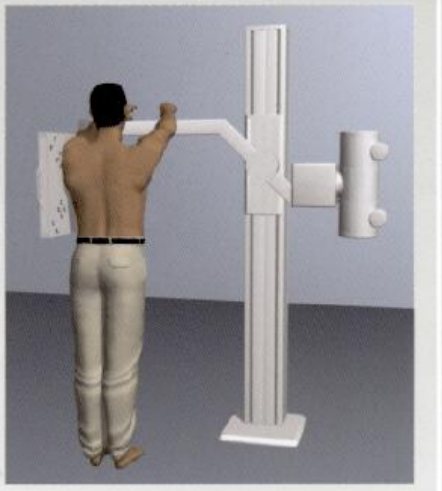
The WHO manual of diagnostic imaging

RADIOGRAPHIC TECHNIQUE AND PROJECTIONS



World Health Organization
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The WHO manual of diagnostic imaging

Radiographic Technique and Projections

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Foreword

Modern diagnostic imaging offers a vast spectrum of modalities and techniques, which enables us to study the function and morphology of the human body in details that approaches science fiction.

However, it should be noted that even in the most advanced Imaging Department in the economically privileged parts of the world, 70–80% of all clinically relevant questions may be solved by using the two main *cornerstones* of diagnostic imaging, which are Radiography (X-ray) and Ultrasonography.

It should also be remembered that thousands of hospitals and institutions worldwide do not have the facilities to perform even these fundamental imaging procedures, for lack of equipment and/or diagnostic imaging skills.

Therefore, WHO in collaboration with the International Commission for Radiologic Education (ICRE) of the International Society of Radiology (ISR) is creating a series of "*WHO Manuals of Diagnostic Imaging*", developed under the umbrella of the Global Steering Group for Education and Training in Diagnostic Imaging. Among the members of this group are the major regional and global societies involved in Diagnostic Imaging, including the International Society of Radiology (ISR), the International Society of Radiographers and Radiological Technologists (ISRRT), and the World Federation for Ultrasound in Medicine and Biology (WFUMB).

The full series of manuals will primarily cover the examination techniques and interpretation of Radiography, in a later stage also Ultrasonography. The manuals are meant for health care personnel who in their daily work are responsible for producing and interpreting radiographs, be they radiologists or other medical specialists, general practitioners, or radiological technologists working in rural areas.

The manuals are authored by authorities in the specific fields dealt with within each manual, and supported by a group of collaborators who together cover the experience, knowledge and needs, which are specific for different regions of the world.

It is our sincere hope that the manuals will prove helpful in the daily routine, facilitating the diagnostic work up and hence the treatment, to the best benefit for the patient and it is with great pleasure and anticipation we present to you, the readers, the next manual in this series: "*Radiographic Technique and Projections*".

Geneva, Switzerland and Lund, Sweden, May 2003

Harald Ostensen
Holger Pettersson

Preface

This manual on radiographic technique and projections, is a successor to the *Manual of Radiographic Technique* that was published in 1986 with Drs T Holm, P Palmer and E Lehtinen as authors, and was meant as a manual for the WHO Basic Radiological System—WHO-BRS. The present manual can be used with any equipment, but is especially designed for the use with X-ray machines that comply with the specifications for the World Health Organization Imaging System for Radiology, WHIS-RAD.

The *positioning* of the patient is illustrated with a computed animation technique, showing one male and one female patient that are meant to represent all ethnic groups in the world. Reasonable *cassette-screen-film combinations* are suggested, as well as *exposure values*, which have to be adjusted to local conditions. Each page contains a short recommendation of how to handle the patient, and it should, as a rule, be possible to perform the examination of the patient only following the illustrations and instructions on the relevant page. An acceptable, usually normal, *resulting X-ray image* is shown. Following the instructions, the result will be a standard projection that is easily repeated for comparison and easily understood by physicians and others trained to interpret radiographs.

The work with this manual has been done at the WHO Collaborating Centre in Lund, with the old BRS manual as base, and with a strong support from the whole Department of Diagnostic Imaging at the Lund University Hospital, as well as with input from members of the ISRRT and members of the International Commission on Radiologic Education (ICRE). The important input from Dr Thure Holm and Dr Philip Palmer should be noted. The devoted and highly professional and skillful work of the department photographer, Göran Eliasson, should be specifically acknowledged, and so should the work with the final lay-out, performed by Dr Kaj Knutson.

Lund and Riyadh, May 2003

Staffan Sandström

General principles for good radiographic practice

Equipment

Appropriate equipment, well maintained, is the basis for all good radiographic practice.

The present manual is primarily meant for the WHIS-RAD system (the World Health Imaging System for Radiology), but with appropriate modifications the instructions may be used with any type of adequate radiographic machines.

For a detailed description of the WHIS-RAD system, see page 113.

Maintenance and management

It is mandatory for good radiographic practice that the examination room with its X-ray equipment and accessories, as well as the dark room and the facilities to evaluate radiographs are in good condition. For a thorough description of management and maintenance, see the WHO Manual "Quality Assurance Work Book", Geneva 2001. (WHO/DIL/01.3)

Patient care

A radiographic examination is an integrated part of clinical management and care of a patient, and the same rules for good patient care apply for the radiographic personnel as for the rest of the clinical team.

Always give each patients a friendly greeting, treat them with care and respect their individuality.

Observe the medical/clinical instructions (concerning the patient's mobility, possible medication, etc.), given by the referring doctor.

Always make sure that the films are marked with correct name of the patient, date and name of the hospital.

And always remember: a professional, well-performed examination is good patient care.

Radiation protection

X-rays are potentially harmful, and should be used with care.

Care for the personnel and persons accompanying the patient:

- stand behind the control panel when the X-ray exposure is made.
- make sure that lead aprons are worn if the patient needs to be held.
- if possible, do not allow anyone else in the X-ray room. If other persons must be present, keep them behind the control panel when the exposure is made.
- when supplied, always wear your film badge. Have it checked regularly.

Care for the patient:

The radiation risk for the patients being x-rayed is very low because they are exposed to x-rays infrequently, and because only a small part of the body is exposed for each patient. Therefore, whenever there is a clinical reason for X-ray examination such an examination is justified and should be performed. However, always try to get all the details right the first time, so that there is no need for a second exposure.

The guiding rule for radiographic examinations must be the ALARA principle:

Radiation doses to everybody in or in the vicinity of an active X-ray room shall be As Low As Reasonably Achievable (ALARA) taking into account economic and social factors.

That rule will be kept if you follow what is said above in the general principles, and if you follow the instructions for examinations given in this manual.

And always remember:

X-RAYS MAY CAUSE HARM EVEN IF YOU DO NOT SEE OR FEEL THEM!

How to use the manual

The instructions in the present manual are meant to be self-explanatory. Each page displays one examination. Read through the text, look at the images, and follow the instructions given, step by step.

Techniques: BASIC or ADDITIONAL

All BASIC views must be taken whenever an examination is ordered.

ADDITIONAL views are taken only when:

(a) the condition of the patient does not permit a basic view; or

(b) the diagnostic information provided by the basic view is insufficient.

Position of the patient

ERECT	standing or sitting up,
SUPINE	lying on the back,
PRONE	lying on the stomach,
DECUBITUS	lying on the side,
OBLIQUE	turned a little, usually at a given angle,
LATERAL	standing or sitting or lying with one side close to the cassette or cassette holder.

X-ray beam direction: AP or PA

AP = Antero–Posterior (front to back) and

PA = Posterior–Anterior (back to front)

indicates the direction of the X-ray beam through the patient onto the cassette.

Instructions on each page

The position of the X-ray equipment.

The cassette size and nominal speed of the screen-film combination (see below).*

When appropriate to use Right or Left marker.

Recommendation to collimate (the X-ray field).

Exposure factors (see below).**

The position of the patient.

An example of resulting radiograph.

* *Film speed and cassettes*

The speed of the screen-film combination should be written on the cassettes.

In the **"blue" system** (calcium-tungstate and rapid yttrium-tantalate screens) the nominal speed is equal to the actual speed at any kV value. In the manual, the used speeds of the screen-film combinations are 50 and 200 for the "blue" system.

In the **"green" system** (gadolinium-oxysulfide) the actual speed varies with the kV value, low speed at low kV values, nominal speed at 70–75 kV and a little higher speed at higher kV values. In the manual, the used speeds of the screen-film combinations are 100, 200, and 400 for the "green" system. Actual speed is shown for different kV values as nominal speed/actual speed, for example 100/63 and 400/500.

In a few cases a loose grid is recommended, but a grid cassette is preferable.

** *Exposure factors*

The presented exposure values are based on a standard **WHIS-RAD installation**, with a focus-film distance (FFD) of 140 cm, a fixed Pb/Al grid (with a ratio of 10:1 and 40 lines/cm focused at 135–140 cm) built into the cassette holder. Where shown, the cassette is placed outside the cassette holder, adjacent to the body part examined.

The exposure factors are based on a **"reference man"** with a height of 180 cm (6 feet) and a weight of 80 kg (175 lbs).

Note that the exposure factors also are dependent on the brand of screens, brand of films, and the film processing. The values have to be locally adjusted.

Exposure factors for **children** are very difficult to give, depending on the different shape of children with the same weight or age. Approximate values are given but have to be individually adjusted.

The **kV** value will determine the contrast in the image.

The **mAs** value will determine the image blackening.

For detailed **exposure tables**, see chapter 11.

Chest

LUNGS AND HEART

Patients able to stand

1. Chest PA, page 6.
2. Chest lateral, page 7.

Patients unable to stand but able to sit

3. Chest AP, page 8.
4. Chest lateral, page 9.

Patients lying down, unable to stand or sit

5. Chest AP, page 10.

Other additional views

6. Chest apical (lordotic) AP, page 11.
7. Chest lateral decubitus AP or PA, page 12.

RIBS

A Chest PA 1, or a Chest AP 3, or a Chest AP 5, as described above must always be taken first.

Patients able to either stand or sit

8. Ribs oblique AP, page 13.
   Two views to be taken

Patients lying down, unable to stand or sit

9. Ribs oblique AP, page 14.

INFANTS WEIGHING UP TO 10–15 kg – LUNGS AND HEART

10. Chest AP erect, page 15.
11. Chest AP supine, page 16.

CHEST PA Standing erect BASIC

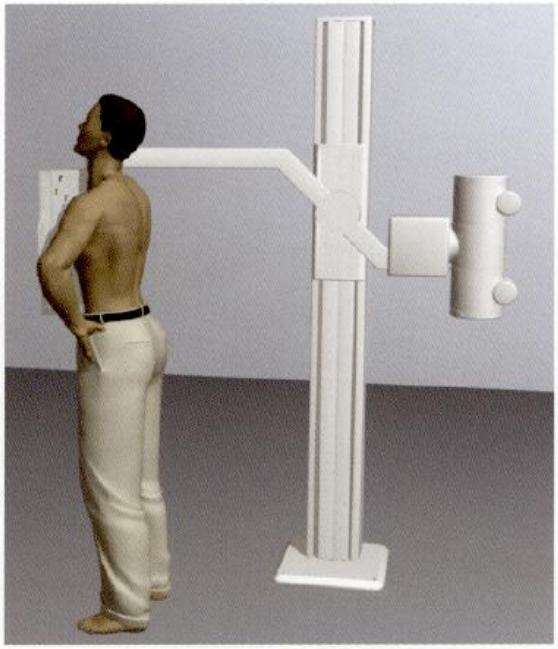
Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

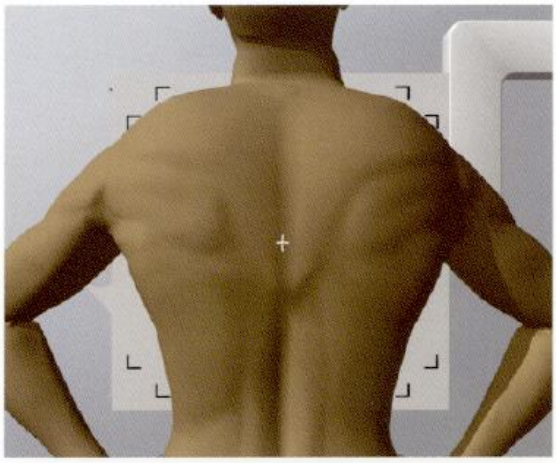
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
24×30 cm (10×12 inches) for a child
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	120	2–2.5	1–12
Child	90	1.6–2	1–4

1. Bring in the patient, decide the cassette format and put the cassette in the cassette holder. Collimate to that format.
2. Position the patient, make sure the patient's shoulders are well pressed forward. Collimate further, if possible.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.

For INFANTS weighing less than 10 and SMALL CHILDREN 15 kg, see CHEST 10 or CHEST 11.





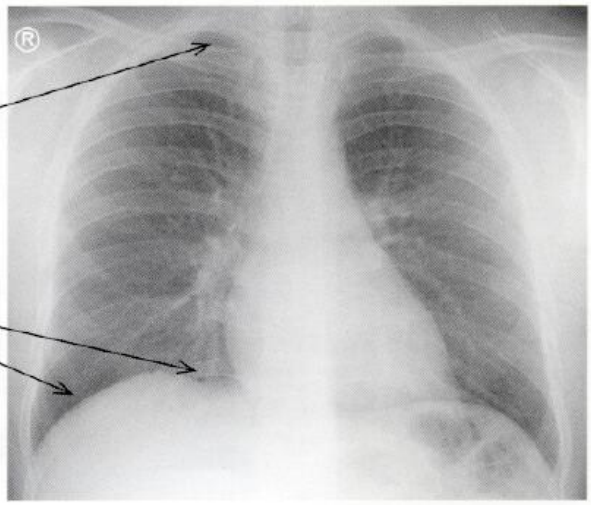
Comments

The top of the lungs must be visible.

The exposure shall be made at full inspiration: rib 10 shall be visible posteriorly above the diaphragm and rib 6 anteriorly.

Make sure that the lower parts of the diaphragm is visible on both sides, including both costophrenic angles.

The lung structure and the spine must be discernible (seen) behind the heart.



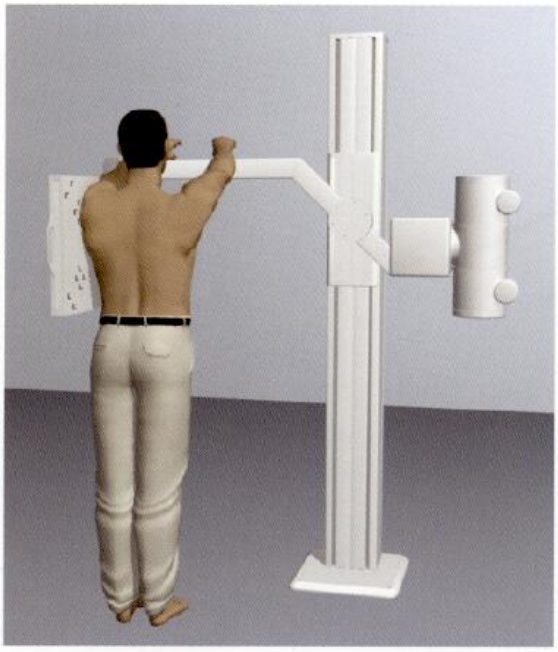
CHEST LATERAL Standing erect – left (or right) BASIC

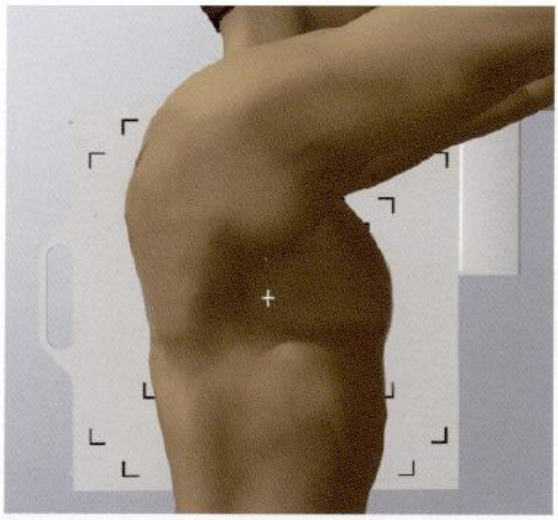
Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

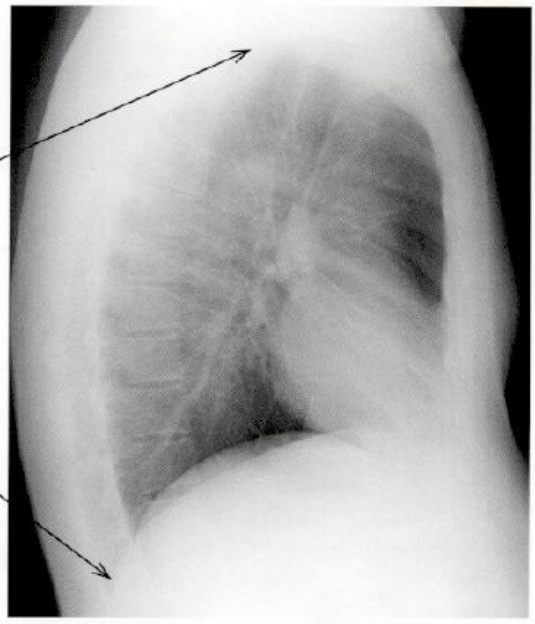
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
24×30 cm (10×12 inches) for a child

Exposure values	kV	mAs average	mAs range
Adult	120	4–5	2–16
Child	90	2.5	1–5

1. Bring in the patient, decide the cassette format and put the cassette in the cassette holder. Collimate to that format.
2. Position the patient,(normally left lateral as shown). The patient should be upright or leaning slightly forwards, not backwards. Use the cassette holder arm for support. Collimate further, if possible.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.







Comments

The top of the lungs must be visible.

Straight lateral view of the sternum

Make sure that the lower parts of the diaphragm is visible.

CHEST AP Sitting erect

on a stool or trolley – only used when the patient is unable to stand

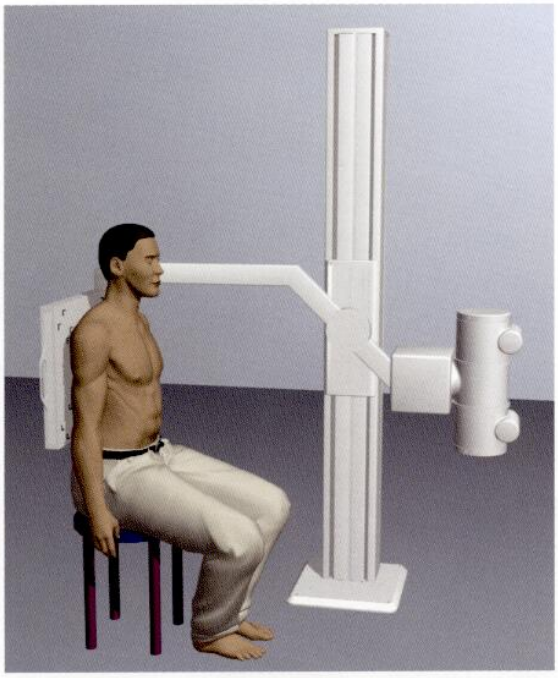
Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

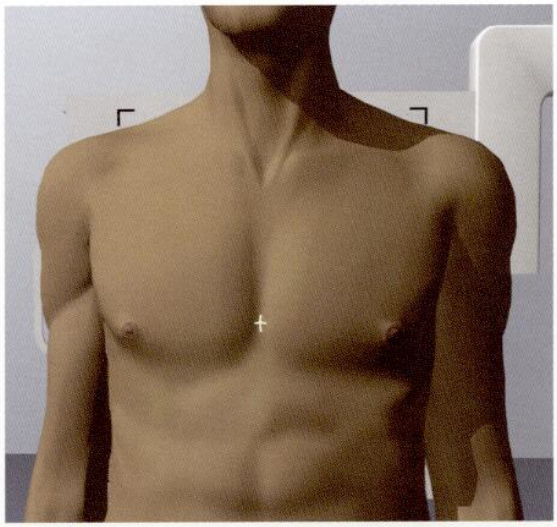
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
24×30 cm (10×12 inches) for a child
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	120	2–2.5	1–12
Child	90	1.6–2	1–4

1. Bring in the patient, decide the cassette format and put the cassette in the cassette holder. Collimate to that format.
2. Position the patient, make sure the patient is sitting erect! Collimate further, if possible.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.

For INFANTS weighing less than 10 and SMALL CHILDREN 15 kg, see CHEST 10 or CHEST 11.





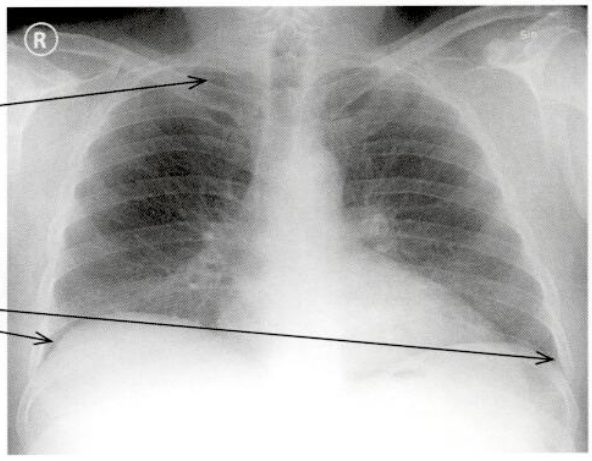
Comments

The top of the lungs must be visible.

The exposure shall be made at full inspiration.

Make sure that the lower parts of the diaphragm is visible on both sides, including both costophrenic angles.

The lung structure and the spine must be discernible (seen) behind the heart.



CHEST LATERAL Sitting erect – left (or right)

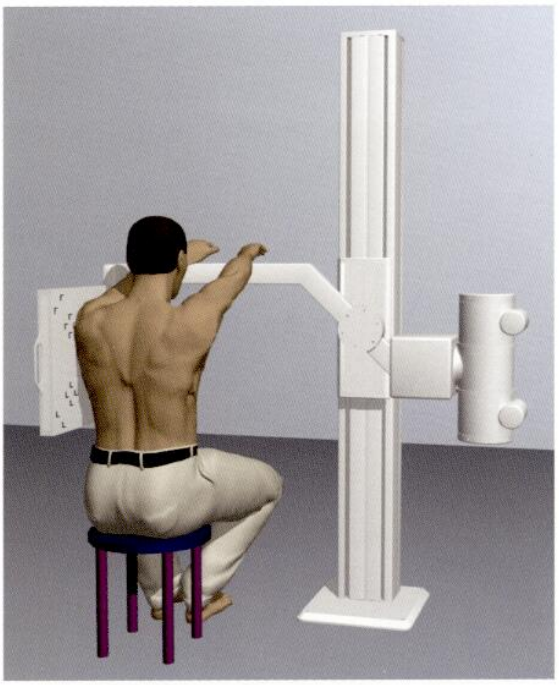
on a stool or trolley – only used when the patient is unable to stand

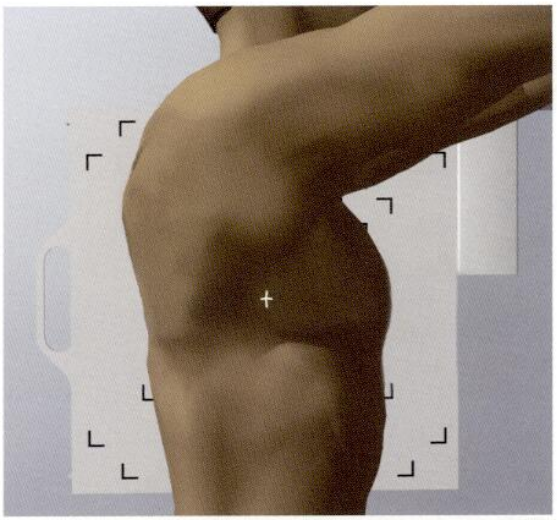
Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

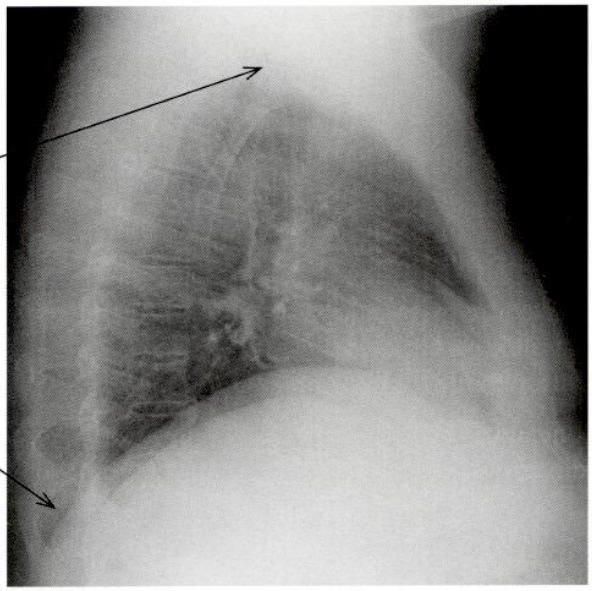
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
24×30 cm (10×12 inches) for a child

Exposure values	kV	mAs average	mAs range
Adult	120	4–5	2–16
Child	90	2.5	1–5

1. Bring in the patient, decide the cassette format and put the cassette in the cassette holder. Collimate to that format.
2. Position the patient. The patient should be upright or leaning slightly forwards, not backwards. Use the cassette holder arm for support. Collimate further, if possible.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.







Comments

The top of the lungs must be visible.

Straight lateral view of the sternum

Make sure that the lower parts of the diaphragm is visible.

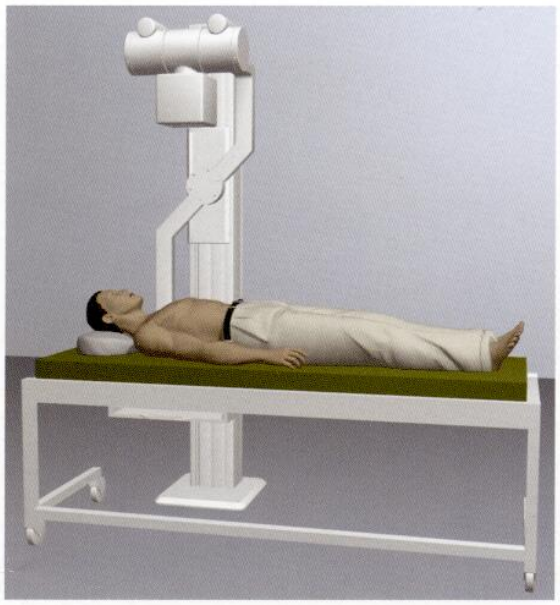
CHEST AP Supine

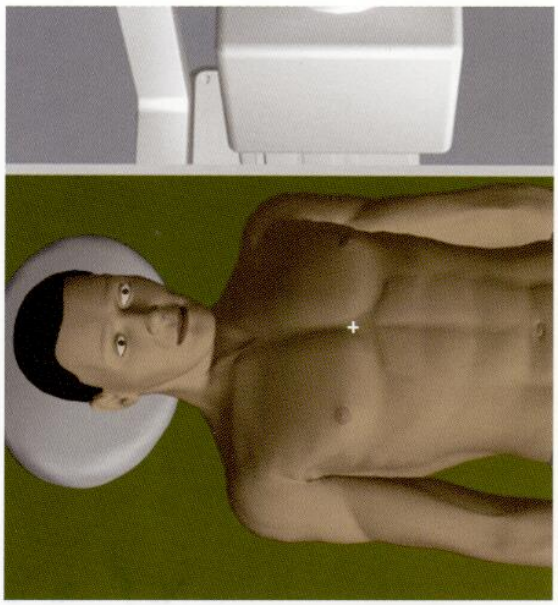
Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
24×30 cm (10×12 inches) for a child
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	120	2–3.2	1–12
Child	90	1.6–2	1–4

1. Bring in the patient, decide the cassette format and put the cassette in the cassette holder. Collimate to that format.
2. Position the patient. Put a small pillow under the head. Centre.
   Collimate further, if possible.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.





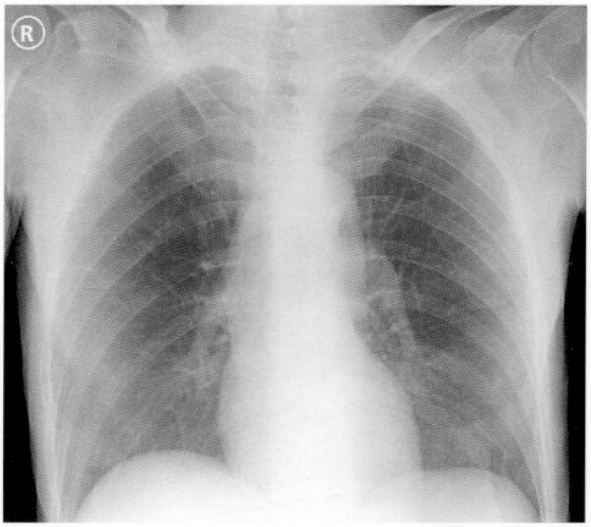
Comments

The top of the lungs must be visible.

The exposure shall be made at full inspiration.

Make sure that the lower parts of the diaphragm is visible on both sides, including both costophrenic angles.

The lung structure and the spine must be discernible (seen) behind the heart.



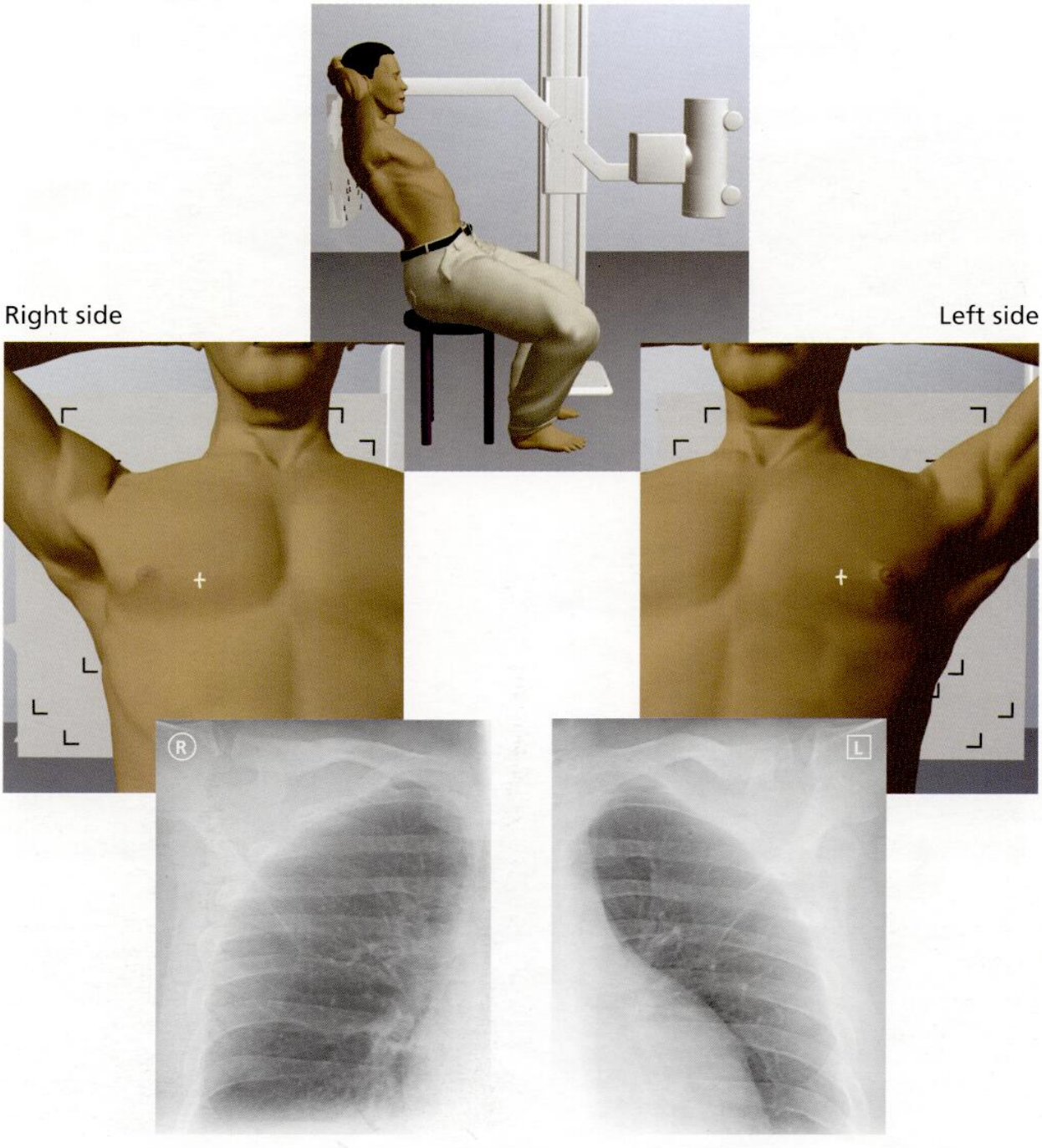
CHEST APICAL (LORDOTIC) AP Sitting reclining backwards ADDITIONAL

Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

Cassette size
24×30 cm (10×12 inches)
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	120	2.5	2–5

1. Bring in the patient, put the cassette in the cassette holder. Collimate to the format.
2. Position the patient as shown. Centre.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.



CHEST LATERAL DECUBITUS Lying on the right (PA) or left (AP) side – horizontal beam

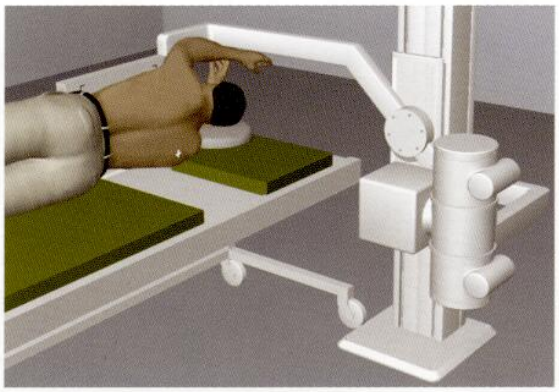
ADDITIONAL views used to detect fluid in the pleural sac

Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

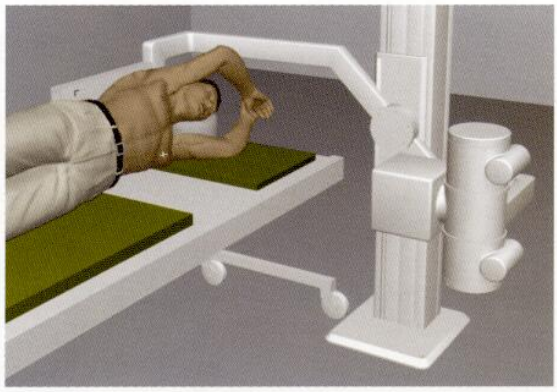
Cassette size
24×30 cm (10×12 inches)
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	120	2	1.6–3.2

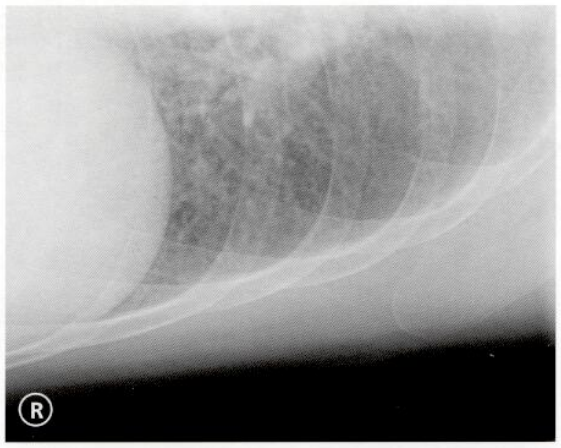
1. Bring in the patient, put the cassette in the cassette holder. Collimate to the format.
2. Position the patient, as shown. The patient must lie on the side where the fluid is suspected, close to the cassette holder on 2 hard pillows (with a distance). Centre.
3. Tell the patient to breathe OUT and hold the breath OUT.
4. Expose.
5. Tell the patient to breathe normally.

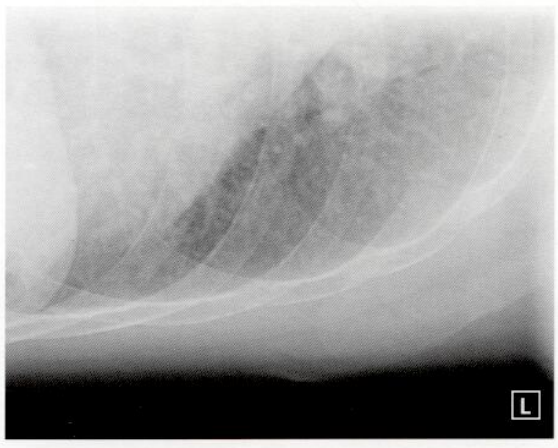


Position for RIGHT lateral decubitus



Position for LEFT lateral decubitus





RIBS OBLIQUE AP Standing or sitting erect – right and left oblique BASIC

CHEST 1 or CHEST 3 or CHEST 5 must always be taken first

Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

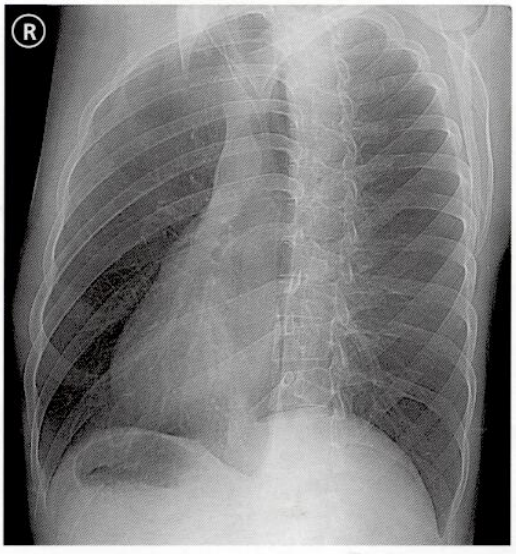
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
Use a **R**ight or **L**eft marker

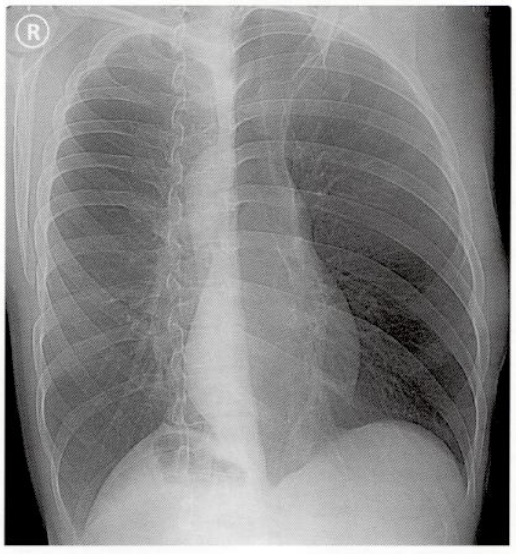
Exposure values	kV	mAs average	mAs range
Adult	70	20–25	10–125

1. Bring in the patient, put the cassette in the cassette holder. Collimate to the format.
2. Position the patient as shown. IF THE PATIENT IS UNABLE TO RAISE HIS ARMS, THE ARMS SHOULD BE HELD OUT FROM THE BODY. Collimate further, if possible. Centre.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.

Left oblique

Right oblique





RIBS OBLIQUE AP Supine – right and left oblique

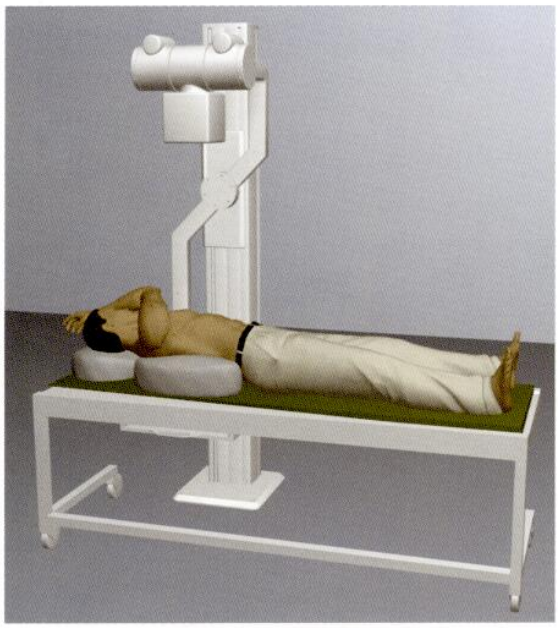
CHEST 1 or CHEST 3 or CHEST 5 must always be taken first

Cassette speed
Cassette with screen-film combination, nominal speed 200 in the cassette holder

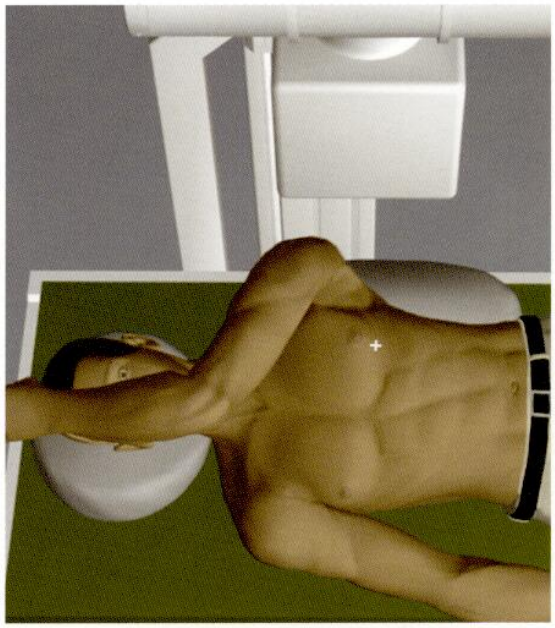
Cassette size
35×43 cm (14×17 inches)
35×35 cm (14×14 inches)
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs average	mAs range
Adult	70	20–25	10–125

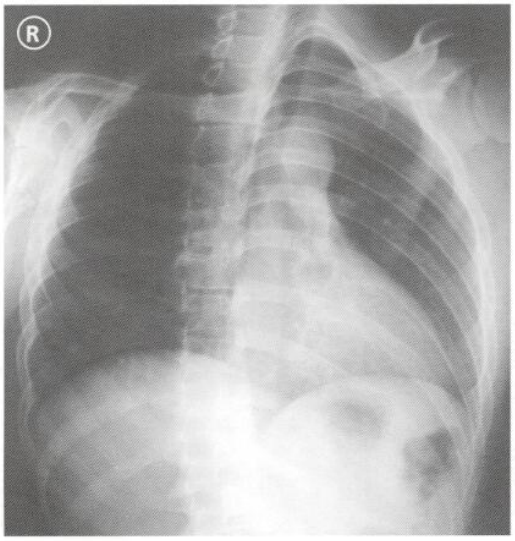
1. Bring in the patient, put the cassette in the cassette holder. Collimate to the format.
2. Position the patient as shown. SUPPORT THE PATIENT WITH A PILLOW UNDER THE NORMAL SIDE. Keep the UPPER arm as high as possible. Collimate further, if possible. Centre.
3. Tell the patient to take a deep breath and hold the breath in.
4. Expose.
5. Tell the patient to breathe normally.

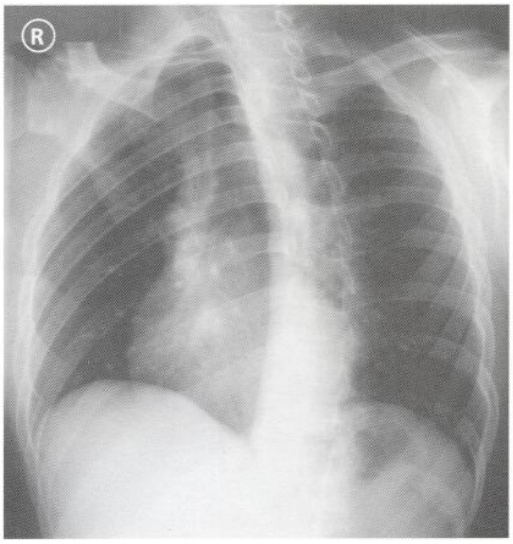


Left oblique



Right oblique





CHEST AP Erect BASIC

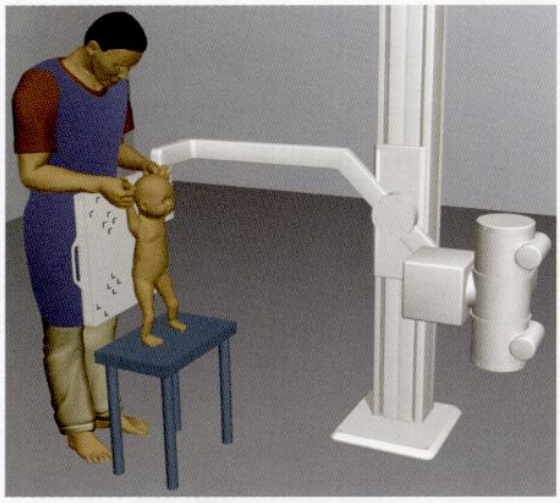
Infants and small children weighing up to 15 kg, hanging by the upper arms

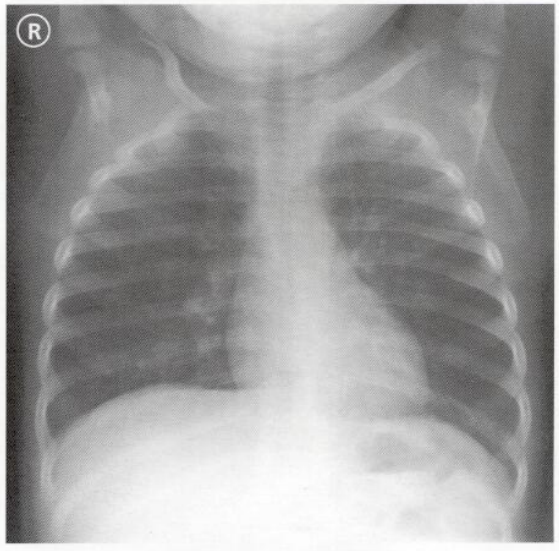
Cassette speed
Cassette with screen-film combination, nominal speed 200 **in** the cassette holder

Cassette size
24×30 cm (10×12 inches)
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs range
Child	90	1.25–2.5

1. Bring in the patient, put the cassette in the cassette holder. Collimate to the format.
2. Position the patient. The child is held hanging by the upper arms (if possible, its feet can be supported by a stool or the floor or by another person holding the thighs) with its back resting against the front of the cassette holder.
3. THE PERSON(S) HOLDING THE CHILD, preferably one of the parents, MUST WEAR A LEAD APRON and, whenever possible, LEAD GLOVES.
4. Centre between the nipples. Collimate further, if possible.
5. Expose when the infant is not moving, preferably in INSPIRATION.





Comment

The person holding the child must wear a lead apron, and, whenever possible, lead gloves.

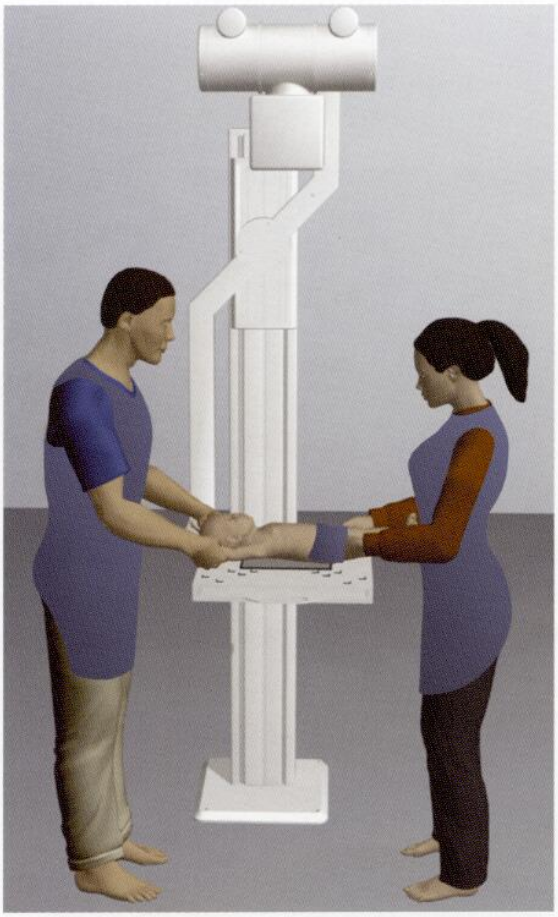
CHEST AP – infant weighing up to 10 kg Supine

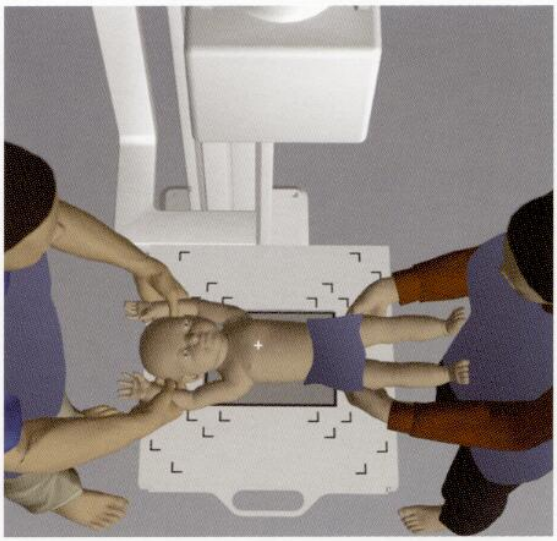
Cassette speed
Cassette with screen-film combination, nominal speed 200 **on** the cassette holder

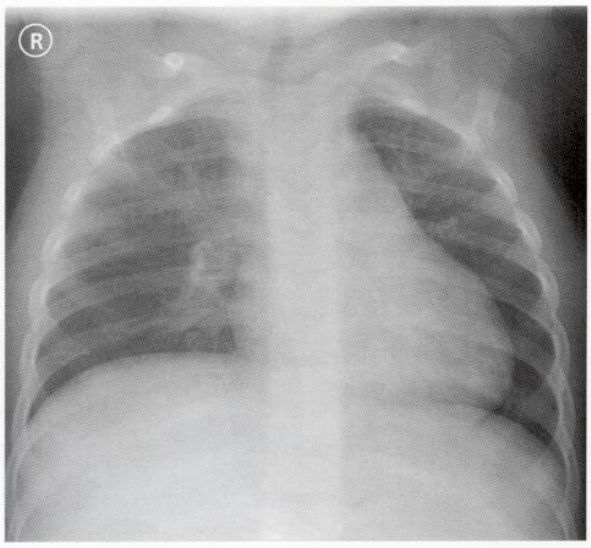
Cassette size
18×24 cm (8×10 inches)
Use a **R**ight or **L**eft marker

Exposure values	kV	mAs range
Child	70	1.6–3.2

1. Centre the cassette on top of the cassette holder. Collimate to that format.
2. Lie the infant on its back on the cassette. THE INFANTS HEAD AND LEGS MUST BE SUPPORTED. THOSE SUPPORTING, preferably the infant's parents, MUST WEAR LEAD APRONS, and, whenever possible, LEAD GLOVES.
3. Centre between the nipples. Collimate further, if possible.
4. Expose when the infant is not moving, preferably in INSPIRATION.







Comments

The persons holding the child must wear lead aprons and, whenever possible, lead gloves.

Use a protective lead strip over the infant's pelvic area.