ORIGINAL ARTICLE

# Estimated Mortality of Breast Cancer Patients Based on Stage at Diagnosis and National Screening Guideline Categorization

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## Abstract

**Purpose:** To compare overall and stage I to IV mortalities of patients diagnosed with breast cancer, calculated from stage at diagnosis using the Surveillance, Epidemiology, and End Results (SEER) database stage mortality estimates, which are based on national screening guideline categorization.

**Methods:** From the stage at diagnosis of new breast cancer patients between 2010 and 2014, percentages of invasive cancers, stage 0 + I of total cancers, and stage I of invasive cancers, were calculated. Five-year estimated overall and invasive mortalities were calculated based on stage at diagnosis and SEER survival data. Program categories defined included an Annual Program, based on the ACR (annual screening age 40 and above), a Biennial Program, based on the US Preventative Services Taskforce (biennial screening ages 50 to 74 years), and a Hybrid Program, based on the American Cancer Society (annual screening ages 45 to 54 years, then biennially at ages 55 and above), including respective interval cancers.

**Results:** In all, 445 breast cancers met the study inclusion criteria. Comparing program categories, the Annual Program had the lowest percentage of invasive cancers (75.3%), highest percentages of stage 0 + I of total cancers (75.3%) and stage I of invasive cancers (67.1%), and the lowest 5-year estimated overall (10.1%) and stage I to IV (12.0%) mortalities. Estimated overall and stage I to IV mortalities for the Annual Program was 37.3% and 30.6% less, respectively, than the Biennial Program, and 31.8% and 26.8% less, respectively, than the Hybrid Program.

**Conclusions:** Based on stage at diagnosis, the greatest mortality reduction is achieved with mammography utilization starting at the age of 40.


**Key Words:** Mammography utilization, breast cancer screening guidelines, breast cancer mortality, cancer stage

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## INTRODUCTION

Breast cancer is the most common cancer diagnosed in women, excluding skin cancer, and is the second leading cause of cancer deaths in women. In 2017, approximately 316,120 new cases of breast cancer will be diagnosed in the United States, of which 252,710 will be invasive and 63,410 will be noninvasive (in situ), with about 40,610 women expected to die [1]. Mammography utilization has the greatest impact on reduction in breast cancer deaths, with mortality reduction reported up to 59% [2-10]. Breast cancer survival is related to many factors, but stage at diagnosis is a critical determinant, with greater survival at a lower stage at diagnosis [11].

The recommended time interval between consecutive screening mammograms and when to start and stop screening mammography varies by organization. For women of average risk, the ACR, Society of Breast Imaging (SBI), and the National Comprehensive Cancer Network recommend annual screening mammography beginning at the age of 40 [12-15]. The US Preventative Services Task Force (USPSTF), American College of Physicians, and the American

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Academy of Family Physicians recommend biennial screening mammography for women 50 to 74 years of age [16-18]. The American Cancer Society (ACS) and the American Society of Breast Surgeons have a "strong recommendation" of annual screening mammography for women 45 to 54 years of age, transitioning to biennial screening mammography for women 55 years of age and older [19,20]. Data from computer models comparing different screening mammography recommendations have shown the greatest mortality reduction with a screening strategy following ACR guidelines versus USPSTF and the most recently updated ACS guidelines [21,22]. However, these recommendations and studies focus on the estimated mortality reduction from screening mammography and not interval cancers detected with diagnostic mammography.

The purpose of this study was to compare estimated 5-year mortalities of patients diagnosed with breast cancer based on stage at diagnosis and national screening mammography guideline categorization. Percentages of invasive cancer, "early" stage cancers (stage 0 and I) of total cancers, and stage I cancer of total invasive cancers were also compared. Screening and diagnostic mammogram-detected breast cancer patients were both included in the study because differences in screening intervals would be expected to impact the stage at diagnosis of interval diagnostic mammogram-detected cancers. The results of this study are relevant to individual health care providers, medical groups, hospitals, health systems, administrators, policymakers, and patients for a greater understanding of the potential impact of following the various national mammography guidelines from a population health perspective because health care is moving toward more transparent population value-based care [23,24].

## METHODS

Institutional Review Board approval with a waiver of HIPAA authorization and informed consent was obtained for this retrospective review.

### Study Population

Patients diagnosed with breast cancer from 2010 to 2014 were identified through a breast imaging reporting and tracking software system. All patients underwent digital mammography, breast ultrasound, and image-guided breast biopsy as needed according to local institutional protocols. The study started in 2010 because the USPSTF published its recommendation of biennial mammographic screening for women 50 to 74 years of age in 2009 [25]. The study ended in 2014 because the author's institution transitioned to digital breast tomosynthesis in 2015. Patients were excluded from the study if one or more of the following criteria were fulfilled: (1) male; (2) <41 years old at diagnosis of breast cancer; (3) personal history of prior breast cancer; (4) referred for image-guided biopsy based on screening or diagnostic mammogram performed at an institution other than the author's primary institution; (5) malignant pathology diagnosis other than ductal carcinoma in situ, invasive ductal carcinoma, invasive lobular carcinoma; (6) diagnosed with breast cancer from initial surgical biopsy without preceding core needle biopsy; or (7) >84 years old at diagnosis, as this age was the upper limit for data modeled by the National Cancer Institute–funded study, which was available to the USPSTF [26]. For all patients subsequently included in the study, the following data were obtained:

- age at diagnosis
- screening mammogram (asymptomatic) detected or diagnostic mammogram (clinical abnormality or short-term follow-up) detected malignancy
- number of months between index mammogram (screening or diagnostic), which is defined as the mammogram immediately preceding biopsy-proven breast cancer, and the most recent comparison prior screening or diagnostic mammogram (If the mammogram was the patient's first mammogram, it was classified as a baseline mammogram.)
- initial cancer staging obtained from the author's institutional cancer registry, based on *AJCC Cancer Staging Manual*, seventh ed [27]

### Mammography Utilization Definitions

Screening-detected breast cancer patients were classified as a Screening-All category and included the following subcategories:

- Annual Screening: index mammogram within 15 months of most recent comparison mammogram for patients ages 41 to 84, which parallels the ACR screening guidelines
- Biennial Screening: index mammogram within 24 to 27 months of most recent comparison mammogram for patient ages 52 to 74, which parallels the USPSTF screening guidelines (Age 52 was used as a starting point for this category because the patient's most recent prior comparison mammogram would be 2