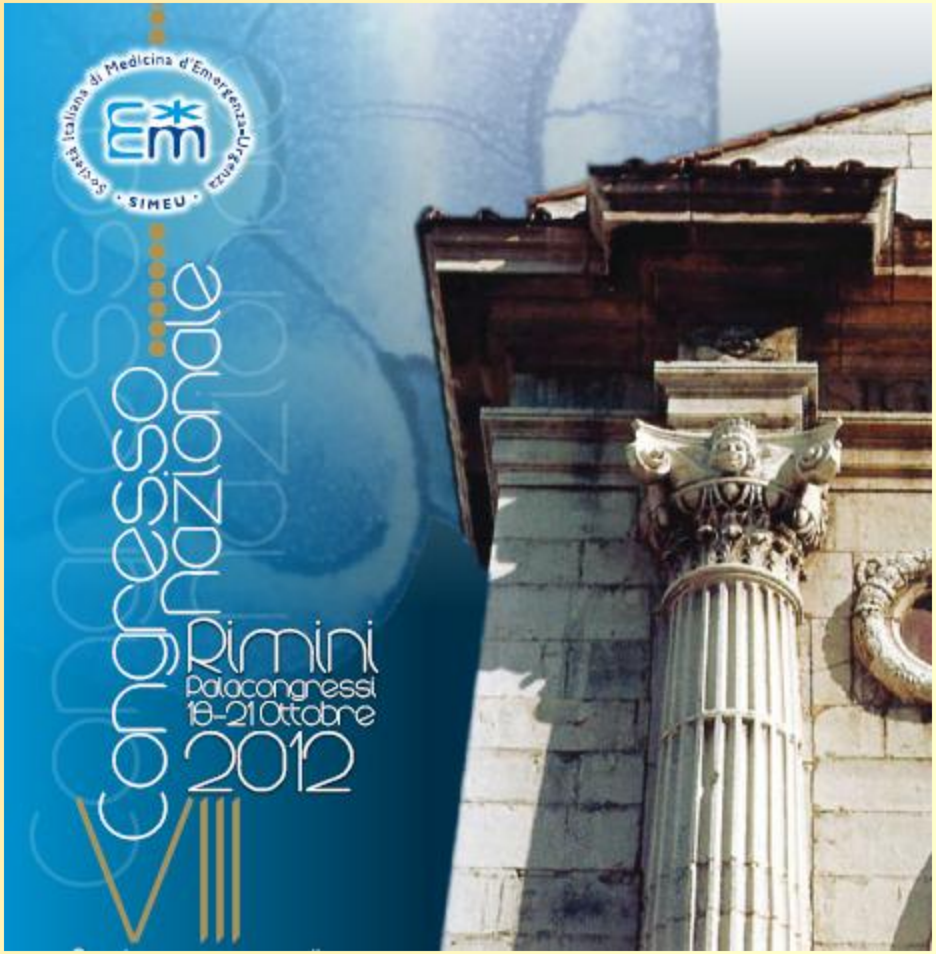
SST Azienda USL 2 Lucca
Servizio Sanitario della Toscana

Imaging in thoracic trauma



Gino Soldati
Ospedale Valle del Serchio, Lucca

g.soldati@usl2.toscana.it

Chest trauma

- Usually blunt, 90%
- Blunt thoracic injuries are caused by motor vehicle crashes in 63-78% of cases
- 33% of thoracic injuries require hospital admission
- Blunt chest trauma is responsible for 25% of all trauma deaths, and major contributor in another 50% of deaths
- Chest trauma is the second most common cause of death following head trauma.

EPIDEMIOLOGY OF THORACIC INJURIES IN BLUNT CHEST TRAUMA

- CHEST WALL 45%-67%
- LUNG 26%-65%
- HEMOTHORAX 25%
- PNEUMOTHORAX 20%-30%
- FLAIL CHEST 26%
- HEART 5%-9%
- DIAPHRAGM 7%-9%
- AORTA AND GREAT VESSELS 4%
- ESOPHAGUS 0,5%
- MISCELLANEA 21%

North America Trauma Outcome Study-ACSCT, 1986
Devitt J et al. Can J Anaesth 1991; 38:506–510.

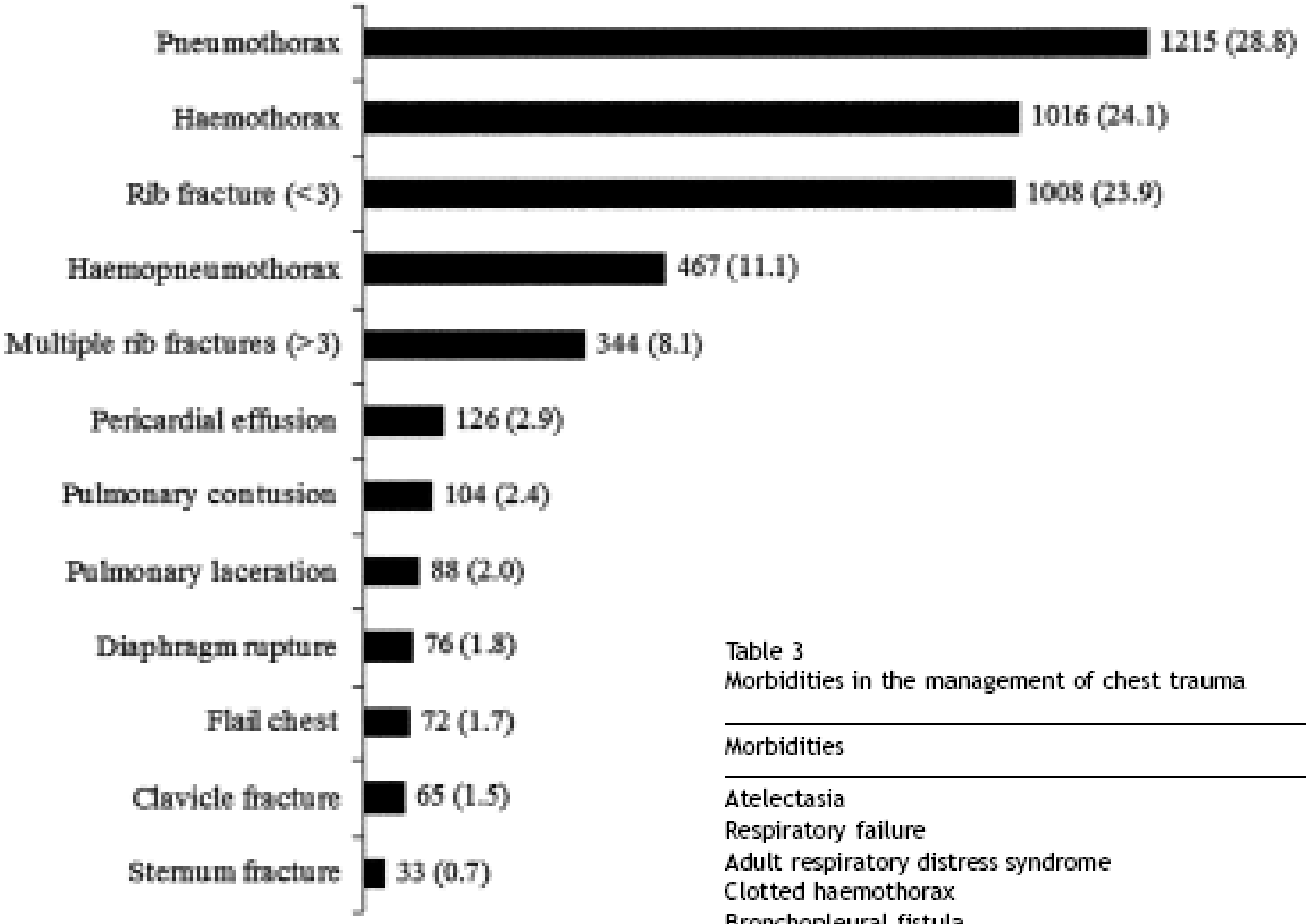


Table 3
Morbidities in the management of chest trauma

Morbidities	Patients (%)
Atelectasia	616 (14.6)
Respiratory failure	232 (5.5)
Adult respiratory distress syndrome	138 (3.2)
Clotted haemothorax	39 (0.9)
Bronchopleural fistula	20 (0.4)
Empyema	14 (0.3)

Recep Demirhan

Interactive CardioVascular and Thoracic Surgery 9 (2009) 450-453

TRAUMA: PRIMARY SURVEY

- establishing a patent airway with cervical spine control
- adequate ventilation
- maintaining circulation (including cardiac function and intravascular volume)
- assessing the global neurologic status
- measuring the core temperature

A, B, C, D, E

Advanced Trauma Life Support Manual. Chicago, American College of Surgeons, 2010,

From the ATLS® manual, it is not clear if a chest radiograph should be performed in every patient.

However, this is in accordance with the literature. At present, no clinical decision rule is available concerning the indication for chest radiography in trauma patients.

Kool DR, Blickman GJ. ATLS. ABCDE from a radiological point of view. Emerg Radiol 2007; 14:135

Advanced trauma life support program for doctors, 8th ed. American College of Surgeons, Chicago

Chest X-Ray in trauma?

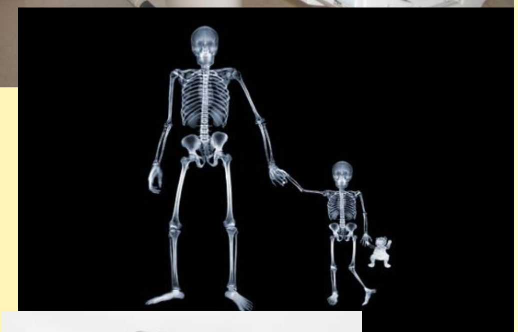
- ...is the single most valuable diagnostic study in chest trauma
- ...performed early in the ATLS

Livingston DH et al. In: Trauma. (Moore EE, Feliciano DV et al eds.), 2008Mc Graw Hill. NY

Imaging of Thoracic Injuries In: Marincek B, Dondelinger RF (Eds.), Emergency Radiology, 2007, Springer, Berlin.

- ...is often done using portable x-ray equipment.
- ...is taken under adverse conditions in trauma
- ...It may be a suboptimal projection (supine patient!) and can be limited in penetration
- ...in critically ill patients has shown low sensitivity and specificity
- ...may not point out or underestimate even life-threatening lesions.

Other questions……..



- Selective use of chest x Ray?
- Chest Xray or CT?
- Selective use of CT?
- What selective criteria for CT?
- ….. And for chest x Ray?
- Always CT?
- …..and so on……

Thoracic occult injuries

- Pneumothorax
- Hemothorax
- Pulmonary contusions
- Vascular injuries
- Cardiac injuries
- Diaphragmatic injuries

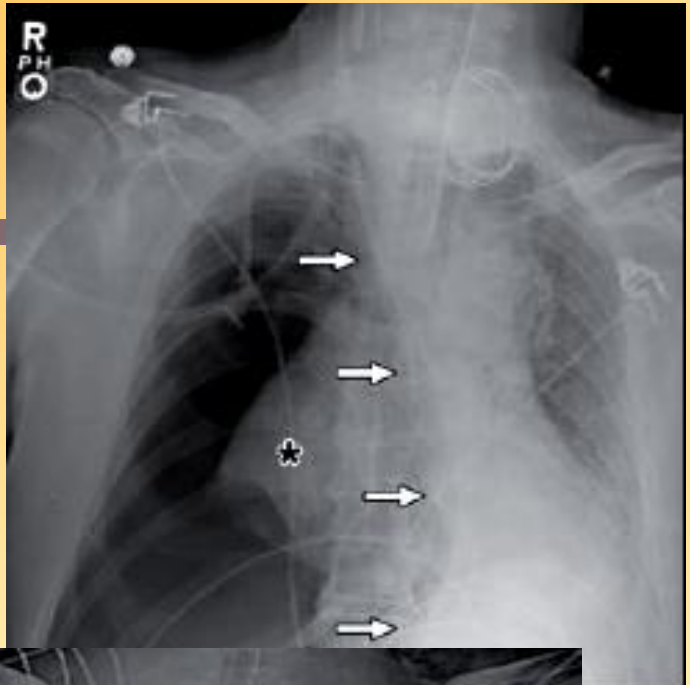
- **They are injuries not suspected on the basis of clinical examination or plain radiography, but are ultimately detected with CT**

Wall SD, Federle MP, Jeffrey RB, et al. *AJR Am J Roentgenol* 1983;141:919-21.
Tocino IM, Miller MH, Frederick PR, et al. *AJR Am J Roentgenol 1984;143:987-90*

Chest sonography in trauma?

- Lung ultrasonography could be the solution between a low sensibility technique as chest Rx and the reference standard technique of CT scan for the study of trauma patients in the ED

Soldati G, Testa A et al Chest 2008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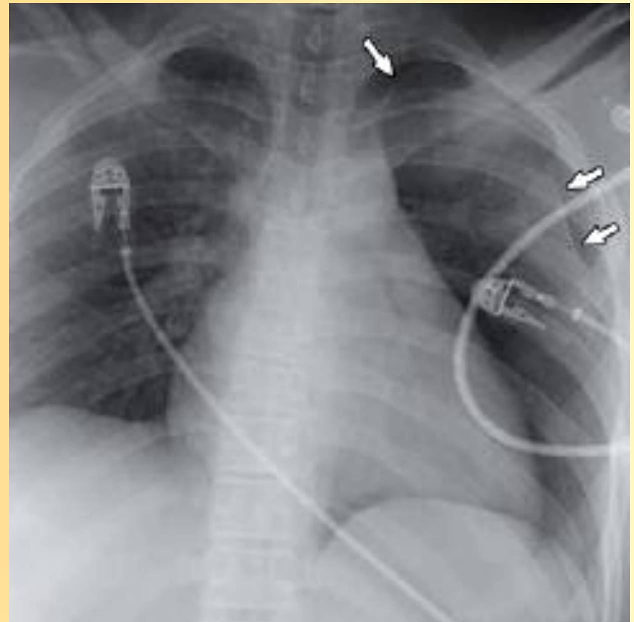

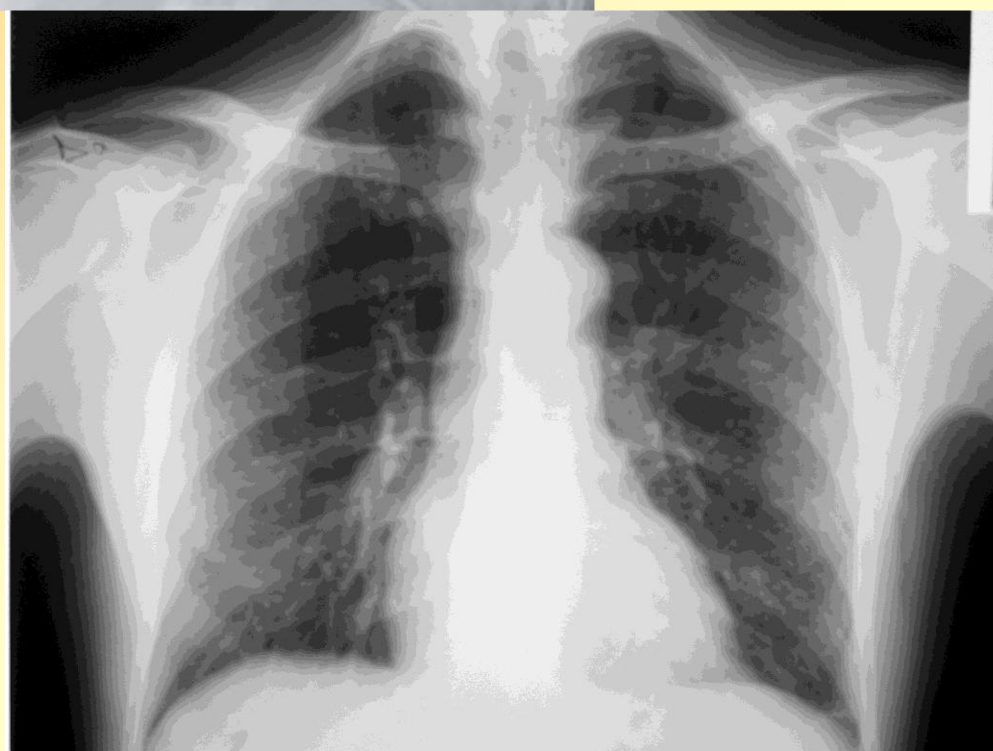

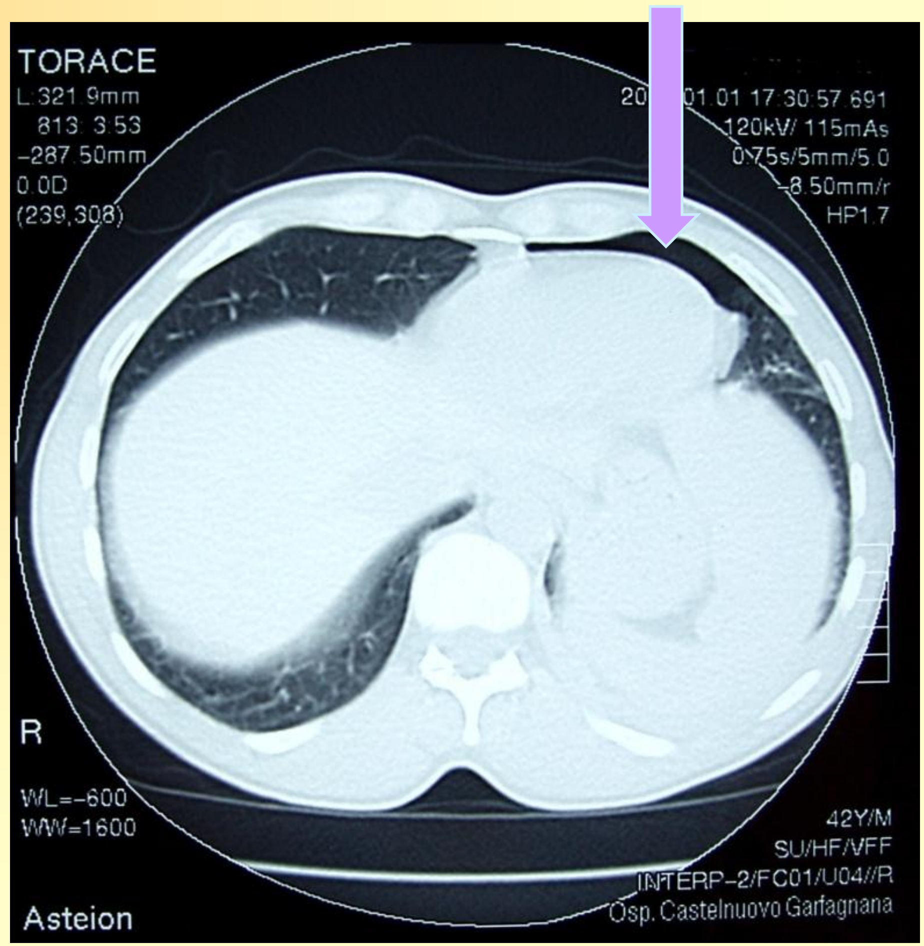
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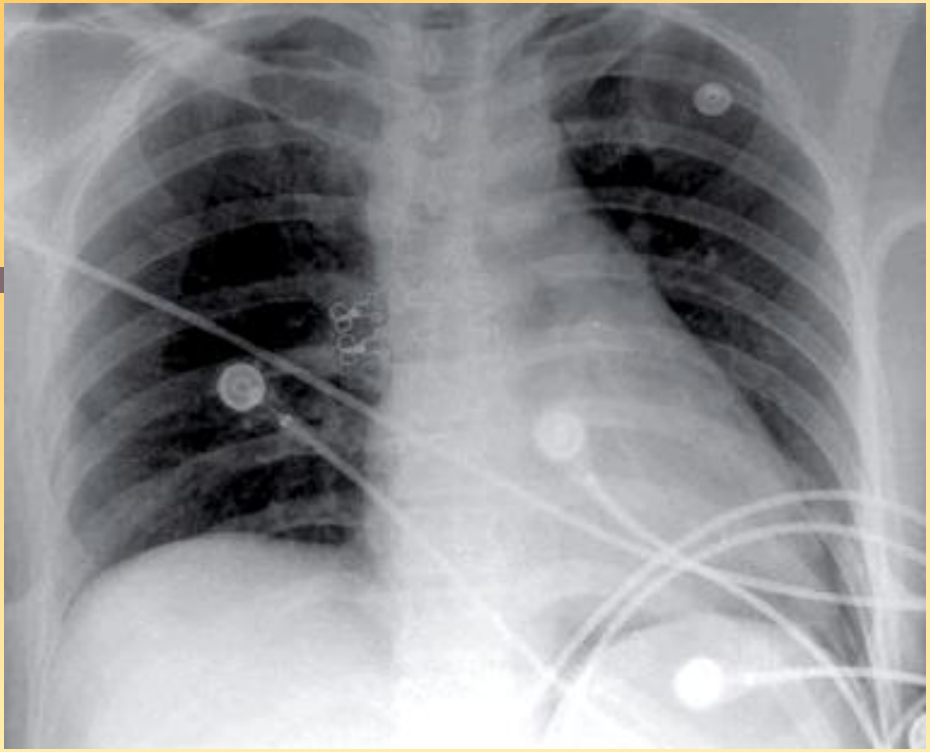
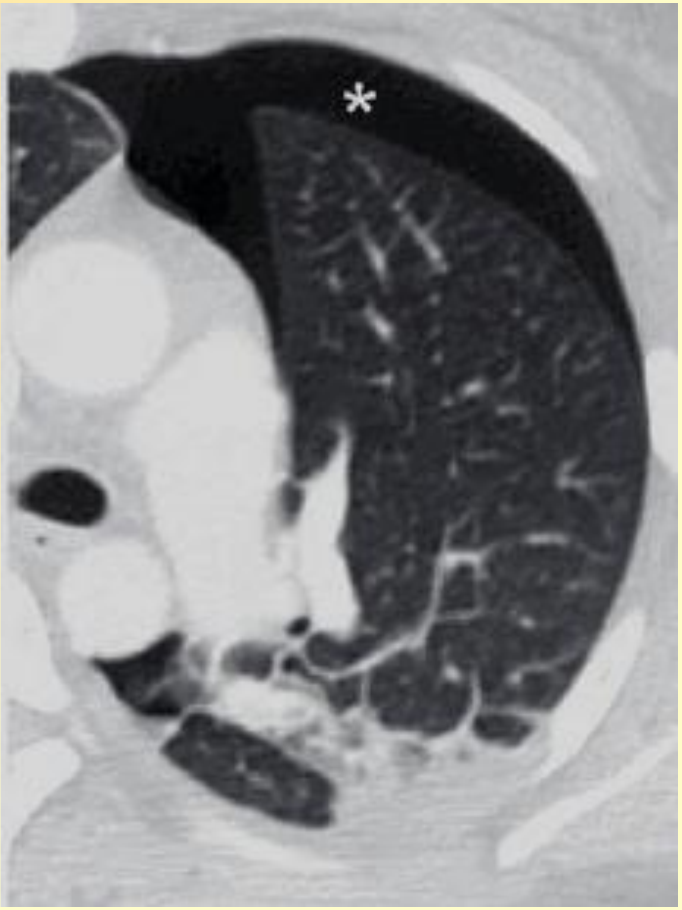
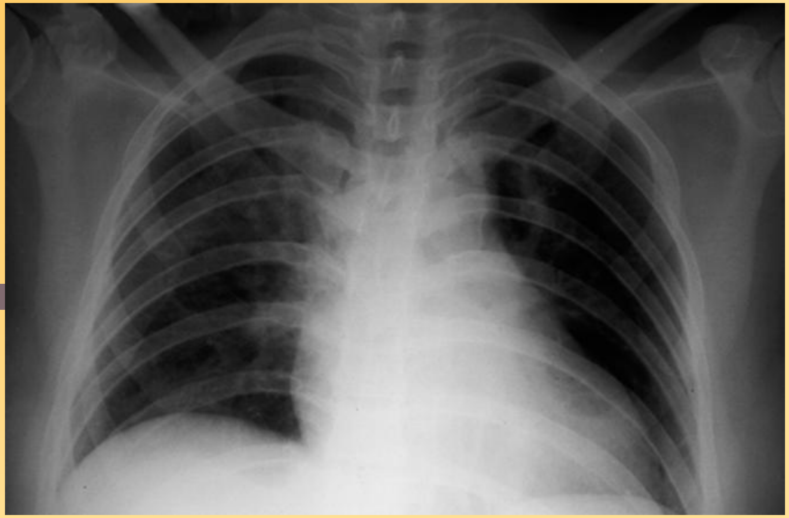
-8.50mm/r
HP1.7
R
WL=-600
WW=1600
42Y/M
SU/HF/VFF
INTERP-2/FC01/U04//R
Osp. Castelnuovo Garfagnana
Asteion





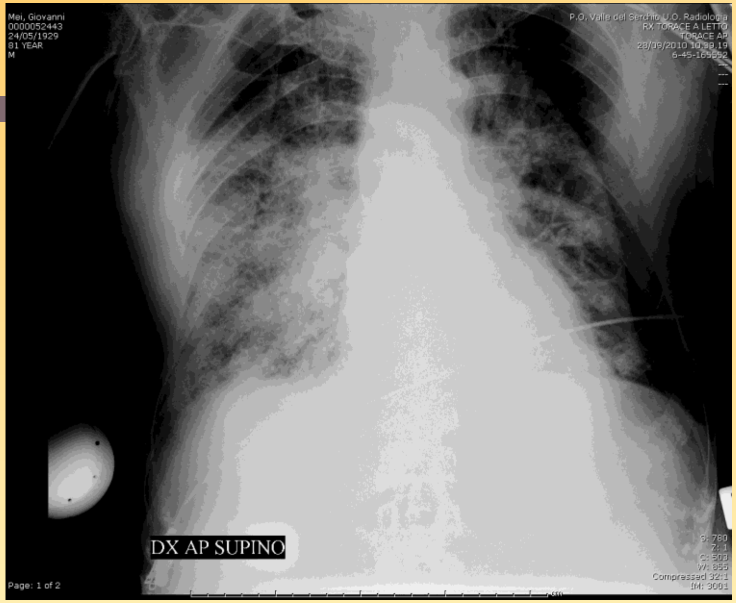
Deep Sulcus (Gordon R. Radiology, 1980; 136.25
Soldati G et al Ultrasound Med Biol 2006)

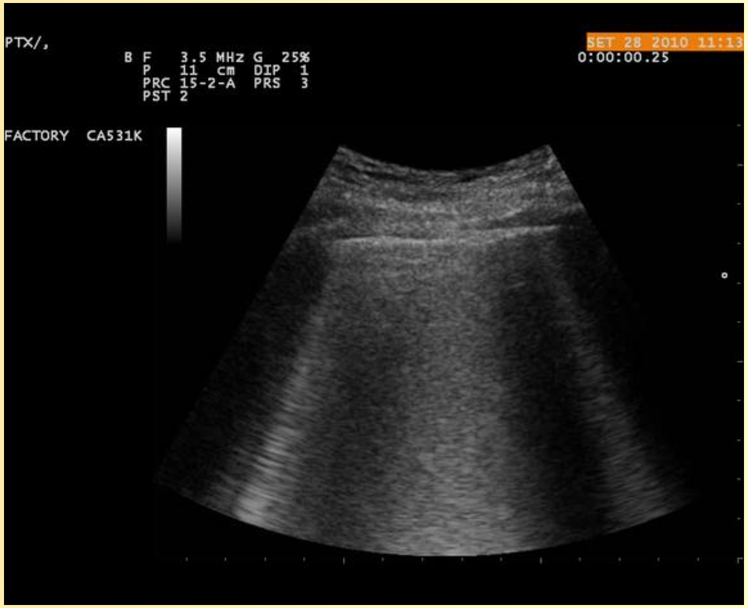


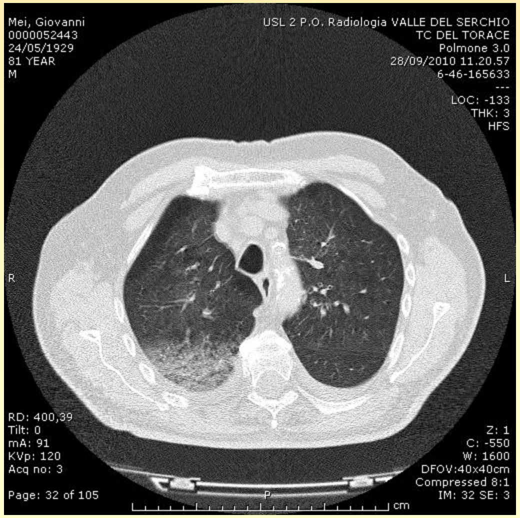
Even though it is well known that it is less sensitive and accurate than computed tomography (CT), chest radiography, usually performed on supine position at the moment of hospital admission, represents the first diagnostic approach to patients sustaining blunt chest trauma

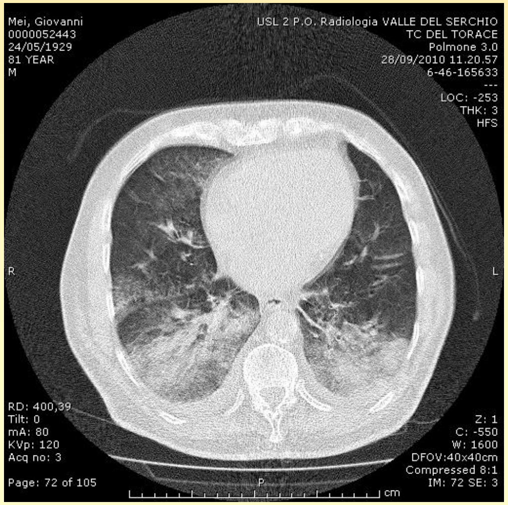
Borut Marincek , Robert F. Dondelinger (Eds.) EMERGENCY RADIOLOGY, Springer 2007

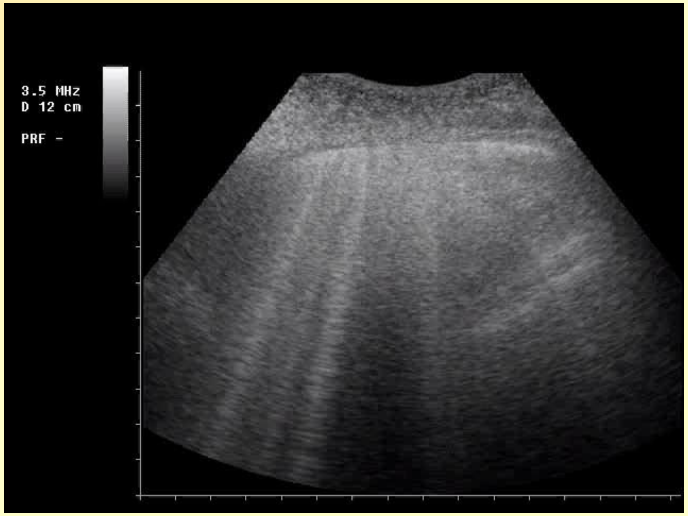
Pneumothorax?

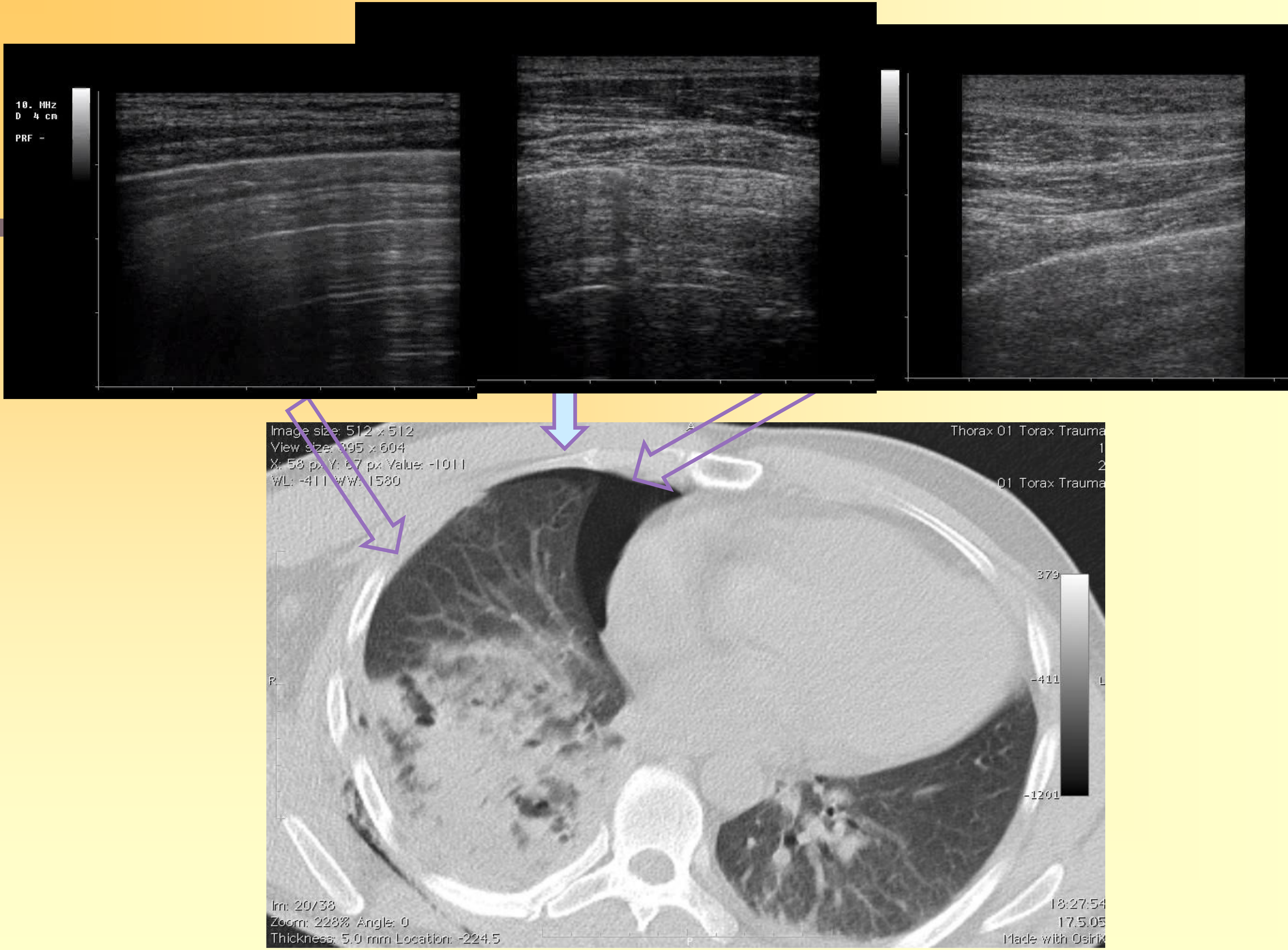








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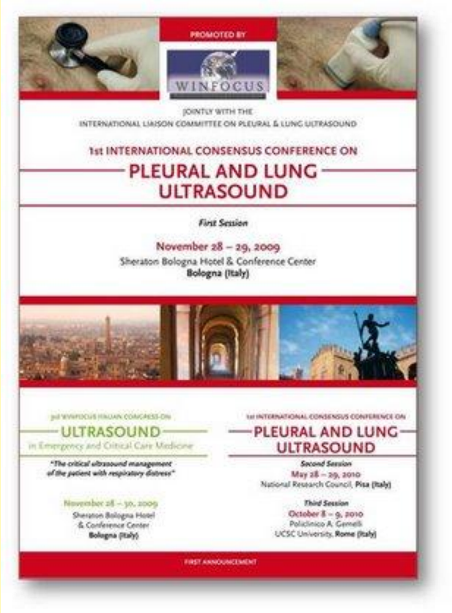
Made with Osirix

- <u>**Domain 1 Pneumothorax**</u>
- **D1-S1 (strong recommendation – perfect consensus)**
- We recommend that the signs that to be used for diagnosis of pneumothorax are absence of lung sliding/gliding, presence of lung point(s) (LP), absence of B-lines, and absence of lung pulse
- **D1-S2 (strong recommendation– perfect consensus)**
- We recommend The technique to be used, in the supine patient, is the exploration of the least gravitationally dependent areas progressing more lateral.
- Adjunct techniques such as M-Mode and color Doppler may be used.
- **D1-S3 (Weak recommendation with – some consensus)**
- We suggest that Ultrasound scanning for Pneumothorax may be a basic ultrasound technique with a steep learning curve.
- **D1-S4 (strong recommendation – very good consensus)**
- We recommend that Lung ultrasound should be used in all clinical settings when a pneumothorax is in the differential diagnosis.
- **D1-S5 (strong recommendation- very good consensus)**
- We recommend that the use of Lung ultrasound when compared to supine anterior chest X-ray can allow more accurate ruling in of Pneumothorax
- **D1-S6 (strong recommendation- good consensus)**
- We recommend that the use of lung ultrasound when compared to supine anterior chest X-ray may allow more accurate ruling out of Pneumothorax
- **D1-S7 (strong recommendation- good consensus)**
- We recommend that the use of Lung ultrasound when compared to supine chest X-ray may be better diagnostic strategy as initial study in critical patients with suspected Pneumothorax and lead to better patient outcome
- **D1-S8 (No recommendation was made)**
- **No recommendation was made** regarding the comparison between Lung ultrasound as compared with CT in assessment of Pneumothorax extension



Traumatic PTX

Table 4
Diagnostic Performance of Supine AP Chest Radiography for Detection of Pneumothorax

Study	Prevalence, % (95% CI)	Sensitivity, % (95% CI)	Specificity, % (95% CI)	LR(+) (95% CI)	LR(−) (95% CI)
Blaivas et al., 2005[10]	30.1 (23.6–37.6)	75.5 (61.4–85.8)	100 (96.2–100)	Infinity	0.25 (0.15–0.39)
Soldati et al., 2006[11]	30.1 (23.7–37.3)	53.6 (39.9–66.8)	100 (96.4–100)	Infinity	0.46 (0.35–0.62)
Zhang et al., 2006[9]	21.5 (15.1–29.5)	27.6 (13.4–47.5)	100 (95.6–100)	Infinity	0.72 (0.58–0.91)
Soldati et al., 2008[12]	11.5 (7.7–16.6)	52 (31.8–71.7)	100 (97.6–100)	Infinity	0.48 (0.32–0.72)

AP = anteroposterior; LR(+) = likelihood ratio of a positive test; LR(−) = likelihood ratio of a negative test.

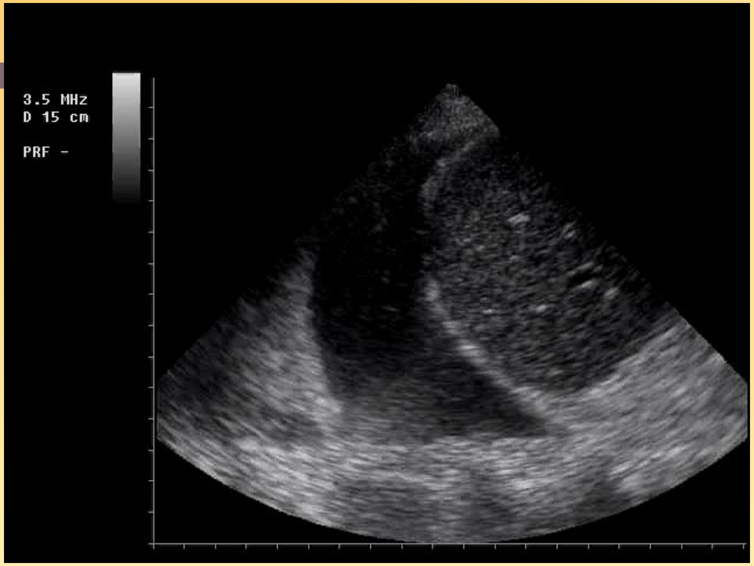
Table 3
Diagnostic Performance of Transthoracic US for Detection of Pneumothorax

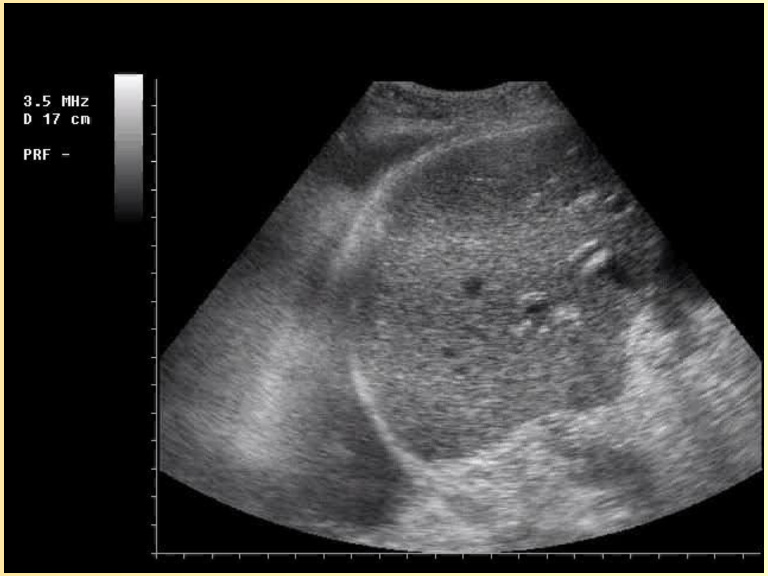
Study	Prevalence, % (95% CI)	Sensitivity, % (95% CI)	Specificity, % (95% CI)	LR(+) (95% CI)	LR(−) (95% CI)
Blaivas et al., 2005[10]	30.1 (23.6–37.6)	98.1 (88.6–99.9)	99.2 (94.9–100)	120.7 (17.1–850.2)	0.02 (0–0.13)
Soldati et al., 2006[11]	30.1 (23.7–37.3)	98.2 (89.2–99.9)	100 (96.4–100)	Infinity	0.02 (0–0.12)
Zhang et al., 2006[9]	21.5 (15.1–29.5)	86.2 (67.4–95.5)	97.2 (91.3–99.3)	30.5 (9.9–93.8)	0.14 (0.06–0.35)
Soldati et al., 2008[12]	11.5 (7.7–16.6)	92 (72.5–98.6)	99.5 (96.7–100.0)	177.6 (25.1–1258.4)	0.08 (0.02–0.3)

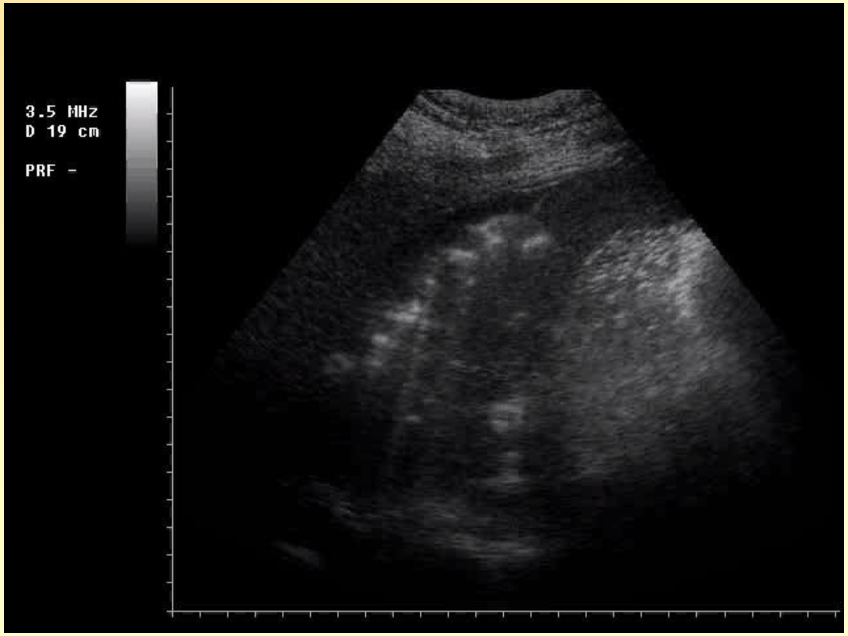
LR(+) = likelihood ratio of a positive test; LR(−) = likelihood ratio of a negative test; US = ultrasound.

Wilkerson RG, Stone MB. Acad Emerg Med 2010;17:11-17

Hemothorax





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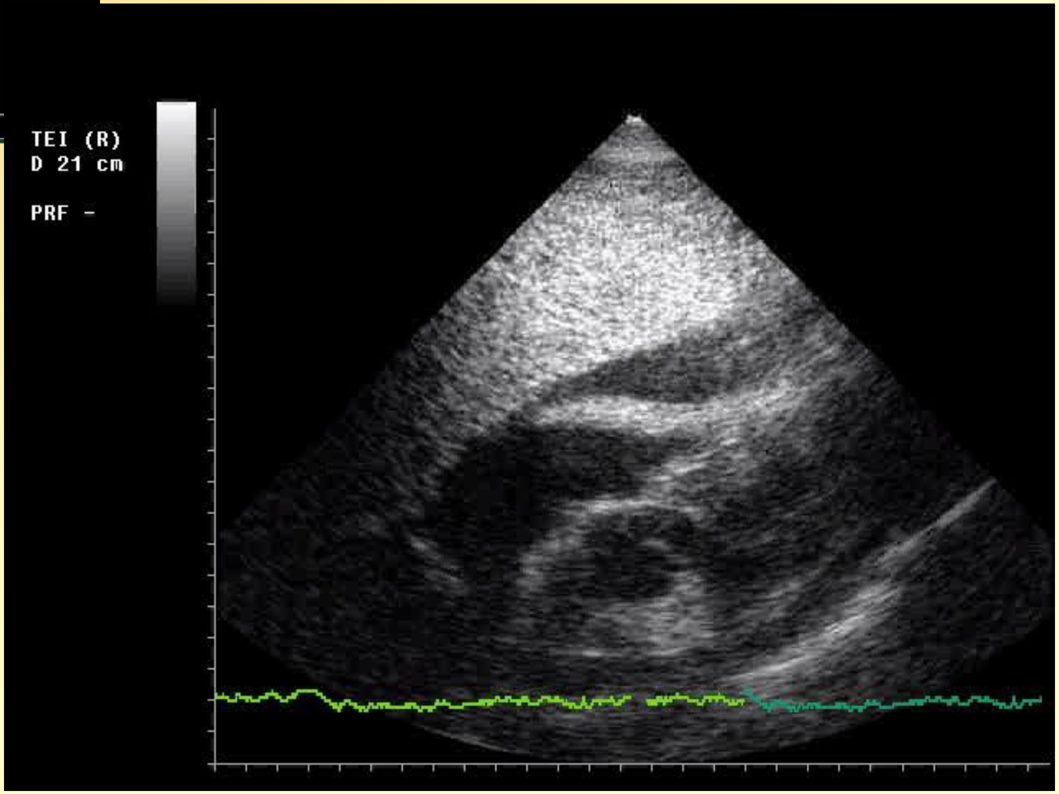

TEI (R)
D 21 cm
PRF -

Lung Contusion

one-third of patients fail to demonstrate a lesion consistent with this diagnosis on the initial chest radiograph

Tyburski JG et al J Trauma 1999;46:833

the mean time to opacification is 6 hours, it may take up to 48 hours

Miller PR et al J Trauma 2001;51:223

Thirty-eight percent of anesthetized dogs sustaining blunt chest trauma showed evidence of a pulmonary contusion on plain radiograph, compared with 100% using CT scans

Schild HH et al J Comput Assist Tomogr 1989;13:417

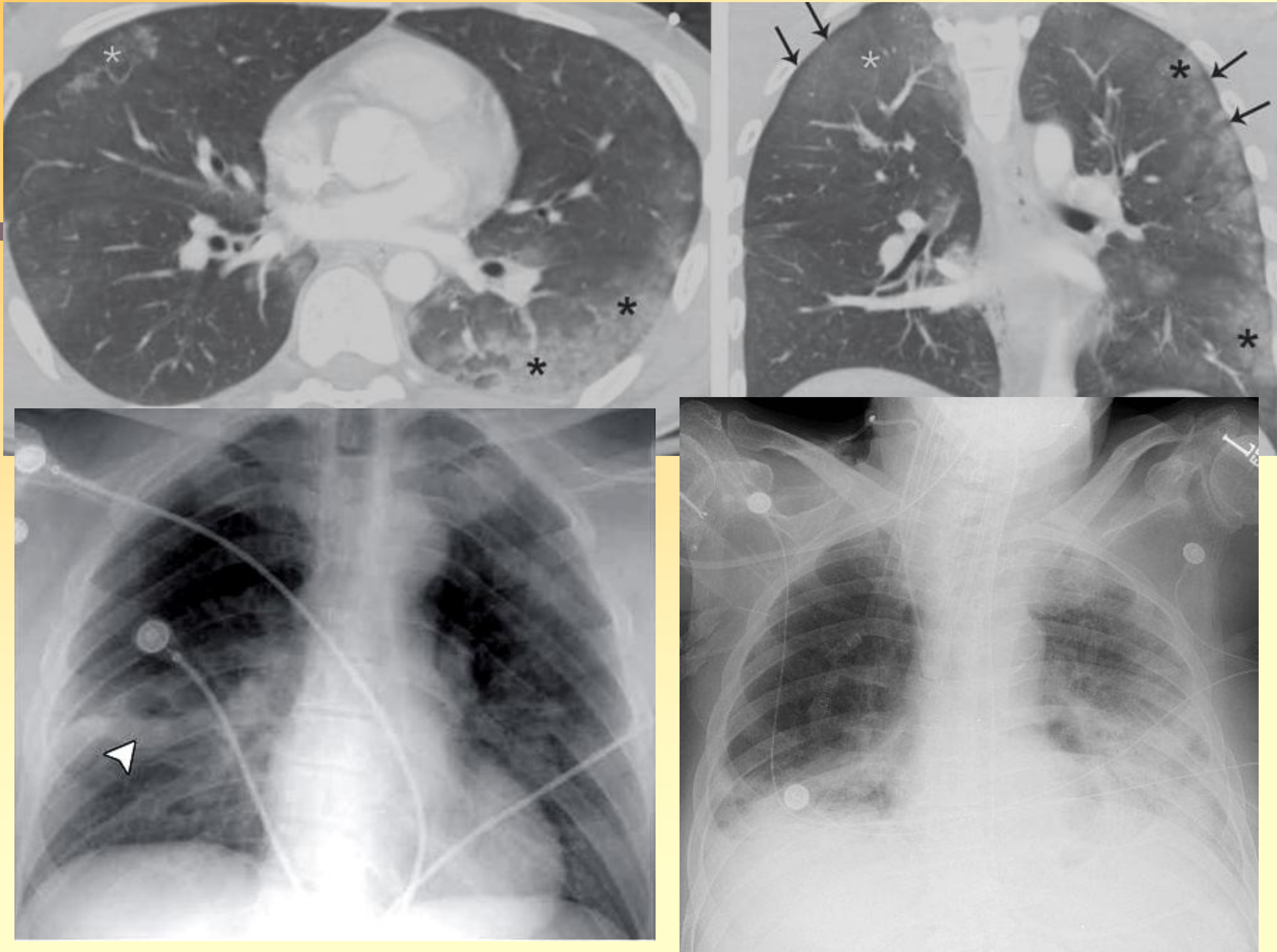
Lung contusion: prognostic implications

- Volume of contusion calculated with 3DCT
- Severe PC >20%
- Moderate PC<20%
- ARDS 82% in severe group
- ARDS 22% in moderate group

Miller PR et al. J Trauma 2001; 68:845

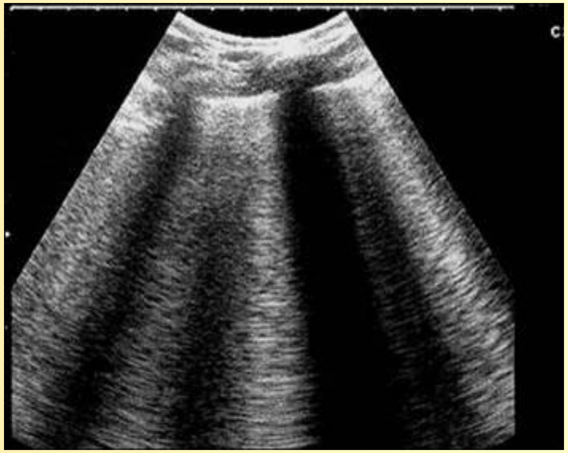
- Volume of contusion calculated with CT
- PC >28 %
- 100 % of patients required mechanical ventilation
- PC < 18%
- No patient required mechanical assistance

Wagner RB et al. J Comput Tomogr 1988; 12:270



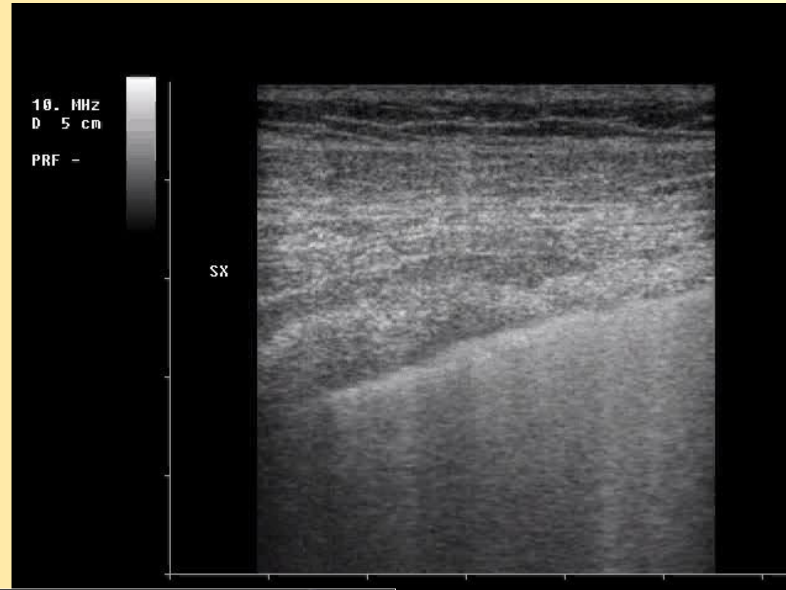
Pathological basis of US imaging in lung contusion

- Interstitial changes (Interstitial edema, hemorrhage, exudation): Interstitio-alveolar syndrome, **interstitial pattern** – B lines.
- Alveolar changes (Consolidations): **Air space pattern** - US consolidations with or without fluid and air bronchograms
- Lung tearing/hematoma: Structural gap with interstitial and alveolar changes



Soldati G , Testa A et al, Chest 2006;130:533


3.5 MHz
D 15 cm
PRF -
DX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D 5 cm
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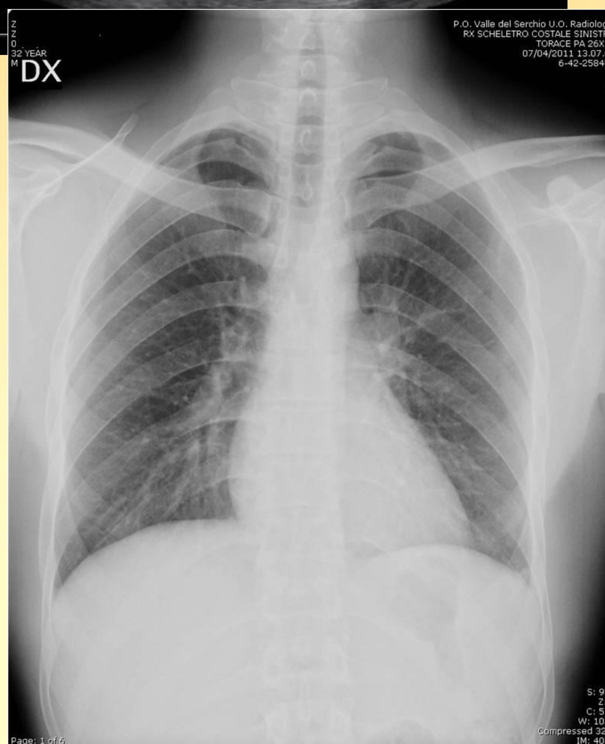
SX


P.O. Valle del Serchio U.O. Radiologi
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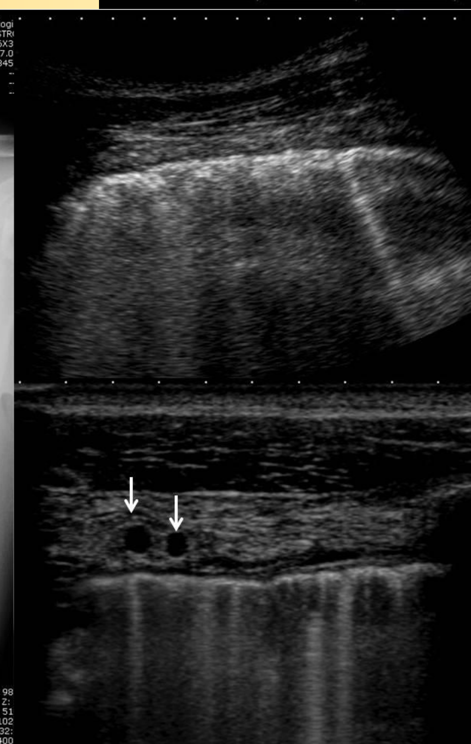
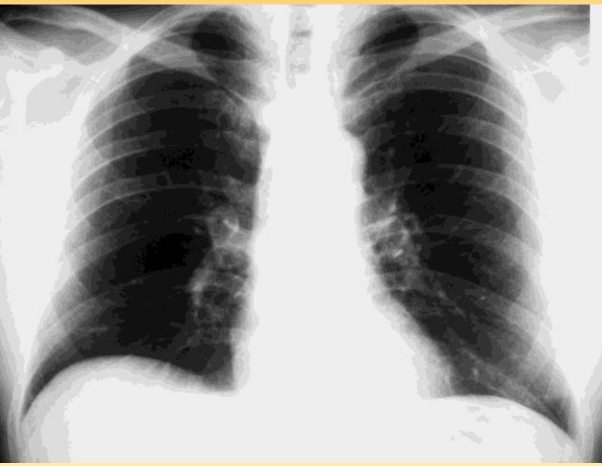
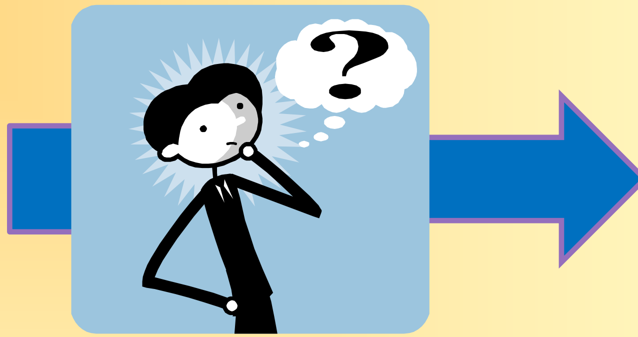
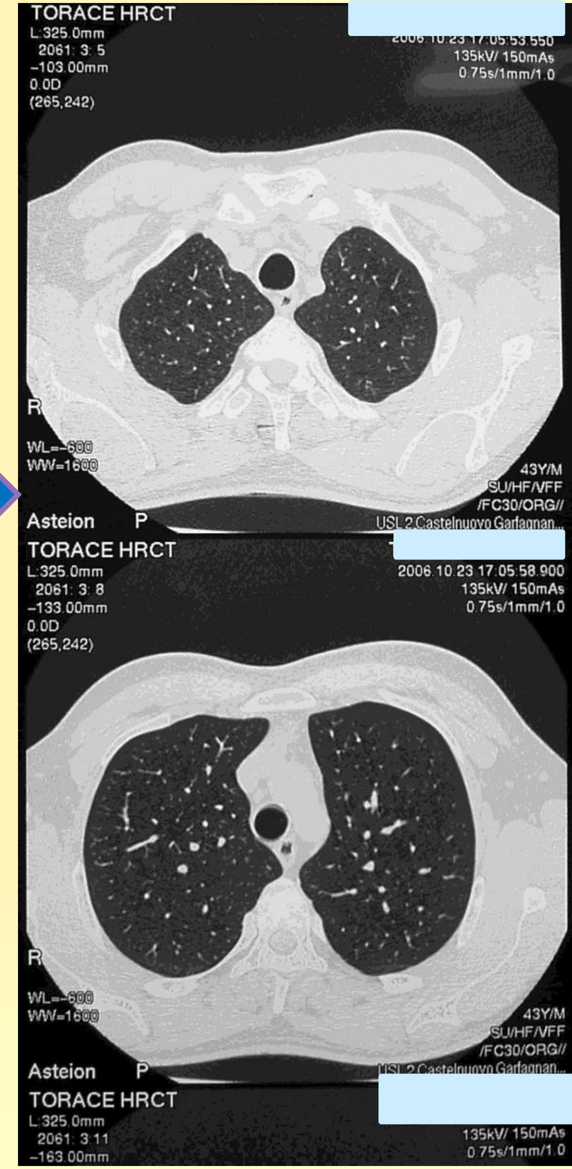
Page: 1 of 6





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TORACE HRCT
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WL=-600
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/FC30/ORG//
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TORACE HRCT
L:325.0mm
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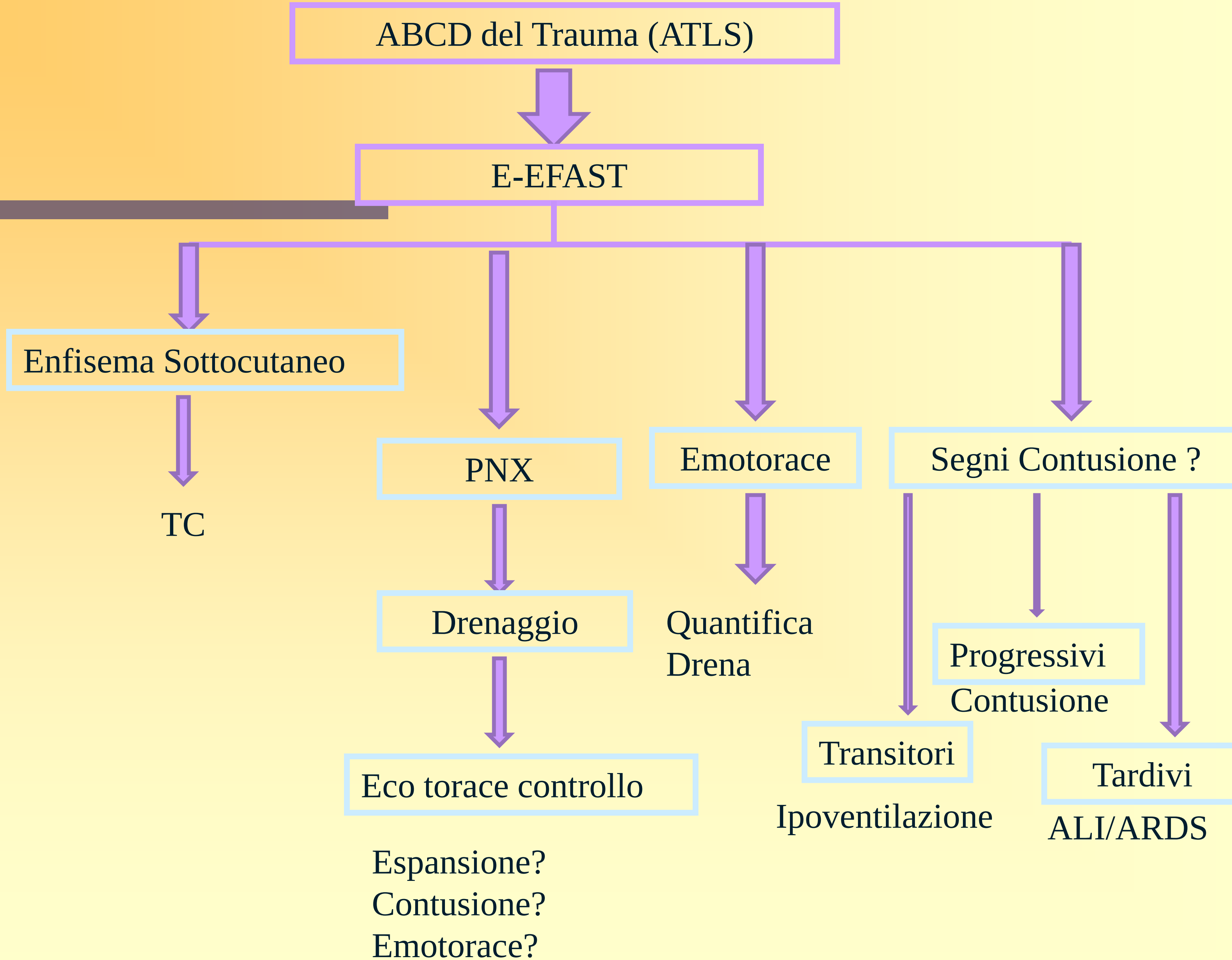
-163.00mm
135kV/ 150mAs
0.75s/1mm/1.0

Criteria for the selective use of chest computed tomography in blunt trauma patients

- Abnormalities identified in E-EFAST
- Abnormalities identified in CXRay (mediastinum)
- High energy mechanism of injury- –No use of constraints, ejection from the vehicle, death occupant, fall from height
- Physical exam of thoracic spine – Clinical signs of injury, thoracolumbar lacerations or haematoma, neurological deficit suggesting spinal cord injury.

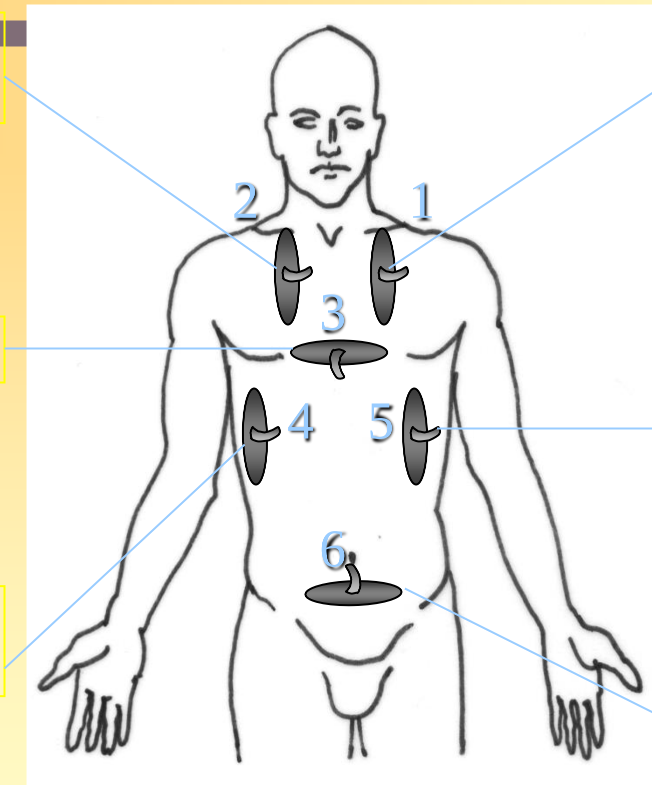

ABCD del Trauma (ATLS)
E-EFAST
Enfisema Sottocutaneo
TC
PNX
Drenaggio
Eco torace controllo
Espansione?
Contusione?
Emotorace?
Emotorace
Quantifica
Drena
Segni Contusione ?
Progressivi
Contusione
Transitori
Ipoventilazione
Tardivi
ALI/ARDS

EFAST
Tecnica

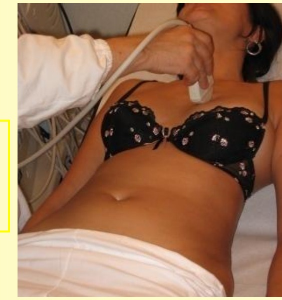
Parasternale dx

Pericardica

Pleurica dx + Periepatica



Parasternale sn



Pleurica sn + Perisplenica

Pelvica

Procedura a 6 finestre ecografiche:

Regola mnemonica delle 6 "P"

Thank You