Chapter 8

Digital Imaging

Learning Objectives

- Define the key terms used in digital imaging
- List the equipment needed to perform digital imaging
- Explain the computed radiography (CR) digital system
- Explain the digital radiography (DR) system
- Compare CR and DR digital systems
- Recognize the importance of using exposure technique charts with digital imaging
- Describe the processing and post-processing of a digital image
- Explain what a picture archival and communications system (PACS) is and how it is used

Digital Imaging

- Image is produced, processed, viewed, and stored on a computer
- Computer networks allow image viewing from outside the medical facility
- Types of digital imaging
  - Computed Radiography (CR) = cassette-based
  - Digital Radiography (DR) = cassetteless

Digital vs. Film

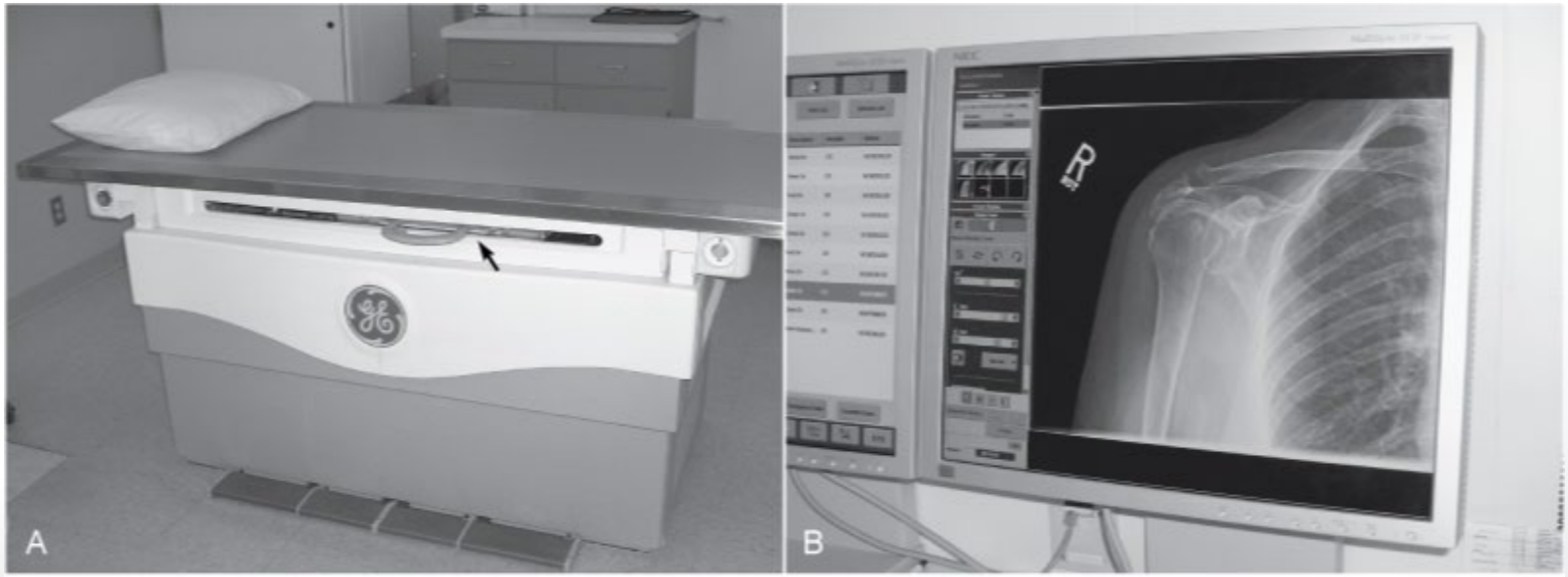
Computed Radiography (CR)

- Image obtained using CR cassettes contain photostimulable phosphor plates
  - Often referred to simply as IP (imaging plates)
- CR systems include a CR reader for image processing

A and **C,** Ballinger PW, Frank ED: *Merrill's atlas of radiographic positions and radiologic procedures,* ed 10, St Louis, 2003, Mosby.

Digital Radiography (DR)

- Referred to as “ cassette-less” because the flat-panel detector is incorporated into the x-ray table or upright wall unit
  - Detector may be indirect or direct conversion
  - Images are ready for viewing within seconds



Ballinger PW, Frank ED: *Merrill's atlas of radiographic positions and radiologic procedures*, ed 10, St Louis, 2003, Mosby.

Digital Imaging Terms

- Viewing monitor and image
  - Matrix
  - Pixel
- Spatial resolution - the larger the matrix and the smaller the pixels, the greater the spatial resolution
- Contrast resolution - ability to distinguish anatomical structures of similar subject contrast
- Dynamic range - range of exposures; DR provides wider range of exposures
- Signal-to-noise ratio (SNR) - how adequately the digital system converts x-rays into image

Digital Processor Functions

- Window level
  - Controls brightness (density)
- Window width
  - Controls contrast
- Shuttering
  - Should never be substituted for proper collimation
- Image stitching
  - “stitching” multiple images together
- Image annotation
  - Adding text
- Edge enhancement
  - makes image appear sharper and increases contrast, but introduces some noise

Exposure Technique Charts

- Ability to manipulate the computer image contrast and density does not eliminate the need for technique charts
- Use technique charts to select mA, kVp, and time to avoid unnecessary patient exposure
- Practice ALARA
- Select correct kVp
- Unethical to set exposure too high to avoid a repeat

Exposure Indicators

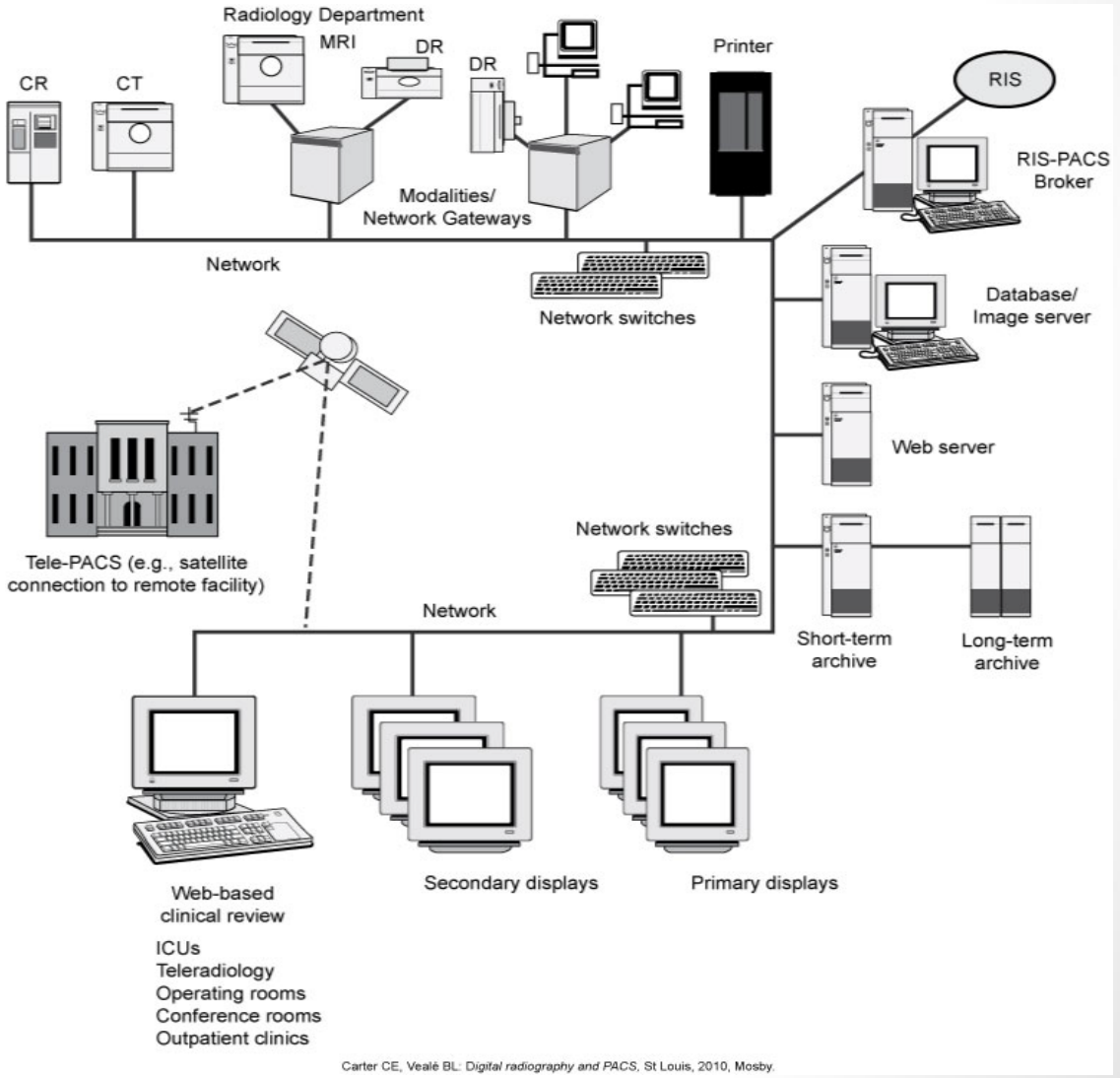
- How much exposure is absorbed in the phosphors
- Varies by manufacturer:
  - Fuji, Philips, Konica – S or sensitivity number
  - Carestream – exposure index (EI)
  - Agfa – log of median exposure (lgM)

Post-processing

- Commom post-processing techniques
  - Subtraction permits viewing of bone only or tissues only
  - Contrast enhancement adjusts contrast from very high to very low
- DICOM – Digital Imaging and Communications in Medicine

Picture Archival and Communication System (PACS)

- PACS used to manage images
- PACS network consists of:
  - Computers
  - Servers
  - Archives



Carter CE, Veale BL: *Digital radiography and PACS*, St Louis, 2010, Mosby.

Artifacts

- Common artifacts include:
  - Quantum mottle – caused by inadequate exposure technique
  - Moire pattern – grid lines not aligned with laser scanner of CR reader
  - Light spots – caused by dust or foreign material
  - Phantom/ghost images – incomplete IP erasure
  - Scratches or tears – damaged CR plates
  - Extraneous line patterns – caused by noise
  - Fogging – caused by background or scatter radiation

Digital Imaging System Technical Considerations

- Kilovoltage
  - May be slightly higher than that used for conventional radiography
- Centering
  - Body part of interest must be placed in or near the center of the detector
- Multiple exposures on one cassette
  - Although not recommended, if IR is divided for two separate exposures, the portion not being exposed must be covered with a lead shield

Digital Imaging System Technical Considerations (Cont'd)

- Over- and underexposure
  - Degree of image density is not an accurate indicator of over- or underexposure
  - Density may be indicated by a unique number that correlates to the amount of exposure
- Collimation
  - Limit the field of radiation to the anatomy of interest
  - Inadequate collimation can result in inappropriate contrast

Digital Imaging System Technical Considerations (Cont'd)

- Open cassettes
  - An exposed IR begins to lose the image within 15 seconds of opening the IR
- Grids
  - Digital systems are more sensitive to scatter radiation
  - Use grids as appropriate
  - Display Monitor Quality Assurance
    - QC tests often performed by trained radiographers or a physicist

Summary

- With CR and DR, the image is produced, processed, viewed, and stored on a computer
- CR uses an IR and requires a reader to process the image
- DR is a cassette-less process that produces an image within seconds
- Use technique charts to select exposure factors

Summary (Cont’ d)

- The appearance of digital images can be manipulated during and after processing
- PACS is a network used to manage the images obtained through DR
- DR technical considerations include kilovoltage, part centering, number of exposures per IR, over- and underexposure, cassette integrity, and collimation