Mammography and Adjunct Modalities

Learning Outcome:

Evaluate the performance of adjunct modalities in the diagnostic imaging department.

Objectives 9.1- 9.5 Readings:
Papp 6th Edition: pg 193-200

Evaluate the performance of a mammography system according to Safety Code 36 requirements.

Objectives 8.1 – 8.5 Readings:
Papp 6th Edition: Chapter 9
Safety Code 36

*****Quality Control procedures may be site specific for the various types of systems and sites. For the purposes of this course, the focus will be on the textbook procedures and SC 35. *****

Digital Networking and Archival System

- In clinical practice, maintenance and QC/QA of the PACS systems is performed by the PACS team or IT services. Smaller sites, or out of province facilities may have different practices
- To align with course objectives and the scope of an MRT, we will focus on the textbook procedures from Papp

- With the implementation of digital systems, an essential component of any imaging department is the storage and retrieval of the digital images
    - PACS is the most common system used
- PACS uses wireless communication networks, there must be additional safeguards in place to protect the information
    - Signal needs to be encrypted for protection of patient privacy, prevent signal interference and corruption
    - There should also be a process in place for loss prevention and image recovery if the signal is interrupted while data is being transferred

- In addition, there also needs to be a disaster recovery plan in place, this ensures that images and data are not lost from the system
    - Commonly this is managed by periodic back up and archiving of data from the system
- Due to the nature of the archiving system being digital, it is rare for variations in system performance to occur
    - But it is still important to have a QC procedure in place to guarantee optimum performance of the system
    - A sample procedure is outlined in Papp, pg 199-200.

- Special Procedures Equipment
    - This includes equipment not regularly found in standard radiographic rooms
        - i.e. pressure injectors, film changers, ECG, monitors and recorders
    - All of the equipment must function properly
        - For acceptable limits, consult the operating manual or a procedure should be developed by a medical physicist and the service representative
    - As per Papp, here are some sample guidelines for testing pressure injectors
        - Important variables to test are injected volume and injection time
            - This is critical for some exams
        - To test for accuracy of the injected volume, the injector should be set up with the catheter and contrast that is commonly used, and parameters should be programmed
            - After programming, the injector can administer the contrast into a beaker/graduated container
                - The volume can be compared with what was set on the control panel
                - Can also time the procedure using a stopwatch to assess administration time
        - Acceptance will be site specific and often manufacturer dependent.

Mammography

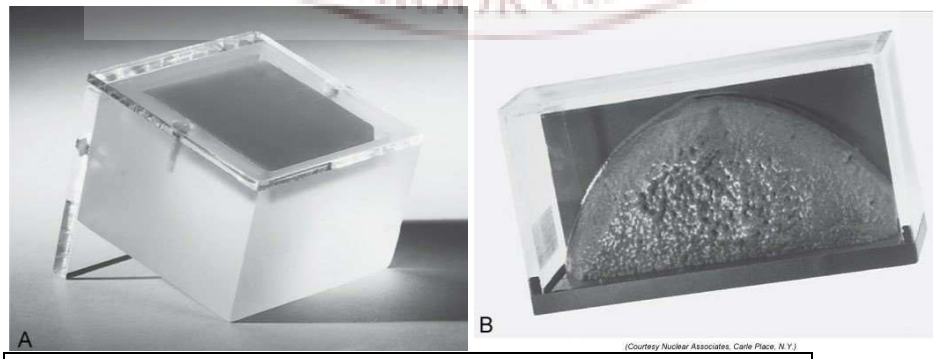
*****Quality Control procedures may be site specific for the various types of systems and sites. For the purpose of this course, the focus will be on the textbook procedures and SC 36. For the QC tests, focus on the frequency and types of testing performed *****

- For a refresher regarding mammography equipment, review pg 206-212
- Depending on the site, it is a mammography tech (daily testing), QC tech or a medical physicist that performs the testing on mammography equipment.
    - Many tests are similar to the general x-ray radiographic unit tests, as they are testing the performance of the x-ray generator. Acceptance criterion may differ.
    - To perform the tests, a dosimeter and mammography phantoms are used
        - Additional testing equipment includes items to test darkroom/processor, film/screen contact test tools, compression force devices, towels/blocks of foam rubber, PMMA slabs of uniform thickness, densitometer, stopwatch
    - Performance of a mammographic unit must be assessed taking patient dose values into consideration
        - Uses phantom with image quality evaluation objects
            - This allows quantitative evaluation: fibers, specks, masses that are similar to those found in breast tissue



(Courtesy (A) Priscilla Butler, ACR; (B) Pamela Darden, Gammex.)

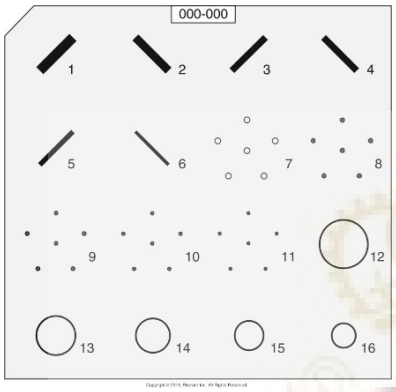
Bushong Fig 24-9 ACR accreditation test object and its image



(Courtesy Nuclear Associates, Carle Place, N.Y.)

Papp Fig 9-9 Mammographic phantom, and a "lifelike" phantom

- Phantom images can be used for establishing baseline values for QC programs
  - A different phantom with composition similar to compressed breast tissue used for calculating mean glandular dose.
  - Testing with the phantom images can include scoring of the image
    - For example, determining the number of fibers, speck groups and masses visible in the test object image
      - The results should be plotted on a control chart



Papp Fig 9-14

There are many quality control tests that may be performed, and this will vary from site to site. Each site may have a specific procedure for the environmental and visual inspections, and the start-up/shut down procedures as per manufacturer recommendations. A few common performance tests are:

- Automatic Exposure Control (AEC) (SC 36 pg 29)
  - In accordance with the SC 36, for units with a film/screen IR, the AEC must be capable of maintaining the optical density of the film within +/- 0.15 of the mean optical density using a phantom of homogenous material thickness of 2-7 cm
    - If the requirement cannot be met, a technique chart needs to be developed to show appropriate loading factors for varying thicknesses that must be used so that the OD is within +/- 0.15 of the average
  - This can be tested by taking images of the phantom (homogenous thickness), and comparing the OD on multiple films/images
  - The same testing can be performed on a digital unit, using the density values

- AEC Reproducibility (SC 36 pg 30)
  - Testing for reproducibility of exposures using AEC
    - Evaluated by repeatedly exposing a phantom under specified conditions
    - Measure the variation of:
      - mAs, or air kerma, or pixel values
        - Measured value of the selected quantity cannot differ by more than +/- 15% of the mean value of the test values

- Reproducibility of Exposure (SC 36 pg 29)
    - According to the SC 36, the coefficient of variation of any 10 consecutive exposures taken within 1 hour must be no greater than 0.05
    - The maximum deviation of any exposure must be less than 15% of the mean value of the exposures

- mA Linearity (SC 36 pg 30)
    - The exposure measurement must not differ by more than 0.1 times their sum as determined by the formula
        - $|x_1-x_2| \leq 0.1(x_1+x_2)$ where x_1 and x_2 are the quotients of the average exposure measurement divided by the current time product

- Compression Device (SC36 pg 58)
    - The compression device needs to be evaluated to verify the compression force, how the plates are aligned and the accuracy of the breast thickness measurement
    - It could be detrimental to the patient if the compression device is not functioning within acceptance limits – especially with regards to the compression force
    - Firm compression is necessary for high quality mammography imaging, but it is also the reason for patient complaints – it must be checked regularly to ensure proper function
    - The equipment must provide adequate compression in both manual and power- assist modes, but also needs to be checked that it does not allow excessive compression to occur
    - One method of checking the compression devices is to place a type of cushioning material (folded towel, washcloth) onto the cassette holder assembly, followed by a flat bathroom scale. The scale must be centered under the compression device, and the towel should not obscure the display. The compression devices should be engaged automatically until it stops, and the degree of compression recorded. The procedure can be repeated with the manual drive, and the degree of compression recorded again.
        - If the tests fail, the equipment required re-calibration and re-testing.
        - Variation between the measured compression and the displayed compression force must be within +/- 2.0 kg
        - Equipment must be able to maintain the compression force to within +/- 1 kg for at least 1 minute
        - Paddle must be flat and parallel to the IR surface; it cannot deviate from parallel by more than 1 cm on any point of the paddle surface when force is applied
        - Precision of the displayed breast thickness must be within +/- 8 mm, and should be within +/- 5mm

- kVp Accuracy (SC 36 pg 29)
    - According to the SC 36, the maximum deviation the actual kVp can be from what is set, is +/- 5%

- Timer Accuracy (SC 36 pg 29)
    - According to the SC 36, the maximum deviation of set exposure time and actual exposure time is +/- 10% + 1 ms

- Beam Quality and HVL (SC 36 pg 28)
        - This is particularly important in mammography as low kVp is utilized for soft tissue radiography
        - In accordance with the SC 36, the minimum HVL is:
            - 0.3 mm Al for 30 kV
            - 0.4 mm Al for 40 kV
            - 0.5 mm Al for 50 kV

- Additional quality control testing includes darkroom/film/screen/processor tests for film/screen mammography units

- For digital mammography units, consideration must be taken for testing of display devices, PACS, and image compression