# Introducing *Radiology* Select: *Breast Cancer Screening*

Constance D. Lehman, MD, PhD

## Introduction

Few topics have received more attention in radiology than breast cancer screening. Mammography as a screening tool for breast cancer has been shown to enable diagnosis of breast cancers at an earlier stage, when less aggressive therapies can be offered and when cure is more likely. Randomized clinical trials with mortality as an endpoint have confirmed that women undergoing screening mammography have significantly lower breast cancer mortality rates compared with women who do not.

The first original research published in *Radiology* on mammography was in 1960 by Egan (1). Egan reported on 1000 consecutive diagnostic mammographic studies in women presenting with signs or symptoms of breast cancer. In 1964, at the 50th Scientific Assembly and Annual Meeting of the Radiological Society of North America in Chicago, Ill, Wolfe reported results from 3891 women, aged 46–81 years, undergoing screening mammography. In his subsequent 1965 *Radiology* publication (2), he concluded that

> [t]he tedious task of examining about 250 women to detect one cancer seems relatively unrewarding unless it is realized that the cancer found is most likely to be in a curable stage. If left until it is clinically evident, the likelihood of salvage diminishes rapidly.... Carefully performed mammography is effective in the discovery of small, clinically occult cancers in a significant number of patients. In the great majority of these cases, the growth is found before axillary lymph node metastases appear. This is the measuring stick of effective early cancer detection in the breast.

The 1980s witnessed a large number of clinical research trials published on screening mammography performance, including reports of the American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) program, developed to address a lack of standardization and uniformity in mammography practice reporting (3). This work also directly supported development of a voluntary accreditation program by the American College of Radiology, which led to the Mammography Quality Standards Act passed by Congress in 1992.

Since that time, hundreds of articles specific to screening for breast cancer have been published in *Radiology*. A PubMed search using terms "breast" and "screening" published in *Radiology* returned a total of 1463 articles (accessed Sept 6, 2012).

**Video**
Online Education Edition and Tablet Edition of *Radiology* Select include a video with guest editor Constance D. Lehman, MD, PhD.

This *Radiology* Select collection covers research relevant to breast cancer screening between 2004 and 2012 and is limited to only 34 articles. Many outstanding articles are not included in this collection. Articles were chosen to represent five key topics in breast cancer screening and to represent findings from centers in and outside the United States. When possible, multi-center, prospective trials were emphasized. The five chapters are "Mammography Performance," "Digital Mammography," "Screening Mammography and Computer-aided Detection," "Screening in High-Risk Patients," and "Other Screening Tools."

The articles selected for "Mammography Performance" include a sampling from the Breast Cancer Surveillance Consortium (BCSC), a National Cancer Institute–sponsored collaborative network of mammography registries with linkages to tumor registries in the United States (4-9). The BCSC was established in 1994 to evaluate the performance of mammography in a community practice and currently includes data from more than 9 million mammograms in the United States. These studies from the BCSC have substantially improved our understanding of breast cancer screening practices in the United States and continue to address important issues on accuracy, cost, and quality of screening programs.

The results of the long-term (29-year) effect of mammographic screening on breast cancer mortality are included in the report from the Swedish two-county study of women aged 40–74 years, who were invited to undergo one-view screening mammography or to receive the usual care (10). This study demonstrated a highly significant reduction in breast cancer mortality in the population invited to screening (RR = 0.69; 95% confidence interval: 0.56, 0.84; $P <$ .0001) and emphasized the importance of long-term follow-up in assessing absolute benefit of screening.

The second chapter is on digital mammography (11-16). Full-field digital mammography received approval by the Food and Drug Administration in 2000, and the first article comparing digital mammography with screen-film mammography in *Radiology* was published by Lewin et al in 2001 (17). The articles selected for this chapter include findings of the American College of Radiology Imaging Network (ACRIN) Digital Mammographic Imaging Screening Trial (DMIST), where 33 centers in the United States and Canada enrolled 49 528 women to undergo both screen-film and digital mammography (11). The study demonstrated that digital mammography performed significantly better than screen-film mammography for the specific subgroup of pre- and perimenopausal women younger than 50 years and with dense breasts. This chapter also includes findings on the performance of digital mammography from Spain (16), Norway (12), and the Netherlands (13). The most recent publication of 2012 from the Netherlands is particularly important because those investigators focus not only on the performance of digital versus screen-film mammography but also address the clinical relevance of the cancers detected.

The third chapter groups articles on computer-aided detection (CAD) in screening mammography (18-23), including results from studies performed at Duke University Medical Center (Durham, NC) (18), Stanford (Stanford, Calif) (19,21), and the United Kingdom (20). The Computer Aided Detection Evaluation Trial II (CADET II), a large multicenter prospective trial in Scotland of more than 31 000 women, is included and compares double reading to single reading with CAD (23). This report clarified that readers using either single reading with CAD or double reading need to be aware of the strengths and weaknesses of each reading regimen to avoid missing cancers.

The fourth chapter on screening of high-risk patients includes studies from the United States, Canada, Germany, and Italy (24-29). A multicenter prospective trial from the International Breast MRI Consortium (Schnall, principal investigator) compared magnetic resonance (MR) imaging, ultrasonography (US), and mammography in screening high-risk women and found MR imaging to be the most sensitive method in detecting breast cancer in women at high risk (24). Similar results were reported by Sardenelli et al in the HIBRCRIT study from Italy (25) and by Scharading and Kuhl from Germany (28). Finally, a study by Lee et al reported on the cost-effectiveness of breast MR imaging and screen-film mammography for screening *BRCA1* gene mutation carriers (29). This simulation model compared three strategies of screening with mammography and MR imaging, reporting that annual combined MR and mammography screening provides the greatest life expectancy and is likely cost-effective when the value placed on gaining an additional quality-adjusted life years is in the range of $50 000–$100 000.

Finally, the fifth chapter includes screening studies that evaluated potential methods of screening for breast cancer outside of mammography, US, and MR imaging (30-34). These "other" screening tools include preliminary results from dedicated breast CT, breast-specific gamma imaging, and breast tomosynthesis. This section also includes a recent study reporting on reasons women in the ACRIN 6666 study refused breast MR screening and raises important issues regarding the acceptance of new imaging technologies into screening programs (32).

In addition, the popular section *Controversies* in the journal *Radiol-*

*ogy* has provided summaries and scientific discourse for readers on challenging and controversial topics. In 2009, when the U.S. Preventive Services Task Force (USPSTF) published their update on breast cancer screening recommendations, the editor of *Radiology*, Dr Herbert Kressel, invited the task force to provide an overview of the rationale for their recommendations. At the same time, Kopans (35) provided his commentary on the USPSTF recommendations. Petitti and her colleagues on the USPSTF (36) provide a historic perspective of the mission of the task force, the methods used for developing their guidelines, and clarification of points that were fraught with misunderstanding by medical and lay populations alike. Kopans (35) provides a historic perspective of the controversies surrounding breast cancer screening and a summary of key issues in study design and analyses, including the challenges of comparing results from randomized controlled trials to those from computer modeling. Further, he explains the importance of assigning appropriate weighting to benefits and risks of screening mammography to guide effective and informed decision making by our patients and their clinicians. Taken together, these two editorials provide a comprehensive summary of the highly publicized and often misunderstood USPSTF recommendations, with particular emphasis on the recommendation regarding routine mammographic screening of women in their 40s.

Breast cancer continues to increase as a major source of morbidity and mortality around the world. Imaging has played a central role in early detection, diagnosis, and treatment of breast cancer. As new technology and new approaches continue to be developed, careful scientific investigation of these emerging applications is essential. This *Radiology* Select series highlights the developments in the imaging sciences both in technical developments and clinical practice. The results of the research summarized should help guide us in better care of our patients.

## Reference List


1. Egan RL. Experience with mammography in a tumor institution: evaluation of 1000 studies. Radiology 1960; 75:894-900.
2. Wolfe JN. Mammography as a screening examination in breast cancer. Radiology 1965; 84:703-708.
3. Burnside ES, Sickles EA, Bassett LW, et al. The ACR BI-RADS experience: learning from history. J Am Coll Radiol 2009; 6:851-860.
4. Rosenberg RD, Yankaskas BC, Abraham LA, et al. Performance benchmarks for screening mammography. Radiology 2006; 241:55-66.
5. Schell MJ, Yankaskas BC, Ballard-Barbash R, et al. Evidence-based target recall rates for screening mammography. Radiology 2007; 243:681-689.
6. Carney PA, Sickles EA, Monsees BS, et al. Identifying minimally acceptable interpretive performance criteria for screening mammography. Radiology 2010; 255:354-361.
7. Yankaskas BC, May RC, Matuszewski J, Bowling JM, Jarman MP, Schroeder BF. Effect of observing change from comparison mammograms on performance of screening mammography in a large community-based population. Radiology 2011; 261:762-770.
8. Elmore JG, Jackson SL, Abraham L, et al. Variability in interpretive performance at screening mammography and radiologists' characteristics associated with accuracy. Radiology 2009; 253:641-651.
9. Buist DS, Anderson ML, Haneuse SJ, et al. Influence of annual interpretive volume on screening mammography performance in the United States. Radiology 2011; 259:72-84.
10. Tabar L, Vitak B, Chen TH, et al. Swedish two-county trial: impact of mammographic screening on breast cancer mortality during 3 decades. Radiology 2011; 260:658-663.
11. Pisano ED, Hendrick RE, Yaffe MJ, et al. Diagnostic accuracy of digital versus film mammography: exploratory analysis of selected population subgroups in DMIST. Radiology 2008; 246:376-383.
12. Skaane P, Hofvind S, Skjennald A. Randomized trial of screen-film versus full-field digital mammography with soft-copy reading in population-based screening program: follow-up and final results of Oslo II study. Radiology 2007; 244:708-717.
13. Karssemeijer N, Bluekens AM, Beijerinck D, et al. Breast cancer screening results 5 years after introduction of digital mammography in a population-based screening program. Radiology 2009; 253:353-358.
14. Weigel S, Decker T, Korsching E, Hungermann D, Bocker W, Heindel W. Calcifications in digital mammographic screening: improvement of early detection of invasive breast cancers? Radiology 2010; 255:738-745.
15. Glynn CG, Farria DM, Monsees BS, Salcman JT, Wiele KN, Hildebolt CF. Effect of transition to digital mammography on clinical outcomes. Radiology 2011; 260:664-670.
16. Sala M, Salas D, Belvis F, et al. Reduction in false-positive results after introduction of digital mammography: analysis from four population-based breast cancer screening programs in Spain. Radiology 2011; 258: 388-395.
17. Lewin JM, Hendrick RE, D'Orsi CJ, et al. Comparison of full-field digital mammography with screen-film mammography for cancer detection: results of 4945 paired examinations. Radiology 2001; 218:873-880.
18. Baker JA, Lo JY, Delong DM, Floyd CE. Computer-aided detection in screening mammography: variability in cues. Radiology 2004; 233:411-417.
19. Birdwell RL, Bandodkar P, Ikeda DM. Computer-aided detection with screening mammography in a university hospital setting. Radiology 2005; 236:451-457.
20. Khoo LA, Taylor P, Given-Wilson RM. Computer-aided detection in the United Kingdom National Breast Screening Programme: prospective study. Radiology 2005; 237:444-449.
21. Ikeda DM, Birdwell RL, O'Shaughnessy KF, Sickles EA, Brenner RJ. Computer-aided detection output on 172 subtle findings on normal mammograms previously obtained in women with breast cancer detected at follow-up screening mammography. Radiology 2004; 230:811-819.
22. Tchou PM, Haygood TM, Atkinson EN, et al. Interpretation time of computer-aided detection at screening mammography. Radiology 2010; 257:40-46.
23. James JJ, Gilbert FJ, Wallis MG, et al. Mammographic features of breast cancers at single reading with computer-aided detection and at double reading in a large multicenter prospective trial of computer-aided detection: CADET II. Radiology 2010; 256:379-386.
24. Lehman CD, Isaacs C, Schnall MD, et al. Cancer yield of mammography, MR, and US in high-risk women: prospective multi-institution breast cancer screening study. Radiology 2007; 244:381-388.

25. Sardanelli F, Podo F, D'Agnolo G, et al. Multicenter Comparative Multimodality Surveillance of Women at Genetic-Familial High Risk for Breast Cancer (HIBCRIT study): interim results. Radiology 2007; 242:698-715.

26. Weinstein SP, Hanna LG, Gatsonis C, Schnall MD, Rosen MA, Lehman CD. Frequency of malignancy seen in probably benign lesions at contrast-enhanced breast MR imaging: findings from ACRIN 6667. Radiology 2010; 255:731-737.

27. Sung JS, Malak SF, Bajaj P, Alis R, Dershaw DD, Morris EA. Screening breast MR imaging in women with a history of lobular carcinoma in situ. Radiology 2011; 261:414-420.

28. Schrading S, Kuhl CK. Mammographic, US, and MR imaging phenotypes of familial breast cancer. Radiology 2008; 246:58-70.

29. Lee JM, McMahon PM, Kong CY, et al. Cost-effectiveness of breast MR imaging and screen-film mammography for screening BRCA1 gene mutation carriers. Radiology 2010; 254:793-800.

30. Lindfors KK, Boone JM, Nelson TR, Yang K, Kwan AL, Miller DF. Dedicated breast CT: initial clinical experience. Radiology 2008; 246:725-733.

31. Rhodes DJ, Hruska CB, Phillips SW, Whaley DH, O'Connor MK. Dedicated dual-head gamma imaging for breast cancer screening in women with mammographically dense breasts. Radiology 2011; 258:106-118.

32. Berg WA, Blume JD, Adams AM, et al. Reasons women at elevated risk of breast cancer refuse breast MR imaging screening: ACRIN 6666. Radiology 2010; 254:79-87.

33. Kontos D, Ikejimba LC, Bakic PR, Troxel AB, Conant EF, Maidment AD. Analysis of parenchymal texture with digital breast tomosynthesis: comparison with digital mammography and implications for cancer risk assessment. Radiology 2011; 261:80-91.

34. Brem RF, Rapelyea JA, Zisman G, et al. Occult breast cancer: scintimammography with high-resolution breast-specific gamma camera in women at high risk for breast cancer. Radiology 2005; 237:274-280.

35. Kopans DB. The 2009 U.S. preventive services task force guidelines ignore important scientific evidence and should be revised or withdrawn. Radiology 2010; 256:15–20.

36. Petitti DB, Calonge N, LeFevre ML, et al. Breast cancer screening: from science to recommendation. Radiology 2010; 256:8-14.

## Constance D. Lehman, MD, PhD

**Constance D. Lehman, MD, PhD,** graduated from Duke University (Durham, NC). She received her MD and PhD degrees from Yale University (New Haven, Conn). She completed her residency and fellowship training at the University of Washington in Seattle, Wash. She now serves as professor and vice chair of radiology and section head of breast imaging at the University of Washington and director of imaging at the Seattle Cancer Care Alliance. Her research is focused on new methods and applications of advanced imaging in breast cancer detection and diagnosis, as well as factors that influence the performance of mammography.

*Radiology* Select is a continuing series of *Radiology* articles chosen by a guest editor for their importance in radiologic science. It is published biannually with each volume focusing on a specific subspecialty topic. The series is available to members and nonmembers for a fee and is offered in three formats: online, tablet, and print. Both *Radiology* and *Radiology* Select are owned and published by the Radiological Society of North America, Inc.

For more information on the *Radiology* Select series, please contact RSNA Publications, 630-590-7770.