

National Quality Measure Compliance for Palliative Bone Radiation Among Patients With Metastatic Non–Small Cell Lung Cancer

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ABSTRACT

Background: There exists wide practice variability in palliative treatment schedules for bone metastases. In an effort to reduce variation and promote high-quality, cost-conscious care, the National Quality Forum (NQF) endorsed measure 1822 in 2012. This measure recommends the use of 30 Gy in 10 fractions, 24 Gy in 6 fractions, 20 Gy in 5 fractions, or 8 Gy in a single fraction for palliative radiation for bone metastases. We report on longitudinal compliance with this measure.

Methods: Using the National Cancer Database, patients with metastatic thoracic non–small cell lung cancer diagnosed between 2004 and 2016 who received radiation therapy for bony sites of metastatic disease were identified. Treatment courses fitting 1 of the 4 recommended schedules under NQF 1822 were coded as compliant. Rates of compliance by patient, tumor, and treatment characteristics were analyzed. **Results:** A total of 42,685 patients met the criteria for inclusion. Among all patients, 60.2% of treatment courses were compliant according to NQF 1822. Compliance increased over time and was highest for treatments to the extremity (69.8%), lowest for treatments to the skull or head (48.8%), and higher for academic practice (67.1%) compared with community (56.0%) or integrated network facilities (61.2%). On multivariable analysis, predictors of NQF 1822 compliance included year of diagnosis after 2011, treatment to an extremity, or treatment at an academic facility. Of noncompliant treatment courses, extended fractionation (≥ 11 fractions) occurred in 62.6% and was more common before 2012, in community practice, and for treatments of the skull or head. **Conclusions:** Among patients treated for metastatic non–small cell lung cancer, compliance with NQF 1822 increased over time. Although extended fractionation constituted a majority of noncompliant treatment courses, a substantial proportion also involved shorter courses.

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Background

Bone metastases are common in patients presenting with metastatic non–small cell lung cancer (NSCLC) and are often treated with palliative radiation therapy.¹ There exists wide practice variability in palliative treatment schedules,^{2,3} with multiple randomized trials showing similar pain relief between single- and multiple-fraction courses for uncomplicated metastases.^{4,5} However, single-fraction treatments are relatively uncommon in the United States,⁶ despite proven advantages with regard to patient cost and convenience.⁷

The National Quality Forum (NQF) is a not-for-profit healthcare organization that recommends consensus and evidence-based quality measures to state and federal pay-for-performance programs. In August 2012, the NQF, in collaboration with the American Society for Radiation Oncology (ASTRO), endorsed measure 1822, “External Beam Radiotherapy for Bone Metastases.”⁸ With the goal of improving quality and patient convenience while reducing practice variation and treatment costs, the measure provides the following recommended fractionation schemes for the treatment of bone metastases: 30 Gy in 10 fractions, 24 Gy in 6 fractions, 20 Gy in 5 fractions, or 8 Gy in a single fraction.⁸ Although there are exclusions for reirradiation, large-volume femoral cortical involvement, sites of surgical stabilization, cord/cauda compression, and radicular pain, the recommendation is largely agnostic of tumor site, histology, or other clinical considerations. NQF 1822 was later adopted by the Hospital Outpatient Quality Reporting (HOQR) Program as measure OP-33, and the Prospective Payment System-Exempt Cancer Hospital Quality Reporting Program was adopted as measure PCH-25, both of which are value-based programs under the Centers for Medicare & Medicaid Services.^{9,10} ASTRO has since withdrawn endorsement of NQF 1822 because of concerns about the complexity of reporting.¹¹ Although the continued relevance of the quality measure is questionable in the era of dose-escalation and oligometastases, NQF 1822 remains a measure of payment determination.

Because NSCLC represents the majority of palliative bone radiation courses,³ we used a national database of

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Table 1. Patient Characteristics by NQF 1822 Compliance

Characteristic	Patients N	Compliance %	P Value
All patients	42,685	60.2	
Age			<.001
<67 y (median)	20,267	61.2	
≥67 y	22,418	59.3	
Race			<.001
White	36,864	59.5	
Black	4,275	63.4	
Other	1,546	67.1	
Sex			.041
Female	17,814	60.8	
Male	24,871	59.8	
Charlson-Deyo comorbidity score			.001
0	28,343	60.6	
1	9,810	58.5	
≥2	4,532	61.0	
Facility type			<.001
Community	23,081	56.0	
Academic	13,193	67.1	
Integrated network	6,411	61.2	
US region			<.001
Northeast	9,847	63.2	
South	11,787	59.9	
Central	15,350	57.2	
West	5,390	63.8	

(continued)

Table 1. Patient Characteristics by NQF 1822 Compliance (cont.)

Characteristic	Patients N	Compliance %	P Value
Distance ^a			<.001
First quartile (closest)	10,887	58.6	
Second quartile	10,809	59.3	
Third quartile	10,386	60.4	
Fourth quartile (furthest)	10,603	62.5	
Insurance status			<.001
Private	13,070	60.9	
Medicare	23,578	59.2	
Medicaid	3,092	63.5	
Other government	771	64.9	
Uninsured	1,525	61.1	
Year of diagnosis			<.001
<2012	22,832	52.4	
≥2012	19,853	69.1	
Treatment site			<.001
Skull/Head	1,010	48.8	
Ribs/Chest wall	3,163	60.9	
Spine	24,237	58.4	
Hips/Pelvis	8,905	61.2	
Shoulder	1,959	65.6	
Extremity NOS	3,411	69.8	
Systemic therapy			<.001
No	17,785	54.3	
Yes	24,900	64.4	

Abbreviations: NOS, not otherwise specified; NQF 1822, National Quality Forum measure 1822.

^aDistance between patient's residence and hospital reporting the case.

patients diagnosed with metastatic NSCLC to (1) assess the frequency of quality measure–concordant radiation for bone metastases as per NQF 1822; (2) describe variation in compliance by tumor, patient, and treatment characteristics; and (3) explore and consider the value, shortcomings, and future direction of radiation treatment guideline measures.

Methods

The National Cancer Database (NCDB) was used as the primary data source and is estimated to capture approximately 70% of all newly diagnosed malignancies in the United States annually. Because the primary dataset is deidentified, this project was deemed exempt from Institutional Review Board approval.

A total of 565,347 patients with metastatic NSCLC diagnosed between 2004 and 2016 were identified in the NCDB. Of these patients, 56,113 received nonstereotactic external-beam radiation therapy for bony sites of metastatic disease

as part of their initial treatment. Notably, the NCDB only captures data from the patient's initial course of treatment after diagnosis. If multiple sites receive radiation therapy during the initial course of treatment, then data from only the most "clinically significant" target of radiation are reported, with the primary site taking precedence over metastatic sites. Patients were excluded if the radiation dose or fractionation was unknown or included a boost. Furthermore, out of concern for coding errors or irregularities in the primary database, patients were excluded if the received dose was >60 Gy, the number of delivered fractions was >30, the dose per fraction was <1 or >16 Gy, or the treatment schedule was delivered to <100 patients (Figure 1).

Treatment courses meeting 1 of the 4 NQF 1822–approved schedules were coded as compliant. All others were considered noncompliant and were grouped as 1 to 5, 6 to 10, or ≥11 fractions and at a fractional dose of <3 or ≥3 Gy. A cutpoint at 2012 was introduced, reflecting

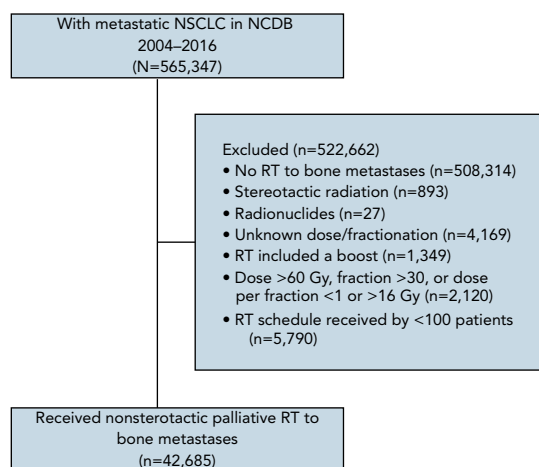


Figure 1. Diagram illustrating criteria for inclusion. Abbreviations: NCDB, National Cancer Database; NSCLC, non-small cell lung cancer; RT, radiation therapy.

the year of the NQF 1822 adoption. A Pearson chi-square test was used to assess differences in univariable association. A multivariable modified logistic regression model was estimated to determine the association between compliant treatment courses and patient/tumor characteristics.¹² Statistical tests were based on a 2-sided significance level with $\alpha = 0.05$. Data analysis was performed using STATA/IC, version 15.1 (StataCorp LLP).

Results

A total of 42,685 courses met the criteria for inclusion, of which 60.2% were compliant according to NQF 1822. Compliance by patient and tumor characteristics is shown in Table 1. Compliance at academic facilities was higher than at community or integrated network facilities (67.1% vs 56.0% and 61.2%, respectively; $P < .001$) and for treatment of patients diagnosed during or after 2012 (69.1% vs 52.4% before 2012; $P < .001$). Compliance differed by site of treatment and increased over time (Figure 2).

On multivariate analysis, statistically significant predictors of NQF 1822 compliance included year of diagnosis during or after 2012 (relative risk [RR], 1.31), receipt of systemic therapy (RR, 1.18), and academic or integrated network facilities compared with community practice (RR, 1.19 and 1.09, respectively; Table 2). Among all treatment courses, 46.7% were to 30 Gy in 10 fractions, 9.0% were to 20 Gy in 5 fractions, 4.3% were to 8 Gy in a single fraction, and <1% were to 24 Gy in 6 fractions, which were all considered compliant; 39.8% of courses were considered noncompliant (Figure 3A). Among noncompliant courses, more than half (57.8%) were noncompliant because of extended fractionation (≥ 11 fractions) at a low fractional dose (< 3 Gy per fraction), whereas 16.5%

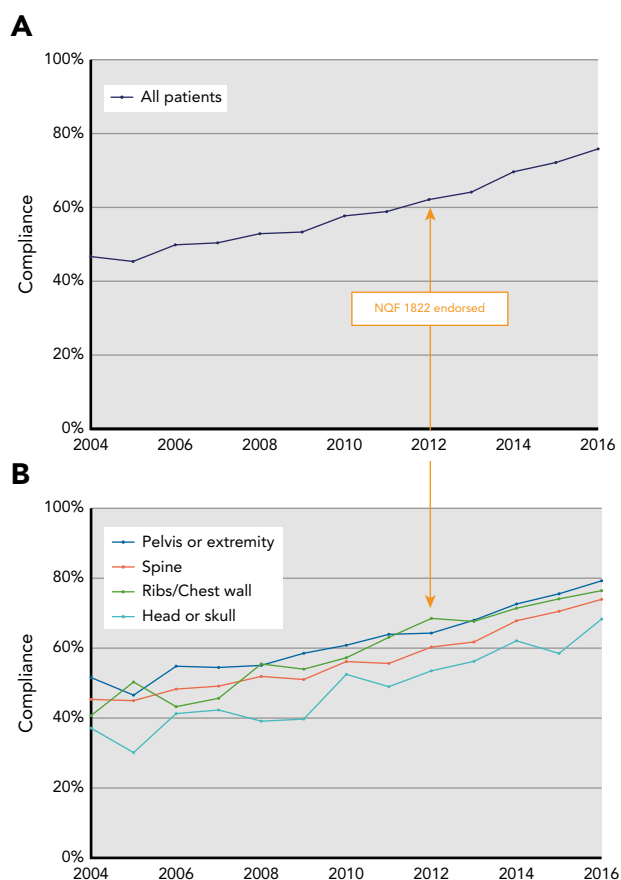


Figure 2. NQF 1822 compliance between 2004 and 2016 (A) for all patients and (B) by treatment site. Abbreviation: NQF 1822, National Quality Forum measure 1822.

were short (1–5 fractions) at a high fractional dose (≥ 3 Gy per fraction; Figure 3B). Of noncompliant courses, extended fractionation at a low fractional dose was more common before 2012; in community practice; for treatments of the skull, head, or pelvis; and among patients who received systemic therapy, whereas short treatments at a high fractional dose were more common during and after 2012, in academic practice, and for treatments of the extremities including shoulders (Table 3).

Discussion

Approximately 4 of 10 palliative radiation treatments for bone metastases in this national database study were noncompliant as per the NQF 1822 quality measure. More than half of noncompliant treatments resulted from extended fractionation, although a significant proportion also resulted from short course treatments. Compliance increased over time and was highest for treatments of the extremity and for courses performed at an academic versus a community facility.

In 2018, ASTRO leadership withdrew endorsement of NQF 1822 and urged the Centers for Medicare &

Table 2. Factors Associated With NQF 1822–Compliant Treatments in Multivariate Analysis

Predictor	RR (95% CI)	P Value
Year of diagnosis		
<2012	Ref	—
≥2012	1.31 (1.29–1.33)	<.001
Treatment site		
Skull/Head	Ref	—
Ribs/Chest wall	1.25 (1.18–1.32)	<.001
Spine	1.21 (1.15–1.27)	<.001
Hips/Pelvis	1.26 (1.19–1.32)	<.001
Shoulder	1.35 (1.27–1.42)	<.001
Extremity NOS	1.42 (1.36–1.49)	<.001
Systemic therapy		
No	Ref	—
Yes	1.18 (1.16–1.19)	<.001
Facility type		
Community	Ref	—
Academic	1.19 (1.15–1.19)	<.001
Integrated network	1.09 (1.07–1.12)	<.001

Abbreviations: NOS, not otherwise specified; NQF 1822, National Quality Forum measure 1822; RR, risk ratio.

Medicaid Services to remove measure OP-33 from the HOQR Program.¹¹ Citing questions around the use of radiation planning versus delivery codes, the large number of measure exclusions, the complexity of reporting concurrent palliative treatment sites, and potential differences between intended versus delivered treatment schedules, ASTRO argued that the measure

had become overly burdensome to accurately report. With a significant portion of recent palliative treatments not compliant with NQF 1822, coupled with the increasing number of shorter and higher dose-per-fraction schedules, these data call into question the relevance of NQF 1822 in the current era and support ASTRO's withdrawn endorsement.

The landscape of radiation therapy for bone metastases has shifted in the almost 10 years since NQF 1822 was initially introduced. There is renewed interest in single-fraction dose escalation with the goal of improved pain response or, in some patients, more durable local control, with mixed results in recent trials.^{13–15} The line between treatment for palliative versus definitive intent may seem blurred in patients who fit the evolving definition of oligometastasis.^{16,17} Indeed, numerous factors must be considered when determining an appropriate palliative treatment course—tumor histology, size, and location, nearby critical structures, overall disease burden, patient performance status, patient preference, and others. In a time of emerging data and evolving expert opinions, it is possible that NQF 1822 guidelines are unnecessarily narrow and fail to reflect the full range of acceptable treatment options. That said, with nonacademic facilities displaying less NQF 1822 compliance and higher rates of extended fractionation, our data suggest that at least a portion of the practice variation is driven by factors outside of the patient case mix. Although the use of extended fractionation accounted for more than half of noncompliant courses in this study, a large proportion of noncompliant courses also resulted from shorter fractionation schedules with variation in dose per fraction. Higher doses per fraction do not generally

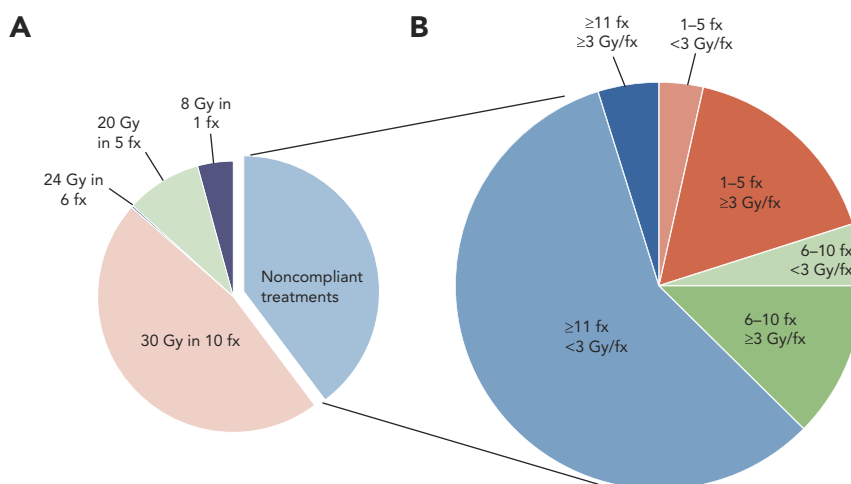


Figure 3. Relative use of the schedules for (A) all treatments and (B) NQF 1822–noncompliant treatments. Abbreviations: fx, fraction; NQF 1822, National Quality Forum measure 1822.

Table 3. Relative Percentage Use of Dose/Fractionation Schemes for Noncompliant Treatment Courses

	1–5 Fractions		6–10 Fractions		≥11 Fractions		P Value
	<3 Gy/fx	≥3 Gy/fx	<3 Gy/fx	≥3 Gy/fx	<3 Gy/fx	≥3 Gy/fx	
All patients	3.6	16.5	4.9	12.4	57.8	4.8	
Year of diagnosis							<.001
<2012	3.7	12.6	5.0	10.3	63.6	4.7	
≥2012	3.3	23.4	4.8	16.2	47.3	4.9	
Treatment site							<.001
Skull/Head	3.1	14.5	5.4	9.1	65.6	2.3	
Ribs/Chest wall	2.3	15.8	4.0	9.3	59.7	8.8	
Spine	4.0	16.2	5.1	14.3	60.0	3.4	
Hips/Pelvis	3.8	15.6	5.1	9.4	60.3	5.8	
Shoulder	1.3	21.8	4.6	12.2	50.6	9.5	
Extremity NOS	1.8	20.5	3.8	10.2	55.2	8.5	
Systemic therapy							<.001
No	5.7	24.3	6.8	18.2	41.2	3.7	
Yes	1.6	9.4	3.2	7.1	72.9	5.8	
Facility type							<.001
Community	3.8	14.2	5.4	12.0	60.0	4.7	
Academic	3.2	21.3	4.2	13.4	51.9	6.1	
Integrated network	3.3	17.5	4.6	12.6	59.0	3.0	

Abbreviations: fx, fraction; NOS, not otherwise specified; NQF 1822, National Quality Forum measure 1822.

increase costs, so it is unclear whether avoiding this type of variation in care achieves the objective of improving value.

Notwithstanding, NQF 1822 remains a measure of payment determination (OP-33) in the HOQR Program through calendar year 2020.⁹ With the forthcoming Radiation Oncology Alternative Payment Model,¹⁸ quality metrics are becoming an increasingly important part of clinical practice and reimbursement. Measures that are simple, reflect current best practice, and allow for an appropriate degree of flexibility are likely to be of highest value.

There are several limitations to this study. Chief among them are the limitations of the primary dataset (the NCDB), including the capture of only treatments performed as a component of initial management and possible inaccuracies in the coding of radiation treatment records.¹⁹ Although efforts were made to exclude patients who received nonpalliative treatment, implausible dose fractionation, and fractional doses exceeding 16 Gy, it is possible that there could be remaining inaccuracies in the data. In addition, several exclusionary criteria from NQF 1822, such as cord compression, were not available in the primary dataset. Although this limitation may have affected rates of compliance, a sensitivity analysis excluding treatments to the spine yielded similar results and associations. Furthermore, the dataset included only

patients diagnosed with a primary lung cancer. Although differences may be observed with other histologies, such as breast or prostate cancer, lung cancer represents the majority of palliative radiation courses for bone metastases.^{3,6,13} Finally, although we observed an increase in rates of compliance with NQF 1822 since its introduction, some of the increase predated adoption of the measure, and it is likely that additional factors have contributed to this trend.

Conclusions

Although compliance with NQF 1822 has improved since it was first introduced nearly 10 years ago, it is an inflexible measure that may fail to capture important nuances in treatment decisions including short-course treatments. More flexible quality measures that continue to promote high-quality, cost-conscious care may be warranted as the management of bone metastases continues to evolve.

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References

- Chen AB, Cronin A, Weeks JC, et al. Palliative radiation therapy practice in patients with metastatic non-small-cell lung cancer: a Cancer Care Outcomes Research and Surveillance Consortium (CanCORS) study. *J Clin Oncol* 2013;31:558–564.
- Fairchild A, Barnes E, Ghosh S, et al. International patterns of practice in palliative radiotherapy for painful bone metastases: evidence-based practice? *Int J Radiat Oncol Biol Phys* 2009;75:1501–1510.
- Gupta A, Wang P, Sedhom R, et al. Physician practice variability in the use of extended-fraction radiation therapy for bone metastases: are we choosing wisely? *JCO Oncol Pract* 2020;16:e758–769.
- Chow E, van der Linden YM, Roos D, et al. Single versus multiple fractions of repeat radiation for painful bone metastases: a randomised, controlled, non-inferiority trial. *Lancet Oncol* 2014;15:164–171.
- Hartsell WF, Scott CB, Bruner DW, et al. Randomized trial of short- versus long-course radiotherapy for palliation of painful bone metastases. *J Natl Cancer Inst* 2005;97:798–804.
- Wegner RE, Matani H, Colonias A, et al. Trends in radiation fractionation for bone metastases: a contemporary nationwide analysis. *Pract Radiat Oncol* 2020;10:402–408.
- Bekelman JE, Epstein AJ, Emanuel EJ. Single- vs multiple-fraction radiotherapy for bone metastases from prostate cancer. *JAMA* 2013;310:1501–1502.
- National Quality Forum. Quality Positioning System (QPS) measure description display information. Accessed November 20, 2020. Available at: <http://www.qualityforum.org/QPS/MeasureDetails.aspx?standardID=1822&print=1&entityTypeID=1>
- Centers for Medicare & Medicaid Services. Hospital Outpatient Quality Reporting Program. Accessed November 20, 2020. Available at: <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/HospitalOutpatientQualityReportingProgram>
- Quality Reporting Center. PPS-Exempt Cancer Hospital Quality Reporting (PCHQR) Program. Accessed November 20, 2020. Available at: <https://www.qualityreportingcenter.com/en/inpatient-quality-reporting-programs/pps-exempt-cancer-hospital-quality-reporting-pchqr-program/>
- American Society for Radiation Oncology. Medicare program: proposed changes to hospital outpatient prospective payment and ambulatory surgical center payment systems and quality reporting programs; requests for information on promoting interoperability and electronic health care information, price transparency, and leveraging authority for competitive acquisition program for part b drugs and biologicals for a potential CMS Innovation Center model. Accessed November 20, 2020. Available at: <https://www.astro.org/ASTRO/media/ASTRO/Daily%20Practice/PDFs/2019HOPPSProposedRuleComments.pdf>
- Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA* 1998;280:1690–1691.
- Nguyen QN, Chun SG, Chow E, et al. Single-fraction stereotactic vs conventional multifraction radiotherapy for pain relief in patients with predominantly nonspine bone metastases: a randomized phase 2 trial. *JAMA Oncol* 2019;5:872–878.
- Ryu S, Deshmukh S, Timmerman RD, et al. Radiosurgery compared to external beam radiotherapy for localized spine metastasis: phase III results of NRG Oncology/RTOG 0631. *Int J Radiat Oncol Biol Phys* 2019;105(Suppl):S2–3.
- Muller DA, Wages NA, Wilson DD, et al. STAT RAD: a prospective dose escalation clinical trial of single fraction scan-plan-QA-treat stereotactic body radiation therapy for painful osseous metastases. *Pract Radiat Oncol* 2020;10:e444–451.
- Gomez DR, Tang C, Zhang J, et al. Local consolidative therapy vs. maintenance therapy or observation for patients with oligometastatic non-small-cell lung cancer: long-term results of a multi-institutional, phase II, randomized study. *J Clin Oncol* 2019;37:1558–1565.
- Palma DA, Olson R, Harrow S, et al. Stereotactic ablative radiotherapy versus standard of care palliative treatment in patients with oligometastatic cancers (SABR-COMET): a randomised, phase 2, open-label trial. *Lancet* 2019;393:2051–2058.
- Centers for Medicare & Medicaid Services. Radiation oncology model. Accessed November 20, 2020. Available at: <https://innovation.cms.gov/innovation-models/radiation-oncology-model>
- Jacobs CD, Carpenter DJ, Hong JC, et al. Radiation records in the National Cancer Database: variations in coding and/or practice can significantly alter survival results. *JCO Clin Cancer Inform* 2019;3:1–9.