Economic Savings and Costs of Periodic Mammographic Screening in the Workplace

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his article discusses the costs and benefits of mammographic screening in the workplace. The cost of mammography itself and of diagnostic work-up are two of the largest costs involved.

Breast cancer is the second leading cause of cancer death in US women. According to the American Cancer Society [1], an estimated 46,000 women died from this disease in 1995, and 182,000 new cases were diagnosed. Over 50% of US breast cancer patients are working-aged women. Thus, the morbidity, mortality, and costs of this cancer have a significant impact on working women and their employers.

Epidemiologic studies have shown that one of the most effective ways to reduce breast cancer mortality and morbidity is through early detection with periodic mammographic screening. Although screening does not prevent breast cancer, it can increase the likelihood that it is detected at a stage when it can be treated more effectively. Several trials have shown that routine mammographic screening may reduce breast cancer mortality by up to 30% [2-5]. The magnitude of this benefit is particularly large among women age 50 or older, who are at higher risk of breast cancer. The value of routine mammographic screening in women under age 50 years who have no known risk factors is a source of considerable controversy [6-8] (see also "Screening Mammography for Women Aged 40 to 49?"). However, recent data suggest that a reduction in mortality also may be demonstrated for women 40 to 49 years old [9]. Modern screening and diagnostic techniques may further improve our ability to reduce breast cancer mortality in women older than 40 years [10].

As the benefits of periodic mammographic screening have become apparent, initiatives have been developed to promote the value of screening to employers and to help launch screening programs in the workplace. These programs can be classified broadly according to the types of arrangements made by employers to provide mammographic screening. Some employers own their own mammography equipment and provide mammographic screening, breast physical examinations, education, and counseling services at the workplace. Others contract with mobile mammography units that visit the workplace. Some of these mobile units also may provide other types of services. Other employers simply include routine screening in their basic health benefits package and help coordinate access to screening mammography, but play no active role in the promotion or follow-up of screening.

Although the health benefits of screening mammography relative to reducing mortality and morbidity are well-known, less is known about the costs of attaining those benefits through screening, or about whether any cost savings are associated with those health benefits. With the current emphasis on the cost of health care, relative to its benefits, the development of a successful mammographic screening program in the workplace may depend not only on the health benefits that it produces but also on the program's costs and cost savings to the employer and employee. In this article, we explain the types of costs and savings associated with mammographic screening in the workplace, and discuss several options to improve the efficiency of a screening program.

Several types of costs are associated with establishing and implementing a mammographic screening program in the workplace [11].

Direct Costs
For companies that provide screening using their own equipment, costs include those for purchase and maintenance of the mammography machine, certification, and dedicated space to house the
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machine. Other costs include those for a technician to perform the mammograms, a physician to interpret them, and a nurse to provide other types of services related to the screening program, such as clinical breast examinations. Companies that perform screening in the workplace using their own equipment may contract out for film processing and interpretation. Other companies may elect to provide mammographic screening at the workplace through a mobile mammography unit for a fixed price per mammogram. Yet another option is to pay a fixed price to an off-site facility. Estimates of the average cost per mammogram range from $35 to more than $100, depending on the type of mammographic screening provided (two- vs single-view), other services provided (eg, clinical breast examination, instruction in breast self-examination), and the number of employees screened.

Costs of Lost Productivity

Other costs that a company incurs when employees are screened relate to lost productivity during screening. If an employee must travel off-site during business hours, her productivity to the company is lost for that period of time. This lost productivity is the value of goods and services that the employee could produce during this time and, according to economic theory, is equal to the employee’s wage. Recent estimates of lost productivity due to mammographic screening range from 2 to 4 hours for off-site screening, and ½ to 1 hour for screening at the workplace. Therefore, on-site screening may be an attractive option for companies that must hire temporary help if a regular employee is absent. This could be particularly relevant to manufacturing companies, where the absence of an employee has important implications for the production process.

Costs of Further Diagnostic Tests

Other costs are not due to screening itself, but rather, relate to the diagnostic work-up that follows a suspicious mammographic finding. A diagnostic work-up usually includes additional mammographic views, with or without compression of the breast. Additional imaging with ultrasonography may be necessary to distinguish cystic from solid lesions. Abnormalities in any of these diagnostic evaluations may necessitate a consultation with a general practitioner followed by a surgical consultation; an invasive procedure, such as needle-core or open biopsy, to obtain a specimen; and a pathologic work-up and interpretation to make the diagnosis. These diagnostic work-ups result in costs associated with medical care, as well as lost employee productivity.

The impact of diagnostic work-ups on the overall cost of screening depends on several factors. One of the limitations of mammographic screening is that, like most other tests, it is not perfectly accurate. (Its limitations are related not only to the radiographic technology but also to the interpretation of the image.) That is to say, sometimes a mammogram fails to detect a cancer, and sometimes it results in a suspicious finding that turns out not to be cancer. When a mammography screen fails to detect a cancer, treatment is delayed and the cancer may result in more severe clinical consequences and additional costs. When a mammography screen produces a suspicious finding that is not cancer, unnecessary costs for further diagnostic work-ups may be incurred. The number of women with suspicious findings that are not cancers increases when the underlying incidence of cancer in the screened population is low. The following examples serve to illustrate this point.

These examples illustrate the association between the accuracy of mammography; the prevalence of cancer in a hypothetical, previously unscreened population; the number of missed cancers; and the number of unnecessary work-ups. The number of missed cancers and unnecessary work-ups depend on: (1) the sensitivity of mammography (the probability of a suspicious finding on a mammogram, given that a cancer is present); (2) the specificity of mammography (the probability of no suspicious finding on a mammogram, given that no cancer is present); and (3) the prevalence of undetected cancer (the number of undetected cancers per 100,000 women) in the population.

Scenario 1

The first scenario (Table 1) assumes a population of 100,000 women whose average age is 55 years and who are not undergoing regular mammography, in which the anticipated prevalence of undetected breast cancer is .6% (ie, 600 cancers are present, but not yet detected). It further assumes a sensitivity of 91.5% and a specificity of 90% for a standard two-view mammogram, which is consistent with the performance of mammography under favorable conditions. As shown in Table 1, of the 600 cancers in this population, 549 are detected through mammography. However, 51 cancers not detected through mammography would progress and be detected through
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a subsequent screen or through clinical symptoms. Also, most women without cancers (89,460 out of 99,400) do not have a suspicious finding on mammography. However, because the number of women without cancer is large, even though the specificity of mammography is quite high, only 5.2% (549/10,489) of suspicious mammograms actually result in the detection of cancer through a diagnostic work-up. Therefore, approximately 20 diagnostic work-ups are performed for each cancer detected.

**Scenario 2**

As the prevalence of cancer in the population decreases, more diagnostic work-ups are performed for each cancer detected. The second scenario (Table 2) again assumes a population of 100,000 women whose average age is 55 years. However, this population is assumed to be receiving regular mammographic screening, and therefore, the prevalence of undetected breast cancer is only 2% (200 cancers are present but not yet detected).

As shown in Table 2, with the same sensitivity and specificity of mammography, only 2% (183/10,163) of suspicious mammograms actually result in the detection of cancer. Therefore, as the prevalence of cancer in the screened population decreases, a larger portion of diagnostic work-ups are unnecessary, resulting in a larger proportion of costs that are unnecessary.

For purposes of simplification, this example ignores the fact that some suspicious findings on mammograms will result in detection of benign breast disease through a diagnostic work-up. Therefore, in screening programs clinical benefits may accrue even if cancer is not detected.

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**Lower Treatment Costs**

Cost savings due to mammographic screening are thought to accrue because, through screening, cancers are detected earlier when they may be less expensive to treat. However, a recent study from the National Cancer Institute [12] reports that among Medicare patients with breast cancer, total Medicare payments from diagnosis to death, according to stage at diagnosis, were as follows: $61,790 for carcinoma in situ; $53,788 for local disease; $48,941 for regional disease; and $31,932 for distant disease. Yet, the study also reports that the costs of initial, continuing (eg, monthly), prefinal, and final care were higher among those staged distant at diagnosis than among those staged local.

These findings suggest that the total costs from diagnosis to death are higher for patients with carcinoma in situ because these patients survive longer. Therefore, it appears that, for Medicare patients, although screening results in reduced breast cancer mortality and morbidity, longer survival also results in higher cost due to continuing treatment. However, there have been no studies on the cost of managing cancer in working-age women, with patients stratified by stage at detection. Studies are needed to examine the cost of cancer in a population of working-age women.

**Reduced Short- and Long-Term Disability**

Savings could also accrue from a workplace mammographic screening program as a result of reduced short- and long-term disability due to breast cancer treatment and outcomes. These savings could result from lower lost productivity during treatment, lower long-term disability claims, and lower costs of having to train new personnel to fill the positions of women who can no longer work due to this disease. Again, little is known about these costs.

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It is important to recognize that while mammographic screening could result in cost savings associated with reduced morbidity and mortality of breast cancer, it is unlikely that these savings will completely offset the costs of screening, for the following reasons. First, as previously mentioned, the economic savings of screening relative to no screening could accrue if cancers detected at earlier stages were less expensive to treat than those detected when they are more advanced. In this case, the total savings of a mammographic screening program would amount to the difference in cost between treating cancers in a screened vs nonscreened population. However, studies have shown that although there is a trend toward detection at earlier stages, differences in the percentage of women detected with early- vs late-stage cancers in screened vs nonscreened populations may be small.

Second, in a population with no discernible risk factors for breast cancer, the costs of screening many women must be incurred to realize the savings of a single early detection.

Third, although the costs of mammographic screening are relatively low, the costs of diagnostic follow-up are often much higher, due to the invasive procedures for obtaining biopsy specimens.
discussed above, even if the diagnostic accuracy of mammography is quite good, when the prevalence of undetected breast cancer in the population is low, the number of diagnostic work-ups that do not result in a diagnosis of cancer is large. Therefore, the induced costs of unnecessary diagnostic work-ups also may be much greater than the savings associated with early detection of cancer.

**Impact of Screening vs Treatment on Quality of Life**

An area that has been poorly explored is the relative impact of screening vs treatment of symptomatic breast cancer on quality of life. Although the adverse effect of delayed diagnosis and the resultant toxicity of aggressive therapy on quality of life is obvious, there is also a negative impact on quality of life when the results of screening tests necessitate a lengthy, expensive, and invasive evaluation for a false-positive mammographic abnormality. Despite the fact that breast cancer screening is unlikely to result in a net savings (savings due to early detection minus the costs of screening) to the employer, taking into account both the costs and savings of mammographic screening and the reduction in mortality and morbidity through early detection of cancer, screening is a cost-effective health service because it costs less money to save a year of life through breast cancer screening, compared to other types of health services, such as certain types of organ transplants, cancer treatments, and intensive care. This is especially true for populations with identifiable risk factors for breast cancer.

Above, we have discussed the costs and savings associated with periodic mammographic screening in the workplace, and have identified several key cost factors, features of screening, and characteristics of the screened population that can influence the overall cost and savings of screening. Several comments about these cost factors may be useful in making such programs even more cost-effective.

**How Screening is Provided**

First, the choice of how to provide mammographic screening will influence the cost of an employer-based program and the overall cost-effectiveness of screening. For large companies with a large number of women eligible to participate in a screening program, the average cost of a mammogram may be lowest when the company owns and operates the equipment, because the fixed cost of equipment and maintenance can be spread out among more mammograms. Smaller companies may find that their average cost per mammogram will be lower if they contract with a mobile unit or another facility outside of the workplace. However, companies electing to contract out for mammographic screening should not neglect other important elements of a comprehensive screening program, such as education, breast physical examination, reminders for mammography and counseling, and the cost of ensuring that employees take steps to resolve abnormal screening results, especially when a diagnostic work-up is required. From an employer's perspective, measures to boost participation in a screening program are important. If employee participation rates are low due to fear or ignorance, neither employer nor employee will realize the full benefits of screening.

**Mammogram Quality and Population Selection**

Second, the accuracy of the mammogram and the underlying incidence of breast cancer in the screened population are important determinants of how many diagnostic work-ups must be performed in the screened population to detect a single cancer. Therefore, it is important to ensure quality in the performance and interpretation of mammograms. This can be accomplished by compliance with standards set by the American College of Radiology and the federal Mammography Quality Standards Act (MQSA). Also, it is important to select populations for screening that are at sufficient risk of breast cancer to outweigh the adverse impact (short-term morbidity, loss of quality of life associated with obtaining a specimen for biopsy, and cost) of unnecessary diagnostic work-ups.

**Coordination of Care and Counseling**

Third, because an unnecessary diagnostic work-up may be a cause of both significant employee lost productivity and psychological stress, efforts by the program on behalf of the employee to coordinate process of care and to provide counseling on the significance of results may help minimize the disruption to the employee's general well-being and work schedule.

There are important gaps in our ability to quantify the savings and costs of breast cancer screening
in the workplace. To our knowledge, there have been no studies on the costs to the employer of breast cancer or on the costs of diagnostic work-ups for suspected cancer, including medical costs and costs of lost productivity. Therefore, research in these areas is necessary to precisely quantify the economic costs and savings of breast cancer screening in the workplace.

Until additional data become available, it is reasonable to continue to screen women 50 years of age and older, as well as women ages 40 to 49 who have risk factors for breast cancer. This recommendation will be revised and updated as additional evidence about mortality reduction, cost-effectiveness, and quality of life changes due to mammographic screening is produced by ongoing research.

References:

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