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Scientific Article

The Effect of Surgeon Referral and a Radiation Oncologist Productivity-Based Metric on Radiation Therapy Receipt Among Elderly Women With Early Stage Breast Cancer: Analysis From a Tertiary Cancer Network

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Abstract

Purpose: : Guidelines for early-stage breast cancer allow for radiation therapy (RT) omission after breast conserving surgery among older women, though high utilization of RT persists. This study explored surgeon referral and the effect of a productivity-based bonus metric for radiation oncologists in an academic institution with centralized quality assurance review.

Methods and materials: : We evaluated patients ≥70 years of age treated with breast conserving surgery for estrogen receptor (ER)+ pT1N0 breast cancer at a single tertiary cancer network between 2015 and 2018. The primary outcomes were radiation oncology referral and RT receipt. Covariables included patient and physician characteristics and treatment decisions before versus after productivity metric implementation. Univariable generalized linear effects models explored associations between these outcomes and covariables.

Results: : Of 703 patients included, 483 (69%) were referred to radiation oncology and 273 (39%) received RT (among those referred, 57% received RT). No difference in RT receipt pre- versus post-productivity metric implementation was observed (P = .57). RT receipt was associated with younger patient age (70-74 years; odds ratio [OR], 2.66; 95% confidence interval [CI], 1.54-4.57) and higher grade (grade 3; OR, 7.75; 95% CI, 3.33-18.07). Initial referral was associated with younger age (70-74; OR, 5.64; 95% CI, 3.37-0.45) and higher performance status (Karnofsky performance status ≥90; OR, 5.34; 95% CI, 2.63-10.83).

Conclusions: : Nonreferral to radiation oncology accounted for half of RT omission but was based on age and Karnofsky performance status, in accordance with guidelines. Lack of radiation oncologist practice change in response to misaligned financial incentives is

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reassuring, potentially reflecting incentive design and/or centralized quality assurance review. Multi-institutional studies are needed to confirm these findings.

Introduction

Although adjuvant radiation is a standard component of breast conservation,[1] multiple randomized controlled clinical trials show that radiation does not improve overall survival, distant metastasis, or rates of subsequent mastectomy among elderly patients with early-stage invasive estrogen receptor (ER) positive breast cancer.[2-4] As a result, in 2004, the National Comprehensive Cancer Network (NCCN) Guidelines incorporated omission of adjuvant radiation therapy (RT) as a category I option for women meeting eligibility criteria for the Cancer and Leukemia Group B (CALGB) 9343 trial, specifically age over 70 and T1N0 disease.[5] But despite availability of randomized evidence and practice guidelines, management of early-stage invasive breast cancer has remained largely unchanged in the United States. According to Surveillance, Epidemiology, and End Results (SEER)−Medicare data, adjuvant RT use was reduced by only 4% (79%-75%) among women meeting CALGB 9343 criteria between 2001 and 2007,[6] though more recent population-based estimates suggest approximately 60% of patients in this low-risk population receive radiation.[7]

Evidence suggests high variability between centers, with the proportion of patients receiving RT ranging from 49% to 93% among NCCN member institutions in 2009.[8] Because variability can reflect underlying inefficiency and bias, it is important to understand factors potentially driving both physician and patient decision-making. For example, up to 40% of surgeons and 20% of radiation oncologists in a nationally representative sample incorrectly cite a survival benefit for RT in this cohort[9]; this is important because patients report that trust in their physician's recommendation is one of the most important factors guiding their decision.[10] Although data on overall receipt of radiation are known, evidence regarding the role of surgeon referral versus radiation oncologist recommendation is less understood because of limitations of population-based data sets.

Financial misalignment in a fee-for-service health care system may contribute to overtreatment in radiation oncology,[11] unlike other interventional specialties. Evidence supports financial incentives leading to practice change in oncology, most commonly de-prescribing in response to decreased reimbursement for systemic therapy.[12] Additionally, more frequent unnecessary procedures, specifically cystoscopy for bladder cancer, occur in response to increased reimbursement.[13] Little is known about the potential influence of institutional productivity-based bonus metrics, including on the use of unnecessary procedures in radiation oncology, despite this being the predominant practice payment model.[14]

The current study was conducted in a large multisite tertiary care network with a relatively low proportion of patients undergoing radiation (54% as of 2012[15] compared with approximately 62% nationally at that time[7]) to better understand surgeon referral patterns and radiation treatment decision-making. Specifically, we hypothesized that the enactment of a productivity-based bonus metric for radiation oncologists could have the negative consequence of increasing the proportion of patients receiving RT (among those referred). We also investigated physician, patient, and tumor-related determinants of RT receipt, as well as factors that are associated with initial referral to radiation oncology.

Methods and Materials

Data set and primary analysis

This retrospective analysis included all patients ≥70 years of age who underwent breast conserving surgery for ER+ pT1N0 breast cancer between 2015 and 2018 at Memorial Sloan Kettering Cancer Center, a tertiary cancer network with multiple clinical practice locations for radiation therapy. Electronic medical records were reviewed for RT receipt (including RT at outside institutions), the primary endpoint. To confirm accuracy in assignment of RT receipt, a second abstractor performed a 10% random sample chart audit.[16] Patients undergoing BCS at outside institutions were not included. Throughout the study period, the department of radiation oncology conducted weekly centralized quality assurance processes (ie, peer review or "chart rounds"), in which radiation treatment plans for all patients undergoing breast radiation at the main and regional sites were reviewed by at least 2 radiation oncologists specializing in breast cancer. Institutional board review approval was obtained for this study.

Covariates

Explanatory variables were collected and incorporated into adjusted models. A productivity-based bonus metric was instated for radiation oncologists at both the main and regional sites in January 2017 based on the number of treatment "new starts." Rather than a relative value unit (RVU)-based system that results in incentives for more complex techniques and longer fractionation schedules, at our institution every unique patient treatment course (ie, "new start") is counted equally. With the implementation of this new metric, physicians have an annual target that reflects an expected minimum number of new start treatments per year. Exceeding the annual target can result in a surplus bonus but is capped at 20% above the target. Previously, a salary-based model without clinical productivity measures was used. Referred patients were thus grouped into pre-metric and post-metric cohorts to evaluate its effect on practice patterns.

Although patient preferences are incorporated into shared decision making by both surgeon and radiation oncologist regarding adjuvant radiation among this low-risk group in routine care, there is currently no standard approach to soliciting patient preferences. A multidisciplinary breast team retreat held in 2018 recommended that omission be considered for patients with early-stage ER+ disease over age 75 years and/or with poor performance status. This was formally incorporated into departmental guidelines for radiation oncologists, while radiation referral remained at the discretion of the treating surgeon.

Electronic medical records were reviewed for biologic variables (tumor size, tumor grade, presence of lymphovascular invasion [LVI] that included "suspicious," human epidermal growth factor receptor 2 (HER2) status, laterality, focality, Oncotype DX score), patient clinical characteristics (Karnofsky performance status [KPS] score, smoking status, age), patient-reported sociodemographic characteristics (race/ethnicity, highest level of education, preferred language; pulled from intake surveys), types of adjuvant therapies (chemotherapy, hormone therapy, RT), treating physicians (surgeons, radiation oncologists), and radiation clinical practice site. Physician years of experience was estimated from publicly available medical school graduation year. Level of specialization was based on the number of patients treated per physician within this data set and dichotomized (<10 vs 10 or more consults).

Socioeconomic status (SES) was calculated using the University of Wisconsin's Neighborhood Atlas, as previously reported.[17,18] We determined the national percentile for each patient according to their home address and associated Area Deprivation Index (ADI) ranking, with 1 indicating the least disadvantaged and 100 indicating the most disadvantaged neighborhood. Distances from patients' homes to the nearest clinic site were calculated using Google Maps[19,20] by selecting the shortest recommended route. Distances were analyzed on a continuous scale and in 5-mile increments, based on prior research.[21]

Statistical analyses

Descriptive statistics were calculated for all baseline characteristics in accordance with statistical guidelines published by *The New England Journal of Medicine*.[22] Univariable generalized linear mixed effects models were used to explore associations between the binary outcome, RT receipt, and explanatory variables of interest among patients referred to radiation oncology. This same approach was used to evaluate associations between initial referral and explanatory variables among all patients. A logit link function was specified for each univariable model, and each included a random intercept and a random slope to account for random variation due to physician. For each surgeon, we reported radiation referral frequency and the median odds ratio (OR) computed from an intercept-only model with no other fixed effects or random slopes (ie, only a fixed intercept and random intercept) to quantify the variation between surgeons. Variation in treatment rates among radiation oncologists was demonstrated via a simplified approach, by calculating the median and interquartile range (IQR) of RT rate among those who treated 10 or more patients during the study period. False discovery rate (FDR) adjustments were used to account for multiple comparisons. Results were adjusted within outcomes (RT receipt or radiation oncology referral); for example, RT receipt results were adjusted based on the number of associations with RT receipt that were tested. *P* values were deemed significant if they were less than the FDR-adjusted significance threshold. All statistical computations were performed and all output was generated using SAS Software Version 9.4 (The SAS Institute, Cary, NC).

Results

Patient characteristics

Among 703 patients who met inclusion criteria, 39% (n = 273) received RT. The overall median age was 74, and most were non-Hispanic White with a median national SES percentile of 10. Median tumor size was 1.0 cm and most patients presented with grade 2 (56%), HER2 negative disease (96%) without LVI (84%). For the 301 patients (43%) who received an Oncotype DX score, the median score was 15. Nine percent (n = 60) of patients received chemotherapy, and hormone therapy was recommended for 95% (n = 666). Patient characteristics pre- and post-metric implementation were comparable, as outlined in Table 1.

Covariates associated with radiation receipt

Among 483 patients referred to radiation oncology, 57% (n = 273) received RT. The median unadjusted proportion of patients receiving RT from radiation oncologists treating at least 10 patients in the study period (n = 14 of 28 total radiation oncologists) was 67% (IQR,

Table 1 Patient characteristics among all patients, then subgroups of patients (a) referred to RO and (b) seen in RO before and after implementation of a new RO payment model (productivity-based bonus metric)

		All patients	Patients referred to RO	Patients seen in RO before (pre-metric) and after (post-metric) change in RO payment model (n = 483)	
		n = 703 n (%)	n = 483 (68.7%)	Pre-metric, n = 182 (37.7%)	Post-metric, n = 301 (62.3%)
Age, years	Median (range)	74 (70-92)	73 (70-90)	73 (70-90)	73 (70-88)
	≥75	341 (48.5)	37.3	39.6	35.9
Education	College or higher	232 (33)	38.7	42.9	36.2
	Below college	177 (25.2)	27.1	29.7	25.6
	Missing	294 (41.8)	34.2	27.5	38.2
Race	White	609 (86.6)	84.3	87.9	82.1
Ethnicity	Hispanic	32 (4.6)	6.2	5.5	6.6
	Missing	53 (7.5)	6.8	6.6	7.0
Preferred language	English	580 (82.5)	82.8	83.0	82.7
	Not English	69 (9.8)	10.4	9.9	10.6
	Missing	54 (7.7)	6.8	7.1	6.6
Marital status	Married	557 (79.2)	78.7	83.5	75.7
	Single/widowed	110 (15.6)	14.7	12.1	16.3
	Divorced	24 (3.4)	4.3	0.0	7.0
Smoking status	Yes/prior	319 (45.4)	44.3	43.4	44.9
Practice setting	Main campus	—	54.2	57.1	52.5
	Regional site	—	41.6	35.7	45.2
	Missing	—	4.1	7.1	2.3
Tumor grade	3	77 (11)	12.6	10.4	14.0
	2	392 (55.8)	58.0	54.9	59.8
	1	173 (24.6)	21.1	23.6	19.6
	Missing	61 (8.7)	8.3	11.0	6.6
KPS score	≥90	427 (60.7)	77.6	77.5	77.7
	<90	80 (11.4)	11.6	11.0	12.0
	Missing	196 (27.9)	10.8	11.5	10.3
LVI	Positive/suspicious	86 (12.2)	13.3	15.4	12.0
HER2 status	Positive	24 (3.4)	4.3	4.4	4.3
Multifocal	Yes	81 (11.5)	13.0	12.1	13.6

(*continued on next page*)

Table 1 (*Continued*)

		All patients	Patients referred to RO	Patients seen in RO before (pre-metric) and after (post-metric) change in RO payment model (n = 483)	
		n = 703 n (%)	n = 483 (68.7%)	Pre-metric, n = 182 (37.7%)	Post-metric, n = 301 (62.3%)
Tumor laterality	Left	362 (51.5)	51.8	54.9	49.8
Tumor size, cm	Median (range)	1.0 (0.1-2.0)	1.0 (0.1-2.0)	1.0 (0.1-2.0)	1.1 (0.1-2.0)
Oncotype DX score	Median (range)	15 (0-53)	15.5 (0-53)	15 (1-53)	16 (0-46)
	Ordered	301 (42.8)	53.4	57.1	51.2
Chemotherapy	Received	60 (8.5)	11.2	8.2	13.0
Hormone therapy	Recommended	666 (94.7)	95.2	96.2	94.7
Radiation receipt	Received	—	56.5	55.5	57.1
	Did not receive	—	43.5	43.5	42.9
Radiation dose, cGy	Median (range)	—	4000 (0-6000)	4000 (0-6000)	4000 (0-5740)
	Missing	—	3.7	6.0	2.3
Distance to nearest clinic, mi	Median (range)	13 (1-1993)	12 (1-1594)	13 (1-1165)	12 (1-1594)
	1-5 mi	146 (20.8)	22.8	20.9	23.9
	6-10 mi	128 (18.2)	17.6	16.5	18.3
	11-15 mi	162 (23)	21.5	22.5	20.9
	16-20 mi	73 (10.4)	11.6	11.5 25.3	11.6
	>20 mi	180 (25.6)	24.2		23.6
National percentile	Median (range)	10 (1-100)	10 (1-100)	8 (1-100)	11 (1-100)

Abbreviations: HER2 = Human epidermal growth factor receptor 2; KPS = Karnofsky performance status; LVI = lymphovascular invasion; RO = radiation oncology.

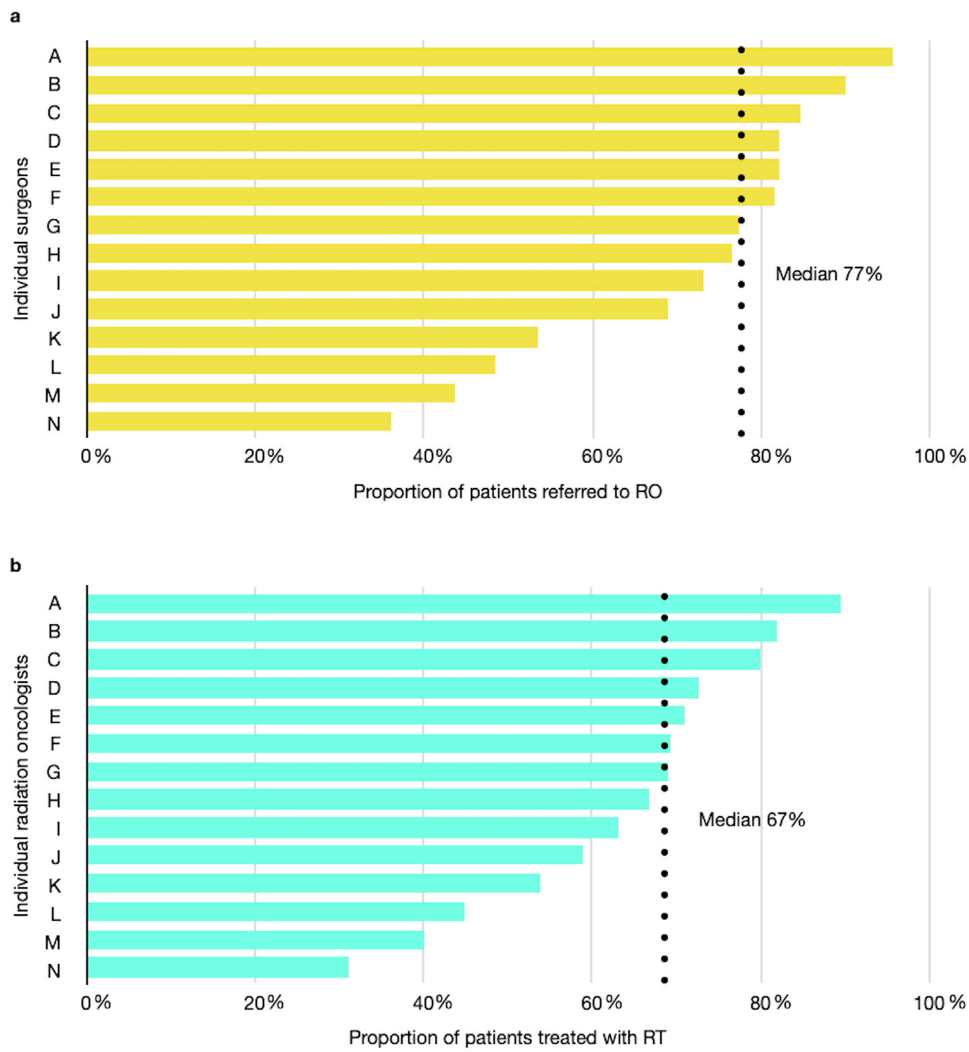

Figure 1 A, Unadjusted proportions of patients referred to radiation oncology by high volume surgeons.* B, Unadjusted proportions of patients treated with radiation therapy by high volume radiation oncologists.* (*Defined as having seen ≥10 consultations during the study period.)

54-73), as seen in Fig 1. No significant difference was observed in the proportion of patients receiving RT pre- versus post-metric implementation (OR, 1.16; 95% confidence interval [CI], 0.68-1.98; P = .57). Differences in unadjusted proportion of patients treated over time are shown in Fig 2. The only variables significantly associated with RT receipt after adjusting for multiple comparisons were younger patient age (70-74 years; OR, 2.66; 95% CI, 1.54-4.57; P = .001) and higher tumor grade (grade 3; OR, 7.75; 95% CI, 3.33-18.07; grade 2; OR, 1.83; 95% CI, 1.11-3.02; $P < .001$) (Table 2).

Of the 255 patients with RT plans available, 20% (n = 52) received partial breast irradiation, which is delivered in 40 Gy in 10 fractions, per our institutional standard.[23] The remaining patients received hypofractionated whole breast radiation over 3 to 4 weeks. The use of partial breast irradiation did not change with implementation of the productivity metric (P = .943).

Covariates associated with referral to radiation oncology

The median proportion of patients referred to radiation oncology among surgeons treating at least 10 patients during the study period (n = 16 out of 17 total breast surgeons) was 77% (IQR, 53-82), as seen in Fig 1. The median OR that quantifies variation in referral between all surgeons was 2.31. A univariable generalized mixed effects regression model revealed that younger patient age (70-74 years; OR, 5.64; 95% CI, 3.37-0.45; $P < .001$) and higher performance status (KPS ≥90; OR, 5.34; 95% CI, 2.63-10.83; $P < .001$) were significantly associated with surgeon referral to radiation oncology after adjusting for multiple comparisons (Table 2). No other post-FDR significant associations were observed between surgeon referral to radiation oncology and the remaining characteristics.

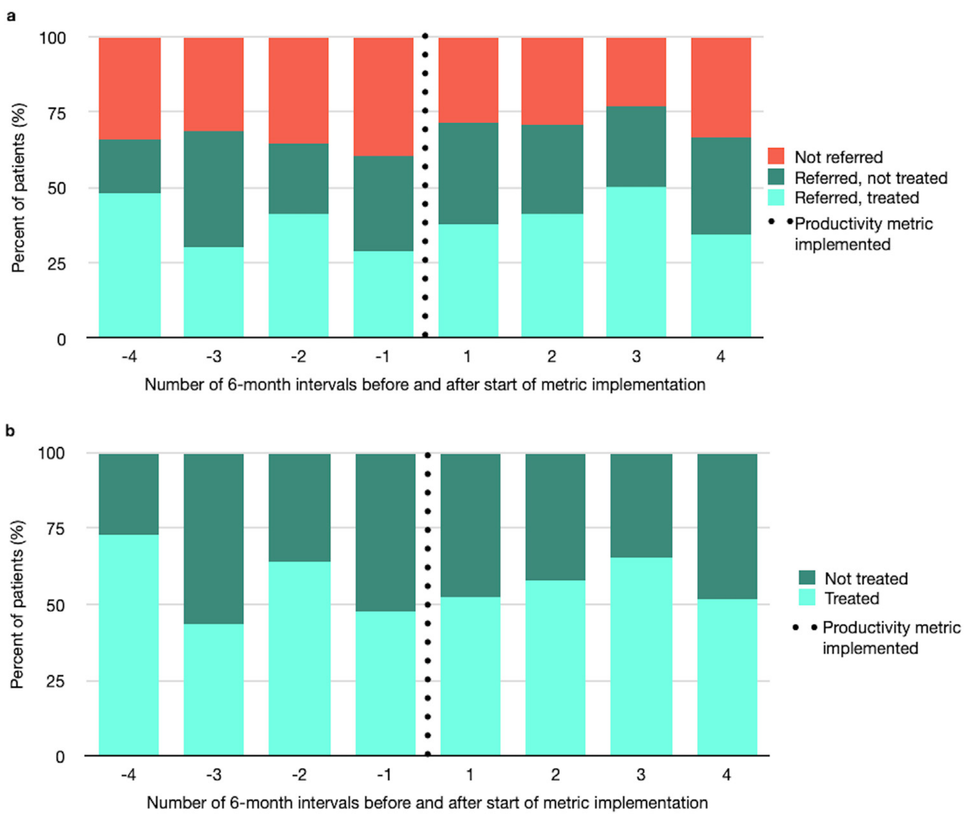

Figure 2 A, Proportion of patients referred to radiation oncology and receiving radiation therapy over time. B, Proportion of referred patients receiving radiation therapy over time.

Discussion

In a large academic center with a relatively low rate of adjuvant radiation among elderly patients with early-stage ER+ breast cancer, we did not observe increased use of radiation in response to a productivity-based financial incentive for radiation oncologists. Approximately half of radiation omission was because of nonreferral by surgeons, who less often referred patients who were older and frailer. Limited variation between radiation oncologists and lack of additional variables associated with treatment suggest the likely influence of patient preference.

The absence of physician practice change in response to a new financial incentive departs from much, but not all, of the prior literature in oncology.[12,24-26] It is therefore important to understand the context in which this finding may apply. In the current study, we tested whether financial misalignment could instigate overtreatment and found that it did not. It is noted that the 20% cap on productivity bonus may be 1 characteristic of this model that influenced this. Additionally, in the single institution setting, there is greater potential for the influence of local culture to supersede a financial incentive. We hypothesize that existence of centralized quality assurance of radiation plans in chart rounds helps prevent inappropriate treatment, given the opportunity for peers to inquire about the indication for radiation in low-risk disease, thereby providing feedback to physicians that could influence future decision-making. Although the practice of peer review is common in radiation oncology, there are limited data on its efficacy, particularly in the setting of a multisite network with a centralized process led by subspecialists.[27,28] Understanding the consequences of a capitated productivity-based bonus model in combination with strategies to maintain treatment quality is relevant to proposed bundled payment models such as the Radiation Oncology Alternative Payment Model.[29] This model introduced the potential for physicians to lower their threshold to treat patient populations that previously were not routinely receiving treatment, as centers using long-course radiation observe decreased revenues under the new model. Therefore, although we provided evidence that incentives do not necessarily increase overuse, further research is needed to understand the role of peer review and quality assurance strategies in providing a balance in this system. It is noted that many complexities in implementing a bundled payment model for radiation oncology have led to an indefinite hold as of the August 29, 2022, final rule.

It is notable that approximately half of radiation omission occurred because of nonreferral, confirming the

Table 2 Univariable generalized linear mixed effects regression results for predictors of referral and radiation receipt

Variable		Referral to radiation oncology among all patients			Radiation receipt among referred patients		
		n (no. of events)	OR (95% CI)	*P* value	n (no. of events)	OR (95% CI)	*P* value
Tumor characteristics							
Size, cm		703 (483)	1.43 (0.93-2.20)	.09	483 (273)	1.56 (0.99-2.44)	.05
Grade	1	642 (443)	Ref	.04	443 (251)	Ref	<.001*
	2	173 (102)	1.86 (0.98-3.52)		102 (43)	1.83 (1.11-3.02)	
	3	392 (280)	2.95 (1.22-7.11)		280 (157)	7.75 (3.33-18.07)	
		77 (61)			61 (51)		
LVI	Negative	676 (467)	Ref	.32	467 (263)	Ref	.30
	Positive/suspicious	590 (403)	1.33 (0.73-2.45)		403 (222)	1.37 (0.74-2.52)	
		86 (64)			64 (41)		
HER2 status	Negative	701 (482)	Ref	.10	482 (272)	Ref	.09
	Positive/suspicious	677 (461)	3.32 (0.76-14.47)		461 (254)	3.55 (0.82-15.45)	
		24 (21)			21 (18)		
Multifocal	No	703 (483)	Ref	.15	483 (273)	Ref	.03
	Yes	622 (420)	1.67 (0.80-3.47)		420 (227)	2.16 (1.06-4.40)	
		81 (63)			63 (46)		
Laterality	Left	703 (483)	Did not converge	—	483 (273)	Ref	.14
	Right	362 (250)	Did not converge		250 (130)	1.35 (0.90-2.03)	
		341 (233)			233 (143)		
Laterality†	Left	703 (483)	Ref	.55	—	—	—
	Right	362 (250)	0.88 (0.57-1.37)				
		341 (233)					
Patient characteristics							
Age	<75	703 (483)	5.64 (3.37-9.45)	<.001*	483 (273)	2.66 (1.54-4.57)	.001*
	≥75	362 (303)	Ref		303 (200)	Ref	
		341 (180)			180 (73)		
KPS score	≥90	507 (431)	5.34 (2.63-10.83)	<.001*	431 (234)	Ref	.04
	<90	427 (375)	Ref		375 (211)	0.46 (0.23-0.95)	
		80 (56)			56 (23)		
Race	White	691 (471)	Ref	.25	471 (266)	Ref	.58
	Nonwhite	609 (407)	1.43 (0.75-2.71)		407 (233)	0.85 (0.46-1.56)	
		82 (64)			64 (33)		
Ethnicity	Non-Hispanic	650 (450)	Ref	.08	450 (257)	Did not converge	—
	Hispanic	618 (420)	4.35 (0.82-23.13)		420 (241)	Did not converge	
		32 (30)			30 (16)		
Ethnicity†	Non-Hispanic	—	—	—		Ref	.89
	Hispanic					0.93 (0.26-3.31)	

(*continued on next page*)

Table 2 (*Continued*)

Variable		Referral to radiation oncology among all patients			Radiation receipt among referred patients		
		n (no. of events)	OR (95% CI)	*P* value	n (no. of events)	OR (95% CI)	*P* value
					450 (257) 420 (241) 30 (16)		
Preferred language	English Not English	649 (450) 580 (400) 69 (50)	Ref 0.79 (0.33-1.89)	.57	450 (260) 400 (241) 50 (19)	Ref 0.42 (0.20-0.90)	.03
Education	College or higher Missing Below college	703 (483) 232 (187) 294 (165) 177 (131)	Ref 0.52 (0.31-0.86) 0.62 (0.37-1.06)	.04	483 (273) 187 (106) 165 (99) 131 (68)	Ref 0.98 (0.61-1.57) 0.79 (0.48-1.30)	.60
National percentile[†]		685 (466)	1.00 (0.98-1.01)	.75	466 (262)	0.99 (0.98-1.00)	.07
Distance to nearest clinic	>20 mi 1-5 mi 6-10 mi 11-15 mi 16-20 mi	689 (472) 180 (117) 146 (110) 128 (85) 162 (104) 73 (56)	Ref 2.16 (1.25-3.73) 1.41 (0.82-2.43) 1.37 (0.83-2.26) 2.07 (1.03-4.14)	.06	472 (267) 117 (74) 110 (59) 85 (47) 104 (63) 56 (24)	Ref 0.86 (0.47-1.58) 0.77 (0.41-1.43) 0.95 (0.52-1.72) 0.44 (0.21-0.89)	.19
Treated pre- or post-metric implementation	Pre-metric Post-metric	—	—	—	483 (273) 182 (101) 301 (172)	Ref 1.16 (0.68-1.98)	.57
Physician characteristics							
Practice setting	Main campus Regional site	—	—	—	463 (255) 262 (120) 201 (135)	Ref 1.75 (0.75-4.05)	.15
Years of experience[‡]	≤15 y >15 y	703 (483) 114 (74) 589 (409)	Ref 1.56 (0.46-5.23)	.45	468 (258) 223 (131) 245 (127)	Ref 0.92 (0.47-1.80)	.79
10+ consults/patients in entire study period	Yes No	703 (483) 700 (480) 3 (3)	Did not converge Did not converge	—	468 (258) 403 (220) 65 (38)	Ref 0.85 (0.41-1.75)	.65

Abbreviations: CI = confidence interval; HER2 = Human epidermal growth factor receptor 2; KPS = Karnofsky performance status; LVI = lymphovascular invasion; OR = odds ratio.

* Indicates significant *P* value after false discovery rate adjustments. Estimates were obtained using a residual pseudo-likelihood estimation technique with a random effects solutions expansion locus, and denominator degrees of freedom were computed using the containment method. Exceptions are denoted with superscripts as follows.

† Estimation technique: maximum likelihood (Laplace).

‡ Denominator degrees of freedom computation method: Kenward and Roger (1997)[42].

critical role of surgeons in the radiation decision-making process. Referral rates were generally considered appropriate given referred patients were younger and healthier (78% with KPS ≥90), consistent with eligibility criteria for CALGB 9343, NCCN recommendations,[2,3,5] and institutional guidelines later formalized in 2019. Additionally, most breast surgeons at our institution report undertaking a discussion with the patient about their tolerance of risk, uncertainty, and anxiety, and may use this additional information in their decision to refer them to radiation oncology. This element of shared decision-making may contribute to the variation observed between surgeons (although provided proportions are unadjusted). Furthermore, with increasing options for short-course and partial breast radiation, such discussion is increasingly nuanced and more frequent radiation oncologist consultation may be warranted, as discussed in the following sections.

Although no tumor characteristics were significantly associated with surgeon referral, patients with high-grade tumors were more likely to receive radiation once seen by radiation oncology. The (Post-operative Radiotherapy In Minimum-risk Elderly) PRIME II trial did prohibit patients from enrolling if they had both LVI and high-grade tumors,[4] and evidence supports grade (an important factor differentiating luminal A and luminal B subtypes) as a predictor of recurrence.[30] Although trends existed, neither LVI nor HER2 expression (which was not collected on prospective trials) was significant in this cohort. Future studies are being considered to evaluate recurrence in HER2+ patients. In general, variation by radiation oncologists in which at least 10 patients were treated (and therefore a reliable fraction could be estimated) was fairly small (IQR, 54%-73%), and patient volume was not significantly associated with a radiation oncologist's likelihood to recommend RT.[31,32]

Several studies have documented variability in RT receipt based on SES[33-35] and race/ethnicity.[34,36-38] In this patient population, more educated patients may be more likely to be referred for a discussion, but there was insufficient evidence that they were more likely to be treated. Longer distance from a patient's home was also not significant, in contrast to prior studies, which may be because of the urban/suburban nature of this population with a median distance from home to clinic of 13 miles.

It is important to consider that there is a high proportion of patients who were recommended and initially received adjuvant hormone therapy within this study cohort, which could have played a role in the lower rate of RT receipt. Based on the National Surgical Adjuvant Breast and Bowel Project (NSABP) B21 trial, distant recurrence rates with RT alone were quite low, and this has fueled ongoing discussion of the need for more research investigating the omission of hormone therapy instead of RT.[39] B21 showed lower rates of local recurrence with radiation alone than hormone therapy alone, while the British Association of Surgical Oncology (BASO) II trial demonstrated similar rates of local recurrence. Future studies should collect data on hormone therapy adherence over time and even consider evaluating opportunities to intervene with radiation for early endocrine discontinuation to optimize disease-free survival.

As we move forward into an era of ultrahypofractionated radiation, with the advent of 5-fraction regimens for both partial breast radiation (via Florence trial) as well as whole breast radiation (via FAST Forward, a trial regarding FASTer radiotherapy for breast radiotherapy), risk/benefit calculation for patients may change in the near future.[40,41] Specifically, the Florence trial showed reduced short- and long-term toxicity of radiation compared with whole breast radiation.[40] Hence, the threshold for pursuing radiation in lieu of hormone therapy in this elderly population may be lowered, again warranting patient and radiation oncologist participation in decision-making.

Limitations of this study predominantly relate to its retrospective single-institution design. The ability to generalize the lack of effect of a capitated financial incentive to other clinical settings may therefore be limited. Nonetheless, one potential strength of this specific setting is the high baseline rate of omission, which could more easily detect an increase in radiation use. This study also provides insights into potential mitigating factors to overtreatment and highlights the need for additional work to assess physician- and organizational-level factors that prevent overuse in the setting of such capitated incentives. Second, this study lacks data on patient preference. Patient preference is an important factor we were unable to specifically account for in this study and is therefore a limitation. Future research may be warranted to document patient preference to ensure shared decision-making and assess concordance between patients and clinicians as well as with the final treatment received. Lastly, in this highly selected patient population, we may have limited ability to detect disparities in radiation receipt by socioeconomic or geographic factors. Similarly, this study may have been underpowered to detect a difference based on HER2 status and LVI, which were present in relatively low frequencies among the cohort (3% and 12%, respectively).

In conclusion, referral and treatment patterns for older women with early-stage breast cancer at a single academic institution were largely consistent with CALGB 9343 and national guidelines, with the proportion of patients receiving radiation noted to be lower than population level estimates. The lack of effect of productivity-based financial incentives is reassuring and possibly related to having a cap on the productivity-based metric and/or a centralized system for quality assurance. Additionally, the limited number of significantly associated patient or physician variables suggests that other unmeasured "factors" such as patient preference play an important role. Larger-scale studies with more diverse patient populations are warranted to further explore and better generalize these results.

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