

Chest radiography in the ICU - the importance of correct evaluation of airway, pleural and feeding tubes

Poster No.: C-1047
Congress: ECR 2013
Type: Educational Exhibit
Authors: I. Candelaria, C. Oliveira, S. P. F. P. Basso, A. Estevao; Coimbra/PT
Keywords: Thorax, Conventional radiography, Diagnostic procedure, Education and training
DOI: 10.1594/ecr2013/C-1047

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org

Learning objectives

- Provide an insight on the normal positioning of nonvascular support and monitoring devices in the critically ill patient
- Review some of the most frequent complications associated with these devices

Background

The use of conventional radiology in the evaluation of the critically ill patient is not only fundamental, but recommend. Patients in the ICU should be subject to daily chest radiography not only to evaluate the correct positioning of chest tubes, feeding tubes and vascular catheters, but also to exclude potential complications. Common abnormalities encountered in these patients are atelectasis, aspiration, pulmonary edema (hydrostatic and noncardiogenic), pneumonia, pneumothorax and pleural fluid, which contribute to the difficulty of interpreting these exams.

NORMAL CHEST RADIOGRAPHY IN THE ICU

Why do we perform portable x-ray?

Indications include:

- Cardiopulmonary symptoms following cardiac or thoracic surgery
- Trauma
- Patients who have monitoring and life support devices
- Critically ill patient

When do we perform it?

In patients with acute cardiopulmonary symptoms

After placement of endotracheal tubes, nasogastric tubes, vascular catheters and pleural tubes.

Technical factors

PA radiograph rarely performed (replaced by AP)

Patient in the supine or sitting position due to impaired mobility

This means that there is heart and mediastinum amplification, increase in the blood vasculature, difficulties in differentiating pleural effusions from air-space shadowing and pneumothorax is increasingly difficult to diagnose.

- Chest Tubes

Malpositioning occurs in 10% of placements

Chest tube side-holes (interruptions of the tube's radiopaque line) should be located within the pleural space

Improper placement may manifest as poorly or nonfunctioning tube

Complications: pulmonary contusion, injury to upper abdominal and mediastinal organs, blood vessels and the diaphragm

- Monitoring and support devices

Evaluation of support equipment and monitoring devices is fundamental

Early recognition of incorrect placement reduces the risk of potentially serious complications

IDENTIFYING LINES, TUBES AND OTHER DEVICES

The endotracheal tube

Used to maintain airway access and allow mechanical ventilation of patients in respiratory failure

The ETT is cuffed and placed in the trachea, either via the oropharynx or through tracheostomy

If prolonged intubation is anticipated, a tracheostomy should be preferred

Correct placement: ETT should lie at the level of the mid-trachea, 4 to 6cm above the carina (this allows for the flexion or extension of the head, moving the ETT 2cm in either

movement); if the chest x-ray exposure doesn't allow the recognition of the carina, look at the upper dorsal spine: normally, the carina lies at the level of the D4-D5 interspace (tip at this level is regarded as correct)

Tracheostomy tube

Should be placed when long term intubation is needed

Correct placement: tip of the tube at the D3 level; tube diameter should be 2/3 of the trachea's and the cuff should not distend the tracheal wall

Mediastinal air is considered normal after placement of the tube. Large volumes should raise suspicion of complication.

Chest Tubes (Thoracostomy tubes)

Usually placed in the pleural space to treat pneumothorax (anterosuperiorly) or drain pleural fluid (posteroinferiorly)

Chest x-ray must be obtained following placement of thoracostomy tubes to identify their position.

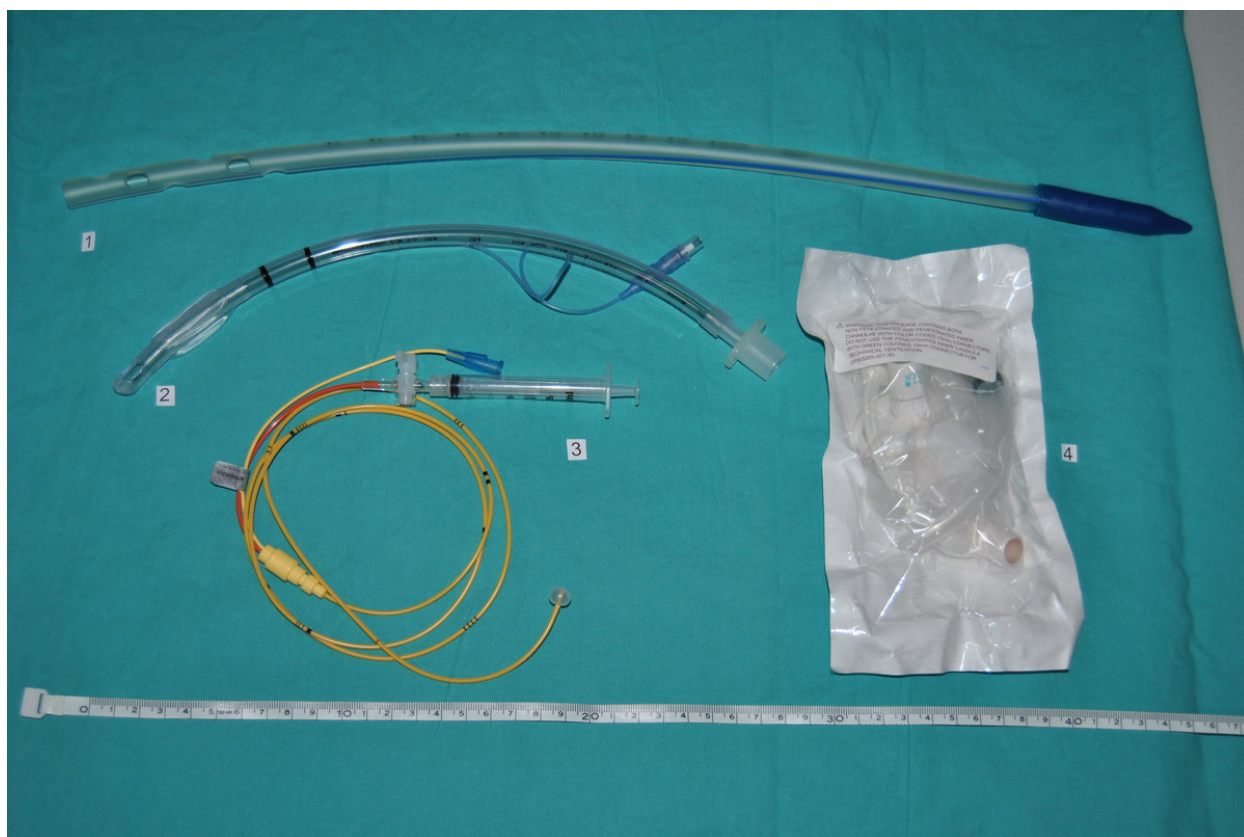


Fig. 1: From top to bottom: 1 - Pleural tube; 2- Endotracheal tube (ETT); 3- Pulmonary artery catheters (Swan Ganz); 4- tracheostomy tube and cannula

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Enteric tubes

Oroenteric and nasoenteric tubes are used for feeding, administering medication and aspiration

Correct placement:

a) For feeding: ideally placed in the gastric antrum or duodenum

b) For aspiration and medication administration: within the stomach

Sideports, when present, should extend beyond the gastroesophageal junction

Vascular monitoring devices

Venous catheters (CVP)

Frequently used for medication and fluid administration, withdraw blood and assess central venous pressure

Catheters may be inserted in peripheral upper extremity veins (PICC) or more proximally, in the subclavian or internal jugular veins.

Correct placement of the tip of the catheter is important to accurately measure CVP.

Pulmonary artery catheters

Used to measure pulmonary artery pressure, pulmonary capillary wedge pressure and cardiac output

They also help assess the patient's volume and differentiate between cardiogenic and noncardiogenic edema

Swan-Ganz catheters are frequently used with this purpose

The catheters should be inserted percutaneously via the right heart and into the pulmonary artery; they inflate and wedge at a distal pulmonary artery.

Intra-aortic counterpulsation balloon pump

Balloon device that measures between 24-26 cm, radiolucent except for its radiopaque tip, which assists in radiographic positioning

It inflates during systole to assist coronary perfusion and deflates during diastole to decrease cardiac afterload

Insertion via right femoral artery.

Cardiac pacing devices

Can be temporarily inserted in ICU patients

Placed through the subclavian vein into the apex of the right ventricle

Placement assessment requires AP and lateral radiographs.

Imaging findings OR Procedure details

The images displayed were obtained with a portable chest x-ray equipment, except for figures 10 and 11.

As was stated before, the standard postero-anterior (PA) radiograph is replaced by a suboptimal antero-posterior (AP) radiograph which causes magnification of the heart and mediastinum.

When possible, the patient is in the most upright position achievable, nevertheless, in most cases there is impaired mobility, so most of the images are obtained with the patient in the supine or sitting position, which alters the physiology of the lung vasculature, diverting blood to the lung apices.

One must keep in mind these changes when interpreting these exams.

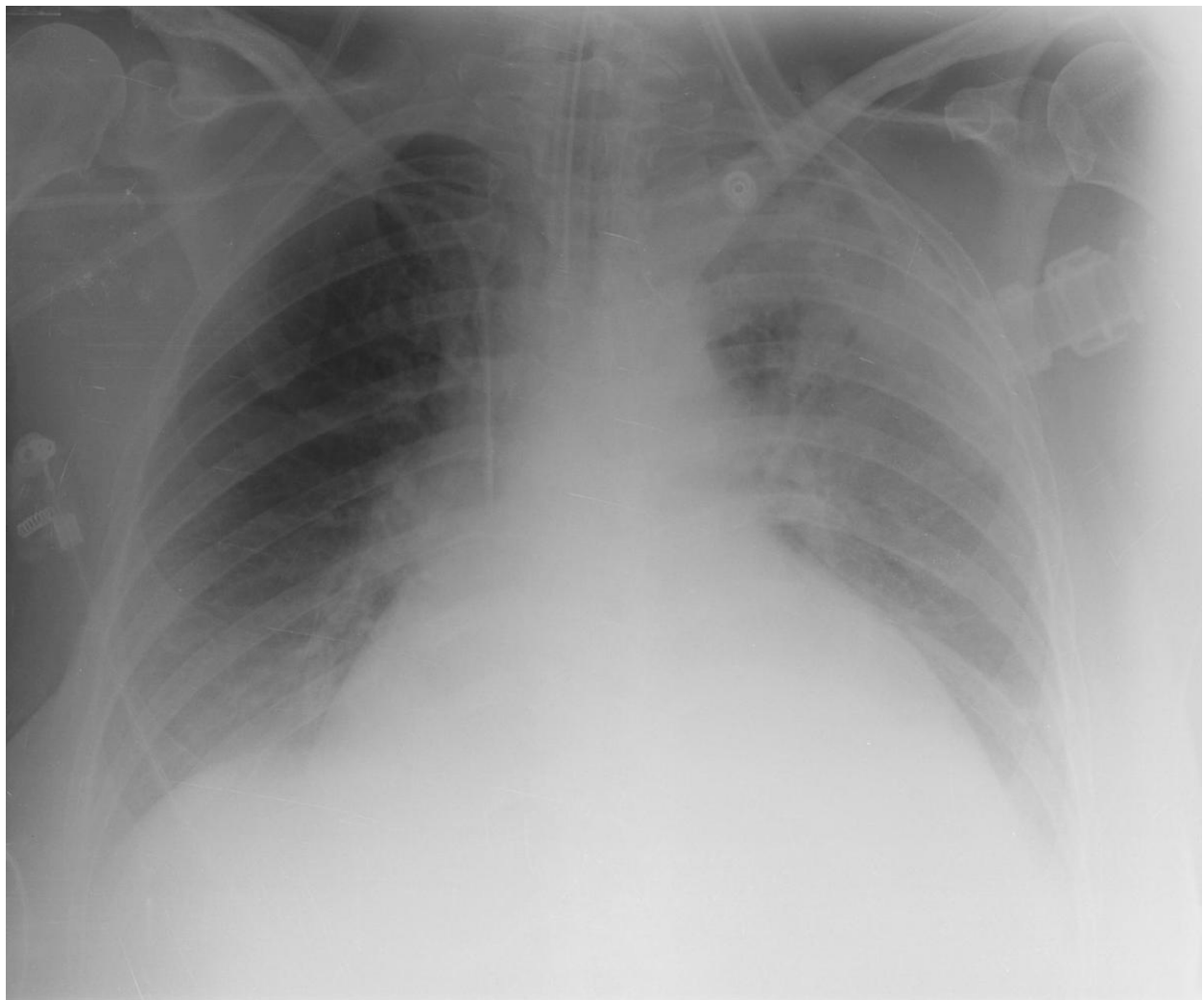


Fig. 2: AP Chest radiography - Female patient in the ICU with respiratory failure due to *Legionella pneumoniae*. There is evident cardiac magnification and increased pulmonary density due to ventilatory impairment.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

LINES, TUBES AND OTHER DEVICES - where should they be?

The endotracheal tube

Misplacement:

Occurs in approximately 10-15% of patients

If too high: inadvertent extubation or hypopharyngeal intubation (ineffective ventilation and gastric distention)

If too low: selective bronchial intubation (+ right main bronchus) with partial or complete collapse of the contralateral lung

Suspect when: subcutaneous emphysema, pneumomediastinum, displacement of the distal tip of the ETT.

Serious complications: tracheal stenosis, tracheal rupture, cord paralysis, cervical and mediastinal emphysema, hematoma and abscess formation

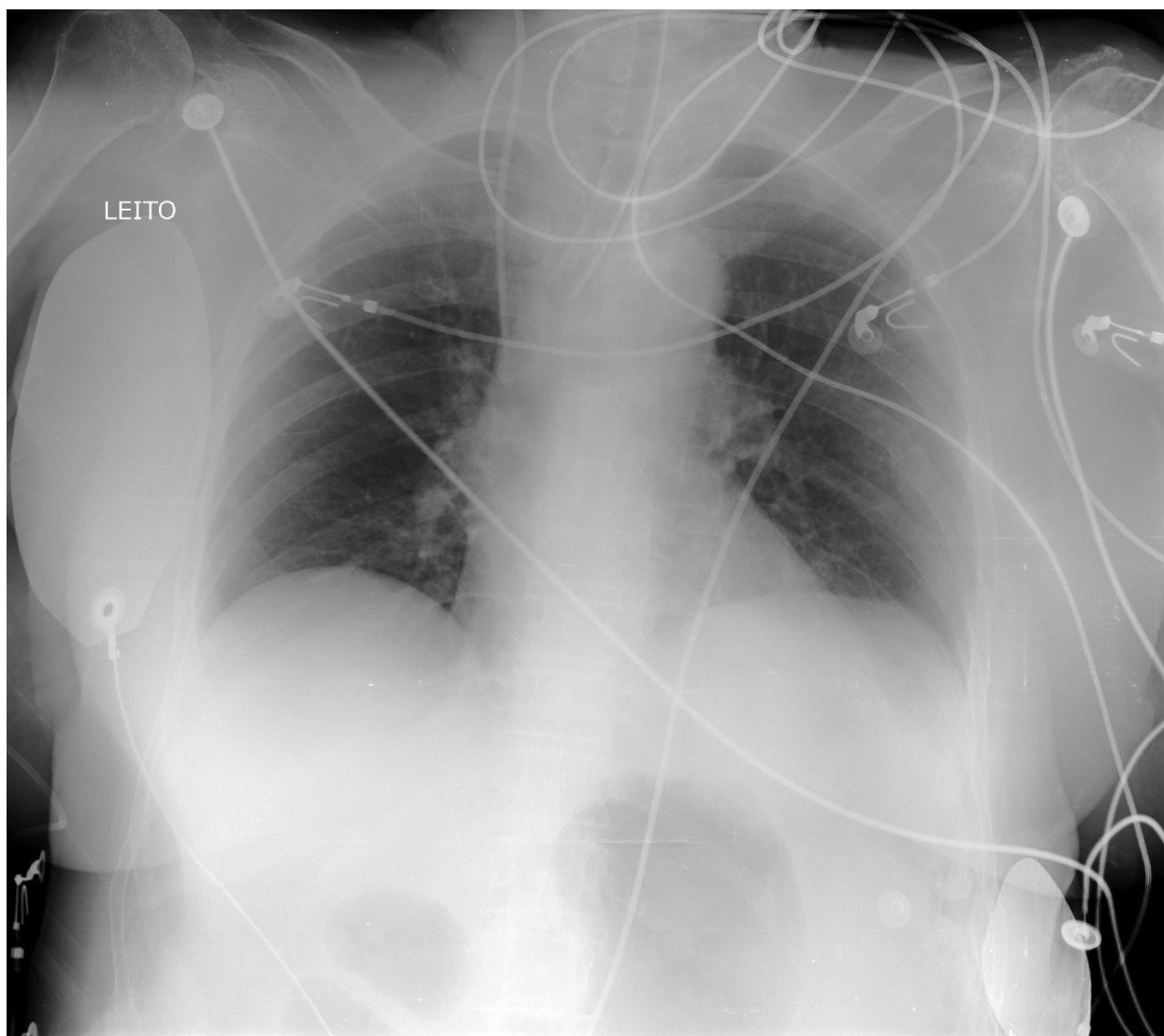


Fig. 3: Endotracheal tube - clearly seen in this patient. This tube had to be adjusted, as it was less than 4 cm from the carina, in the resting position. There was also gastric distention, which required placement of enteric feeding tube.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Tracheostomy tube

Correct placement: tip of the tube at the D3 level; tube diameter should be 2/3 of the trachea's and the cuff should not distend the tracheal wall

Remember: mediastinal air is considered normal after placement of the tube.



Fig. 4: 51 year-old male patient in the ICU following a car accident. There is some subcutaneous emphysema, the tracheostomy tube is also seen, as is the pleural tube, both in the correct position. There is also a central vascular line visible on the right, also correctly placed.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

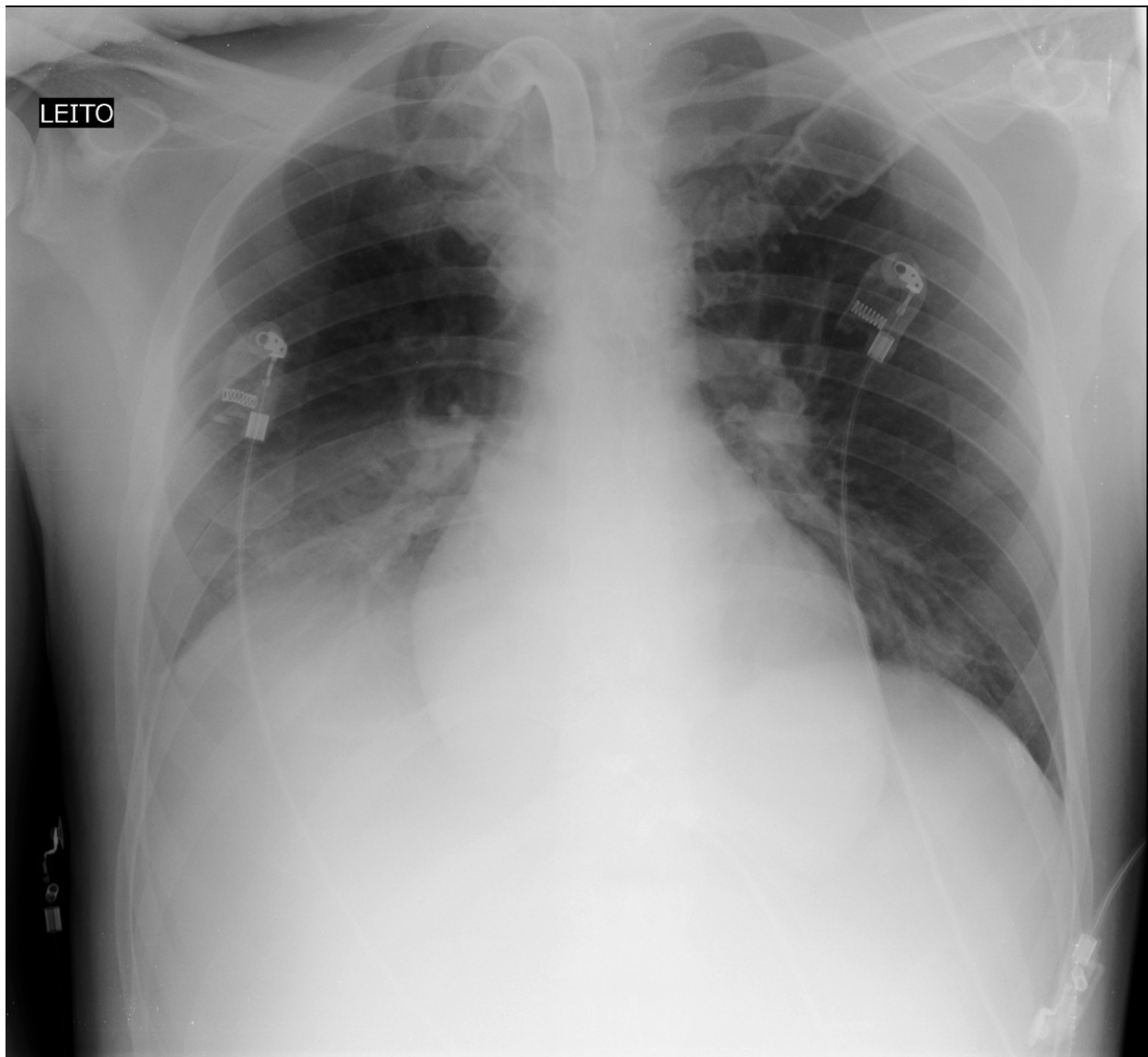


Fig. 5: 46 year-old male patient with advanced Myasthenia Gravis. Tracheostomy tube and external leads are seen in this radiography

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Chest Tubes (Thoracostomy tubes)

Correct placement of fenestration of the tube is important for proper function:

- a) If placed in the fissures - drain ceases when lungs become apposed
- b) If interruption in the radiopaque line isn't seen and there's evidence of subcutaneous air - misplacement should be suspected

Rare complications: heart and great vessel injury, iatrogenic placement in the abdomen with liver, spleen and stomach laceration.

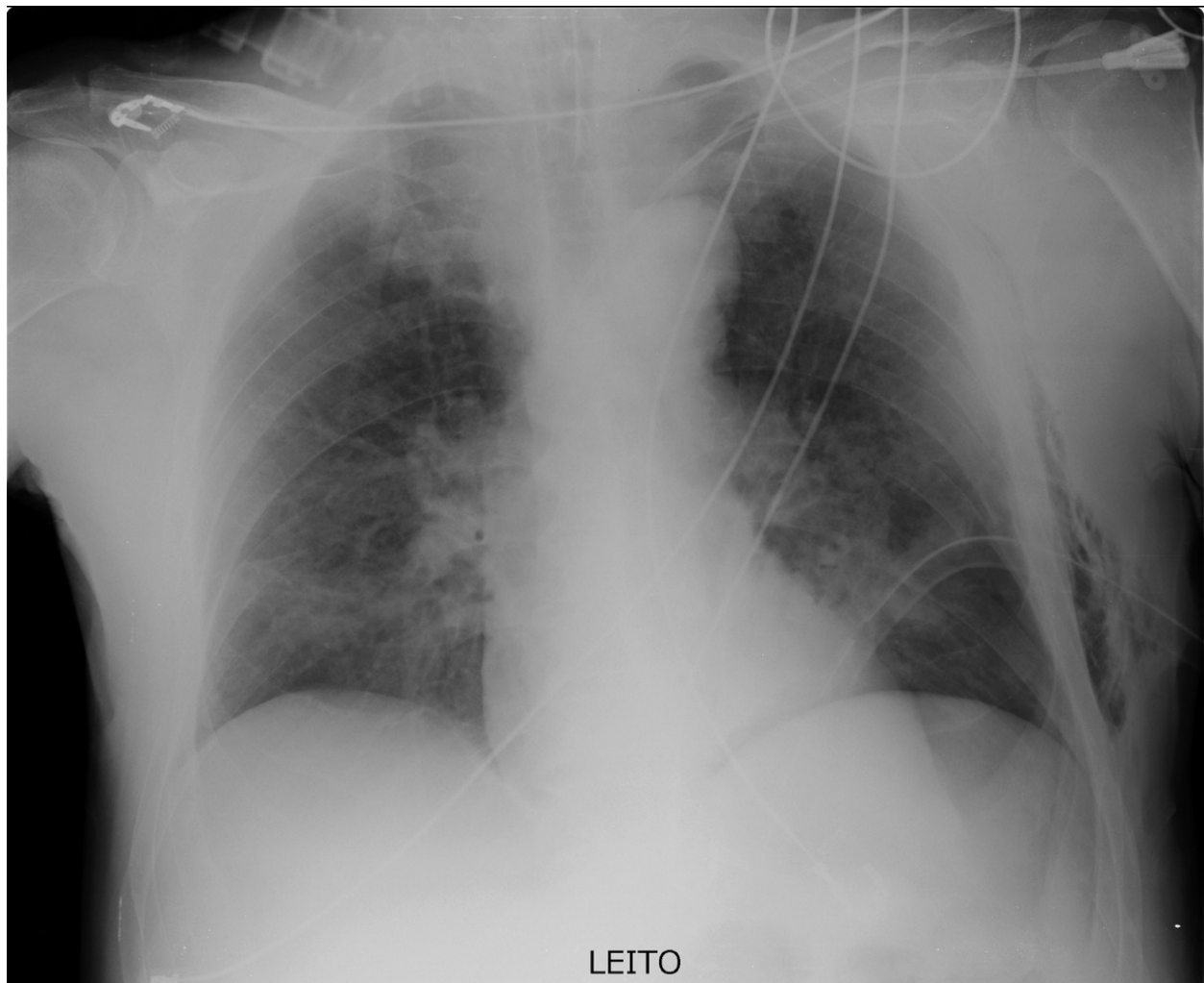


Fig. 6: Pleural Tube Placement - note the presence of a tracheostomy tube adequately placed and pleural tube for hemothorax drainage (postero-inferior orientation). There is some subcutaneous emphysema, which is normal following this procedure.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

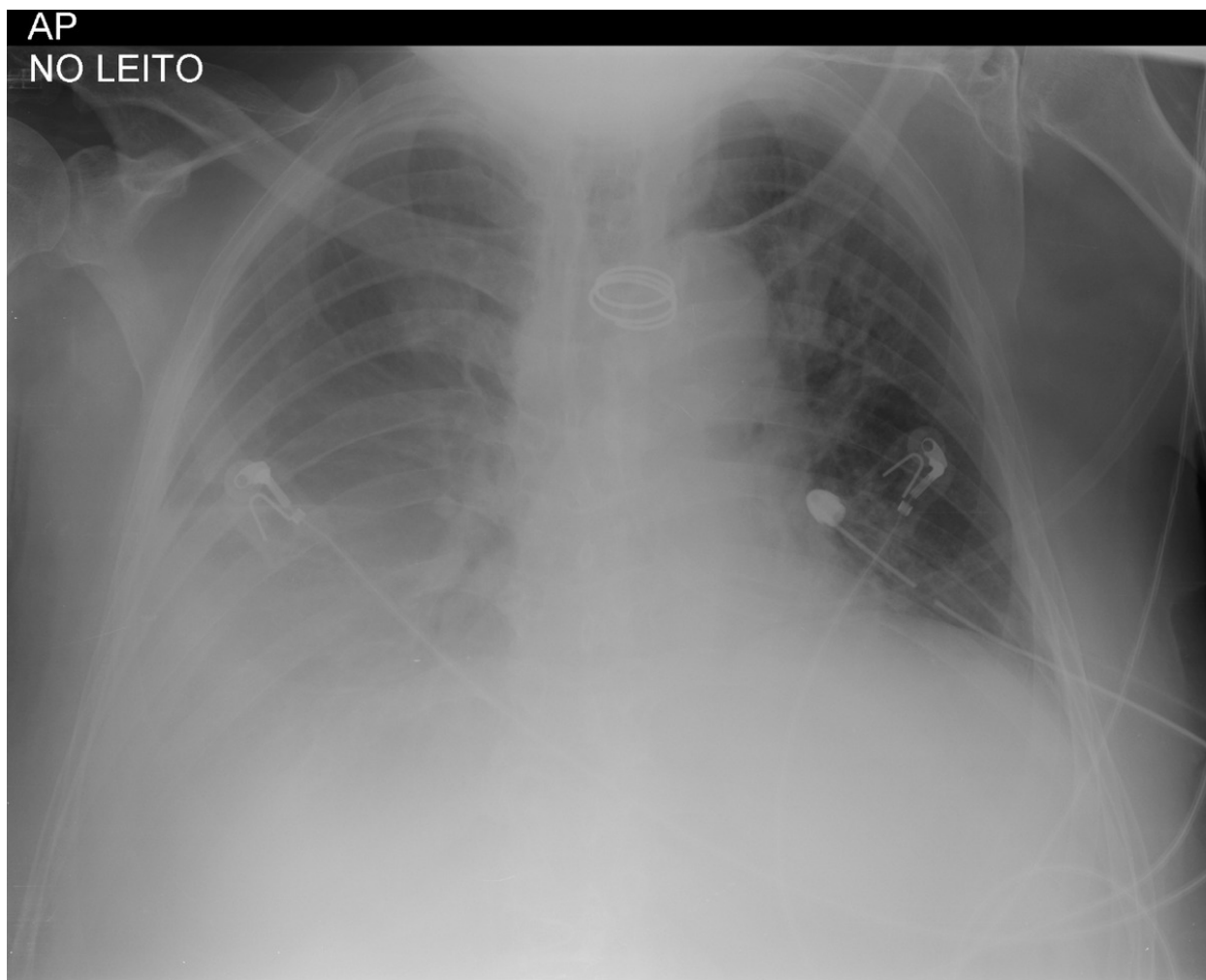


Fig. 7: Pleural tubes - note the ascending position of the tube, adequately placed for pneumothorax drainage.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Enteric tubes

Chest radiography assessment should only be made when the patient is unconscious and there is risk of placement in the bronchial tree.

Complications: aspiration to the airways, pharyngeal and esophageal perforation, bronchopulmonary injury and pneumonia (ectopic feeding), pneumothorax, pulmonary laceration and pulmonary contusion (if the parenchyma is punctured)

Vascular monitoring devices

Venous catheters (CVP)

Ideal location: within the SVC, beyond the venous valves or at the cavoatrial junction

Complications: arrhythmias, cardiac perforation, vascular perforation, pneumothorax, venous thrombosis, arterial catheterization

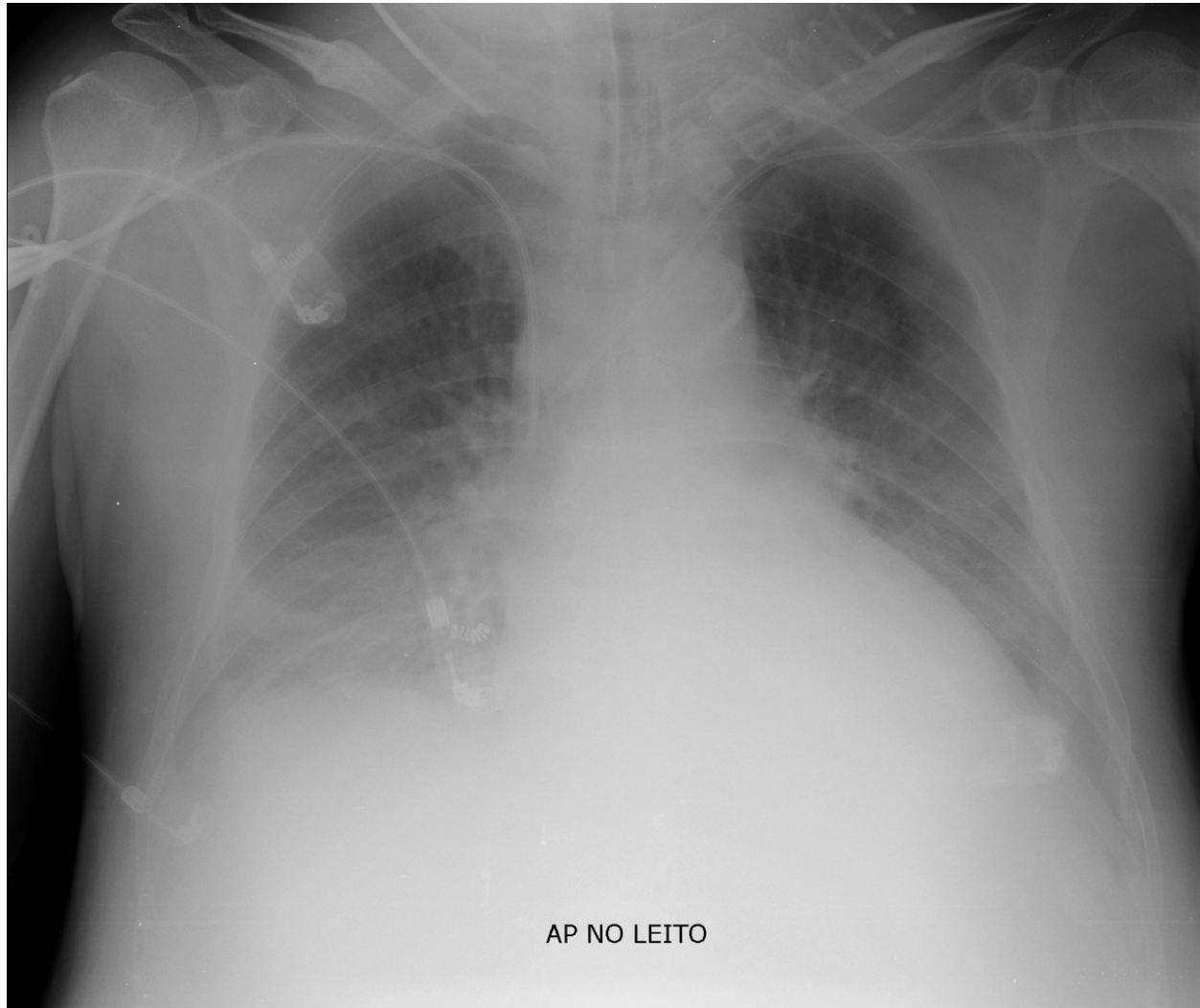


Fig. 8: 60 year-old male in septic shock due to a urinary tract infection. The patient was moved to the ICU for more adequate treatment, requiring intubation and CVP assessment. You can see adequately placed central venous catheters on both sides of the chest.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Pulmonary artery catheters

Correct placement: the tip should be at right main pulmonary artery, left main pulmonary artery or the proximal interlobar pulmonary artery

Complications: same as venous catheters but also pulmonary artery occlusion, pulmonary infarct, pulmonary hemorrhage, pseudoaneurysm, decreased motility and difficult removal (intravascular knots)

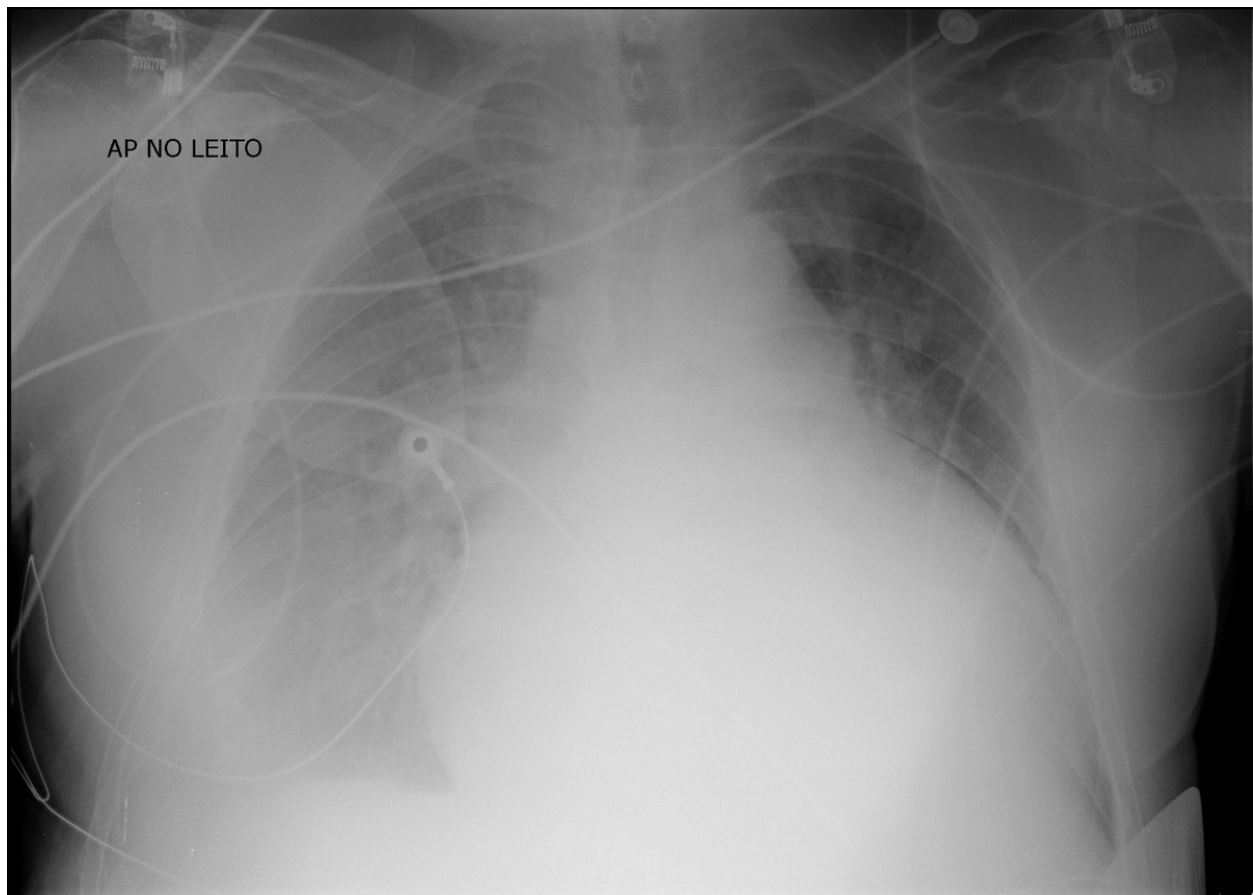


Fig. 9: Acute heart failure. Although there is magnification of the cardiac silhouette, there is evident cardiac enlargement. Multiple vascular devices are seen, most of whom are external to the patient. There is also a CVC in the correct position.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Intra-aortic counterpulsation balloon pump

Correct placement: tip within the proximal descending thoracic aorta, just distal to the origin of the major arteries in the aortic arch

Complications: cerebral or left upper extremity ischemia (too proximal), occlusion of the abdominal aorta branches (too distal), rarely aortic rupture, limb ischemia and air embolization

Cardiac pacing devices

Correct placement: tip at the apex of the heart (no angulations along the length of the wire)

Lateral radiograph shows tip imbedded within the cardiac trabeculae, 3-4mm beneath the epicardial fat pad

Complications: myocardium perforation

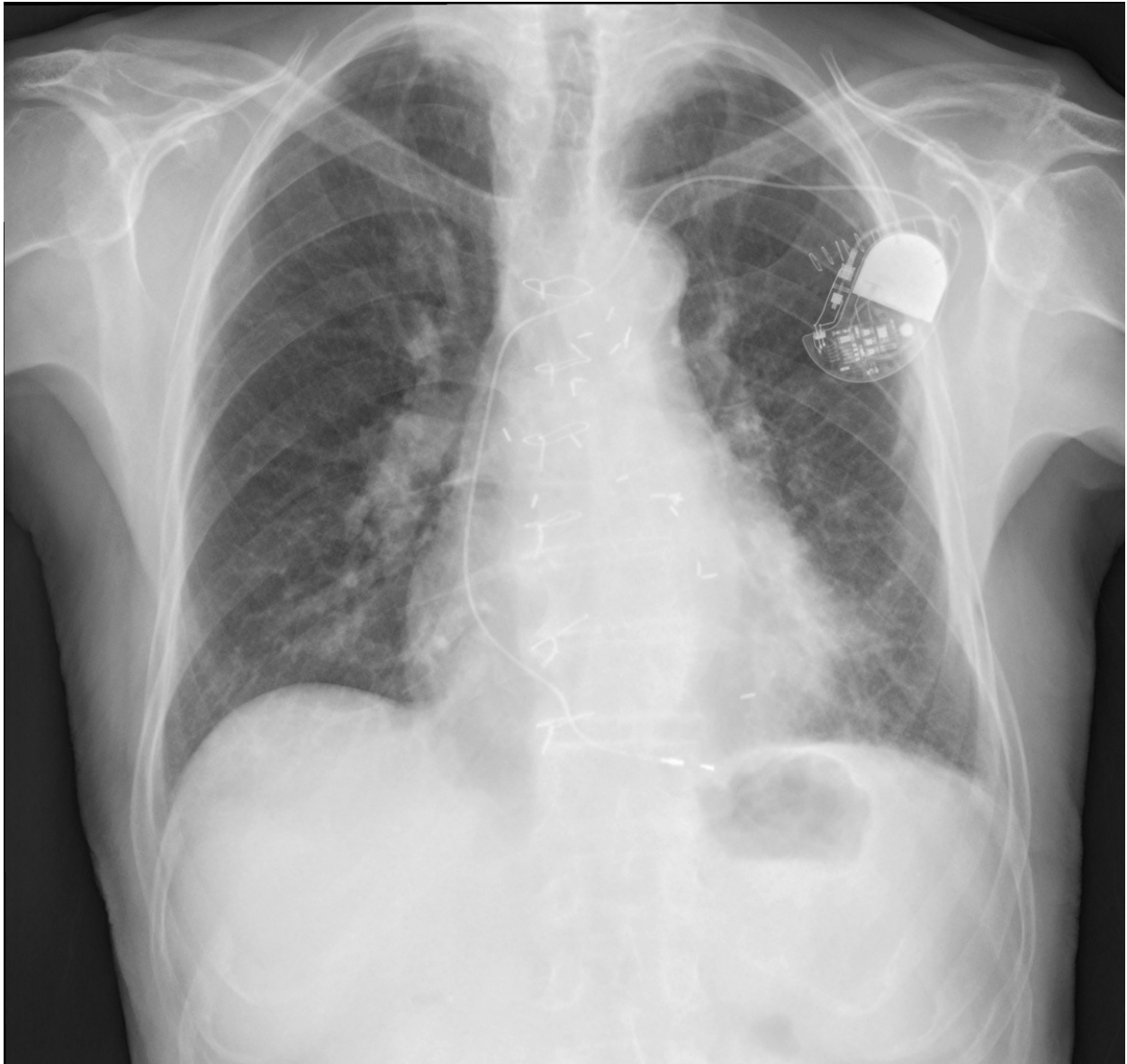


Fig. 10: Post-placement of pacemaker - not the tip of the leds placed in the right auricle and left ventricle.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT



Fig. 11: Post-placement of pacemaker. Lateral view.

References: Radiology, Centro Hospitalar e Universitario de Coimbra, Hospital Geral - Coimbra/PT

Conclusion

There is a wide range of devices used for monitoring of critically ill patients.

The use of conventional radiology, namely the chest radiography, is important in this setting because it allows the diagnosis of misplacement and potentially serious complications due to the use of medical devices, which sometimes aren't clinically apparent.

All radiologists must be familiar with the correct positioning of these devices and be able to suspect when complications arise.

References

Hunter, T., Taljanovic, M., Tsau, P., Berger, M., Standen, J., Medical Devices of the Chest, RadioGraphics, 2004, 24: 1725-1746

Hill, J., Horner, P., Primack, S., ICU Imaging, Clin Chest Med, 2008, 29, 59-76

Khan, A., AlJahdali, H., AlGhanem, S., Gouda, A., Reading chest radiographs in the critically ill (Part I): Normal chest radiographic appearance, instrumentation and complications from instrumentation, Ann Thorac Med., 2009,4(2): 75-87

Godoy, M., Leitman, B., de Groot, P., Vlahos, I., Naidich, D., Chest Radiography in the ICU: Part 1, Evaluation of Airway, Enteric, and Pleural Tubes, American Journal of Roentgenology, 2012, 198:563-571

Personal Information