Digital Versus Analog Mammography in Healthcare Informatics

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History of the Mammogram

- 1895  William Roentgen, a German physicist discovered X-rays.

- 1913  Albert Solomon, a surgeon in Berlin, uses a conventional X-ray machine to visualize breast cancers in 3000 mastectomy specimens.

- 1956  Robert Egan, a radiologist in Houston, introduced dedicated film for mammography to produce simple and reproducible images with improved detail.
History of the Mammogram

- **1966** The first dedicated mammography machine was developed.

- **1980s-1990s** Major improvements in mammography equipment including reduced radiation dosage, better film, digital imaging and computer-aided detection.

- **2003** FDA approved 4 digital mammogram units for clinical use
Implementing Digital Mammography

- Quality
- Safety
- Cost
- Implementation Concerns/Problems

Digital processing improves diagnostics with highly detailed images.
Analog Mammography

- The actual mammogram method is performed the same as digital.
- Uses film as both a receptor and a display for the image to produce static, fixed images.
- Two minutes for a conventional film mammogram to be developed.
Analog Mammography

- Must be stored in protective sleeve/requires large amounts of space
- Must be physically transported to other locations if consultation is necessary
Digital Mammography

- The actual mammogram method is performed the same as analog.
- Uses detectors that change x-rays into electrical signals (pixels) → transferred into a digital receptor → converts x-ray energy into numbers → produces an image displayed on a monitor or printed on high resolution printer.
Digital Mammography

- Higher detected quantum efficiency (DQE) – allows for better detection from dense parenchyma to the skin at a lower radiation level

- Distinguishes more shades of gray than film mammography – Images are presented on cathode ray tube monitors → allows for manipulation of images (brightness, image reversal, magnification, window leveling) → fewer patient callbacks
Digital Mammography

- Electronically archive films → decrease risk of misplacement, damage; immediate electronic transmission; telemedicine and mobile mammography → image transfer thousands of miles
- Image is displayed within 10 seconds after mammogram is performed
Quality of Digital Mammography

- **DMIST TRIAL** (Digital Mammography Imaging Screening)

- Analysis of the mammographic results of 42,760 women was performed by the American College of Radiology Imaging Network

- Mammograms interpreted by 2 radiologists at each of 33 facilities
Quality of Digital Mammography

- Sensitivity and specificity of digital mammography was higher for women:
  - Under the age of 50
  - With dense or heterogeneously dense breasts
  - Pre or perimenopausal
Digital vs. Analog

CC Images of Fatty breast
Digital vs. Analog

MLO images of fatty breasts
Digital vs. Analog

CC images of dense breasts
Digital vs. Analog

MLO images of dense breasts
Digital CC and MLO Images
Demonstrating Skin Line
Digital CC and MLO Images
Demonstrating Skin Thickening
## Safety of Mammography

### Analog
- Radiation dose
- Physical films must be stored → loss leads to repeat exams, increasing costs and XRT exposure
- If consult needed → films must be physically transported

### Digital
- Radiation dose – (must consider diagnostic accuracy of benign masses & calcifications)
- Films are electronically stored → misfiling/loss ↓
- Films can be sent over internet, etc. for evaluation (analog films can be digitized)
Cost Comparison

- DMI ST Trial revealed that:
  - Relative to analog mammography, screening for breast cancer using digital mammography is not cost-effective.
  - Analog and digital mammography had similar results in breast cancer detection.
Cost Comparison

- Digital equipment is expensive up-front but consideration of other aspects is necessary (factor of 4)
  - Film costs (processing, staff, & storage)
  - Downtime
  - Technologists (QC, efficiency)
  - Reimbursement
Project Implementation

- Feasibility study
- Project management
  - Initiation
  - Planning
  - Execution
  - Control and monitoring
  - Closing the project
Implementation of Hologic Digital Mammography System

- Staff Training – Provided by vendor
- Equipment – Poor initial evaluation of hospital needs
- Dictation interfacing with established EMR/Epic system
- Technology problems are ongoing and being dealt with
Digital Imaging Within Healthcare Informatics

- Internet/electronic export and retrieval
  - Images can be retrieved from remote sites for evaluation/consultation
  - Used in telemedicine
  - Helpful to providers when performing procedures in the OR or other facilities where reference to the mammographic study is necessary

- Personal Health Record - digitized images can be integrated in the PHR allowing for comprehensive healthcare and empowering the patient
Digital Imaging Within Healthcare Informatics

- Electronic Health Record
  - Allows for integration of images within the record
  - Provides for integration with databases that record BI RADS and subsequent follow up action
  - Statistical analyses and evaluation of this data is presented for MQSA evaluation as well as individual radiologist and overall clinical evaluation
Digital Imaging Within Healthcare Informatics

- **MQSA** (Mammography Quality Standards Act)
  - Established 1994
  - Created by US Food and Drug Administration
  - Evaluates physicians, technologists, physicists
  - Quality control program and adherence
  - Quality and amount of radiation used to obtain images
  - Mammography follow up program
  - Yearly accreditation inspection
Digital Imaging Within Healthcare Informatics

- Combination of the EHR and the digital mammography system
  - Creates a record to be evaluated by MQSA
  - Statistical records (BI RADS categories, provider specific PPV)
  - Ensures appropriate patient follow up
Digital Versus Analog
Summary

Digital
- Still in its infancy
- Ability to add applications
- Cost savings over time
- Greater efficiency
- Able to integrate into EHR/PHR

Analog
- Has reached its peak
- Set applications
- Cost savings up front
- Less efficient
- Unable to integrate into EHR/PHR

(M. Ulissey, personal communication, April 7, 2009)
QUESTIONS
References