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Original Article

Mammographic screening for breast cancer: An invited review of the benefits and costs

Jon M. Greif*

Bay Area Breast Surgeons, Inc., 3300 Webster Street, Suite 212, Oakland, CA 94609, USA
Attending Surgeon, Carol Ann Read Breast Health Center and Alta Bates Summit Medical Center of Oakland, CA, USA
Associate Clinical Professor of Surgery, University of California, San Diego, CA, USA

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ABSTRACT

Mammographic screening is a proven method for reducing breast cancer mortality for women 40 years of age and older, but the best method for implementation of mammographic screening, particularly in the age group 40–49, remains controversial. The author, in an invited review, summarizes the data and offers guidance based on the best information available for women at risk for breast cancer, and their care providers, with particular emphasis on costs and benefits.

Introduction

There is no denying the fact that after more than 40 years of experience,[1] systematic screening with mammograms reduces breast cancer mortality for women over 40 years of age. A key point of the most recent update of the breast cancer screening recommendations by the United States Preventive Services Task Force (USPSTF),[2] that caused a veritable media frenzy,[3] was not that there was new data, or even new analyses of the existing data that might question that fact, but only that the costs of arriving at the reduction in mortality might be higher than previously imagined, and might extend into areas that are not generally considered. In fact, the most recent Cochrane Analysis of the existing literature for mammographic screening,[4] finds that when the 600,000 women in 7 eligible randomized controlled trials were randomized to a program offering regular mammographic screening or no regular mammographic screening, the group offered the regular screening had a statistically significant reduction in breast cancer mortality of 19% (RR = 0.81 with 95% confidence intervals of 0.74–0.87). A recent study from Cady et al.[5] also demonstrated that in a large cohort of women followed for a median of 12.5 (8–17) years, 75% of all breast cancer deaths occurred in the 20% of women not participating in regular mammography screening. The purpose of this paper is to explore the costs of breast cancer screening, compare them to the benefits, and hopefully provide assistance to women considering this screening examination, and to the physicians advising them.

Materials and methods

Review of the literature of breast cancer screening with particular attention to costs and benefits.

Benefits of screening

The benefits of screening for breast cancer can be summarized as follows:

1. The detection of breast cancer or a pre-malignant lesion in a woman who was previously unaware of the existence of said lesion.
2. The successful treatment of that cancer or precancerous condition and prevention of death from breast cancer.
3. The reassurance that when screening tests are truly negative, there is comfort in knowing that a breast cancer or pre-malignant condition is unlikely to be present.
4. The reduced costs to society of treating breast cancer detected at an earlier stage.[6]

Risk assessment

Screening mammograms successfully identify previously undetected cancers with a frequency that varies depending principally upon the age of the woman being screened, and the

* Bay Area Breast Surgeons, Inc., 3300 Webster Street, Suite 212, Oakland, CA 94609, USA. Tel.: +1 510 835 9900; fax: +1 510 835 9909.
E-mail address: jgreif@babsurgeons.com

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presence or absence of pre-existing risk factors. The commonly referred to pre-existing risk factors include a personal or family history of breast cancer, a known genetic mutation that increases breast cancer risk (such as the presence of a deleterious mutation of one of the BRCA genes), exposure to radiation, and others. The National Comprehensive Cancer Network (NCCN) has recently updated their clinical guidelines for the screening of high risk women for breast cancer, including the addition of annual screening Magnetic Resonance Imaging (MRI) to annual screening mammogram for women in the highest risk categories.[7] For women of average risk, the NCCN's guidelines[8] advise a clinical (professional) breast examination every 1–3 years, beginning at age 20, and to practice "breast awareness" defined as being "familiar with their breasts and promptly report changes…periodic, consistent breast self exam may facilitate breast self awareness". Beginning at age 40, for average risk women, the NCCN Breast Cancer Screening Guidelines call for annual clinical breast exam, annual mammogram and breast awareness. These guidelines for breast cancer screening are identical to those of the American Cancer Society (ACS)[9] and in alignment with those of most other major organizations advocating for or treating cancer patients.

The age factor

Getting older is also a risk factor for breast cancer. The risk of developing breast cancer is very low before age 40, but begins to increase at age 40, and continues to increase in linear fashion for every advancing year as seen in Fig. 1; this trend continues for a woman's lifetime. That increase in risk with increasing age does *not* magically stop at age 70; this reality is the basis for the American Cancer Society's recommendation that annual screening mammography continue for "as long as a woman is healthy". Because the risk of developing breast cancer is age dependent, the risk at age 50 is higher than the risk at age 40, and the risk at age 60 is higher than at 50, and so forth. For this reason, the likelihood of finding breast cancer with a screening mammogram is higher at age 50 than at age 40, and at age 60 than at age 50. In fact, Nelson et al.,[10] using data from the Cochrane Registry[4] and the Breast Cancer Surveillance Consortium,[11] determined that for women in the 39–49 year age group, the number of women needing an invitation to participate in a program of systematic mammography screening to prevent one breast cancer death was 1904. For women aged 50–59 years old, the corresponding number of persons needed to invite to participate in screening to prevent one breast cancer death was 1339. For women aged 60–69, the number needed to invite to prevent one breast cancer death was 1050. There was a significant reduction in mortality for each of these groups in the meta-analysis of the randomized controlled trials, ranging from between 15% for the 39–49 year old group to 30% for the 49–59 year age group (average reduction in mortality for all age groups was 19%). To suggest that because it takes many more screening mammograms to detect a cancer in the 39–49 year age group and conclude that this group should not be screened, reflects a disservice to this subgroup of women, for whom cancer is by far the leading cause of death, and breast cancer the most frequently occurring site of cancer as illustrated in both Table 1[12] and Fig. 2.[13]

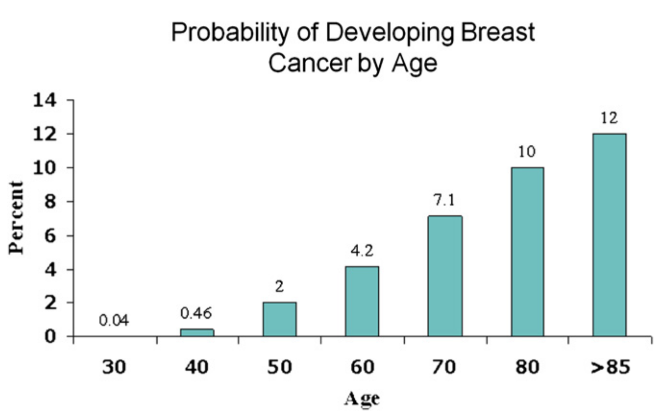

Fig. 1. Used with permission, courtesy of Robert A. Smith, Ph.D, American Cancer Society.

Cost perspectives

The costs of breast cancer screening can be divided into two general categories:

1. The monetary costs to patients and to society.
2. The less tangible, and less easily quantified, costs to women themselves.

There have been a number of studies addressing the monetary costs of mammographic screening for breast cancer. Many of these studies use hypothetical population modelling, e.g. Markov models, which compare a subset of the population assigned to screening to a subset not screened, and make the assumption that the group "invited" to screening always attends, always on time, and the group "not invited" to screening never gets mammograms, even on their own accord. Most of these studies calculate a cost to benefit ratio in terms of the cost per "quality adjusted life year saved," or QALYS. These calculations are often very complex; they need to take into account the often variable costs of the screening mammography, call backs and additional mammograms, additional imaging modalities such as ultrasound and MRI; the cost of biopsies, and of course, the cost of the procedure is often quite different than the charge for that procedure or what is actually paid by the patient and/or her insurer. Furthermore, inflationary changes over time must be accounted for, and there is the need for accurate data regarding the number of screened patients as well as the number and intervals of screening exams performed and required to save a life. This latter point is addressed in a study by Tabár et al.[14] using data from one of the Swedish randomized controlled trials of screening mammography. This particular study also calculated numbers needed to screen in order to save one life from breast cancer, and, interestingly, these numbers were considerably less than the numbers used from the study commissioned by the USPSTF. Finally, accurate data regarding actuarial survival of the life saved is necessary. These last two parameters are of course very much impacted by the age group being considered.

Table 1
Estimated new female breast cancer cases and deaths by age (USA, 2009), rounded to the nearest 10.

Age	In situ cases	Invasive cases	Deaths
Younger than 45	6460	18,640	2820
45 and older	55,820	173,730	37,350
Younger than 55	24,450	62,520	8890
55 and older	37,830	129,850	31,280
Younger than 65	40,940	120,540	17,200
65 and older	21,340	71,830	22,970
All ages	62,280	192,370	40,170

Data source: Estimated cases are based on 1995–2005 incidence rates from 41 states as reported by NAACCR, representing about 85% of the US population. Estimated deaths are based on data from US mortality Data, 1969–2005, National Center for Health Statistics, Centers for Disease Control and Prevention, 2009. American Cancer Society, Surveillance Research, 2009.[12]