

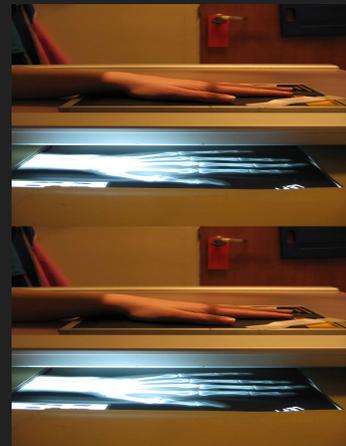
MI123: Clinical Seminar I

Lecture #1

1

How Do X-Rays Work?

- X-rays are produced within the x-ray tube
- X-rays exit the tube through the air and come into contact with the body
 - Pass through soft tissue, skin, organs (darker shades)
 - Become absorbed within dense materials such as bone (whiter shades)
- Plain Film VS Fluoroscopy
 - Plain film – anatomical, still imaging
 - Fluoroscopy – functional, live imaging



2

How Do X-Rays Work?



4 requirements for production of x-rays:

- Vacuum (tube housing)
- Source of electrons (filament)
- Method to accelerate the electrons (voltage) rapidly
- Method to stop the electrons (target)

- ❖ Primary Radiation
- ❖ Remnant Radiation
- ❖ Scatter Radiation

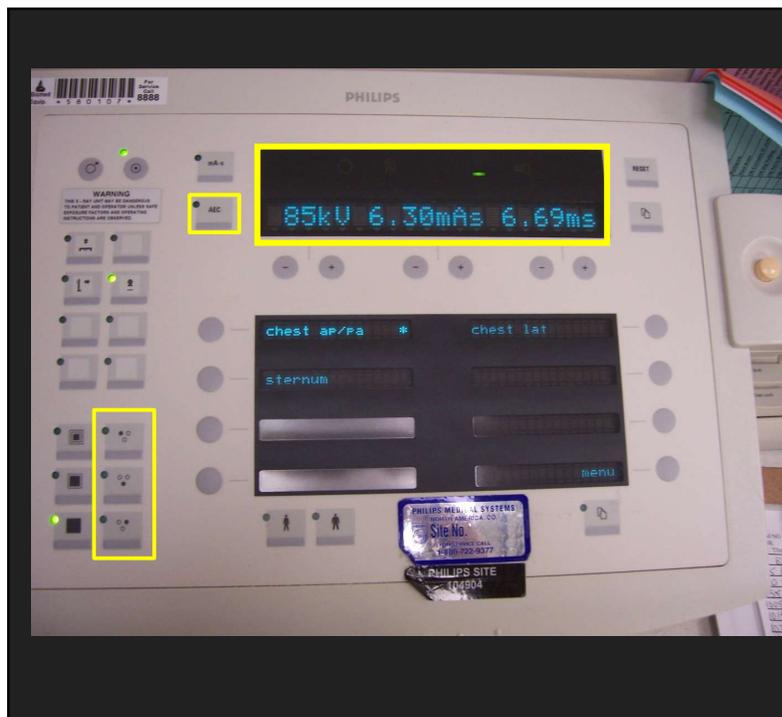
3

X-Ray Tube/Console Terminology

- mA (milliamperage)
 - Measurement of x-ray tube current or the number of electrons crossing the tube from cathode, this is a unit selected on the operating console
- mAs (milliampere seconds)
 - $\text{mA} \times \text{seconds} = \text{mAs}$
 - Controls the amount of radiation produced by the x-ray tube
 - Affects quantity of x-rays
- kVp (kilovoltage peak)
 - Maximum possible energy of a photon that exits the x-ray tube, this is a unit selected on the operating console
 - Affects quantity and quality of the x-ray
- AEC (Automatic exposure control)
 - The cells that are selected on the operating console that will automatically select the mAs according to cell selection and body part



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- kVp (kilovoltage peak)
- mA (milliamperage)
- mAs (milliampere seconds)
- AEC (Automatic exposure control)

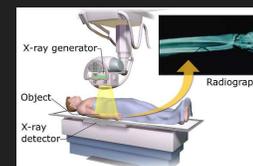
5

Image Receptor (IR)



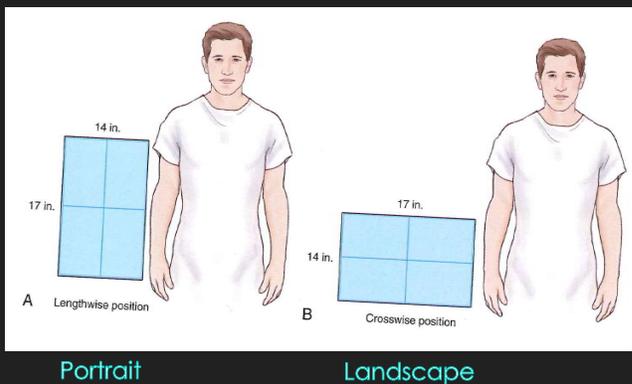
○ Device that receives the energy of the x-ray beam and forms the image of the body part

- Digital Cassette Systems (CR)
- Solid State Digital Detector (DR)
- Fluoroscopy Screen



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Image Receptor Orientation & Size



- Orientation – arranged to the patient's anatomy
 - Portrait (Lengthwise)
 - Landscape (Crosswise)
- Cassette Sizes
 - 14 x 17
 - 10 x 12
 - 8 x 10

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Table

- Motor Driven/Manual/Floating
- Characteristics of a table:
 - Must allow X-rays to pass through
 - Easily Cleaned
 - Hard to Scratch
 - Without Cavities
- Fixed or Tilting



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Tube Supports/Terminology

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Upright Units

- Upright image receptor
- Ancillary piece of equipment



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Overhead Tube Suspension

Also known as **ceiling suspension**

- Most flexible
- Most costly



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Floor-to-Ceiling

- Rails on floor and ceiling
- Longitudinal positioning



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Floor Suspension

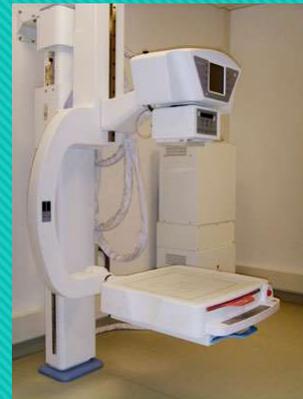
- Tube support column mounted on floor
- May have railing for longitudinal positioning



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C-Arm Equipment

- Tube and image receptor are aligned in a "C" shape
- Operating Room and at Exeter Imaging Center



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Portable Equipment

- Used to perform mobile imaging for patients that are too sick to come to the department



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Specialized Diagnostic Equipment

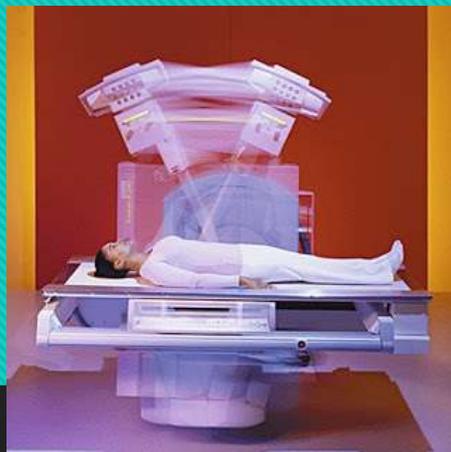
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Mammography



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Tomography



Tube and image receptor move during the exposure to blur out the surrounding areas
Focuses on anatomy of interest

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Panoramic Dental & Facial Units



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Computed Tomography (CT)



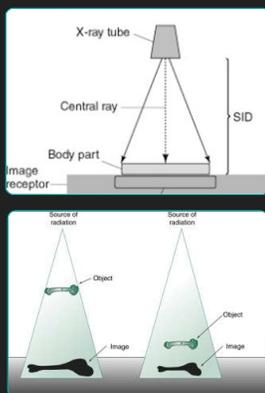
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Radiation Therapy Simulators



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Additional Terminology



○ SID (Source to Image Distance)

- Distance from the x-ray tube (anode side) to the image receptor
 - Affects magnification, detail, density, dose to the patient
 - Larger the SID the less magnified the image

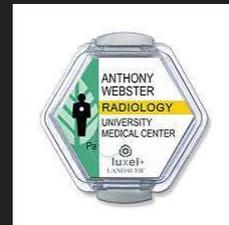
○ OID (Object to Image Distance)

- How far the body part is away from the image receptor
 - Farther away the body part from the image receptor the more magnified the anatomy

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Radiation Protection

- ALARA
 - Cardinal Principles
 - Time
 - Distance
 - Shielding
 - Radiation Monitoring



* Policy: Minimizing Patient Dose during X-ray Imaging Procedures
<https://trh.ellucid.com/documents/view/12708>

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Radiation Protection

- Shields
 - Self/others
 - Patients (if requested)
 - Placement considerations



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Contrast Media

- Utilized to visualize anatomy that could not otherwise be seen on x-ray



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Emergency Equipment

Equipment in x-ray rooms

- Blood pressure cuff
- Stethoscope
- Oxygen
- Suction
- Buttons in rooms



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Emergency Malfunctions



- Breakers
- Report:
 - To Supervising Technologist and Manager of the area
 - To your Clinical Faculty

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Standard Precautions

Precautions to prevent the transmission of disease by body fluids and substance

- Specific with items such as exposure to:
 - Blood
 - All body fluids
 - Secretions and Excretions (except sweat)
 - Non-intact skin
 - Mucous membranes



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Handwashing

Single most important means of prevention of spread of infection

- Handwashing performed before and after patient interactions
- Nails (Fingernails, polish and enhancements) Policy*

<https://trh.ellucid.com/documents/view/6239>

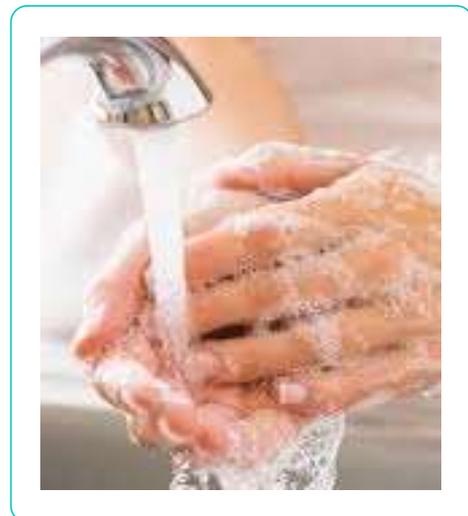


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Personal Protective Equipment (PPE)

Equipment provided to the health care worker to provide a barrier between the patient and the health care provider to prevent exposure to the skin and mucous membranes.

- Gloves
- Gowns
- Masks
- Eye wear



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Donning/Removal Sequence

Donning

- Gown
- Mask
- Goggles
- Gloves



Removal

- Gloves
- Goggles
- Gown
- Mask

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Transmission- Based precautions

- Airborne
- Droplet
- Contact
- RH has Additional Hand and Environmental Contact Precautions
- Reverse Isolation
- *Enhanced Precautions (COVID-19)

- Applied when a patient is infected with a pathogenic organism or a communicable disease
- OR
- When patient is at risk of becoming infected, such as immunosuppressed

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Contact Isolation

Need **gloves** and **gown & hand hygiene**

- For the following:
 - Methicillin Resistant Staphylococcus Aureus (MRSA)
 - Vancomycin Resistant Enterococci (VRE)
 - Lice
 - Scabies
 - Respiratory Syncytial Virus (RSV) (for pediatric patients)
 - Multi-Drug Resistant Organism (MDRO)
 - Impetigo
 - Varicella

STOP: CONTACT PRECAUTIONS
ALTO: PRECAUCIONES CONTRA LA TRANSMISIÓN POR CONTACTO

CHECK WITH STAFF BEFORE ENTERING **CONSULTE CON EL PERSONAL ANTES DE INGRESAR**

BEFORE ENTERING ROOM **ANTES DE INGRESAR A LA HABITACIÓN**

- Perform Hand Hygiene / Desinfectarse las manos
- Disinfect Reusable Items Between Cleaning / DESINFECTE LOS OBJETOS REUTILIZABLES EN CADA LIMPIEZA

EVERYONE ENTERING THE ROOM MUST WEAR: **TODOS LOS QUE INGRESAN A LA HABITACIÓN DEBEN UTILIZAR:**

- Isolation Gown / Una bata de aislamiento
- Clean Gloves / Guantes limpios
- Limit Patient Transport / Límite el transporte del paciente

BEFORE LEAVING ROOM **ANTES DE SALIR DE LA HABITACIÓN**

- Remove Gloves Wash Gown / Quitarse los guantes y lavar la bata
- Perform Hand Hygiene / Desinfectarse las manos

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Droplet Isolation

Need a **regular mask & hand hygiene**

- For the following:
 - Influenza
 - Meningitis
 - RSV
 - Meningococcal meningitis
 - Mumps
 - Adenovirus

STOP: DROPLET PRECAUTIONS
ALTO: PRECAUCIONES CONTRA LA TRANSMISIÓN POR GOTAS

CHECK WITH STAFF BEFORE ENTERING **CONSULTE CON EL PERSONAL ANTES DE INGRESAR**

BEFORE ENTERING ROOM **ANTES DE INGRESAR A LA HABITACIÓN**

- Perform Hand Hygiene / Desinfectarse las manos
- Disinfect Reusable Items Between Cleaning / DESINFECTE LOS OBJETOS REUTILIZABLES EN CADA LIMPIEZA

EVERYONE ENTERING THE ROOM MUST WEAR: **TODOS LOS QUE INGRESAN A LA HABITACIÓN DEBEN UTILIZAR:**

- Mask / Mascara
- Limit Patient Transport / Límite el transporte del paciente
- Place Mask on Patient During Transport / Coloque una mascarilla al paciente al transportarlo

BEFORE LEAVING ROOM **ANTES DE SALIR DE LA HABITACIÓN**

- Remove Mask / Quitarse la mascarilla
- Perform Hand Hygiene / Desinfectarse las manos

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Airborne Isolation

Need an **N95 mask & hand hygiene**

- For the following:
 - TB
 - Rubeola (Measles)
 - Varicella (Chickenpox)
 - Fever with a rash of unknown origin
 - Disseminated shingles

STOP: AIRBORNE PRECAUTIONS
ALTO: PRECAUCIONES CONTRA LA TRANSMISIÓN POR LA VÍA AÉREA

CHECK WITH STAFF BEFORE ENTERING CONSULTA CON EL PERSONAL ANTES DE INGRESAR

BEFORE ENTERING ROOM ANTES DE INGRESAR A LA HABITACIÓN: Perform Hand Hygiene / Desinfectarse las manos

DISINFECT REUSABLE ITEMS BETWEEN CLEANING / **DESINFECTE** LOS OBJETOS REUTILIZABLES EN CADA LIMPIEZA

HEALTHCARE WORKERS ENTERING THE ROOM MUST WEAR: EL PERSONAL DE ATENCIÓN MÉDICA QUE ENTRA EN LA HABITACIÓN DEBE UTILIZAR: N95 Respirator / Quitarse el respirador N95

Limit Patient Transport During Transport Límite el transporte del paciente. Coloque una mascarilla al paciente al transportarlo

VISITORS ENTERING THE ROOM MUST WEAR: LOS VISITANTES QUE ENTRAN EN LA HABITACIÓN DEBEN UTILIZAR: Surgical Mask / Mascarilla Quirúrgica

BEFORE LEAVING ROOM ANTES DE SALIR DE LA HABITACIÓN: Perform Hand Hygiene / Desinfectarse las manos

AFTER LEAVING ROOM DESPUÉS DE SALIR DE LA HABITACIÓN: Close Door / Cierre la Puerta

Remove N95 Respiratory Surgical Mask Quite el respirador N95

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Additional Hand and Environmental Contact Precautions

Need a **gown and gloves and hand hygiene**

- For the following:
 - Clostridium Difficile (C-Diff)
 - NoroVirus
 - Diarrhea of unknown origin

STOP: ENVIRONMENTAL PRECAUTIONS
ALTO: PRECAUCIONES AMBIENTALES

CHECK WITH STAFF BEFORE ENTERING CONSULTA CON EL PERSONAL ANTES DE INGRESAR

BEFORE ENTERING ROOM ANTES DE INGRESAR A LA HABITACIÓN: Perform Hand Hygiene / Desinfectarse las manos

DISINFECT REUSABLE ITEMS BETWEEN CLEANING / **DESINFECTE** LOS OBJETOS REUTILIZABLES EN CADA LIMPIEZA

EVERYONE ENTERING THE ROOM MUST WEAR: TODAS LAS QUE ENTRAN EN LA HABITACIÓN DEBEN UTILIZAR: Isolation Gown / Una bata de aislamiento / Clean Gloves / Guantes limpios / Limit Patient Transport / Límite el transporte del paciente

BEFORE LEAVING ROOM ANTES DE SALIR DE LA HABITACIÓN: Search Clothing (Respirator) for debris, decontaminate with soap / Busca la ropa (respirador) por residuos, desinfecta con jabón / Remove gloves (Clean Gown) / Quita los guantes (limpia la bata) / Perform Hand Hygiene with Soap & Water / Lávate las manos con jabón y agua

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Reverse Isolation

Immunocompromised patients

- Need at minimum **handwashing** before and after leaving the room and mask
 - **Meet the needs of the patient***
 - OR **gloves, gown, mask**
- Examples of weakened immune system
 - AIDS
 - Transplant
 - Cancer

Protective Precautions for Immunocompromised Patients
Visitors, Physicians, Nurses, Hospital Personnel — Report to Nurses Station With Questions

1. Keep alone.
2. Strict **handwashing** — before and after patient care.
3. No sick visitors or personnel.
4. No live plants or flowers.
5. No raw foods — hot cooked foods only.
6. No foods brought from home.

Medidas de Protección para el Paciente de Inmunidad Comprometida
Visitas, Médicos, Enfermeras, y Personal General: La Estación de Enfermeras Contestará sus Preguntas

1. Mantenga el paciente solo.
2. Estricto lavado de manos — antes y después del cuidado del paciente.
3. Nadie sintiéndose enfermo, puede entrar; empleados o visitas.
4. No se permiten plantas o flores en el cuarto.
5. No se permiten comidas sin cocinar — solo comidas calientes.
6. No se permiten comidas traídas de la casa.

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Enhanced Precautions

***COVID – 19

Need a **gown, N-95 mask, gloves, eye protection and hand hygiene**

- Airborne
- Contact
- Eye Protection

ENHANCED DROPLET & CONTACT PRECAUTIONS
(in addition to Standard Precautions)
PRECAUCIONES CONTRA PARTICULAS O GOTTITAS
(además de las Precauciones Básicas)

Perform Hand Hygiene
Before entering the room
When exiting the room

EVERYONE ENTERING THE ROOM MUST WEAR:



Gown
Batas



Gloves
Guantes



Mask Mascarilla

AND



Eye Protection
proteccion para los ojos

*N95 Respirator and Airborne Infection Isolation Room for Aerosol Generating Procedures

Limit transport

BEFORE LEAVING THE ROOM:
Remove gloves, eye protection, then gown and mask
Perform hand hygiene

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Software Systems

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Hospital Systems

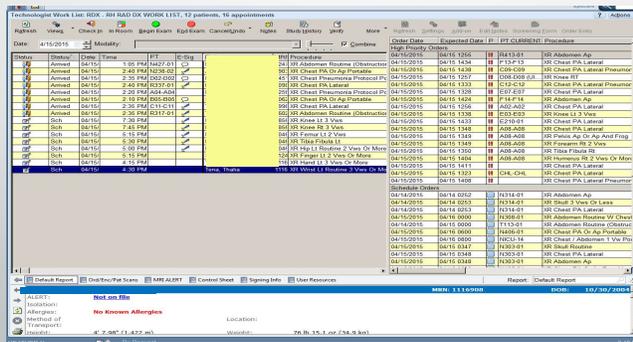
- EPIC
- PACS
- iSite
- Primordial Communicator
- Teletracking
- RL Solutions
- Vocera



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EPIC

- Electronic health records software (“One stop shop”)
 - Assists in coordination of care, improved efficiency, lower health care costs
 - Utilized to check orders, allergies, medication lists, document histories...



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PACS

Picture Archiving and Communication System

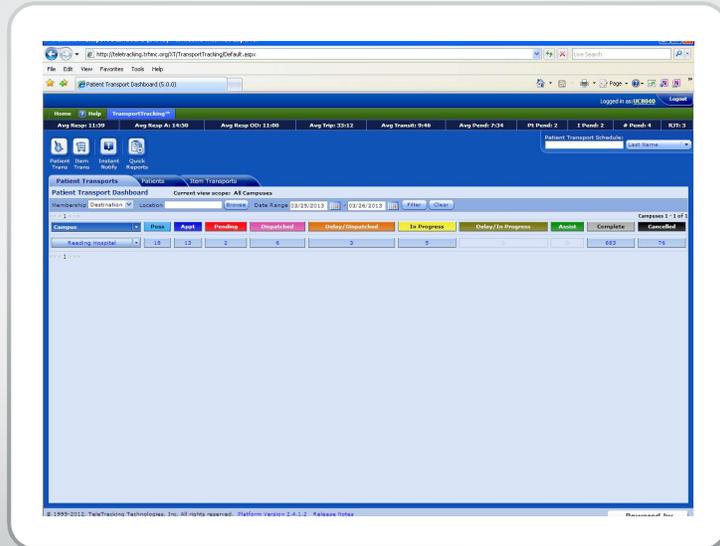
- Manages images electronically
- Stores images
- Uses a network infrastructure to pass information
- Linked to the Hospital Information System (HIS) and all pieces of digital imaging equipment



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Teletracking

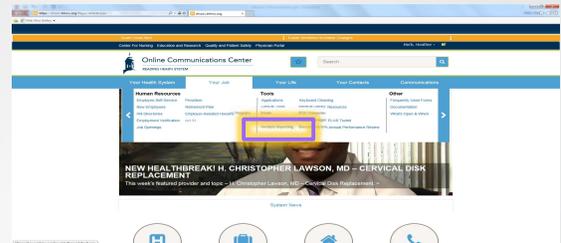
- Utilized to schedule inpatient transportation
 - To the department
 - Return to their rooms



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RL Solutions

- Online incident reporting
- Risk Management



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Vocera

- Wireless communication badge
- Used to streamline communication and improve workflow
- Notification of alerts
 - Internal/External
 - Emergencies

**Since it is wireless be aware of HIPAA



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Health Insurance Portability & Accountability Act

- Federal protection for patients' health information
 - <http://www.hhs.gov/ocr/privacy/hipaa/understanding/consumers/index.html>
- Covers all aspects of health information from hard copy to electronic



HIPAA
Health Insurance Portability
and Accountability Act

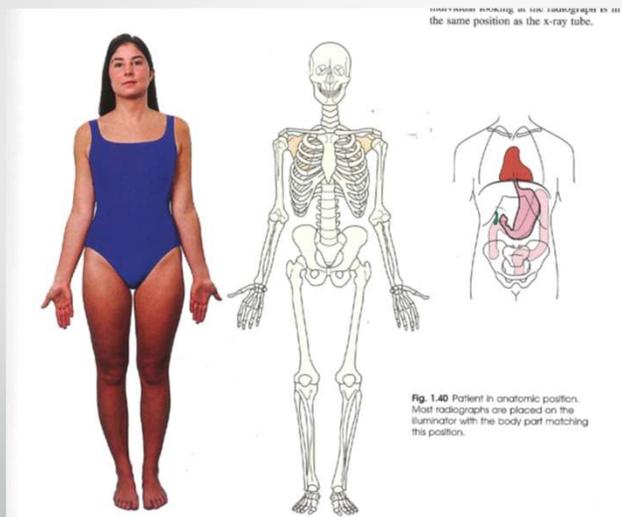
*****Access to any patient information should only be obtained if there is direct contact with the patient and their care*****

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Imaging Fundamentals

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Anatomical Position



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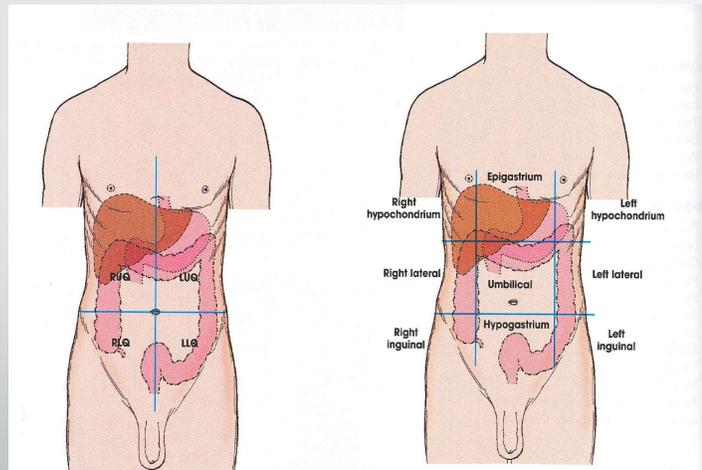
Display of Radiographs

- Images are oriented on the display as if the person were facing you
 - Their right on your left, and their left on your right



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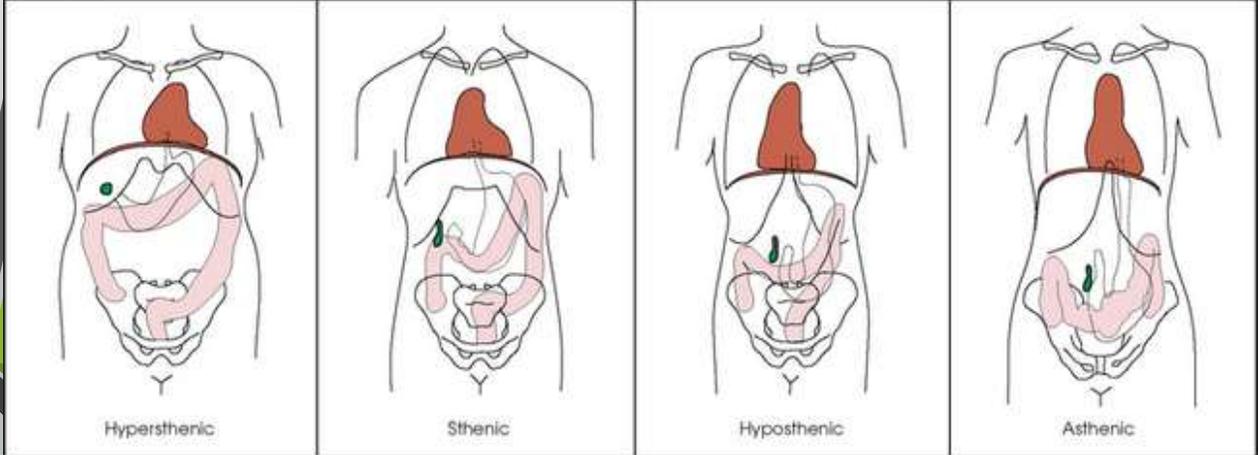
Anatomic Regions



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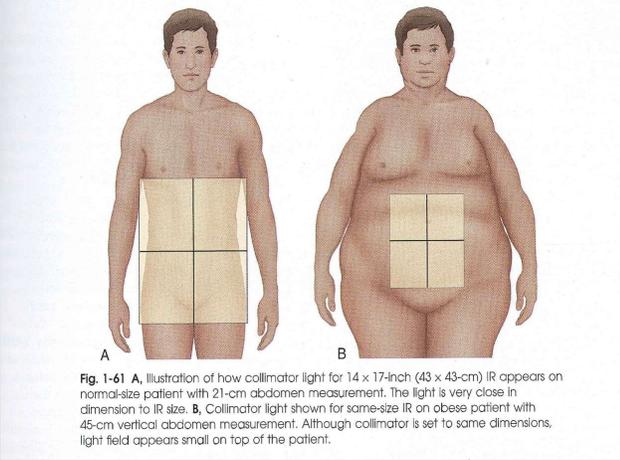
Body Habitus

Refer to Merrill's Vol. I page 59



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Body Habitus – Affect Within X-ray



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Radiographs

- Usually need at least **two** views
 - 90 degrees from one another due to anatomical superimposition
- Minimum 3 projections, when joints are prime area of interest
 - AP or PA
 - Oblique
 - Lateral



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Radiographs

Radiolucent vs.
Radiopaque



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Technique Books



DIAGNOSTIC RADIOLOGY TECHNIQUE CHART

CREATED BY: THE X-RAY CI

BODY PART	TECHNIQUE	GRID (Y/N)	PART THICKNE
PA Finger	55 KVP 2 MAS	NO	4 CM
PA Hand	55 KVP 5 MAS	NO	6 CM
PA Wrist	55 KVP 5 MAS	NO	7 CM

- Includes the proper techniques that should be utilized for various procedures
- Located in all radiographic rooms, as well as on the portables

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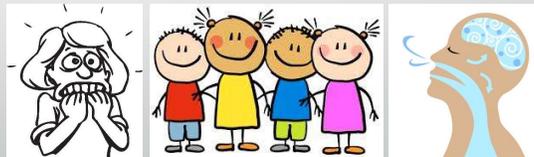
Patient Movement

Involuntary

- Peristalsis
- Heart pulsation
- Chill
- Tremor
- Spasm
- Pain

Voluntary

- Nervousness
- Fear
- Discomfort
- Excitability
- Mental illness
- Age
- Breathing



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Identification of Radiographs

Must include:

- Date
- Patient name and ID number
- Institution identity
- Right or Left marker



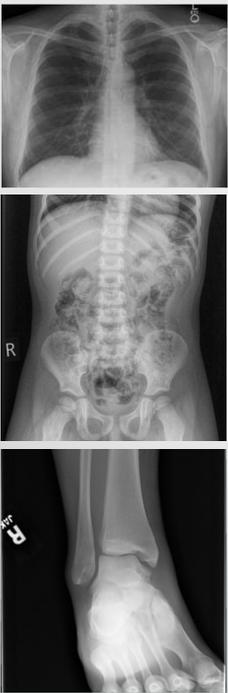
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Anatomic Markers



- Required by medicolegal requirements
- Typically made of lead and are included in the radiograph
- Right and left side of patient must be properly marked
 - Writing a R or L on the image post processing is not acceptable
 - Not recommended to electronically place an R or L due to error and legal implications
 - Exceptions are projections performed

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The image displays three X-ray views illustrating marker placement. The top view is a chest X-ray with a marker 'D' at the top edge. The middle view is an abdominal X-ray with a marker 'R' on the left side. The bottom view is an ankle X-ray with a marker 'R' on the left side. The markers are placed on the edge of the collimation border, outside of lead shielding, and do not obscure anatomy or patient ID.

Basics of Marker Usage

- Always placed on the edge of the collimation border
- Always be placed outside of lead shielding
- Must be used, even on CR & DR
- Never obscure anatomy
- Never placed over patient ID

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