



## Cost of breast radiotherapy

## The impact of radiotherapy costs on clinical outcomes in breast cancer



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## ABSTRACT

**Background and purpose:** In cost-effective healthcare systems, the cost of services should parallel patient complexity or quality of care. The purpose of this study was to determine whether the cost of radiotherapy correlates with patient-related outcomes among a large cohort of breast cancer patients treated with adjuvant breast radiation.

**Materials and methods:** 23,127 women with non-metastatic breast cancer undergoing radiotherapy after breast conservation surgery were identified from the Surveillance, Epidemiology, and End Results database from 2000 to 2009. Medicare reimbursements were used as a proxy for cost of radiotherapy, and Medicare claims were examined to identify local toxicities, and breast cancer-related endpoints. The impact of cost on these outcomes was studied with multivariable Fine-Gray models to account for competing risks.

**Results:** The median cost (and interquartile range) of a course of breast radiation was \$8100 (\$6700–9700). Increased radiation costs were not associated with the occurrence of treatment-related toxicities (all  $p$ -values  $> 0.05$ ), ipsilateral breast recurrence ( $p = 0.55$ ), or breast cancer-related mortality ( $p = 0.55$ ).

**Conclusion:** Higher costs for adjuvant radiation in breast cancer were not associated with a decreased risk of patient-related outcomes suggesting inefficiency in Medicare reimbursements. Future efforts should focus on prospective evaluation of alternative payment models for radiotherapy.

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Radiation therapy is a standard component of treatment for women undergoing breast conservation treatment [1]. Breast radiation reduces the risk of local recurrence and improves survival after lumpectomy [2,3]. However, despite the accepted clinical benefit of breast radiation, questions have been raised as to its costs particularly as new and more expensive technologies become available [4,5]. Breast cancer already accounts for the largest portion of expenditures in the United States (US) for cancer care [6], and evaluation of US healthcare payments has shown that the relative increase in spending for radiation oncology far outpaces that of other medical specialties [7]. As a result, understanding the economic efficiency of radiation therapy for diseases such as breast cancer has become a topic of increasing interest.

In a cost-effective healthcare system, the cost of services should parallel patient complexity or quality of care. Previous research on Medicare beneficiaries demonstrates that the cost of breast radiation does not depend on patient-related factors, tumor characteris-

tics, or other factors related to treatment [8]. However, research has yet to determine whether radiation cost within the US correlates with patient-related outcomes. Higher treatment costs correlating with improved outcomes would suggest that the reimbursement model in the US achieves the goal of reimbursing care based on value. Conversely, if the cost of radiation does not correlate with quality of care then this finding would suggest a degree of inefficiency in reimbursement for breast cancer. The purpose of this study was to evaluate the relationship of cost on patient-specific outcomes in a large cohort of Medicare beneficiaries with localized breast cancer treated with radiation therapy.

## Methods

## Data source

We identified female breast cancer patients from the Surveillance, Epidemiology, and End Results (SEER)–Medicare linked database. The National Cancer Institute manages the SEER program, which pools data from individual cancer registries from across the United States. SEER covers 28% of the population and provides a diverse cohort of patients that approximately represents

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the demographics of the US. Medicare is a federally funded health insurance program for individuals over the age of 65 and is the largest single payer of healthcare costs in the United States. Medicare reimburses according to a set schedule depending on the specific codes for services billed (claims) which is organized according to the coverage (Part A or B) selected by the patient. Part A coverage provides coverage for inpatient services excluding physician fees, home health services, and hospice. Part B reimburses physician fees, specifically identified in the Carrier Claims file, outpatient services including laboratory testing and imaging, and durable medical equipment. The SEER–Medicare linkage provides Part A and B Medicare claims for all beneficiaries within SEER. As a result, this population-based dataset provides researchers the opportunity to study longitudinal patterns of care, outcomes, and expenditures related to a patient's disease. The Institutional Review Board of the University of California San Diego deemed this study exempt from review.

### Study population

An initial query of the SEER database identified 56,128 patients at least 66 years old who were diagnosed between July 2000 and December 2009 with histologically confirmed, non-metastatic breast cancer with known tumor laterality treated with breast-conserving surgery and radiation therapy. Due to changes in outpatient Medicare billing, patients diagnosed prior to July 2000 were not included in the initial study cohort in order to have a uniform reimbursement system for radiation therapy [9]. Patients were required to have continuous Medicare Part A and B coverage from one year before diagnosis until death or the end of the study period (December 2010) to allow for the ascertainment of comorbidities before diagnosis, the cost of radiation therapy, and health outcomes after radiation. Patients enrolled in Medicare Part C, which allows private managed care plans to provide Part A and B coverage, were excluded from the study as these managed care organizations do not routinely submit claims to Medicare resulting in incomplete claims data. Additional patient selection criteria are described below, and the final study cohort included 23,127 patients. The complete patient selection schema is shown in Fig. 1.

### Study covariates

SEER data was used to identify patient characteristics such as age at diagnosis, race, marital status, year of diagnosis, tumor stage (local or regional), primary tumor size and grade, number of positive lymph nodes, laterality, regional lymph node surgery, and median income determined from 2000 US Census tract data. Inpatient and outpatient Medicare claims from the year before diagnosis were used to assess pre-existing comorbidity using the Deyo adaptation of the Charlson comorbidity index [10]. The administration of chemotherapy was ascertained using previously described methods [11]. Specific chemotherapeutic drugs with known cardiovascular toxicities [12] were identified using Healthcare Common Procedure Coding System (HCPCS) J codes (Supplementary Table 1). Care at a teaching hospital was defined as any indirect medical education payment noted during a hospitalization after the patient's diagnosis of cancer. The use of breast MRI after diagnosis was identified using HCPCS codes. Patient characteristics, including radiation-related variables, are presented in Table 1.

### Radiation therapy

Radiation therapy was identified from the Carrier Claims and outpatient files using relevant HCPCS codes for each step in the delivery of treatment [13]. The individual components of a course of radiation include radiation simulation, radiation treatment planning, daily radiation treatments, and weekly management activities. A course of radiation therapy was defined as a cluster of claims within a month of each other; a break of 30 days or more between subsequent radiation codes was assumed to be indicative of an additional course of radiation. Only patients who received one course of radiation were included in this study to ensure that the impact of the first course of radiation was not confounded by later radiation treatments. Patients who received brachytherapy as part of their treatment plan were excluded. Intensity modulated radiation therapy (IMRT), known to be associated with increased treatment costs [5], was defined by the presence of any IMRT planning or treatment code during the course of radiation. To reduce the likelihood of including patients with incomplete records or

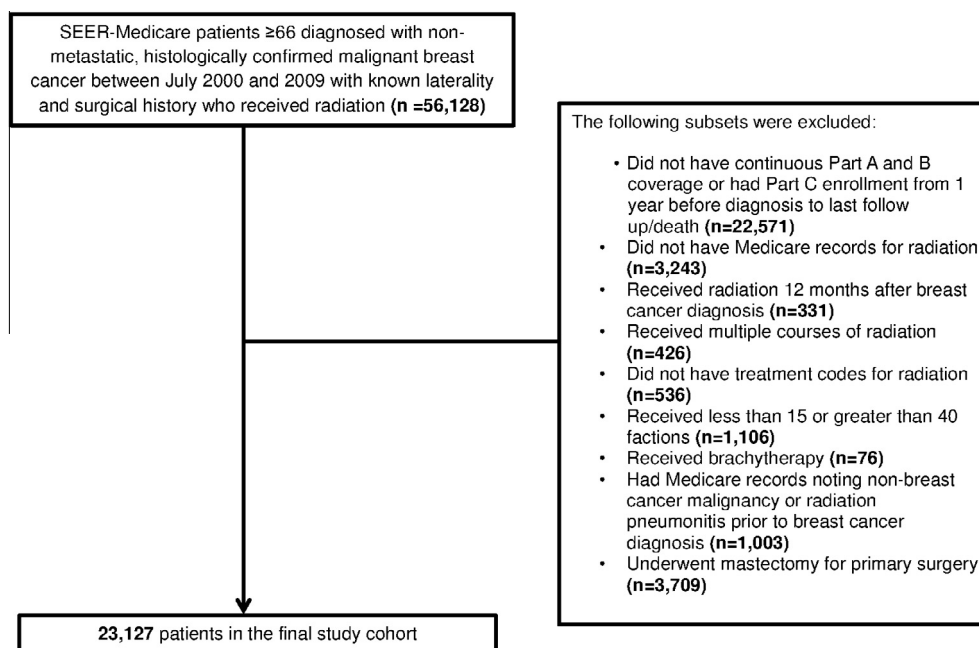


Fig. 1. Patient selection criteria. The final study cohort included 23,127 patients.

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