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Physician-Driven Variation in Nonrecommended Services Among Older Adults Diagnosed With Cancer

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Abstract

IMPORTANCE—Interventions to address overuse of health care services may help reduce costs and improve care. Understanding physician-level variation and behavior patterns can inform such interventions.

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OBJECTIVE—To assess patterns of physician ordering of services that tend to be overused in the treatment of patients with cancer. We hypothesized that physicians exhibit consistent behavior.

DESIGN, SETTING, AND PARTICIPANTS—Retrospective study of patients 66 years and older diagnosed with cancer between 2004 and 2011, using population-based Surveillance, Epidemiology, and End Results (SEER)-Medicare data to assess physician-level variation in 5 nonrecommended services. Services included imaging for staging and surveillance in low-risk disease, intensity-modulated radiation therapy (IMRT) after breast-conserving surgery, and extended fractionation schemes for palliation of bone metastases.

MAIN OUTCOME AND MEASURES—To assess variation in service use between physicians, we used a random effects model and a logistic regression model with a lag variable to assess whether a physician's use of a service for a prior patient predicts subsequent service use.

RESULTS—Cohorts ranged from 3464 to 89 006 patients. The total proportion of patients receiving each service varied from 14% for imaging in staging early breast cancer to 41% in early prostate cancer. From the random effects analysis, we found significant unexplained variation in service use between physicians ($P < .001$ for each service; ICC, 0.04–0.59). Controlling for case mix, whether a physician ordered a service for the prior patient was highly predictive of service use, with adjusted odds ratios (aORs) ranging from 1.12 (95% CI, 1.07–1.18) for surveillance imaging for patients with breast cancer (28% service use if prior patient had imaging vs 25% if not), to 24.91 (95% CI, 22.86–27.15) for IMRT for whole breast radiotherapy (69% vs 7%, respectively).

CONCLUSIONS AND RELEVANCE—Physicians' utilization of nonrecommended services that tend to be overused exhibit patterns that suggest consistent behavior more than personalized patient care decisions. Reducing overuse may require understanding cognitive drivers of repetitive inappropriate decisions.

There is widespread interest in reducing the overuse of harmful and costly health care services.[1–3] Recent initiatives, including the American Board of Internal Medicine (ABIM) Foundation's Choosing Wisely campaign, have compiled lists of scenarios in which health care services are often overused and should be questioned by patients and their physicians.[4] The recommendations largely reflect established evidence or clinical guidelines. Beyond publicizing these lists, effective approaches to reducing overuse have remained elusive but are needed to help improve the overall quality of care.

Cancer care is a prime target for interventions to reduce overuse because it is highly complex and involves an intense period of potentially harmful and costly medical care. Prior studies[5–10] have demonstrated wide utilization of nonrecommended services, including for cancer care, and extensive variation by geographic region, practice setting, and individual physician. At least 1 prior study found that, at the regional level, rates of nonrecommended imaging for disease staging were correlated between early stage prostate cancer and early stage breast cancer. This suggests that nonpatient factors influence physician ordering behavior.[9] As described in the recent Institute of Medicine report[11] on variation in health care spending, there is likely to be considerable variation within the geographic region. Studies[11] have found variation by practice setting and even between individual physicians in

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the same practice. These levels of organization may be more amenable to interventions than regions.

Given the extensive use of many nonrecommended services at the population level, attention to physician-level practice may inform interventions to address overuse. If physicians' use of a service under specific circumstances is consistent and independent of patient factors, it suggests a focus on physician-specific interventions to reduce overuse. Supporting this notion, Obermeyer and colleagues[12] demonstrated differences in hospice utilization at the physician level. The proportion of a physician's patient panel that was not enrolled in hospice prior to death strongly predicted whether or not his or her patient would receive hospice care. Alternatively, if physicians' ordering behavior is random across patients, implementing interventions that focus on reducing the use of specific services across all physicians may be more effective.

Our objective was to assess whether physicians exhibit consistent patterns of behavior regarding health care services that are known to be overused in cancer care. We examined physicians' behavior for 5 services among physicians treating patients with different diseases.

Methods

We assessed physician-level variation in nonrecommended service use using a population-based sample of older adult patients with cancer.

Services

We selected examples of nonrecommended services that could be readily identified in health insurance claims. We used recommendations from the Choosing Wisely campaign proposed by the American Society of Clinical Oncology (ASCO) and the American Society for Radiation Oncology (ASTRO). Services included: imaging for staging of early prostate or breast cancer at low risk for metastasis; surveillance imaging for asymptomatic individuals treated for low-risk breast cancer,[10,13–18] intensity-modulated radiation therapy (IMRT) for whole breast radiotherapy,[19,20] and extended fractionation schemes (>10 fractions) for palliation of bone metastases[20,21] (Table 1).

Key Points

Question

What is the extent of physician variation for health care services that tend to be overused in cancer care?

Findings

In this study using population-based Surveillance, Epidemiology, and End Results (SEER) Medicare data, significant unexplained variation between physicians was found. Whether a physician ordered a service for a patient was highly predictive of whether the physician would order the same service for the next patient.

Meaning

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Physicians' utilization of nonrecommended services exhibit patterns that suggest consistent behavior more than personalized patient care decisions.

Data Source

The population-based Surveillance, Epidemiology, and End Results (SEER)-Medicare database links 2 sources of data:SEER cancer registry files and Medicare enrollment information and claims. The National Cancer Institute (NCI)-sponsored SEER program includes several US states and regions, covering about 28% of the US population.[22] Surveillance, Epidemiology, and End Results registries collect information on site and extent of disease, first course of cancer-directed therapy, and sociodemographic characteristics, with active follow-up for date and cause of death. For older adults diagnosed with cancer in a SEER region, SEER records have been linked with Medicare claims. The SEER-Medicare population has a similar age and sex distribution, a slightly higher proportion of people living in urban and high income areas, and a smaller proportion of nonwhite individuals compared with the US older adult population.[22]

Study Sample and Time Period

We included patients 66 years and older diagnosed with cancer between 2004 and 2011, with follow-up through 2012. We excluded patients enrolled in an health maintenance organization (HMO) or with incomplete Medicare coverage during the study period, and those diagnosed with cancer on death. We also excluded patients whose physician had only 1 patient. We applied additional inclusion and exclusion criteria for each cohort based on measure definitions used in the literature or provided in the Choosing Wisely campaign (Table 1). For example, for imaging in early breast cancer staging, we included women with stage 0 to II breast cancer as the first primary breast cancer diagnosis. They had to have received a mastectomy or breast conserving surgery within 6 months of diagnosis and not received neoadjuvant chemotherapy.

Variables and Outcomes

Patient demographic, disease, and treatment characteristics from SEER and Medicare records were defined as applicable to the service. Demographic characteristics included: age; race; a modified Charlson comorbidity index based on all inpatient, outpatient, and physician claims from 1 year prior to diagnosis[23,24]; marital status; median income of census tract of residence; geographic region; and metropolitan location. Disease and treatment characteristics included: cancer stage; tumor characteristics; year of diagnosis; surgery; radiation therapy; and chemotherapy.

For each cohort, we identified use of the service within the defined study time period. For the example of imaging for breast cancer staging, we identified claims for positron emission tomography (PET), computed tomography (CT), and bone scans from diagnosis through surgery (Table 1).

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Physician Assignment

Eligible patients were assigned to the physician most likely to be the primary decision maker for the service in question, based on an algorithm involving physician specialty and frequency of visits (Table 1). All physicians had to have a Unique Physician Identification Number(UPIN) or a National Provider Identifier (NPI). A crosswalk provided by NCI was used to link physicians over time. In the example of imaging for breast cancer staging, we assigned accountability for each patient to the surgeon associated with her curative treatment. Surgeons' patients were sorted chronologically by surgery date.

Statistical Analysis

We examined the proportion of eligible patients who received each service by patient, disease, and treatment characteristics. We also assessed the use of these services among physicians.

Our primary objective was to better understand the extent of physician variation in practice. To meet our objective, we assessed the extent of unexplained variation in service use between physicians using a nonlinear random effects model with logit link function. This model estimates the logit probability of service use as a linear function of case mix and a random effect for physician assigned to the service.[25–28] It assumes that differences in underlying physician patterns lead to differences in proportions of service use. A test of whether the estimated variance of the random effects differs significantly from zero provides an indication of significant unexplained variation between physicians. We also calculated the intraclass correlation (ICC) which provides information on the magnitude of the correlation.[29]

If we found evidence of physician variation using the random effects model, we thought we would more finely assess the magnitude of the correlation between patients. Therefore, we also performed a logistic regression analysis with a lag variable. This model would allow us to examine the likelihood that a physician's patient received a service, given that the physician's previous patient also received that service. This model does not include physicians' first patient because we required each patient to have a lag value. We hypothesized that information on the physician's prior patient would be informative and reflect physician practice, and trend in a similar direction as the findings from the random effects model. The parameter estimate of the lag variable would offer another and potentially more interpretable measure of the magnitude of physician variation.

For both approaches, services were analyzed separately. In adjusted models, we controlled for case mix. The individual patient encounter was the unit of analysis.

For imaging related to staging breast cancer, some physicians might consider imaging more appropriate for patients with stage II disease than for patients with stage I or 0 disease, even though the Choosing Wisely recommendation does not make this distinction.[13] We therefore repeated the analysis, and assigned a perceived level of indication to the physician's ordering of the test for the prior patient: indicated (ie, prior patient did not receive test); potentially indicated (ie, prior patient received test and had stage II disease); and not indicated (ie, prior patient received test and had stage 0 or 1 disease).

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We repeated the imaging analyses accounting for physician ownership of different types of imaging machines. We also conducted separate analyses for CT scan and PET scan. Similarly, for radiation therapy, we repeated the analyses accounting for setting: outpatient hospital facility or standalone facility.

Analyses were performed in SAS statistical software (version 9.2, SAS Institute). A 2-sided *P* value of less than .05 was considered to be statistically significant. The NCI approved the use of the SEER-Medicare database for this study, which was deemed exempt research by the Memorial Sloan Kettering Cancer Center institutional review board.

Results

The number of patients in each cohort varied from 3464 for the assessment of extended fractionation schemes for palliation of bone metastases to 89 006 for imaging in early breast cancer staging (Table 2). Between 695 and 4285 physicians were included in the analyses. Across services, the median number of patients assigned to each physician ranged from 3 to 11 (Table 2).

Fourteen percent of patients received imaging in breast cancer staging, 18% IMRT for whole breast radiotherapy, 26% posttreatment surveillance in low-risk breast cancer, 35% extended fractionation schemes for palliation of bone metastases, and 41% imaging in early prostate cancer staging (Table 3). The proportions differed by patient characteristics, including age and geographic region (eTable 1 in the Supplement).

From the random effects analysis, there was significant unexplained variation in service use between physicians, accounting for case mix ($P < .001$ for each service) (Table 3). The ICCs ranged from 0.04 for surveillance imaging for breast cancer to 0.59 for IMRT for whole breast radiotherapy.

Since we found significant physician variation based on the random effects model, we also conducted the logistic regression model using the lag variable. The likelihood of a patient receiving a nonrecommended service differed by whether or not the physician's prior patient received the service (eTable 1 in the Supplement). For staging early prostate cancer, 60% of patients received imaging if the prior patient also received imaging compared with 26% if the prior patient did not. Respectively, 28% vs 12% for imaging in breast cancer staging, 28% vs 25% for imaging for posttreatment surveillance in breast cancer, 69% vs 7% for IMRT for whole breast radiotherapy, and 41% vs 32% for extended fractionation schemes for bone metastases. Across all services, the odds of an individual patient receiving a service were higher if the physician's prior patient had received the service than if the physician's prior patient had not (Table 3). Controlling for case mix did not change the interpretation of our main effect in any of the examples. The adjusted odds of a patient receiving the service ranged from 1.12 (95% CI, 1.07–1.18) for surveillance imaging for patients with breast cancer, to 24.91 (95% CI, 22.86–27.15) for IMRT to deliver whole breast radiotherapy (Table 3; see eTable 2 in the Supplement for full results).

For the example of imaging for breast cancer staging, the adjusted odds of a woman receiving an imaging test were approximately 3 times higher if the physician's prior patient

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also had the test (OR, 3.02; 95% CI, 2.88–3.17). The odds of a patient receiving the test increased by the increasing level of inappropriateness of the prior patient's receipt of the test, from 2.58 (95% CI, 2.41–2.76) if the prior patient received the test and had stage II disease up to 3.40 (95% CI, 3.21–3.61) if the prior patient received the test and had stage 0 or 1 disease (Table 4).

The addition of ownership or setting of care as covariates did not change the interpretation of the main effect in any model. Ownership of a CT scanner was associated with increased likelihood of CT scan use in the context of prostate cancer staging and breast cancer surveillance. Ownership of a PET scanner was associated with use of a PET scan for breast cancer surveillance. Radiation therapy delivered in a standalone facility compared to a hospital outpatient facility was associated with increased use of IMRT, but not with extended fractionation for bone metastases (Table 5).

Discussion

Contemporary paradigms of clinical practice emphasize that patient care should be individualized to the patient; but consistent behavior by physicians would tend not to be. Under this premise, we assessed the extent of physician variation in use of nonrecommended services. We used a random effects model and a logistic regression model with a lag variable to assess whether the likelihood of a patient's receipt of an overused service was associated with whether the physician had ordered that service for the prior patient. We observed extensive physician-level variation. This observation held across different services, and for physicians treating patients with different diseases. Over utilization in cancer care may be physician-specific.

Our results were robust to patient characteristics that predicted service use, as well as physician ownership and setting of care delivery. For imaging for staging women with low-risk breast cancer, the strength of the relationship between current and prior use increased with the degree of inappropriateness of the service use for the prior patient.

These findings raise questions about the degree to which marginal decisions, such as those that are a focus of Choosing Wisely, are currently influenced by patient preferences and patient-directed decision making. The campaign specifically focuses on educating patients to question their physicians about the need for overused services.[4] For our results to reflect the service use preferences of patients rather than physicians, patients would have to select physicians who would satisfy their preferences for the receipt of specific services. The ability of patients to select physicians in this way is unlikely given the types of services we are examining and today's relatively opaque health care system.

We observed a wide range of ORs across our service-specific analyses, but all findings were in the hypothesized direction. We might have seen a small effect for surveillance imaging after treatment for breast cancer because there was inaccurate physician assignment given the long follow-up period, symptom-driven imaging was misclassified as inappropriate, or the true effect is small. We saw a very large effect in the context of IMRT for whole-breast radiotherapy. Given that IMRT is widely available across the nation, we can be confident

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that our observation of IMRT use in breast cancer does not reflect availability of the technology in certain facilities. Possible explanations for our observations include clinical indication not reflected in the current data set, physician preference, patient desire, and financial concerns.

Oncology has been touted as an important area for overuse reduction efforts given its complexity, costs, and the uncertainty surrounding decision making.[13,30–34] Accounting for patient and disease characteristics and preferences, several studies[12,35,36] have documented unexplained variation in practice, which may be attributable to the physician or practice setting. Using claims, we were able to observe physicians' consistent inter patient behavior in practice for several services that reflect different types of care and contexts. Our analysis provides evidence of physicians' consistent behavior with regard to overused services in oncology. We observed similar findings in our prior study[37] examining another example of a likely overused therapeutic service, implanted infusion ports in patients receiving chemotherapy. Our results are also consistent with evidence of patterns of hospice referral.[12]

The magnitude of the effects we observed raises an important question: to what extent is the observed behavior driven by physicians' intentional choices vs reflexive, ingrained tendencies? We still have an incomplete understanding of the mechanisms driving these decisions and the most effective physician-level strategies to address them. Habit and past behavior might influence physicians' intentions and resulting consistent behaviors in this context.[38] Factors such as beliefs about evidence based practices or guidelines, knowledge, skills, self-efficacy, anticipated consequences of the decision, and motivation and goals might also inform physicians' decisions.[39] A deeper understanding of drivers behind physician decision making is needed to help change professional practice. In any case, our approach offers an intuitive way to investigate and quantify the consistent and repetitive nature of physicians' behavior at the population level.

Limitations

Findings should be interpreted in the context of its limitations. First, we likely did not include the full patient panel for each physician. However, patients 66 years and older represent a large proportion of patients with the cancer types studied. Second, the decision of whether to order a test may have been made by multiple health care providers. However, assigning the decision to the wrong physician would result in an underestimate of the true association. Third, since our sample size is large, statistically significant results may not imply clinical significance. Finally, based on claims alone, we cannot observe the indications for each service. For surveillance imaging following breast cancer treatment, patient-reported symptoms may prompt testing. It is also relevant for radiation for palliation of bone metastases, since we cannot be certain whether the radiation was intended to be palliative or curative, or the metastases site. Following the recommendations, we expect that the majority of service use was not clinically indicated, and cases for which it was would be randomly distributed and cannot explain our results.

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Conclusions

Efforts to address overuse should consider the possibility that it is concentrated among physicians who practice in repetitive ways, relatively uninfluenced by the patient. Ensuring accessible, affordable cancer care was cited as integral to achieving high-quality cancer care by the Institute of Medicine.[32] The physician practice patterns we observed support intervening with physicians who tend to be consistent high users, which can lead to a better understanding of why these behaviors persist.[40] Likewise, there can be learning opportunities from more measured users. Quality measurement activities such as feedback, profiling, and pay-for-performance may be useful, as demonstrated in initiatives such as the MUSIC collaborative to reduce imaging for staging in low-risk prostate cancer.[41] Physician-focused interventions can supplement existing education and dissemination efforts to help reduce overuse in oncology and improve patient outcomes.

Findings provide support that physicians' use of nonrecommended services in the context of cancer care is consistent and repetitive in nature. The interpatient effects are striking in the scenarios included in this study. Reducing overuse may require understanding the cognitive drivers of repetitive inappropriate decisions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Methods for Defining Service Use and Eligible Cohort for Each Nonrecommended Service[a]

Nonrecommended Service	Recommendation	Service Definition	Cohort	Exclusions	Accountable Physician	References
Imaging for staging in early-stage prostate cancer	Don't perform PET, CT, and radionuclide bone scans in the staging of early prostate cancer at low risk for metastasis.	PET, CT, and bone scans between month of diagnosis and date of treatment or up to 6 mo, whichever came first	Men, first or only low-grade prostate cancer, defined as stage T1c/T2a, and Gleason score below 7	None additional	Urologist associated with first claim postdiagnosis; patients ordered by diagnosis date	10, 13–15
Imaging for staging in early-stage breast cancer	Don't perform PET, CT, and radionuclide bone scans in the staging of early breast cancer at low risk for metastasis.	PET, CT, and bone scans between month of diagnosis and date of surgery	Women, first primary breast cancer, in situ, stage I, or stage II disease, mastectomy or breast conserving surgery within 6 mo of diagnosis	Received neoadjuvant chemotherapy	Surgeon associated with curative treatment; patients ordered by surgery date	13, 16
Imaging for posttreatment surveillance in low-risk breast cancer	Don't perform surveillance testing (biomarkers) or imaging (PET, CT, and radionuclide bone scans) for asymptomatic individuals who have been treated for breast cancer with curative intent.	PET, CT, and bone scans between 6 and 18 mo postdiagnosis	Women, first primary breast cancer, in situ or stage I disease, mastectomy or breast conserving surgery within 6 mo of diagnosis	Received neoadjuvant chemotherapy	Medical oncologist associated with most visit-based claims from diagnosis through end of surveillance period; patients ordered by diagnosis date	13, 17, 18
IMRT for whole breast radiotherapy as part of breast conservation therapy	Don't routinely use IMRT to deliver whole breast radiotherapy as part of breast conservation therapy.	IMRT within 90 d of first RT fraction	Women, first primary breast invasive cancer, breast conserving surgery followed by complete course of RT within 2 y of diagnosis	No nodal or distant metastasis; received 12 or less RT fractions; subsequent cancer diagnosis before end of RT course	Radiation oncologist associated with plurality of RT fractions; patients ordered by first radiotherapy date	19, 20
Extended fractionation schemes for palliation of bone metastases	Don't routinely use extended fractionation schemes (>10 fractions) for palliation of bone metastases.	Extended fractionation scheme >10 and <25 fractions, without a 14 d gap	Men, first and only prostate cancer, diagnosed with bone metastasis with subsequent complete course of RT	Subsequent cancer diagnosis before end of RT course	Radiation oncologist associated with plurality of RT fractions; patients ordered by first radiotherapy date	20, 21

Abbreviations: CT, computed tomography; IMRT, intensity modulated radiation therapy; PET, positron emission tomography; RT, radiation therapy.

[a]All services were selected from the American Board of Medicine Foundation's Choosing Wisely campaign.

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Table 2

Cohort Characteristics

Patients	Percentage				
	Imaging for Staging in Early-Stage Prostate Cancer	**Imaging for Staging in Early-Stage Breast Cancer**	**Imaging for Posttreatment Surveillance in Low-Risk Breast Cancer**	**IMRT for Whole Breast Radiotherapy as Part of Breast Conservation Therapy**	**Extended Fractionation Schemes for Palliation of Bone Metastases**
Total No.	32 093	89 006	44 216	25 271	3464
Age at diagnosis, y					
66–69	31	23	25	27	19
70–74	35	26	28	29	29
75–79	22	23	24	24	24
80–84	09	18	16	15	18
≥85	03	11	08	05	10
Race					
White	83	88	89	90	81
Black	11	07	06	05	11
Other	06	05	05	05	08
Region					
Northeast	24	22	23	25	22
South	31	25	23	20	21
Midwest	09	12	13	12	13
West	36	41	42	43	44
AJCC Stage[a]					
In situ	NA	20	23	NA	NA
I	89	51	77	84	32
II	11	29	NA	16	38
III	NA	NA	NA	NA	07
IV	NA	NA	NA	NA	07
Unknown	NA	NA	NA	NA	16
Charlson comorbidity score					

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Patients	Percentage				
	Imaging for Staging in Early-Stage Prostate Cancer	Imaging for Staging in Early-Stage Breast Cancer	Imaging for Posttreatment Surveillance in Low-Risk Breast Cancer	IMRT for Whole Breast Radiotherapy as Part of Breast Conservation Therapy	Extended Fractionation Schemes for Palliation of Bone Metastases
0	0.66	0.64	0.66	0.68	0.67
1	0.22	0.23	0.23	0.22	0.20
≥2	0.12	0.13	0.11	0.10	0.13
Physicians, total No.	2559	4285	2596	1428	695
No. of patients per physician					
Median (IQR)	9 (4–17)	10 (4–24)	11 (4–23)	10 (4–24)	3 (2–6)

Abbreviations: AJCC, American Joint Committee on Cancer; IMRT, intensity modulated radiation therapy; IQR, interquartile range; NA, not applicable.

[a]For prostate cancer services, we used clinical T staging.

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Table 3

Results From Models to Assess Variation in Physician Service Use

Analysis	Imaging for Staging in Early-Stage Prostate Cancer	Imaging for Staging in Early-Stage Breast Cancer	Imaging for Posttreatment Surveillance in Low-Risk Breast Cancer	IMRT for Whole Breast Radiotherapy as Part of Breast Conservation Therapy	Extended Fractionation Schemes for Palliation of Bone Metastases
Proportion of patients who received service	0.41	0.14	0.26	0.18	0.35
Prior patient received service, OR (95% CI)[a]					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	4.18 (3.99–4.40)	2.98 (2.85–3.12)	1.14 (1.09–1.20)	28.71 (26.39–31.23)	1.52 (1.29–1.79)
Prior patient received service, aOR (95% CI)[a,b]					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	3.90 (3.70–4.10)	3.02 (2.88–3.17)	1.12 (1.07–1.18)	24.91 (22.86–27.15)	1.48 (1.26–1.75)
Random effects analysis[b,c,d]					
ICC	0.36	0.21	0.04	0.59	0.13

Abbreviations: ICC, intraclass correlation coefficient; IMRT, intensity modulated radiation therapy; OR, odds ratio.

[a]Likelihood of patient receiving nonrecommended service if the physician's prior patient received the service; logistic regression model.

[b]Adjusted for age, race, a modified Charlson comorbidity index, marital status, median income of Census tract of residence, geographic region, metropolitan location, stage, year of diagnosis, treatment, tumor characteristics.

[c]Nonlinear random effects model with logit link function. Test of whether estimated variance of random effects differs significantly from zero provides indication of significant unexplained variation between physicians.

[d]*P* value of unexplained variation between physicians for all services was <.001.

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Table 4

Imaging for Staging in Breast Cancer by Perceived Level of Appropriateness of Service Received by the Prior Patient

Perceived Level of Appropriateness	Variable Category	Adjusted OR[a] (95% CI)
Indicated	Prior patient did not receive imaging	1 [Reference]
Potentially indicated	Prior patient did receive imaging and stage II	2.58 (2.41–2.76)
Not indicated	Prior patient did receive imaging and stage 0/I	3.40 (3.21–3.61)

[a]Likelihood of patient receiving imaging; logistic model. Adjusted for: age, race, a modified Charlson comorbidity index, marital status, median income of census tract of residence, geographic region, metropolitan location, stage, year of diagnosis, treatment, tumor characteristics.

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Table 5

Sub-Group Analysis Modeling Likelihood of a Patient Receiving Nonrecommended Service Given Physician Ownership or Setting of Care Delivery[a]

Variable	Adjusted OR[b] (95% CI)				
	CT Scan for Staging in Early-Stage Prostate Cancer	**CT Scan for Posttreatment Surveillance in Low-Risk Breast Cancer**	**PET Scan for Posttreatment Surveillance in Low-Risk Breast Cancer**	**IMRT for Whole Breast Radiotherapy as Part of Breast Conservation Therapy**	**Extended Fractionation Schemes for Palliation of Bone Metastases**
Prior patient					
Did not receive service	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Did receive service	4.28 (4.05–4.53)	1.09 (1.03–1.16)	2.12 (1.77–2.53)	22.29 (20.43–24.31)	1.48 (1.26–1.75)
Physician ownership[c]					
No	1 [Reference]	1 [Reference]	1 [Reference]	NA	NA
Yes	1.24 (1.14–1.35)	1.09 (1.01–1.18)	2.10 (1.80–2.45)		
Setting of radiation therapy[d]					
Hospital outpatient facility	NA	NA	NA	1 [Reference]	1 [Reference]
Standalone facility				2.43 (2.22–2.66)	1.04 (0.88–1.23)

Abbreviations: CT, computed tomography; IMRT, intensity modulated radiation therapy; NA, not applicable; PET, positron emission tomography.

[a]We conducted separate analyses by imaging type: CT scan and/or PET scan. Results for other imaging types not presented because of limited use of imaging type or physician ownership of the imaging type.

[b]Likelihood of patient receiving nonrecommended service if the physician's prior patient received the service; logistic regression model. Adjusted for: age, race, a modified Charlson comorbidity index, marital status, median income of Census tract of residence, geographic region, metropolitan location, stage, year of diagnosis, treatment, tumor characteristics.

[c]Physician ownership was determined based on presence of a global claim or a claim with a technical component modifier.

[d]Setting of radiation therapy was determined based on origin of claims.