Women's Health Issues 25-4 (2015) 322–330

WOMEN'S HEALTH ISSUES
www.whijournal.com

Original article

Screening Mammography in a Public Hospital Serving Predominantly African-American Women: A Stage–Survival–Cost Model

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Article history: Received 2 April 2014; Received in revised form 15 February 2015; Accepted 25 February 2015

A B S T R A C T

Background: Ethnic and socioeconomic disparities pervade breast cancer patterns and outcomes. Mammography guidelines reflect the difficulty in optimizing mortality reduction and cost-effectiveness, with controversy still surrounding the 2009 U.S. Preventive Services Task Force (USPSTF) recommendations. This study simulates USPSTF and American Cancer Society (ACS) guidelines' effects on stage, survival, and cost of treatment in an urban public hospital.
Methods: Charts of 274 women diagnosed with stage I, II, or III breast cancer (2008–2010) were reviewed. Published tumor doubling times were used to predict size at diagnosis under simulated screening guidelines. Stage distributions under ACS and USPSTF guidelines were compared with those observed. Cohort survival for observed and hypothetical scenarios was estimated using national statistics. Treatment costs by stage, calculated from Georgia Medicaid claims data, were similarly applied.
Results: Mean age at diagnosis was 56 years. African Americans predominated (82.5%), with 96% publically insured or uninsured. Simulated stages at diagnosis significantly favored ACS guidelines (43.1% stage 1/38.3% stage 2/9.9% stage 3 vs. USPSTF 23.0%/53.3 %/15.0%), as did 5-year survival and cost of treatment relative to both observed and USPSTF-predicted schema ($p < .0001$). Following USPSTF guidelines predicted lower survival and additional costs.
Conclusions: Following ACS guidelines seems to lead to earlier diagnosis for low-income African-American women and increase 5-year survival with lower overall and breast-specific costs. The data suggest that adjusting screening practices for lower socioeconomic status, ethnic minority women may prove essential in addressing cancer disparities.
Published by Elsevier Inc.

The advent of breast cancer screening in the 1970s established that mammography decreases breast cancer mortality (Bjurstam et al., 2003; Hellquist et al., 2011; Miller, To, Baines, & Wall, 2002; Moss et al., 2006; Norman et al., 2007; Shapiro, Strax, & Venet, 1971; Tabár et al., 2011), leading to widespread implementation aimed at earlier detection and treatment. However, in today's era of increasing health care costs (Mariotto, Yabroff, Shao, Feuer, & Brown, 2011) and enhanced consumer autonomy, programs are being reevaluated to weigh financial impact and potential harms against concrete health benefits. The American Cancer Society (ACS) and the U.S. Preventive Services Task Force (USPSTF) both publish screening recommendations based on such investigation, but differences in these statements in 2009 generated considerable controversy. The ACS guidelines endorse mammography starting at age 40 and continuing annually as long as health status and life expectancy allow

Funding: This work was supported by the AVON Foundation for Women (grant number 01-2010-074 to S.G.).
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1049-3867/$ - see front matter Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.whi.2015.02.006

(Smith et al., 2011). In contrast, USPSTF recommendations shifted significantly from 2002, when they roughly matched ACS policies (USPSTF, 2009). The update eliminated routine mammography in women aged 40 to 49 years (instead basing the decision on discussion between the patient and her primary care provider), increased the screening interval from 1 to 2 years, and withheld recommendations for women over 75 years. This policy update was informed by two major studies after years of debate about screening women in their 40s (Green & Taplin, 2003; Salzmann, Kerlikowske, & Phillips, 1997).

The first group, Nelson et al. (2009), used existing data from randomized, controlled trials to compare how mammography impacts the risk of breast cancer death in women of varying ages. The trials that were meta-analyzed by Nelson et al. emerged from the United Kingdom, Sweden, Canada, and New York State. The group found the same reduction in relative risk for breast cancer death (about 15%) for women in the 4th and 5th decades of life, but used mortality rates from the National Cancer Institute's Surveillance Epidemiology and End Results (SEER) database to predict that 1,904 women from the 39 to 49 group would need to be invited to screening to prevent one additional death versus 1,334 from the 50 to 59 group. By comparison, for women 60 to 69 years old (with consensus for screening), mammography offers a 30% risk reduction, and only 377 need to be invited to screening to save one life. The authors stated, however, that data applicability was only fair owing to a lack of U.S.-based studies and that the "number needed to invite to screening could be misleading if…risk for mortality…varied between studies," a mortality variation that occurs in ethnic minority, socioeconomically disadvantaged women. Basing outcomes modeling solely on age-specific variables neglects evidence demonstrating marked ethnic and socioeconomic differences in tumor biology and disease patterns.

The second group, Mandelblatt et al. (2009), modeled various screening schedules and age ranges to determine each models' relative efficiency in decreasing mortality. Although higher screening rates decreased mortality, in each model the benefit for each additional mammogram eventually became marginal. This point was deemed the "efficiency frontier," and the authors concluded that programs that screen biennially from age 50 to 69, 74, or 79 years were among the most efficient. Like Nelson et al., however, the authors acknowledged that "the models…do not capture differences in outcomes among certain risk subgroups, such as women with BRCA1 or BRCA2 genetic susceptibility mutations…or black women who seem to have more disease at younger ages than white women."

These analyses focused on age as the primary determinant of cancer risk and concluded that screening biennially, starting at age 50, was most efficient from a national payer perspective. However, both African-American ethnicity and low socioeconomic status have been associated with inferior cancer outcomes, including younger age at diagnosis and increased mortality at the same age and stage (Aragon, Morgan, Wong, & Lum, 2011; Cunningham, Montero, Garrett-Mayer, Berkel, & Ely, 2010; DuBard, Schmid, Yow, Rogers, & Lawrence, 2008; Howlader et al., 2011; Gabram et al., 2008; Klassen & Smith, 2011; Komenaka et al., 2010; Lobb, Ayanian, Allen, & Emmons, 2010; McBride et al., 2007; O'Brien et al., 2010; Smith-Bindman et al., 2006; Ward, Fedewa, Cokkinides, & Virgo, 2010; Yang et al., 2009). Evidence suggests that such factors may leave low-income African-American women at disproportionate risk of negative consequences from later, less frequent screening. Grady Memorial Hospital is a safety net hospital with more than 900 beds in downtown Atlanta, Georgia, serving predominantly lower-income, publically insured African-American patients whose outcomes may provide evidence to address this question. We modeled the potential impact of strict adherence to ACS or USPSTF screening recommendations on stage at diagnosis and expected survival for the women diagnosed with breast cancer at our AVON Foundation Comprehensive Breast Center. Given that previous studies have demonstrated variation in cost of cancer care with stage at diagnosis (Subramanian et al., 2011; Taplin et al., 1995), we also analyzed potential differences in health care costs associated with any overall stage migration.

Methods

Patient Data Collection

All patients diagnosed with breast cancer in the calendar years 2008 through 2010 were identified from the Grady Memorial Hospital tumor registry (n = 447). Exclusion criteria included in situ disease (n = 73), metastatic disease at diagnosis (n = 49), ipsilateral cancer recurrence (n = 23), duplicate entries of bilateral disease (n = 19), male breast cancer (n = 2), and missing information that prevented confirming the date of diagnosis (n = 7). For women with cancer diagnosed in both breasts during the study period, the earlier diagnosis was included as one occurrence.

The final sample totaled 274 patients. Charts of each patient were reviewed for age at diagnosis, insurance status, ethnic group, clinical tumor stage based on the American Joint Committee on Cancer, 7th edition (AJCC-7), radiographic screening history and reasons for screening, pathologic tumor characteristics, tumor histology, and hormone receptor (estrogen receptor, progesterone receptor, and her2/neu) status. Study variable definitions are clarified below:

Clinical stage ("observed stage")

Staging was primarily based on radiographic reports at the time of diagnosis and defined using the AJCC-7 TNM classification. Tumor size (T) was the largest single dimension on diagnostic ultrasonography. If not performed, or inaccurate owing to a very large lesion, diagnostic mammogram was used. Nodal status (N) was based on radiology reports from diagnostic mammography and ultrasonography, and confirmed with multidisciplinary conference notes, pathology reports of node aspiration, positron emission tomography scans, and/or physical examination findings (breast, radiation oncology, or medical oncology clinic notes). The clinical stage determined in this manner provided the "observed stage" for each patient.

Screening history and reasons for screening

The date and type of imaging performed during the screening and diagnosis process were recorded as well as the interval from last imaging to current mammogram. The reason for the patient's current mammogram was abstracted from the radiology report, including routine screening, workup of symptoms, or other.

Tumor Growth Model and Predicted Stage Distributions

Peer, Dijck, Hendriks, Holland, and Verbeek (1993) have previously published tumor doubling times based on measurements from serial mammograms of women in The Netherlands. The results provide the average number of days for a breast