

The History of Mammography

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The successes and mistakes of the past can provide useful lessons and guidance for the future.



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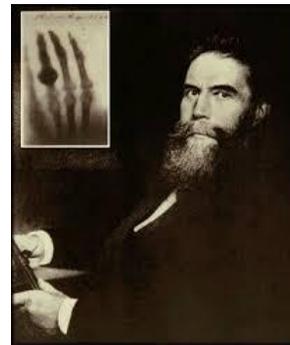
Breast cancer through the ages

- First documentation breast cancer in 1600 BC
- Detection and treatment changed most dramatically in the European Renaissance period
- Discovery of x-ray was the biggest advance in breast cancer dx and tx



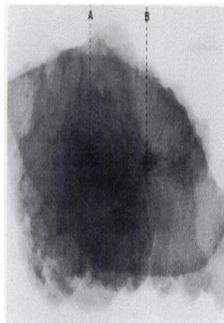
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William Roentgen - 1895



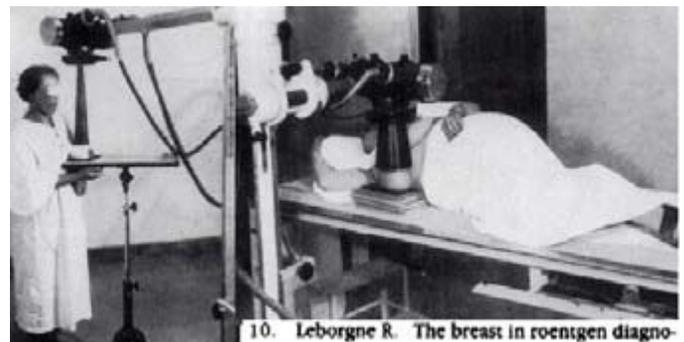
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Albert Solomon – Specimen Radiography - 1913



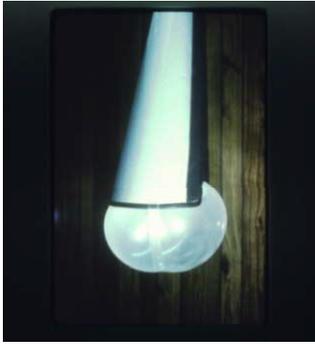
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Uruguay 1949



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Balloon used for compression



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William Egan - 1964



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The Egan Technique



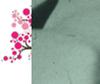
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The Egan Technique was usually done when a patient had a very large palpable mass, but:

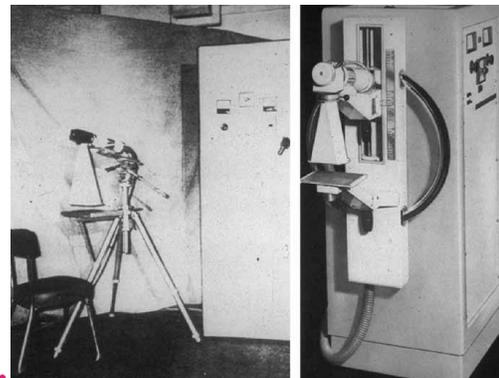
- Limited productivity; 4-5 patients imaged per day
- Limited to CC and MLO views; no ability to do extra diagnostic views



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Mammography technology has come a long way since the first machine specifically designed for producing mammograms was introduced in 1966.



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First production model of the CGR Senographe (1966).¹⁶

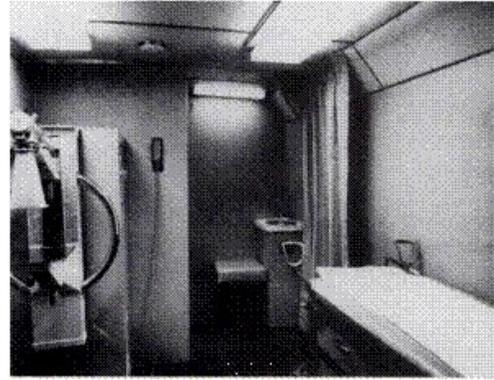


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Mobile Mammography



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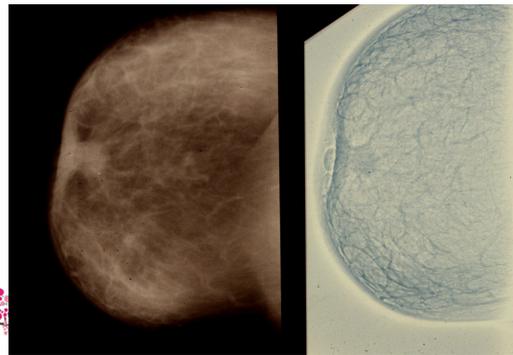
Xerography - 1971

- Provided better image quality than systems using industrial film pack
- Allowed excellent visualization of chest wall
- The foundation of selenium digital Technology
- Key Inventor – Lothar Jeromin



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Film Screen vs. Xerography



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Pat Troyer, X-ray Technologist, shows a completed mammograph and the Xeroradiography equipment at Bass Kaiser Hospital which has helped detect cancer early in hundreds of women over the past three years. A balloon (or sometimes a clear plastic plate) compresses the breast and spreads the tissue to produce a clear picture of the interior.

Xeroradiography produces a highly detailed picture on plastic coated paper. A physician specialist (Radiologist) can interpret the picture without the use of the special viewing apparatus usually needed to read X-rays. This view of both breasts shows mammary dysplasia—a non-malignant condition of the breast. If



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Curved compression paddles



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Xerox Processing



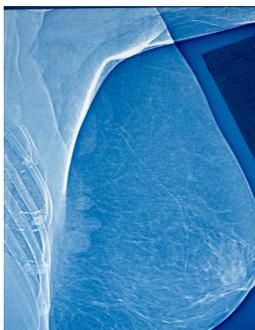
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Xeroradiography had wide exposure latitude



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Lesions could be missed around the curve of the chest due to soft compression.



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AT THE SAME TIME....

- Single emulsion film for use in mammography was being introduced, with the promise of providing faster processing, improved image quality, and significantly decreased dose
- By 1986, film-screen mammography was being used by more than half of all radiologists



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- Production of xeromammography was halted in 1989, due to declining sales
- Screen-film mammography became the gold standard in the late 1980's – early 1990's

1970's Siemens, Phillips, Picker and GE begin selling specialized/dedicated mammography systems.



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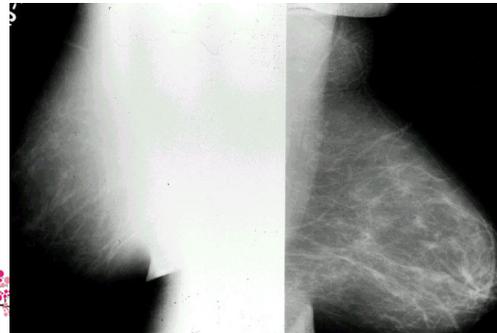


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CGR - GE



The need for dedicated mammography units and rigid compression.



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Rigid compression – Taut Up and Out



1980's-90's - Major improvements in mammography equipment, including:

- Reduced radiation dosage
- Automatic exposure controls
- Better film
- Film emulsifiers and processing
- Digital imaging
- Computerized diagnosis



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1986 – The American Cancer Society (ACS) and the American College of Radiology (ACR) developed a breast screening accreditation program for radiologists and technologists.



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1988 – Congress passes legislation to provide annual screening mammography benefit for Medicare recipients.

1990 – Breast and Cervical Cancer Mortality Prevention Act implemented to provide free or low cost mammograms and pap smears to low-income women.



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1994 – National Mammography Quality Standards Act Implemented

1998 – First Computer Aided Detection (CAD) system for mammography approved by FDA

2000 – First Full Field Digital Mammography system approved by FDA



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Full Field Digital Mammography



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Lorad - Hologic



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Siemens

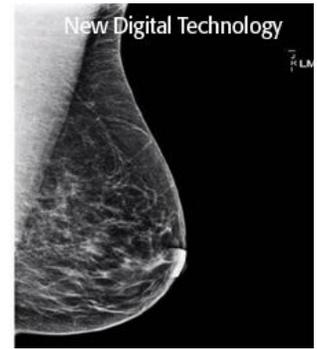


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GE



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Digital Mammography: Changes

- No processors
- Decreased time
- Increased efficiency, but increased expectations
- Ability to instantly evaluate images & correct any positioning problems
- Fewer call-backs
- Decreased patient anxiety
- Larger image receptor (up to 30% longer)



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Digital Mammography: No change in

- Compression
- Equipment problems/breakdowns
- Difficult to position patients
- Uncooperative patients



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Digital Mammography

- Despite the patients' assumption that digital mammography involves less compression than in the past, the need for compression has not changed.



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What the new millennium brought

3D MAMMOGRAPHY IS HERE.



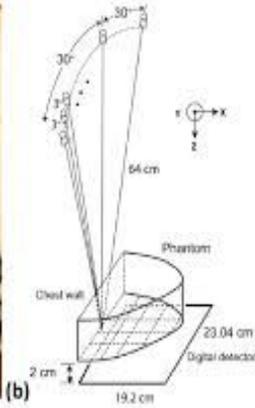
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Tomosynthesis: The latest “best” thing

- This technology has been tested since the 1990s
- Invented by Dr. Daniel Kopans at Harvard Medical School/Massachusetts General Hospital
- Approved by the FDA in 2011



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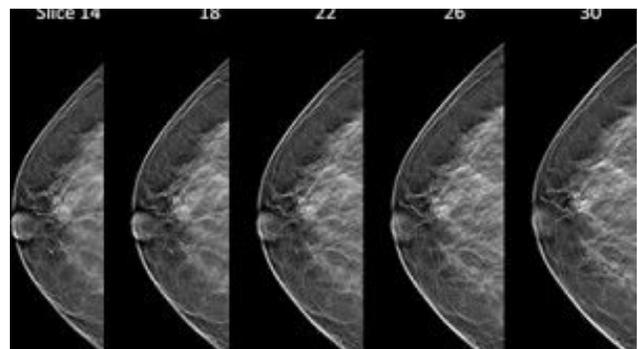
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Tomosynthesis: Changes

- Image receptor longer & thicken than FFDM
- Enlarged face shield
- More images (depending on protocols)



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Tomosynthesis: No change in

- Compression
- Equipment problems/breakdowns
- Difficult to position patients
- Uncooperative patients



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Screening mammography remains the **ONLY** technique that has been scientifically proven to reduce mortality from breast cancer.

- In the 70s and 80s breast cancer mortality rates decreased by approximately 30% with the utilization of screening mammography.
- The most recent data, shows that screening mammography can, in fact, reduce the mortality rate by **up to 50%**.



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Clinical Trials

- Swedish 2 County Trails
- BCDDP
- HIP
- Canadian Study
- DMIST



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Swedish Trials

- The Swedish Two-county study is a randomized controlled trial of invitation to mammography screening. The trial took place in Kopparberg (W), now called Dalarna, and Ostergotland counties in Sweden.



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Swedish Trials

- The trial randomized 77,080 women aged 40-74 years to invitation to screening (active study population, ASP) and 55,985 women to no invitation to screening (passive study population, PSP).



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Swedish Trials

- The trial started in 1977 in W-county and in 1978 in E-county. Women in age 40-49 years were invited to single-view mammography screening on average every 24 months, and women aged 50-74 years on average every 33 months.



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Swedish Trials

- Approximately seven years after randomization a significant 31% decrease in breast cancer mortality was observed in the ASP group, whereupon the PSP was invited to screening once and the screening phase of the trial ended.



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Swedish Trials

- The mortality data have been reported every two years during the follow-up period and published in peer-reviewed medical journals. The investigators have follow-up data to the Dec 31 2015.



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Swedish Trials

- The 29-year follow-up data has been published in 2012 in Radiology. Publication of the long-term data reflects the fact that deaths avoided by early detection include some that would have occurred a considerable time later than the screening.



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Swedish Trials

- Publication of the long-term data reflects the fact that deaths avoided by early detection include some that would have occurred a considerable time later than the screening.
- Breast cancer deaths can be reduced by up to 50% by screening mammography



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Clinical Trials

- Swedish Trails
- **BCDDP**
- HIP
- Canadian Trails
- DMIST



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BCDDP

Breast Cancer Detection Demonstration Project

- Study subjects were participants in the Breast Cancer Detection Demonstration Project (BCDDP), a breast cancer screening program conducted between 1973 and 1980.



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BCDDP

Breast Cancer Detection Demonstration Project

- Sponsored by the American Cancer Society and the NCI, the BCDDP provided up to five annual breast examinations to 283,222 women at 29 screening centers in 27 cities throughout the United States.



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BCDDP

Breast Cancer Detection Demonstration Project

- A follow-up study of a subset of the BCDDP participants (n = 64,182) was begun by the NCI in 1980



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BCDDP

Breast Cancer Detection Demonstration Project

- “Mammography was very effective in identifying most cancers in all age groups but was more sensitive in older women. Mammograms “missed” 10% of cancers in women younger than 50 years but only 5% in women older than 50 years



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BCDDP

Breast Cancer Detection Demonstration Project

- Mammography was very effective in identifying most cancers in all age groups but was more sensitive in older women. Mammograms “missed” 10% of cancers in women younger than 50 years but only 5% in women older than 50 years.



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BCDDP Breast Cancer Detection Demonstration Project

- “The overall breast cancer specific survival for the cohort was much greater than would be expected when compared with survival in a Surveillance Epidemiology and End Results (SEER) population (expressed as “relative survival”).



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BCDDP Breast Cancer Detection Demonstration Project

- Therefore, because tumor characteristics and survival were similar across all age groups, the implication is that screening in the BCDDP population not only conferred a survival advantage but did so equally for younger and older women.



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BCDDP Breast Cancer Detection Demonstration Project

- The real contributions made by the BCDDP, however, go well beyond the Socratic arguments for or against mortality reduction (which the BCDDP was never intended to directly address)..



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BCDDP Breast Cancer Detection Demonstration Project

- Together with HIP, the BCDDP was undoubtedly the stimulus for development of the subsequent randomized clinical trials conducted in Canada and Europe
- The BCDDP significantly advanced both the idea and science of breast cancer screening



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BCDDP Breast Cancer Detection Demonstration Project

- Finally, it stimulated relentless and effective efforts to reduce radiation exposure and improve image quality and overall standards of mammography performance.



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Clinical Trials

- Swedish Trails
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- **HIP**
- Canadian Trials
- DMIST



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HIP

Health Insurance Plan of New York

- From 1963 to 1982, researchers in New York City, New York, carried out a randomized trial of mammography screening.



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HIP

Health Insurance Plan of New York

- The study included sixty thousand women aged forty to sixty-four.
- Half of the women received two annual breast examinations that involved mammography, a breast exam, and an interview.



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HIP

Health Insurance Plan of New York

- The rest of the women were not invited for annual examinations.
- After follow up, the researchers found that of the women who received the examinations, 30% fewer died from breast cancer than the women who did not receive any examinations.



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HIP

Health Insurance Plan of New York

- The HIP trial was one of the first large-scale clinical trials to provide evidence that mammography screenings helped prevent breast cancer deaths in women.



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Clinical Trials

- Swedish Trails
- BCDDP
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- **Canadian Trials**
- DMIST



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Canadian Trial

- Of the randomized controlled trials (RCT) designed to study screening mammography, the Canadian National Breast Screening Study (CNBSS) is certainly the most problematic. The CNBSS, which took place from 1980–1985, is actually two separate studies



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Canadian Trails

- CNBSSI included approximately 50,000 volunteer women age 40–49, and determined the mortality benefit in the experimental group assigned to annual screening mammography plus clinical breast exam (CBE) versus the control group assigned to usual care.



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Canadian Trail

- CNBSS2 had almost 40,000 volunteer women age 50–59, and compared the benefit of annual mammography plus CBE to yearly CBE alone.



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Canadian Trail

- From the time the results were first published in 1992 (1,2) and again in follow-up in 2000, 2002 and 2014 (3-5), the CNBSS has been controversial, because it is the only RCT that found essentially no decrease in mortality associated with an invitation to screening.



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Canadian Trail

- In fact, among women in their 40s at the 7-year report, there were 36% *more* deaths due to breast cancer in the screening group!
- There are a number of explanations for these counterintuitive findings, most of which relate to vulnerabilities and shortcomings in the execution of the study.



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Canadian Trial

- The problems in the study execution have been well-documented, and include:



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Canadian Trial Problems

- Flaws in the randomization process
- Lack of statistical power
- Non-generalizable results
- Poor quality imaging
- Suboptimal interpretation
- Inconsistent threshold for interpretation.



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Canadian Trails

- The Canadian trials were a missed opportunity to measure the efficacy of mammography and clinical breast examination in women ages 40–49, and mammography alone in women ages 50–59.



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Canadian Trial

- The CNBSS trials are an excellent demonstration of the need to carefully consider all facets of a large screening trial before accepting its results as scientifically valid.



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Canadian Trail

- The numerous design and execution flaws described explain in large part why the results of the Canadian National Breast Screening Study are dramatically different than all other RCTs.



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Clinical Trials

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DMIST

- As film/screen (FS) mammography had limited sensitivity for the detection of breast cancer in women with radiographically dense breasts.
- This study assessed whether the use of digital mammography would avoid some of these limitations.



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DMIST

- The overall diagnostic accuracy of digital and film mammography as a means of screening for breast cancer is similar.



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DMIST

- Digital mammography is more accurate in
 - Women under the age of 50 years
 - Women with radiographically dense breasts
 - Premenopausal or perimenopausal women.



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Clinical Trials

- Evidence based and properly run trials show that mammography can decrease the mortality of breast cancer by up to 50%



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But, there is **ALWAYS** room for improvement.



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New techniques are needed to detect the 20% of cancers that are not detectable by mammographic and clinical imaging, as well as the cancers that are not detected early enough to result in a cure.

What does the future hold?

Most of the advances in breast imaging are in non-mammographic imaging:

- Elastography
- ABUS
- Molecular Breast Imaging
- Breast PET-CT
- Spectral imaging



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Where do you fit into this picture?
Past, present and future

The biggest factor in whether a patient will return for a subsequent screening mammogram, is her last experience with the technologist.



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We must find pride in our accomplishments as part of the effort to find breast cancers earlier

- Pride in our ability to adapt to change
- Pride in our ability to embrace and master new technology



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Proud in our ability save lives!



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