

MI123: Clinical Seminar I

Lecture #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



How Do X-Rays Work?



4 requirements for production of x-rays:

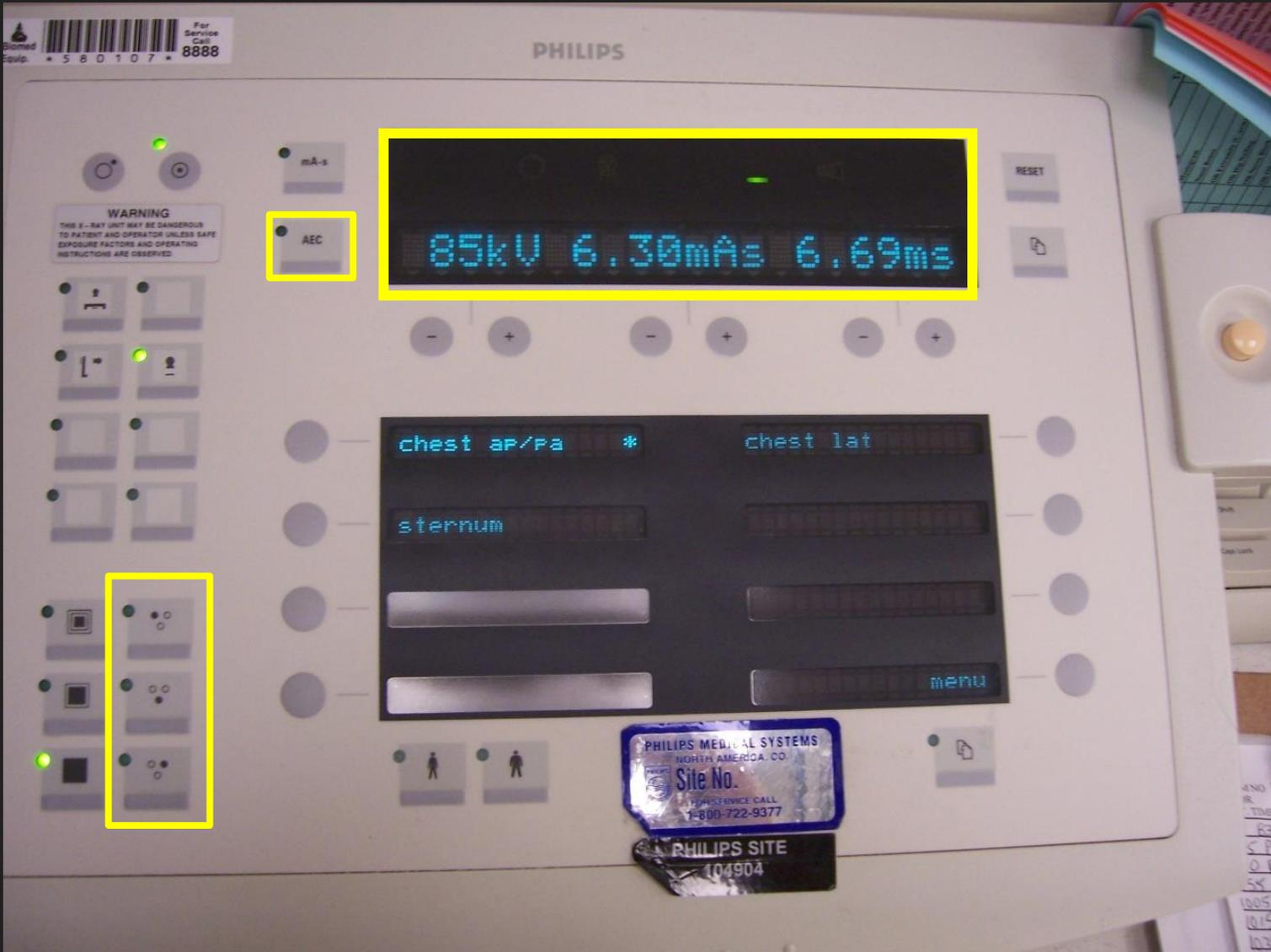
- Vacuum (tube housing)
- Source of electrons (filament)
- Method to accelerate the electrons (voltage) rapidly
- Method to stop the electrons (target)

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

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 (milliamperere seconds)
 - mA X seconds= 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





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

Image Receptor (IR)



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

○ *Film-Screen*

○ *Digital Cassette Systems (CR)*

○ *Solid State Digital Detector (DR)*

○ *Fluoroscopy Screen*

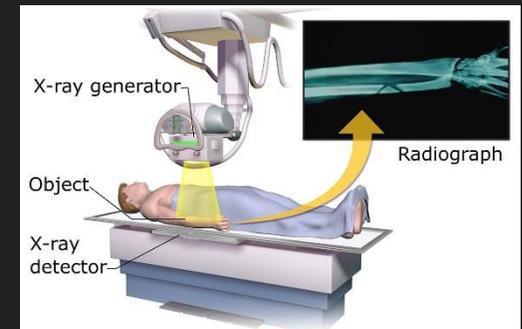
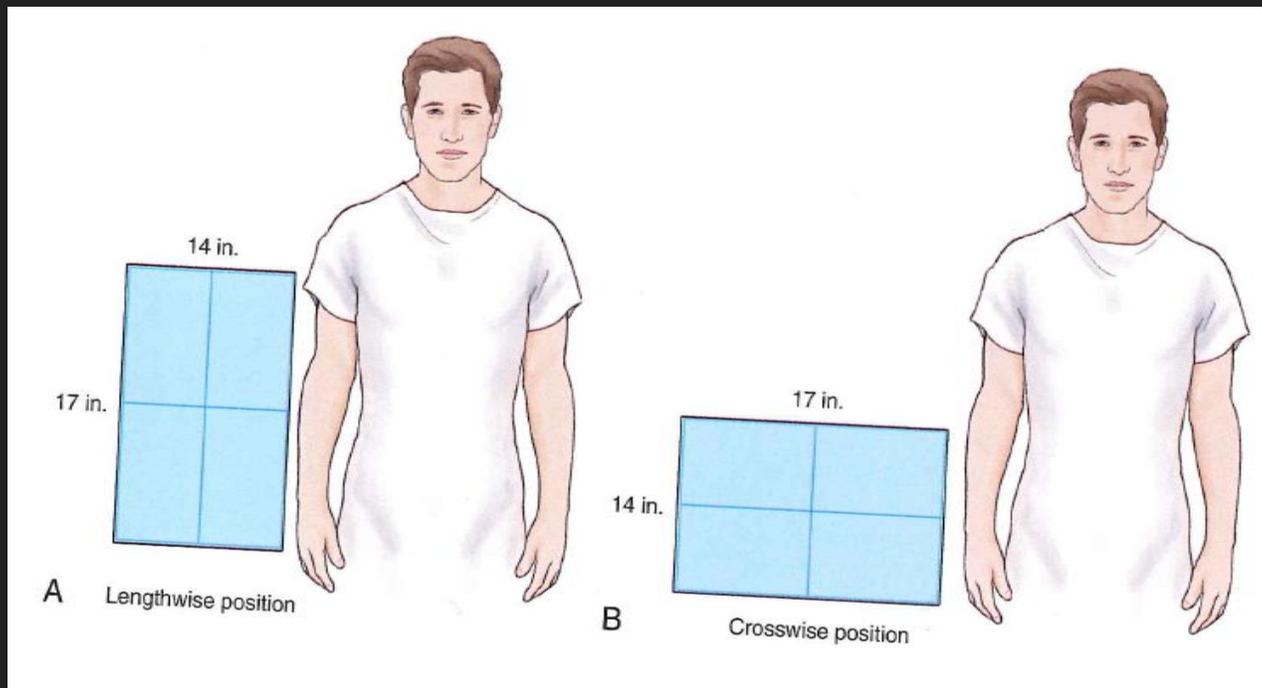


Image Receptor Orientation & Size



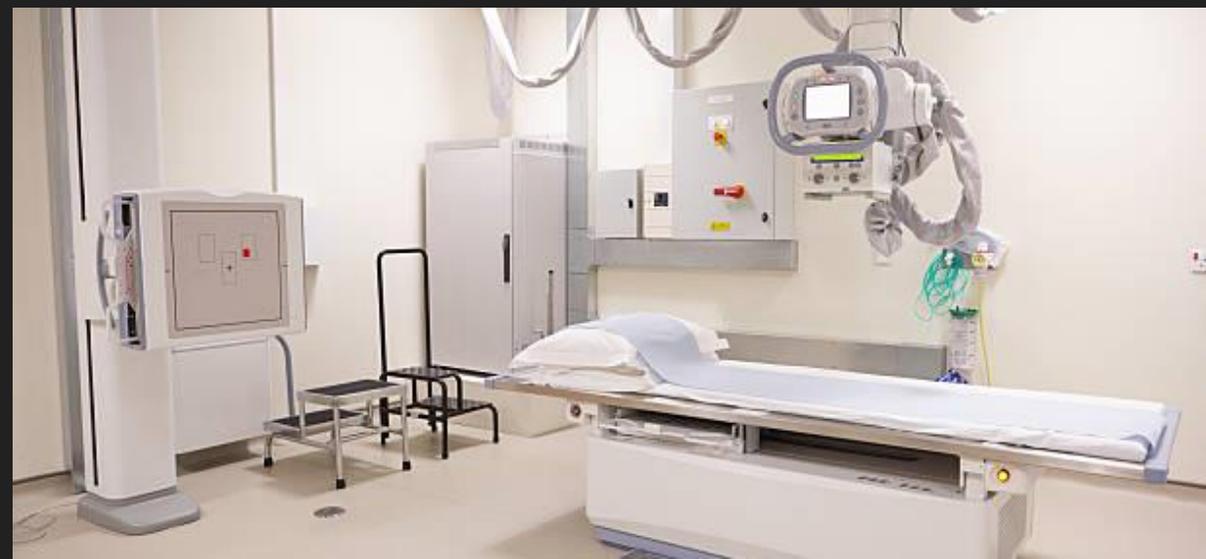
Portrait

Landscape

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

Table

- Motor Driven/Manual/Floating
- Characteristics of a table:
 - Must allow X-rays to pass through
 - Easily Cleaned
 - Hard to Scratch
 - Without Crevices
- Fixed or Tilting
 - 90-90, 90-45, +90/-20



Tube Supports/Terminology

Upright Units

- Upright image receptor
- Ancillary piece of equipment



Overhead Tube Suspension

- Also known as **ceiling suspension**
 - Most flexible
 - Most costly



Floor-to-Ceiling

- ⦿ Rails on floor and ceiling
- ⦿ Longitudinal positioning



Floor Suspension

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



C-Arm Equipment

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



Portable Equipment

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



Specialized Diagnostic Equipment

Mammography



Tomography

Tube and image receptor move during the exposure to blur out the surrounding areas

Focuses on anatomy of interest



Head Units

Used to perform Erect headwork procedures



Panoramic Dental & Facial Units



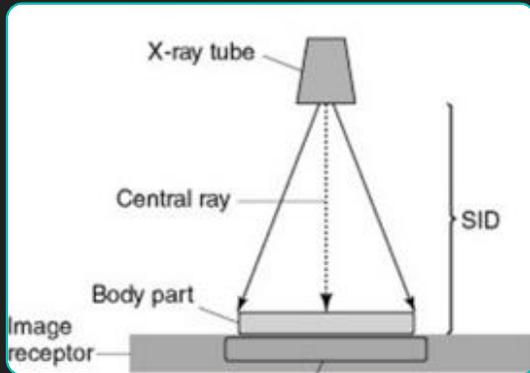
Computed Tomography (CT)



Radiation Therapy Simulators

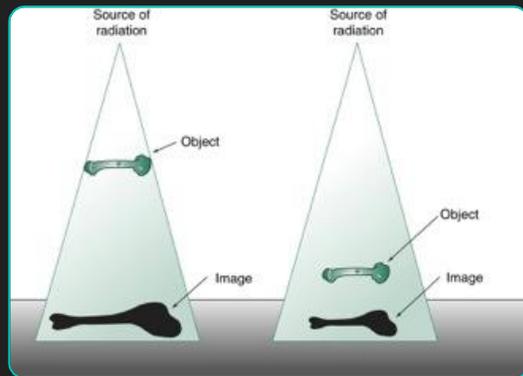


Additional Terminology



○ SID (Source to Image Distance)

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

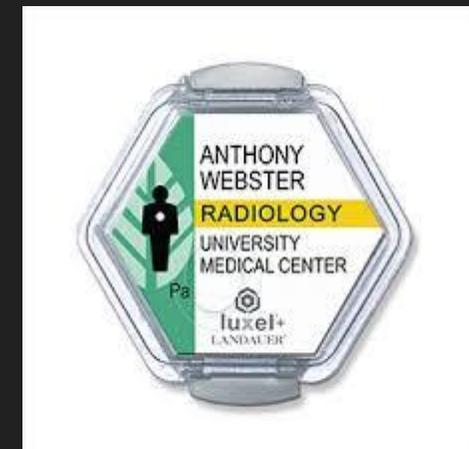


○ OID (Object to Image Distance)

- 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

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>

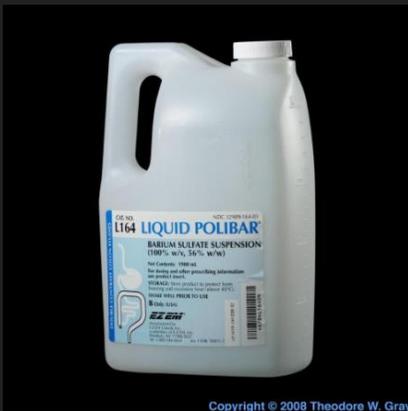
Radiation Protection

- Shields
 - Self/others
 - Patients
 - Placement considerations

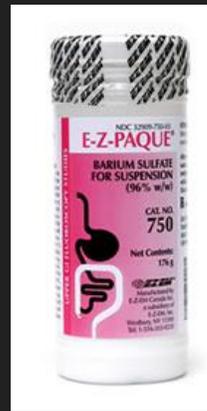


Contrast Media

- 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



Emergency Malfunctions



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

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



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>



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



Donning/Removal Sequence

Donning

- Gown
- Mask
- Goggles
- Gloves



Removal

- Gloves
- Goggles
- Gown
- Mask

Transmission- Based precautions

- Airborne
 - Droplet
 - Contact
 - RH has Additional Hand and Environmental Contact Precautions
 - *Enhanced Precautions (COVID-19)
- OR
- Applied when a patient is infected with a pathogenic organism or a communicable disease
 - When patient is at risk of becoming infected, such as immunosuppressed

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

IN ADDITION TO STANDARD PRECAUTIONS
ADEMÁS DE LAS PRECAUCIONES ESTÁNDAR

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

BEFORE ENTERING ROOM
ANTES DE INGRESAR A LA HABITACIÓN

Perform Hand Hygiene
Desinfectese las manos

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

EVERYONE ENTERING THE ROOM MUST WEAR:
TODAS LAS QUE INGRESEN A LA HABITACIÓN DEBEN UTILIZAR

Isolation Gown
Una bata de aislamiento

Clean Gloves
Guantes limpios

Limit Patient Transport
Limite el transporte del paciente

BEFORE LEAVING ROOM
ANTES DE SALIR DE LA HABITACIÓN

Remove Gloves then Gown
Sáquese los guantes y después la bata

Perform Hand Hygiene
Desinfectese las manos

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

IN ADDITION TO STANDARD PRECAUTIONS
ADEMÁS DE LAS PRECAUCIONES ESTÁNDAR

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

BEFORE ENTERING ROOM
ANTES DE INGRESAR A LA HABITACIÓN

Perform Hand Hygiene
Desinfectese las manos

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

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

Mask
Mascarillas

Limit Patient Transport
Place Mask on Patient During Transport
Limite el transporte del paciente
Colóquese una mascarilla al paciente al transportarlo

BEFORE LEAVING ROOM
ANTES DE SALIR DE LA HABITACIÓN

Remove Mask
Quitese la mascarilla

Perform Hand Hygiene
Desinfectese las manos

Airborne Isolation

Need an **N95 mask & hand hygiene**

○ For the following:

○ TB

○ Rubella (Measles)

○ Varicella (Chickenpox)

○ Fever with a rash of unknown origin

○ Disseminated shingles

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

IN ADDITION TO STANDARD PRECAUTIONS
ADEMÁS DE LAS PRECAUCIONES ESTÁNDAR

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

BEFORE ENTERING ROOM
ANTES DE INGRESAR A LA HABITACIÓN

Perform Hand Hygiene
Desinfectese 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 INGRESE A LA HABITACIÓN DEBE UTILIZAR:

N95 Respirator
Quite el respirador N95

Limit Patient Transport
Place Mask on Patient During Transport
Limite el transporte del paciente. Colóquese una mascarilla al paciente al transportarlo

VISITORS ENTERING THE ROOM MUST WEAR:
LOS VISITANTES QUE INGRESEN A LA HABITACIÓN DEBEN UTILIZAR:

Surgical Mask
Mascarillas Quirúrgicas

BEFORE LEAVING ROOM
ANTES DE SALIR DE LA HABITACIÓN

Perform Hand Hygiene
Desinfectese las manos

AFTER LEAVING ROOM
DESPUÉS DE SALIR DE LA HABITACIÓN

Close Door
Cierre la Puerta

Remove N95 Respirator/Surgical Mask
Quite el respirador N95

Additional Isolation Precautions

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

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



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 Proteccion para el Paciente
de Inmunidad Comprometida**
Visitas, Medicos, Enfermeras, y Personal General:
La Estacion de Enfermeras Contestara
sus Preguntas

1. Mantenga el paciente solo.
2. Estricto lavado de manos — antes y despues del cuidado del paciente.
3. Nadie sintiendose 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 traidas de la casa.

Enhanced Precautions

COVID – 19

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

- Airborne
- Contact
- Eye Protection

*N-95 Mask

ENHANCED DROPLET & CONTACT

PRECAUTIONS
(in addition to Standard Precautions)

PRECAUCIONES CONTRA PARTICULAS O GOTTAS
(ademas 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



Software Systems

Hospital Systems

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



- 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...

The screenshot displays the 'Technologist Work List' for 'RH RAD DX WORK LIST' with 12 patients and 16 appointments. The interface includes a toolbar with options like 'Refresh', 'View', 'Check In', 'In Room', 'Begin Exam', 'Egd Exam', 'Cancel/Undo', 'Notes', 'Study History', and 'Verify'. Below the toolbar, there are filters for 'Date' (4/15/2015) and 'Modality'. The main area is divided into two tables: 'High Priority Orders' and 'Schedule Orders'.

Status	Arrived	Date	Time	PT	E-Sig	Procedure
Arrived	04/15/	1:05 PM	N427-01			XR Abdomen Routine (Obstruction)
Arrived	04/15/	2:40 PM	N238-02			XR Chest PA Or Ap Portable
Arrived	04/15/	2:35 PM	D02-D02			XR Chest Pneumonia Protocol Pc
Arrived	04/15/	2:40 PM	R337-01			XR Chest PA Lateral
Arrived	04/15/	2:20 PM	A04-A04			XR Chest Pneumonia Protocol Pc
Arrived	04/15/	2:10 PM	B05-B05			XR Chest PA Or Ap Portable
Arrived	04/15/	2:35 PM	C11-C11			XR Chest PA Lateral
Arrived	04/15/	2:35 PM	R317-01			XR Abdomen Routine (Obstruction)
Sch	04/15/	7:30 PM				XR Knee Lt 3 Vws
Sch	04/15/	7:45 PM				XR Knee Rt 3 Vws
Sch	04/15/	5:15 PM				XR Femur Lt 2 Vws
Sch	04/15/	5:30 PM				XR Tibia Fibula Lt
Sch	04/15/	5:00 PM				XR Hip Lt Routine 2 Vws Or More
Sch	04/15/	5:15 PM				XR Finger Lt 2 Vws Or More
Sch	04/15/	4:15 PM				XR Hand Lt 3 Vws Or More
Sch	04/15/	4:30 PM		Tena, Thalia		XR Wrist Lt Routine 3 Vws Or More

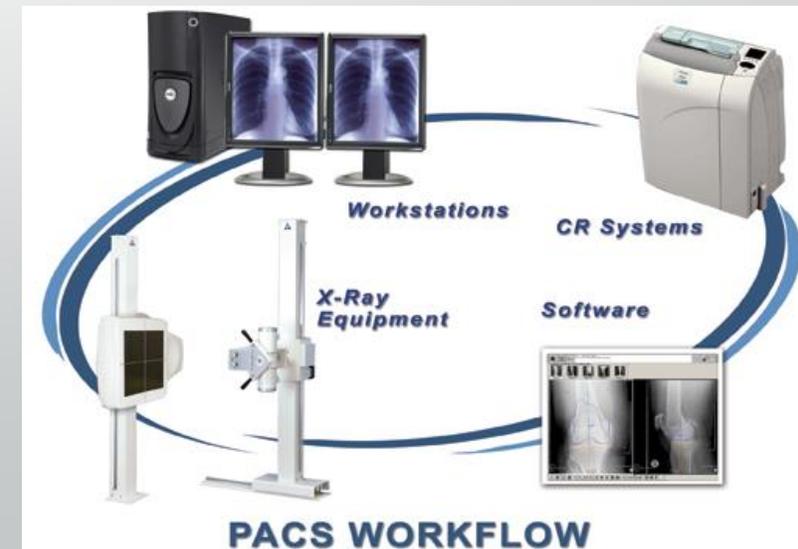
Order Date	Expected Date	P	PT CURRENT	Procedure
04/15/2015	04/15 1255		R413-01	XR Abdomen Ap
04/15/2015	04/15 1434		F13-F13	XR Chest PA Lateral
04/15/2015	04/15 1438		C09-C09	XR Chest PA Lateral Pneumor
04/15/2015	04/15 1257		D08-D08 (UJ...	XR Knee RT
04/15/2015	04/15 1333		C12-C12	XR Chest PA Lateral Pneumor
04/15/2015	04/15 1328		E07-E07	XR Chest PA Lateral
04/15/2015	04/15 1424		F14-F14	XR Abdomen Ap
04/15/2015	04/15 1256		A02-A02	XR Chest PA Lateral
04/15/2015	04/15 1338		E03-E03	XR Knee Lt 3 Vws
04/15/2015	04/15 1433		E210-01	XR Chest PA Lateral
04/15/2015	04/15 1348		A08-A08	XR Chest PA Lateral
04/15/2015	04/15 1349		A08-A08	XR Pelvis Ap Or Ap And Frog
04/15/2015	04/15 1349		A08-A08	XR Forearm Rt 2 Vws
04/15/2015	04/15 1350		A08-A08	XR Tibia Fibula Rt
04/15/2015	04/15 1404		A08-A08	XR Humerus Rt 2 Vws Or Mor
04/15/2015	04/15 1411			XR Chest PA Lateral
04/15/2015	04/15 1323		CHL-CHL	XR Chest PA Lateral
04/15/2015	04/15 1408			XR Chest PA Lateral Pneumor

At the bottom, there is a patient information section for MRN: 1116908 and DOB: 10/30/2004. It includes fields for 'ALERT: Not on file', 'Allergies: No Known Allergies', 'Height: 4' 7.98" (1.422 m)', and 'Weight: 76 lb 15.1 oz (34.9 kg)'. The interface also shows a 'Report: Default Report' and a 'Rx Request' button.

PACS

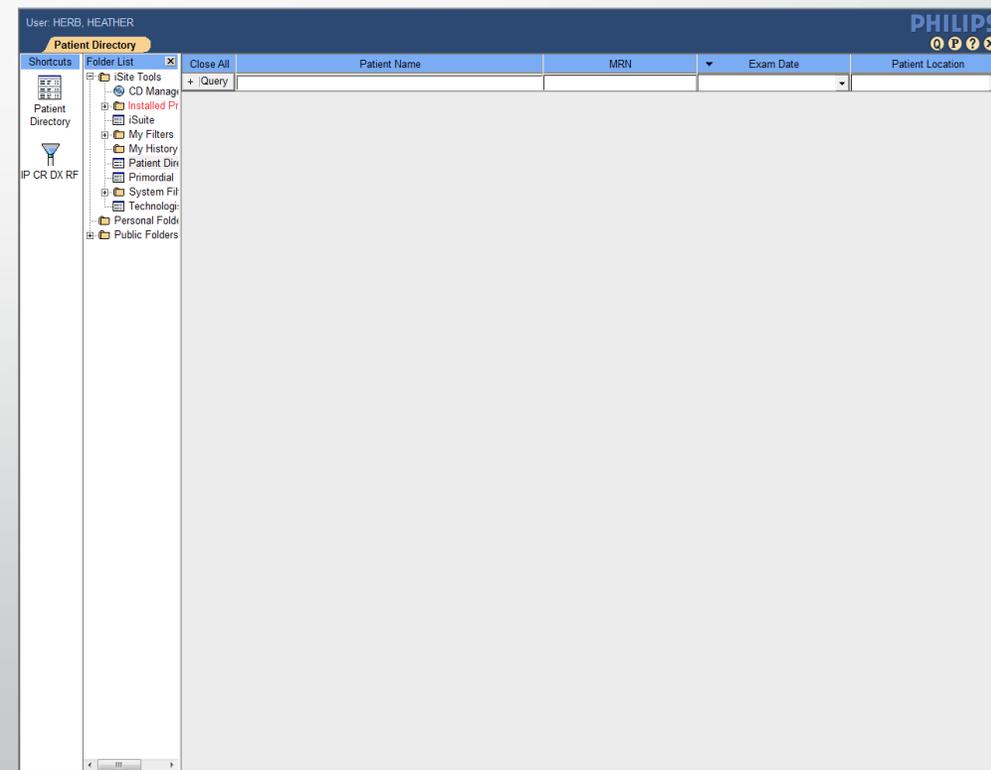
Picture Archiving and Communication System

- 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



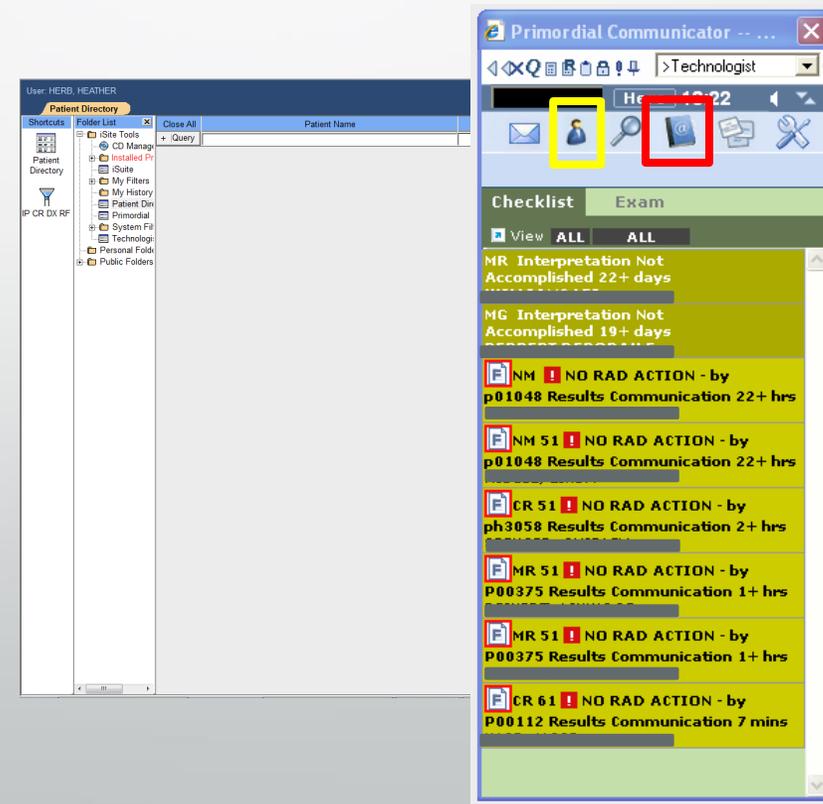
ISITE

- RH – PACS
- Radiologists view the images through iSite in order to provide a dictation
- Utilized to quality control (QC) your images before ending a procedure
- Review images after ending



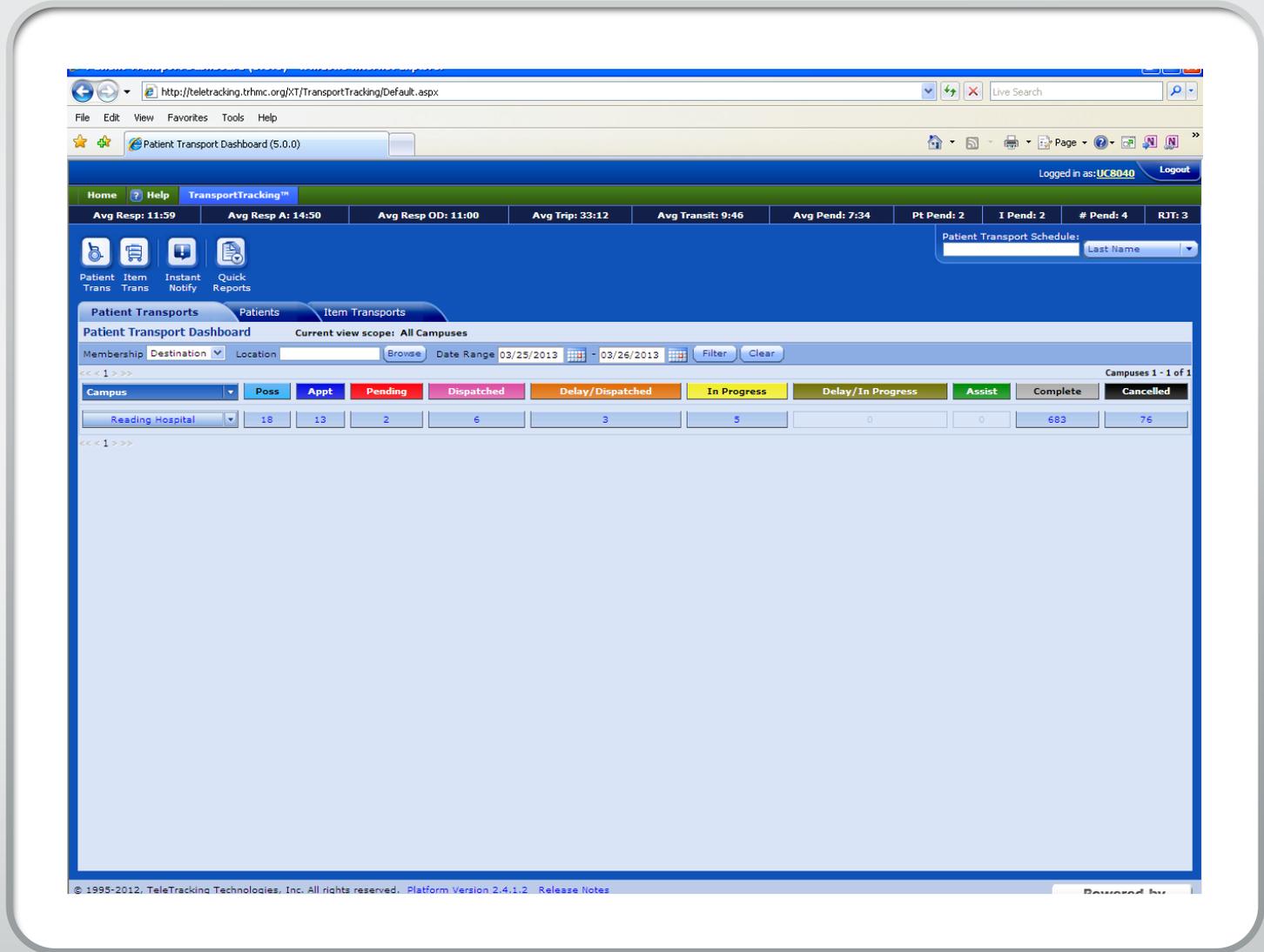
PRIMORDIAL Communicator

- Allows communication to occur between healthcare workers in the Radiology department
- Part of the iSite system
- Document verbal reports
- Radiology protocols
- Radiology Policies
- Radiology phone list
- EPIC guides
- Locate Radiologist/Others signed on to iSite



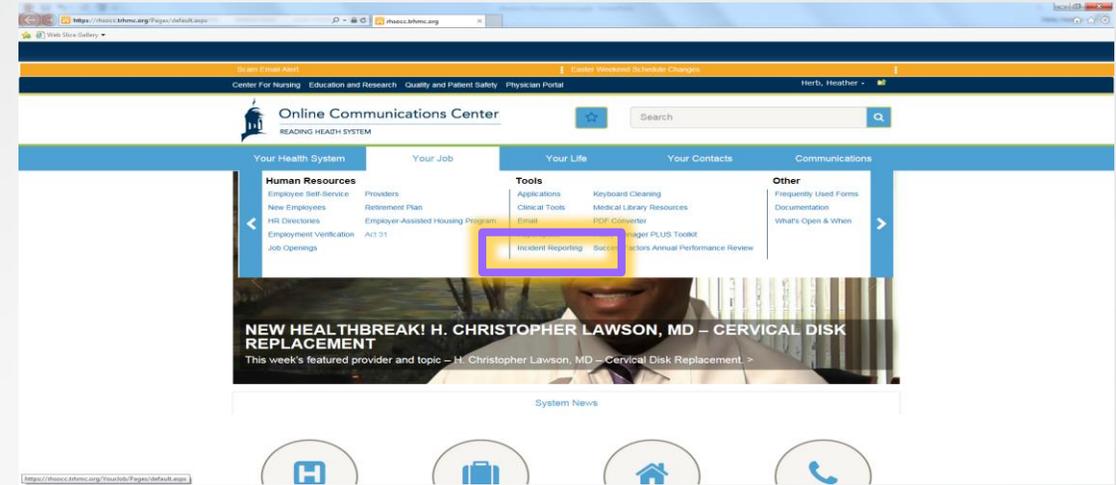
Teletracking

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



RL Solutions

- Online incident reporting
- Risk Management

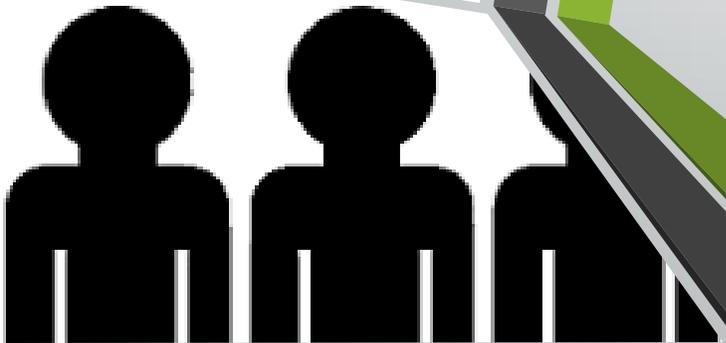


Vocera



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

**Since it is wireless be aware of HIPAA



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******

The image features a dark grey background with abstract geometric shapes. On the left side, there are several overlapping shapes in a vibrant green color, some with white outlines, creating a sense of depth and movement. The text 'Imaging Fundamentals' is centered in the right half of the image in a clean, white, sans-serif font.

Imaging Fundamentals

Anatomical Position

Individual looking at the radiograph is in the same position as the x-ray tube.

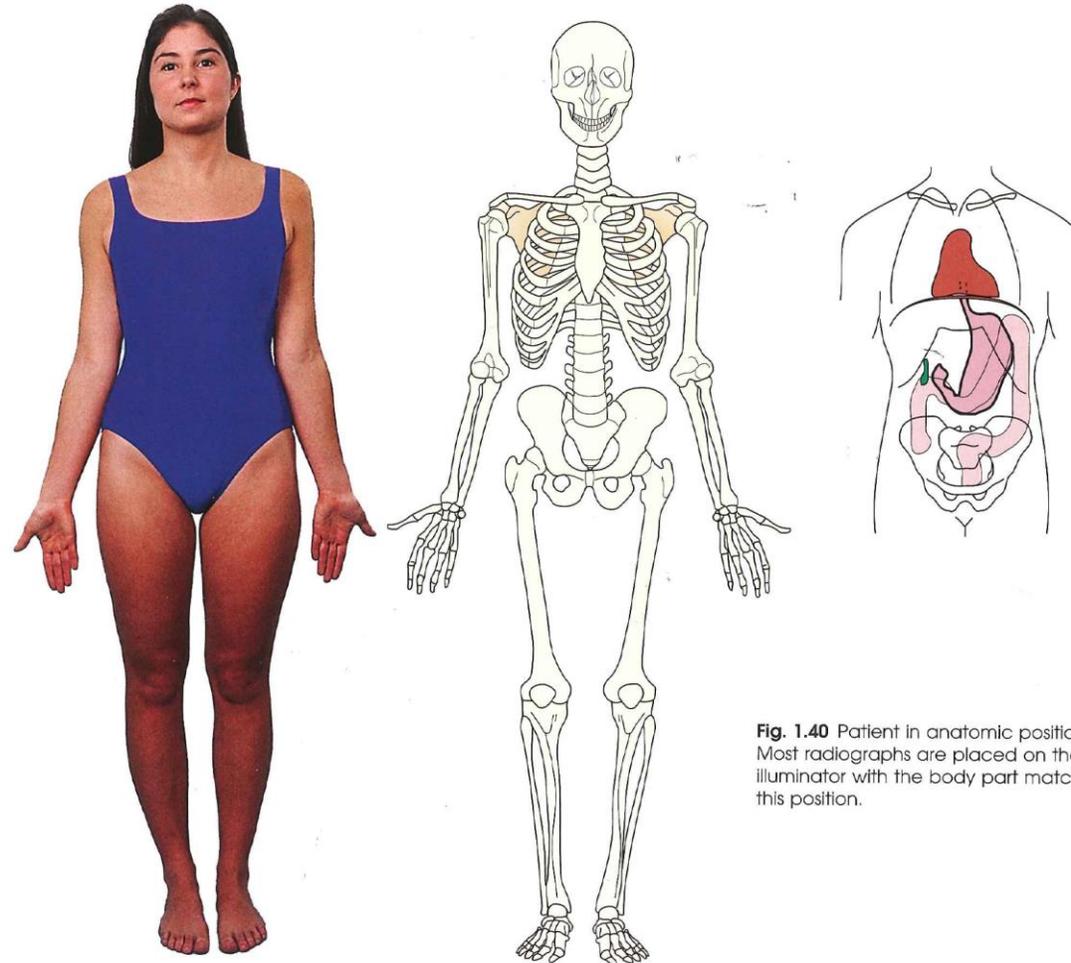


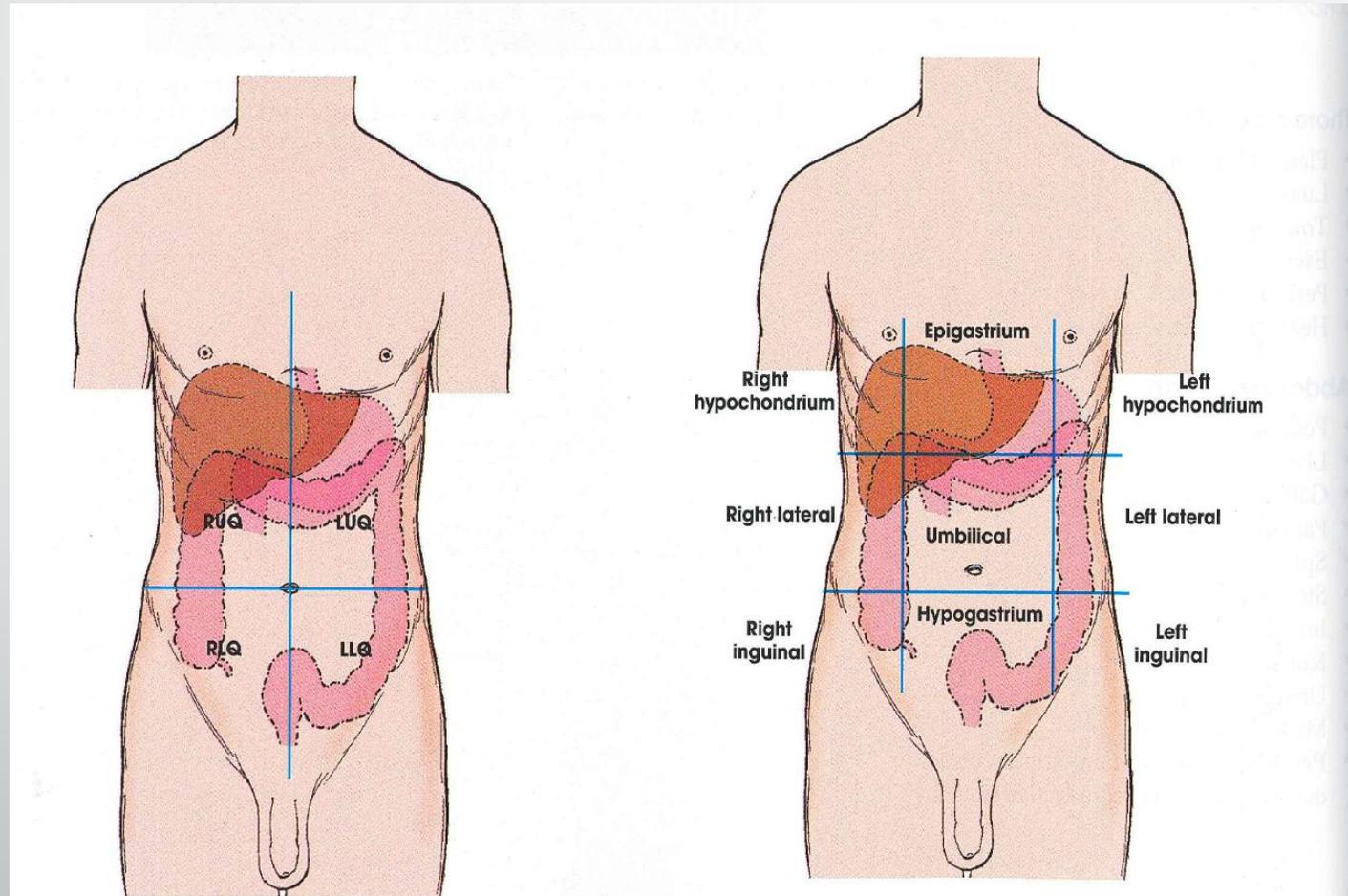
Fig. 1.40 Patient in anatomic position. Most radiographs are placed on the illuminator with the body part matching this position.

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



Anatomic Regions

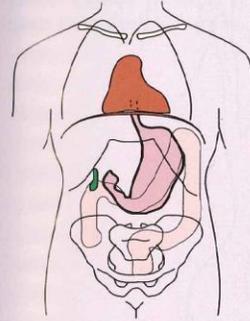


Body Habitus

BOX 2.1

Four types of body habitus: prevalence, organ placement, and characteristics

Sthenic, 50%



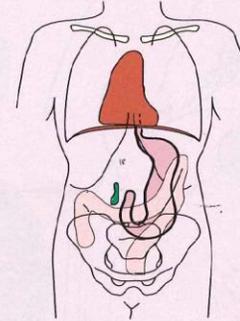
Organs

Heart: Moderately transverse
Lungs: Moderate length
Diaphragm: Moderately high
Stomach: High, upper left
Colon: Spread evenly; slight dip in transverse colon
Gallbladder: Centered on right side, upper abdomen

Characteristics

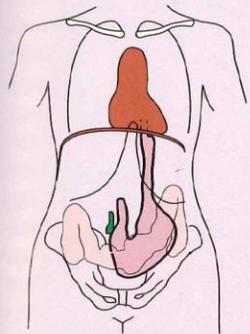
Build: Moderately heavy
Abdomen: Moderately long
Thorax: Moderately short, broad, and deep
Pelvis: Relatively small

Hyposthenic, 35%



Organs and characteristics for this habitus are intermediate between sthenic and asthenic body habitus types; this habitus is the most difficult to classify.

Asthenic, 10%



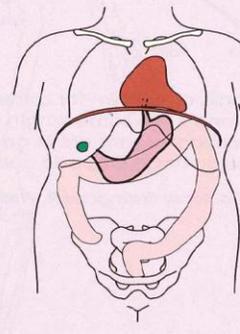
Organs

Heart: Nearly vertical and at midline
Lungs: Long, apices above clavicles, may be broader above base
Diaphragm: Low
Stomach: Low and medial, in the pelvis when standing
Colon: Low, folds on itself
Gallbladder: Low and nearer the midline

Characteristics

Build: Frail
Abdomen: Short
Thorax: Long, shallow
Pelvis: Wide

Hypersthenic, 5%



Organs

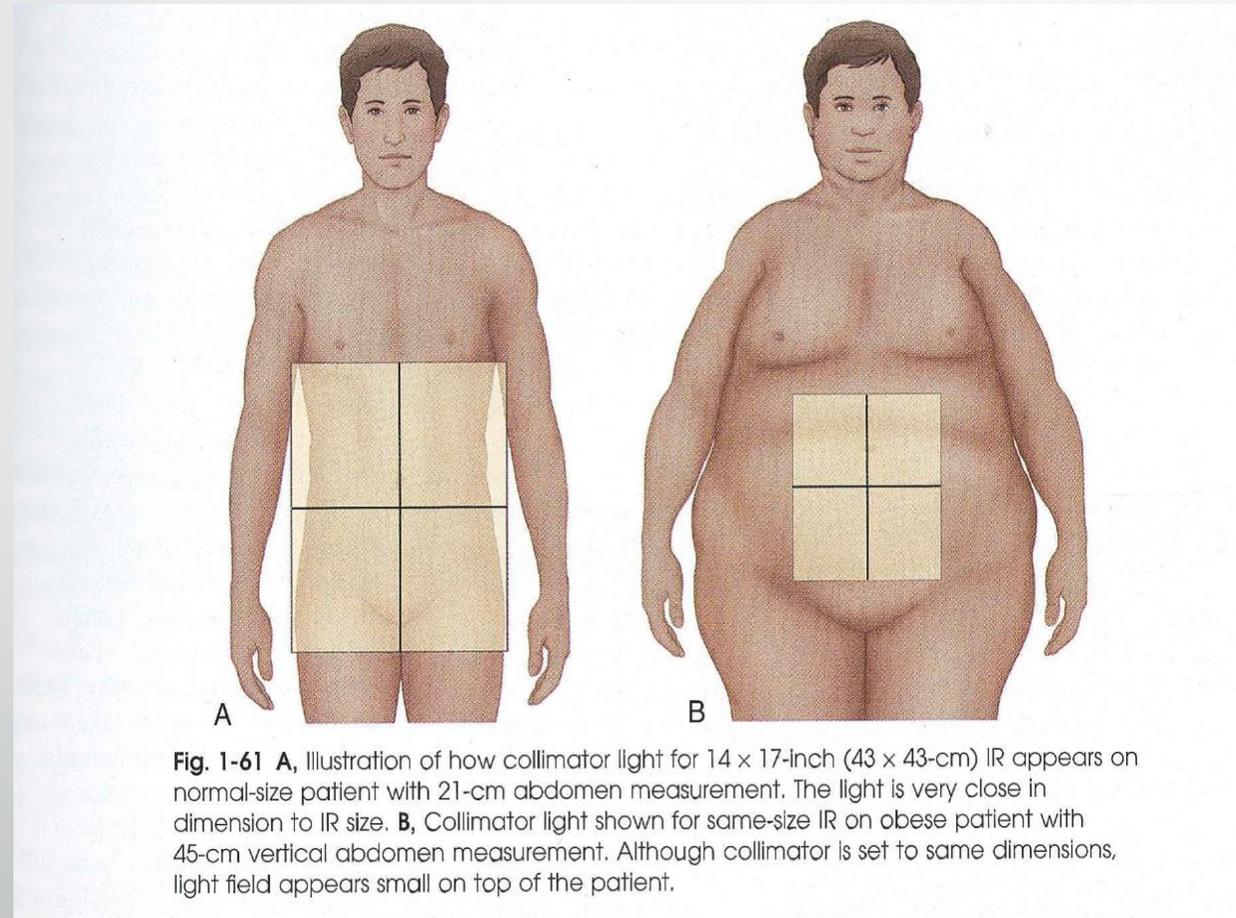
Heart: Axis nearly transverse
Lungs: Short, apices at or near clavicles
Diaphragm: High
Stomach: High, transverse, and in the middle
Colon: Around periphery of abdomen
Gallbladder: High, outside, lies more parallel

Characteristics

Build: Massive
Abdomen: Long
Thorax: Short, broad, deep
Pelvis: Narrow

Note the significant differences between the two extreme habitus types (i.e., asthenic and hypersthenic). The differences between sthenic and hyposthenic types are less distinct.

Body Habitus – Affect Within X-ray



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

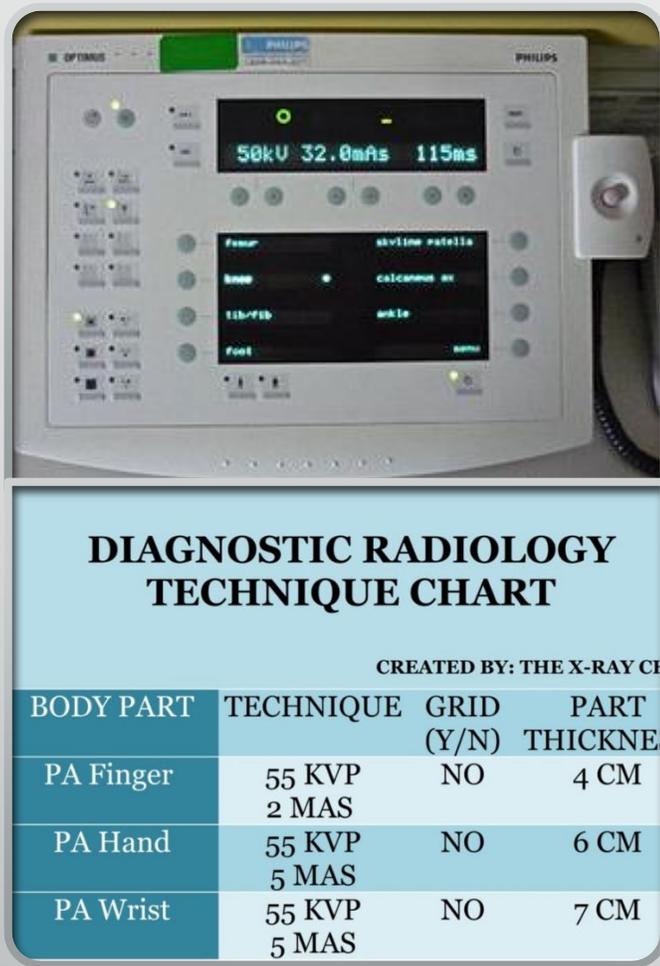




Radiographs

Radiolucent vs.
Radiopaque

Technique Books



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

Patient Movement

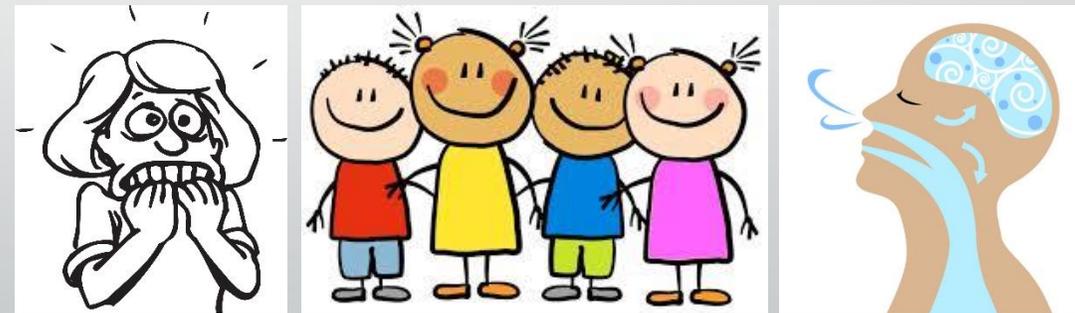
Involuntary

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



Voluntary

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



Identification of Radiographs

Must include:

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

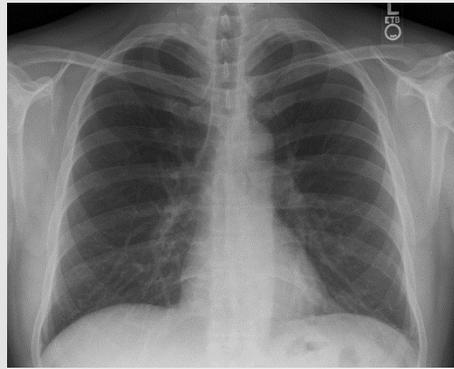


Anatomic Markers



- 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

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