treatment, regardless of other factors, if prognosis was six months or less. Use of greater than 10 fractions was rated as inappropriate regardless of other factors with the exception of treatment for large spinal tumors. Older age and greater travel distance were associated with favoring 8 Gy single-fraction treatment. There was less consensus regarding whether single-fraction treatment was the most appropriate treatment for lesions located on the spine (especially large lesions), for patients with oligometastases, and for patients with a longer prognosis for whom goals may include local tumor control in addition to palliation. However, in most cases, regimens consisting of <10 fractions were considered more appropriate or at least equivalent to the 10-fraction regimen.

Current practice patterns

Among the 172 patients identified with a documented radiation consult using the 198.5 diagnosis code, 84 had treatment initiated for painful bone metastases during the study period. We performed chart abstraction on the 81 patients who had a completed initial radiation oncology consult documented in the medical record.

The majority, 66 out of 81 (81%), of the initial radiation oncology consults were seen in the outpatient setting, and a variety of cancers were represented (Table 3). Patients had a mean age of 61 years, and the majority were men (62%), white (64%), and married (59%). These 81 patients had 107 different metastases treated (44% spine, 12% rib, 10% pelvis, 12% shoulder/arm, 8% hip/leg, 13% other). Sixty-nine percent of these metastases met our definition for being uncomplicated. Thirty-one percent of lesions were considered complicated because of one or more of the following issues: spinal cord compression (13%), history of prior radiation to the same location (11%), or an associated pathological fracture (10%) (Table 4).

The majority of metastases (74%) were treated with conformal therapy, and 26% were treated with SBRT. Among patients with uncomplicated bone metastases receiving conformal treatments, almost one-half received the most common treatment plan (3 Gy × 10 fractions) and one-third received greater than 10 fractions. One patient received single-fraction treatment with 8 Gy, and 15% received four or five fractions. Most patients who received SBRT received their treatment in one dose 16/27 (59%). There was no difference between practice patterns for complicated and uncomplicated metastases (Table 5).

Documentation of patient functional status occurred to some degree in most cases (77%), but documentation of a

TABLE 3. PATIENT-LEVEL CHARACTERISTICS (N = 81)

<i>Setting of initial radiation oncology consult</i>	
Inpatient, <i>n</i> (%)	14 (17)
Outpatient, <i>n</i> (%)	66 (81)
Missing, <i>n</i> (%)	1 (2)
<i>Cancer type, <i>n</i> (%)</i>	
Bladder	1 (1)
Lung	9 (11)
Breast	19 (23)
Cervical	2 (2)
Colorectal	4 (5)
Head and neck	1 (1)
Liver	2 (2)
Lymphoma	1 (1)
Melanoma	2 (2)
Prostate	15 (19)
Renal	5 (6)
Thyroid	2 (2)
Unknown primary	3 (4)
Other	15 (19)
Age, mean (SD)	61.1 (17.2)
<i>Gender, <i>n</i> (%)</i>	
Male	50 (62)
Female	31 (38)
<i>Race, <i>n</i> (%)</i>	
White	52 (64)
African American	7 (9)
Asian	7 (9)
Other	2 (3)
No data	13 (16)
<i>Marital status, <i>n</i> (%)</i>	
Married	48 (59)
Lives with significant other	1 (1)
Single/separated/divorced/widowed	32 (40)

TABLE 4. CHARACTERISTICS OF BONE METASTASES BY LOCATION

	Location of Metastases					
	Spinal (N=47)	Rib (N=13)	Shoulder/Arm (N=13)	Pelvis (N=11)	Hip/Leg (N=9)	Other (N=14)
Total (N=107)						
Number of metastases						
1	40 (85%)	10 (77%)	8 (62%)	8 (73%)	7 (78%)	8 (57%)
2	6 (13%)	3 (23%)	5 (38%)	3 (27%)	2 (22%)	5 (36%)
3	1 (2%)	0	0	0	0	1 (7%)
Number of fractions completed						
Mean (SD)	6.4 (5.1)	9.7 (3.2)	9.5 (5.6)	10.1 (4.9)	11.0 (6.0)	9.6 (4.7)
Median (Q1, Q3)	5.0 (1.0, 10.0)	10.0 (10.0, 10.0)	10.0 (4.8, 12.8)	10.0 (6.2, 11.5)	11.0 (8.8, 15.0)	10.0 (6.2, 10.0)
Min, max	1.0, 16.0	4.0, 15.0	1.0, 20.0	4.0, 20.0	1.0, 20.0	1.0, 20.0
Missing	5	3	1	1	1	0
Total dose delivered						
Mean (SD)	2356.2 (895.2)	3265.0 (793.7)	2820.8 (887.7)	3275.0 (691.7)	3331.2 (822.4)	3353.6 (639.2)
Median (Q1, Q3)	2050.0 (1600.0, 3000.0)	3000.0 (3000.0, 3562.5)	3000.0 (2075.0, 3187.5)	3000.0 (3000.0, 3687.5)	3300.0 (3000.0, 3812.5)	3250.0 (3000.0, 3975.0)
Min, max	500.0, 4000.0	2000.0, 5000.0	1200.0, 4000.0	2000.0, 4500.0	1800.0, 4500.0	1800.0, 4000.0
Missing	7	3	1	1	1	0
Radiation technique used						
Conformal	28 (60%)	11 (85%)	12 (92%)	8 (73%)	8 (89%)	11 (79%)
Stereotactic RT (SBRT/radiosurgery)	18 (38%)	1 (8%)	1 (8%)	3 (27%)	1 (11%)	3 (21%)
Missing	1 (2%)	1 (8%)	0	0	0	0
Previously irradiated?						
Yes	6 (13%)	0	1 (8%)	3 (27%)	1 (11%)	1 (7%)
No/no data	41 (87%)	13 (100%)	12 (92%)	8 (73%)	8 (89%)	13 (93%)
Concern related to spinal cord compression from the bone metastases?						
Yes	12 (26%)	0	0	0	0	2 (14%)
No/no data	35 (74%)	13 (100%)	13 (100%)	11 (100%)	9 (100%)	12 (86%)
Pathological fracture associated with the bone metastases?						
Yes	7 (15%)	1 (8%)	1 (8%)	1 (9%)	1 (11%)	0
No/no data	40 (85%)	12 (92%)	12 (92%)	10 (91%)	8 (89%)	14 (100%)
None of the above? (i.e., uncomplicated metastases)						
Yes	27 (57%)	12 (92%)	11 (85%)	7 (64%)	7 (78%)	10 (71%)
No/no data	20 (43%)	1 (8%)	2 (15%)	4 (36%)	2 (22%)	4 (29%)

SBRT, stereotactic body radiation treatment.

TABLE 5. NUMBER OF PRESCRIBED AND COMPLETED FRACTIONS STRATIFIED BY TYPE OF RADIATION AND WHETHER THE BONE METASTASES WERE COMPLICATED OR UNCOMPLICATED

	<i>Conformal</i>		<i>p</i>	<i>Stereotactic RT (SBRT or radiosurgery)</i>		<i>p</i>
	<i>Not complicated</i> (N = 54)	<i>Complicated</i> (N = 24)		<i>Not complicated</i> (N = 18)	<i>Complicated</i> (N = 9)	
Number of fractions prescribed (categorized)						
1	1 (2%)	0	0.811	11 (61%)	5 (56%)	1
2–9	9 (17%)	3 (13%)		5 (28%)	3 (33%)	
10	27 (50%)	14 (58%)		0	0	
10+	15 (28%)	5 (21%)		0	0	
Missing	2 (4%)	2 (8%)		2 (11%)	1 (11%)	
Number of fractions completed (categorized)						
1	1 (2%)	0	0.444	11 (61%)	5 (56%)	1
2–9	8 (15%)	7 (29%)		5 (28%)	3 (33%)	
10	24 (44%)	10 (42%)		0	0	
10+	17 (32%)	5 (21%)		0	0	
Missing	4 (7%)	2 (8%)		2 (11%)	1 (11%)	

formal functional status scale occurred less commonly (Karnofsky Performance Status [KPS] documented for 35% of patients and Eastern Cooperative Oncology Group [ECOG] score documented for 23% of patients). Documentation of patient prognosis (2%), discussion regarding patient preferences regarding choices, options, or alternative radiation oncology regimens (14%), travel distance (10%) or length of regimen (4%) rarely occurred during the initial radiation oncology consult. No patient was receiving hospice at the time of initial consult.

Thirteen of the 81 patients (16%) died within six months of the radiation oncology initial consult, and three of these patients received hospice before death. Thirty-six percent of the treatments for these patients involved >10 fractions, and there was no statistically significant difference in practice patterns when comparing patients who lived less or more than six months. An additional 12 patients received hospice services within the year after initial radiation consult. Seventy percent of the patients were concurrently receiving chemotherapy or had received chemotherapy in the past 90 days. Receipt of chemotherapy was not significantly associated with a difference in the number of fractions used to treat painful bone metastases. Only 15% had decided to forgo further chemotherapy. Seventy-five percent of these patients (61/81) had documentation of a surrogate decision maker in the medical record, but only 19% (15/81) had an advance directive that identified patient preferences regarding life sustaining treatments. During the study period, prognosis or goals of care were considered and discussed for (51/81) 63% of patients.

Discussion

Although guidelines suggest that <10 fractions, or even single-fraction radiation, is an appropriate alternative to longer treatment plans for patients presenting with painful bone metastases¹⁶ and the radiation oncologists at the studied practice agreed with those guidelines, their practice did not routinely utilize shorter course treatments. Only one of the 74 uncomplicated bone metastases was treated with single-fraction conformal radiotherapy, and the most common treatment regimen was 3000 cGy in 10 fractions. The low proportion of patients with metastatic bone disease receiving

<10 fractions of radiation found in our small study is consistent with others' findings. A recent published report showed that more than half of Medicare patients who received radiotherapy for painful bone metastases related to prostate cancer received >10 fractions and only 3.3% received single-fraction treatment.²⁷ A recent study of a nationally representative sample of patients with metastatic nonsmall cell lung cancer showed that only 20% patients received five or fewer fractions and only 6% received single-fraction treatment.²⁸ It should be noted that these studies do not distinguish between complicated and uncomplicated bone metastases. Although in our study there was no statistically significant difference in treatment patterns between the 1 out of 3 patients treated for complicated bone metastases compared with those treated for uncomplicated metastases, any evaluation of the best practice for this care process should make this distinction, because the RCTs supporting this practice exclude complicated metastases.

Furthermore, this study demonstrates that, from the perspective of both the selection criteria of the studies underlying the guidelines and also the views of radiation oncologists, decisions about numbers of fractions must account for patient prognosis and other patient factors. Although results of clinical trials suggest that single-fraction radiotherapy is equivalent to multiple-fraction radiotherapy in most scenarios, our study, consistent with ACR Appropriateness Criteria, suggests that there are circumstances in which multiple fractions may be more beneficial.^{24,25} For example, 31% of metastases in this study were classified as complicated (and, therefore, perhaps not appropriate for single-fraction therapy). Such clinically relevant considerations are not accounted for in many reports of the single-fraction radiation therapy quality gap.^{27,28}

Reasons for quality problems in this area are complex, and high-quality supportive care, which requires communication and continuity of care across care settings and providers for seriously ill patients, is not incentivized by the fee-for-service healthcare system.²⁹ A prior study showed that patients who received care in an integrated network tended to be treated with fewer fractions for metastatic bone lesions.²⁸ For patients with advanced cancer, tumor-directed therapies and challenges with prognostication add

to the complexity of providing high-quality patient-centered care. For example, the use of SBRT is an emerging pattern of practice (25% of metastases in our sample), especially for spinal metastases³⁰ and is often delivered in a single dose, but requires a costly and complex planning process and execution.

Using a modified Delphi panel approach to clarify appropriate treatment provided a valuable mechanism for facilitating group involvement in quality improvement and also a comparison to current practices. An important result of our two-phase evaluation was the recognition that patient preferences for care and other patient factors (such as age and travel distance) that may affect a radiation oncologist's decision are often not discussed and documented in medical records. Quality improvement efforts must integrate a more patient-centered approach to treatment plans in this population. Earlier advance care planning and goals-of-care discussions are an important part of realizing this goal. In fact, a radiation oncology consult may serve as an opportunity to assess palliative care needs for this patient population that is known to benefit from early palliative care.⁵

Another key to improving practice is developing a common strategy toward handling bone metastases across a diverse practice. The large radiation oncology practice studied here treated only 84 cases for painful bone metastases during an entire year; thus, individual clinicians infrequently encounter bone metastases. Guiding practice at the point of care through a note template developed by the group will serve to guide best practices and facilitate data ascertainment for analysis and feedback.

In summary, choosing a radiation treatment schedule for patients with advanced cancer and painful bone metastases requires consideration of many medical and patient-centered factors. Administrative data do not allow for a full evaluation of the appropriateness of care. Our experience suggests that it will take more than the existence of guidelines to change practice in this area; quality improvement efforts are underway.

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