Ultrasonographic finding in thoracic trauma and procedure

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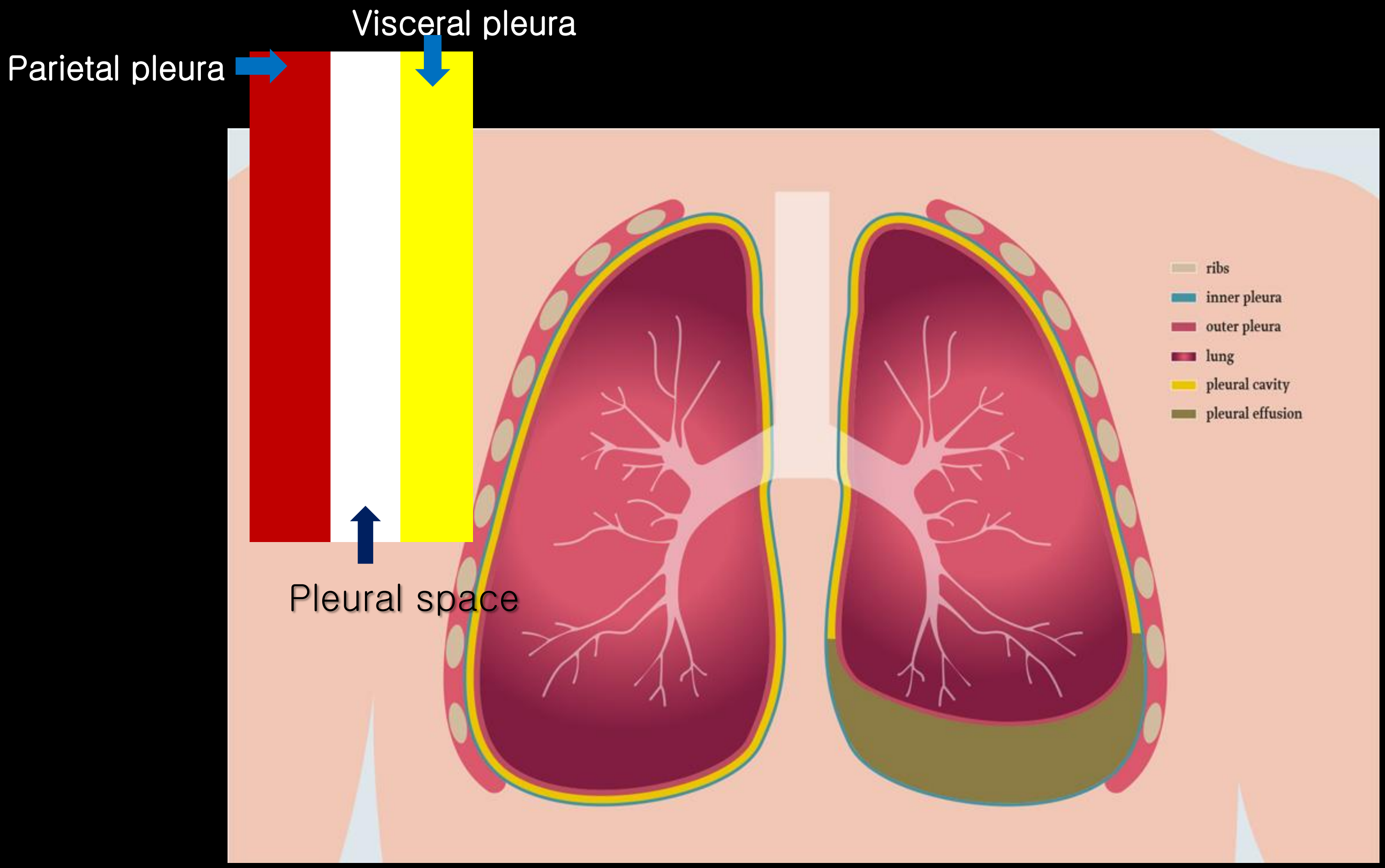
Contents

Ultrasound

- Introduction
- Clinical use
- Case
- Limitation

Approach ?



Visceral pleura
Parietal pleura
Pleural space
ribs
inner pleura
outer pleura
lung
pleural cavity
pleural effusion

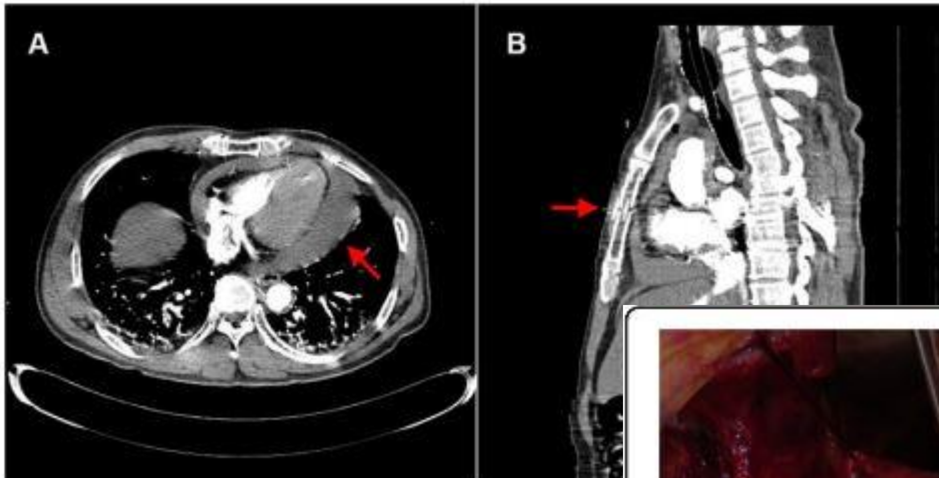


Figure 1 Chest computed tomography at admission. (A) The hemopericardium (re
(red arrow) in the saggital view.

Figure 2 An intraoperative image. White arrow demonstrating a rupture in the distal one-third portion of the coronary sinus: an oval-shaped defect, 2 cm in its longest dimension, with sharp lacerations in the margin.

Reviewer

Reviewer's report

Title:
Traumatic rupture of the coronary sinus following blunt chest trauma

Version:3

Date:
11 August 2014

Reviewer's report:

Major Compulsory Revisions

I think this is a well-written paper even in rare cases of cardiac rupture after blunt trauma. However, the management in this case was unclear, and the title was not directly correlated with the text.

Three questions are here.

Comment 1:
Why did you have to check computed tomography (CT) prior to checking results of FAST?
I think there needs some explanation why you took CT instead of FAST.

EFAST

(Extended Focused Assessment Sonography for Trauma)

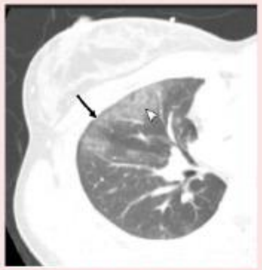
Imaging Manifestations of Chest Trauma

Chest radiography is often the first-line imaging modality

CT is more accurate to assess the nature and extent of injury

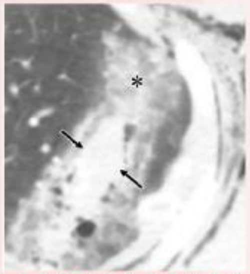
Pulmonary Parenchymal Injury

Contusions



Peak in conspicuity and extent 48-76 hours after trauma

Lacerations



A traumatic laceration cavity can fill with air, blood, or both

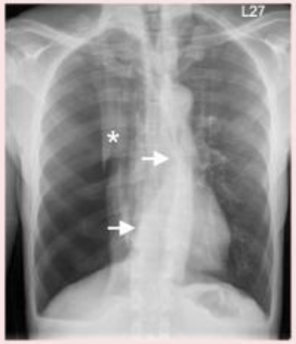
Hematoma

Most resolve in <5 weeks; if longer may be mistaken for neoplasm

Hemothorax

Pleural fluid with values of 30–70 HU or layering of blood in the pleura (hematocrit sign) suggests acute blood products

Pneumothorax



Upright postero-anterior radiographs >90% sensitivity

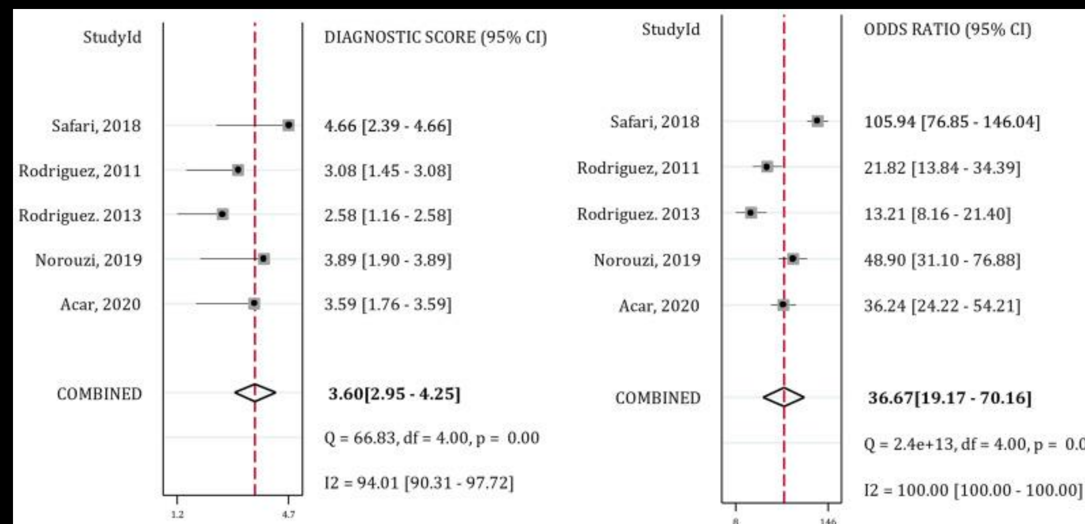
Primary limitations of CT = patient transportation and processing time

Lewis BT et al. Published online: July 16, 2021
https://doi.org/10.1148/rg.2021210042

RadioGraphics

Direction

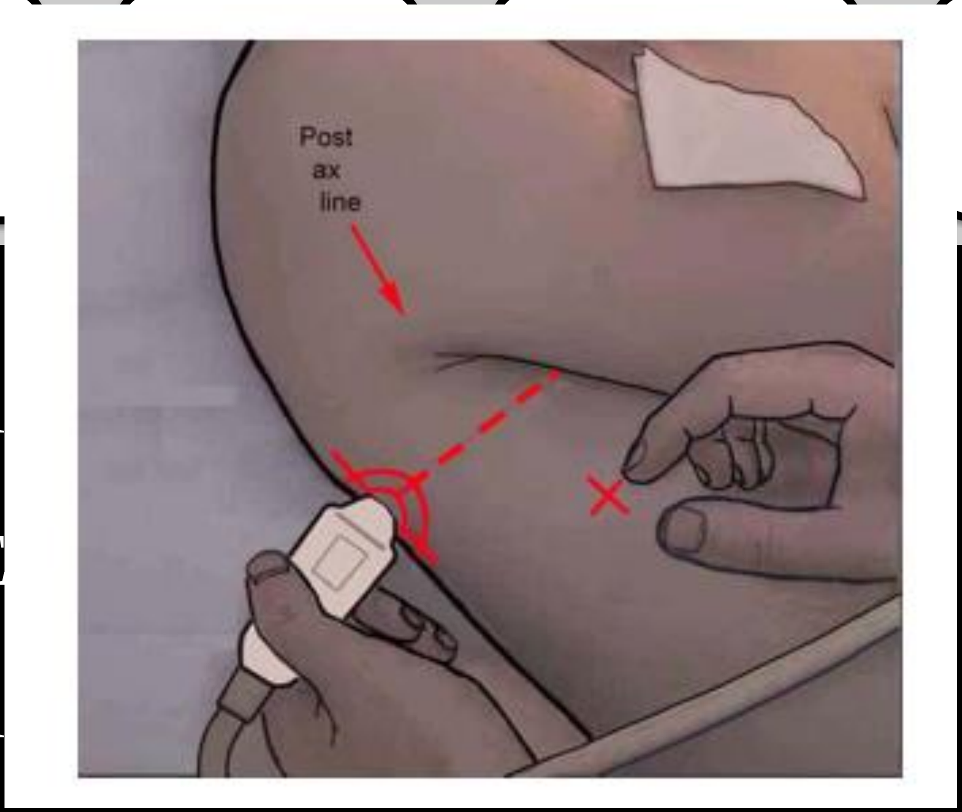
- Simple
- Non invasive
- Portable
- Fast
- NEXUS trial (National Emergency X-ray Utilization Studies)



SAFETY

Am J Emerg Med. 2023 Mar:65:53-8.

Utility



- Ultrasou
- FAST/ E
- Ultrasou
- Ultrasound Organ Preservation ?

FAST

- 1990's blunt abdominal trauma
- Minimal amount of fluid
- High sensitivity
- High specificity
- But, low sensitivity in specific organs (<50%)
- Helps determine the need for angiography, CT

Chest trauma

- Focused on chest wall (rib fracture)
- 1980s, diagnostic sub-xiphoid pericardiostomy : evaluate for a pericardial effusion following a penetrating injury to the thorax
- Resulted in many negative procedures
- Unnecessary procedures ***versus*** life saving chance

Surgery 1990; 108: 676-9.
J Trauma 1999;46: 543-51.

Ultrasound in chest trauma

- Trauma field of General surgery
  - Solid organ protection
  - Spleen, liver
- <u>Trauma field of Chest surgery</u>
  - Fluid status perfusion assessment
  - Not only solid organ but also function evaluation
  - Central organ maintain

Indication

- Penetrating heart trauma
- Blunt chest trauma
- Thoraco-abdominal trauma
- Chest skeletal trauma
- Undefined cause hypotension

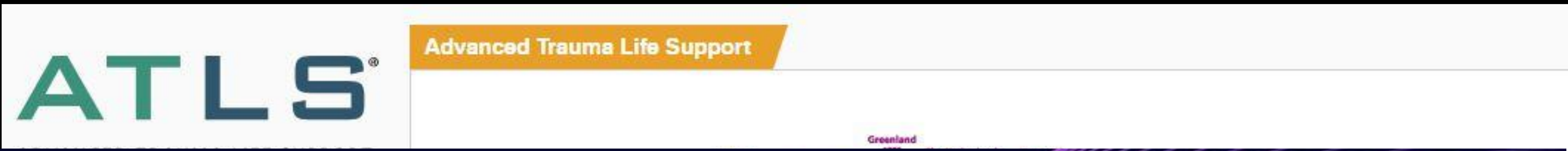
Rev Bras Ter Intensiva. 2010; 22(3):291-9.

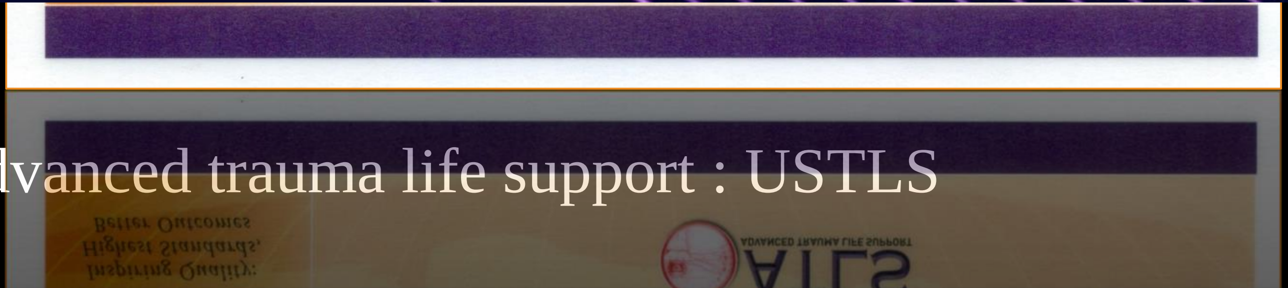
Thoracic injury?

- Ultrasound evaluation : when CT can not taken
  - High sensitivity and 97.3% for detecting hemopericardium
- Lung parenchymal and pleura injury
- Combination of echocardiography : shock
- Procedure: central venous catheter, tracheostomy
- More and more…

Chest. 2006 Aug;130(2):533-8.

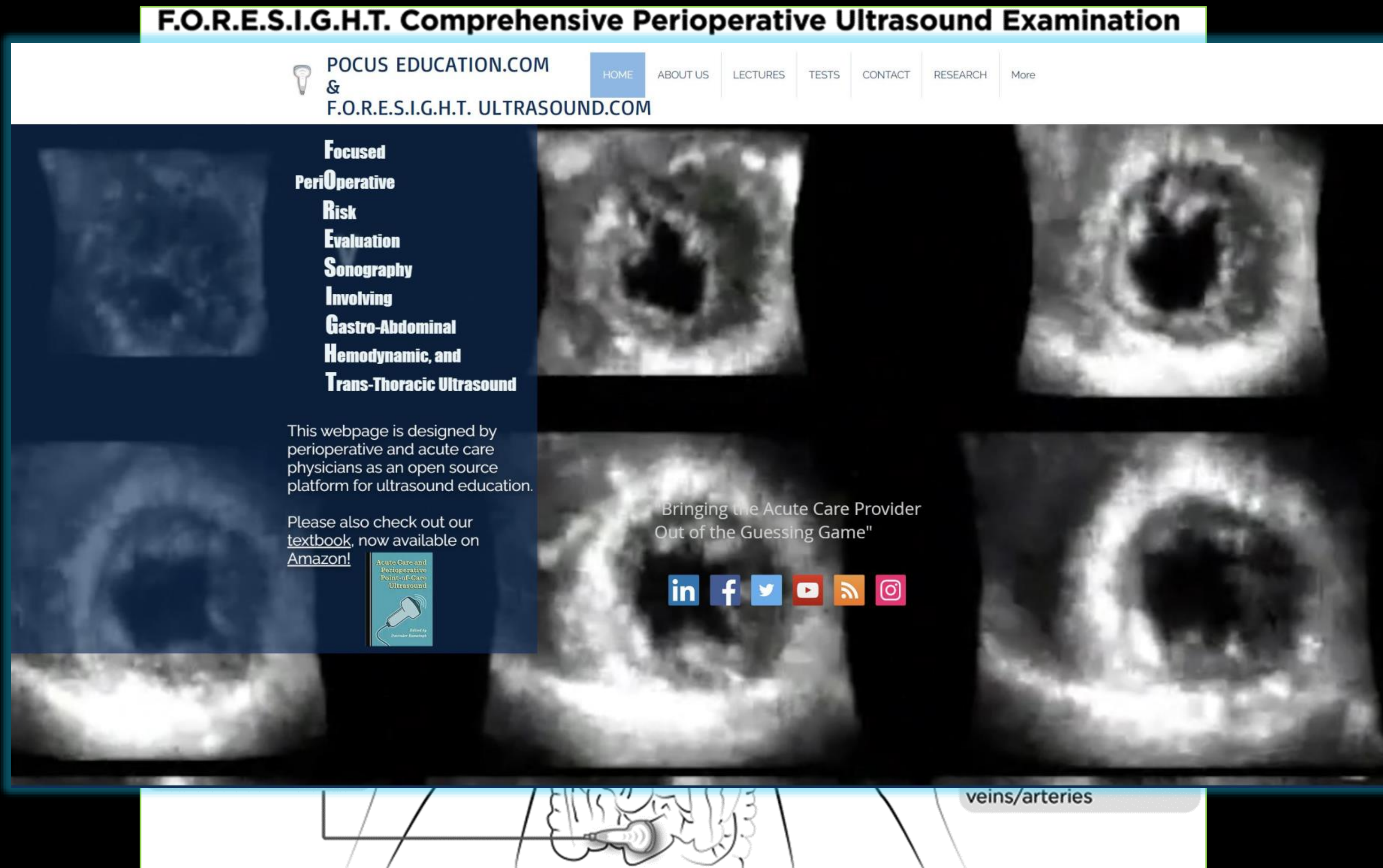
OR





- Advanced trauma life support : USTLS

FORESIGHT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Gastro-Abdominal
Hemodynamic, and
Trans-Thoracic Ultrasound
This webpage is designed by perioperative and acute care physicians as an open source platform for ultrasound education.
Please also check out our textbook, now available on Amazon!
Acute Care and Perioperative Point-of-Care Ultrasound
Bringing
Acute Care Provider
Out of the Guessing Game"
veins/arteries

Blunt thoracic trauma

The combined utility of extended focused assessment with sonography for trauma and chest x-ray in blunt thoracic trauma

Morgan Schellenberg, MD, Kenji Inaba, MD, James M. Bardes, MD, Nicholas Orozco, MD, Jessica Chen, Caroline Park, MD, Tarina Kang, MD, *and* **Demetrios Demetriades, MD, PhD***, Los Angeles, California*

- EFAST combined CXR
- 15 years
- N = 1,311

Blunt thoracic trauma

TABLE 2. Total Injuries and Missed Injuries Among Stable Blunt Trauma Patients

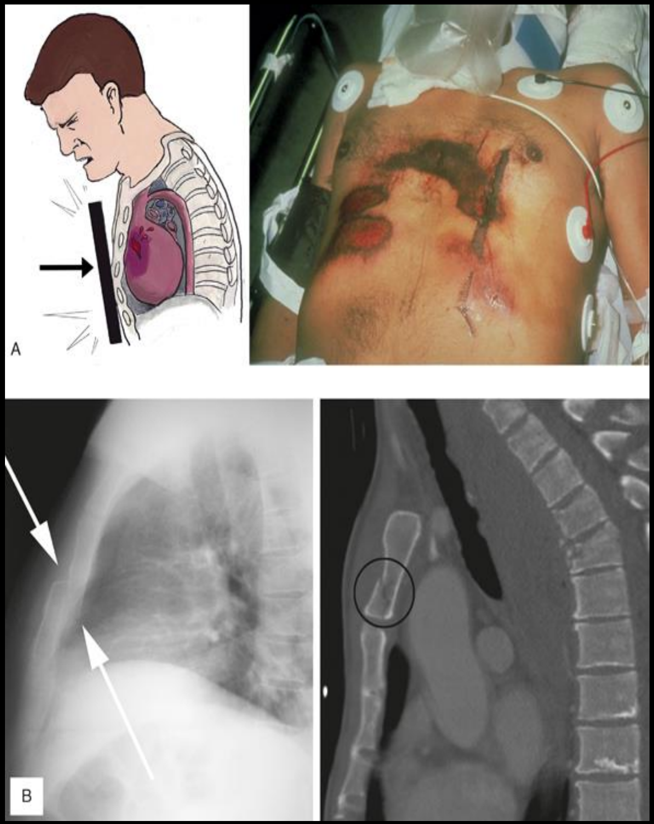
Injury	Total, n (%)	Missed on EFAST/CXR, any (n, %)	Missed on EFAST/CXR, Significant Injuries (n, %)
Rib fracture(s)	382 (29%)	229 (60%)	24 (10%)
Pneumothorax	242 (18%)	153 (63%)	32 (21%)
Pulmonary contusion	213 (16%)	144 (68%)	22 (15%)
Sternal fracture	101 (8%)	82 (81%)	82 (100%)
Hemothorax	82 (6%)	43 (52%)	17 (40%)
Clavicle fracture	76 (6%)	37 (49%)	37 (100%)
Scapula fracture	72 (5%)	47 (65%)	47 (100%)
Thoracic spine fracture	46 (4%)	29 (63%)	19 (66%)
Aortic injury	7 (<1%)	2 (29%)	2 (100%)

TABLE 3. The Diagnostic Yield of EFAST, CXR, PEx, and Their Combinations Among Stable Blunt Trauma Patients in the Detection of Any Injuries

	EFAST	CXR	PEx	EFAST+CXR	EFAST+CXR+PEx
Sensitivity	0.13	0.36	0.36	0.38	0.55
Specificity	1.00	1.00	0.89	0.99	0.82
PPV	0.86	0.93	0.71	0.93	0.41
NPV	0.83	0.90	0.65	0.87	0.89

J Trauma Acute Care Surg. 2018 Jul;85(1):113-17.

Blunt thoracic trauma



- Motorcycle collisions and AVP trauma, missed injury based on EFAST and CXR is significant.
- A population in which CT scan of the chest can safely be forgone remains undefined.

J Trauma Acute Care Surg. 2018 Jul;85(1):113-17.

Initial assessment

Integrating extended focused assessment with sonography for trauma (eFAST) in the initial assessment of severe trauma: Impact on the management of 756 patients

Laurent Zieleskiewicz[a,b,*], Raphaelle Fresco[a], Gary Duclos[a], François Antonini[a], Calypso Mathieu[a,c], Sophie Medam[a], Coralie Vigne[a], Marion Poirier[a], Pierre-Hugues Roche[c,d], Pierre Bouzat[e,f], François Kerbaul[c,g], Ugo Scemama[h], Thierry Bège[c,i,j], Pascal Alexandre Thomas[c,k], Xavier Flecher[c,l], Emmanuelle Hammad[a], Marc Leone[a,c,m]

	Patients (n = 756)
Blunt trauma	690 (91.3%)
Injury type	
Motor accident	526 (69.7%)
Fall	123 (16.3%)
Sports-related	13 (1.7%)
Other	94 (12.4%)
Age (years)	37 [23; 49]
Male sex	620 (82.0%)
In-hospital mortality	108 (14.3%)
SAPS II	33 [21; 50]
ISS	25 [16; 34]
Cardiac arrest	35 (4.6%)
Haemodynamic instability	257 (34.0%)
Norepinephrine infusion	165 (21.8%)
Catheters before WBCT	506 (66.9%)
Brain trauma	374 (49.5%)
GCS score	10 [7; 15]
Chest trauma	430 (56.9%)
Mechanical ventilation	378 (50.0%)
Prehospital chest tube	20 (2.6%)
Subcutaneous emphysema	66 (8.7%)

Values shown are n (%) or median [25th; 75th percentile]. *SAPS II* Simplified Acute Physiology Score, *ISS* Injury Severity Score, *WBCT* whole-body computed tomography, *GCS* Glasgow Coma Scale.

- French
- N = 756
- Blunt trauma = 91.3%
- Chest trauma = 56.9%

Injury. 2018 Oct;49(10):1774-80.

Initial assessment

	Sensitivity %	Specificity %	Youden index	Positive predictive value %	Negative predictive value %	Positive likelihood ratio	Negative likelihood ratio	Diagnostic accuracy
Pneumothorax (n = 198)								
LUS (n = 1495)	69	99	0.7	94	96	112	0.3	96
CXR (n = 1488)	37	100	0.4	95	91	120	0.4	91
Haemothorax (n = 103)								
LUS (n = 1495)	48	100	0.5	90	97	135	0.5	96
CXR (n = 1488)	29	100	0.3	90	95	133	0.7	95
Peritoneal effusion (n = 116)								
FAST (n = 756)	70	96	0.7	78	95	19	0.3	92

Values shown are %. *LUS* lung ultrasonography, *CXR* chest x-ray, *FAST* focused assessment with sonography for trauma. We found no difference between the right and left chest walls regarding the occurrence of each thoracic lesion, which allowed us to analyze the lung fields as separate entities; 1495 lung fields were assessed for LUS and 1488 lung fields for CXR.

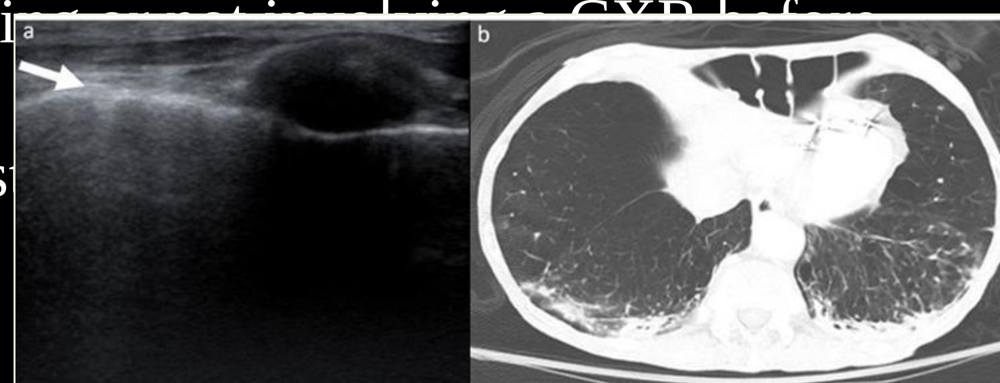
Imaging technique	Therapeutic impact	Appropriate positive decision	Inappropriate positive decision	Appropriate negative decision	Inappropriate negative decision
LUS (n = 751)	5 (0.7%)	5 (100%)	0	745 (99.9%)	1 (0.1%)
CXR (n = 745)	5 (0.7%)	53 (100%)	0	678 (98%)	14 (2%)
LUS + CXR (n = 741)	48 (6 %)	48 (100%)	0	693 (100%)	0
Pericardial sonography (n = 683)	2 (0.3%)	2 (100%)	0	681 (100%)	0
PXR (n = 745)	0	0	0	744 (99.9%)	1 (0.1%)
Abdominal sonography (n = 756)	16 (2%)	15 (94%)	1 (6%)	740 (100%)	0
Global therapeutic impact of initial assessment	76 (10%)	123 (99.2%)	1 (0.8%)	741 (99.6%)	1 (0.4%)

Values shown are n (%). *LUS* lung ultrasonography, *CXR* chest x-ray, *FAST* focused assessment with sonography for trauma.

Injury. 2018 Oct;49(10):1774-80.

Initial assessment

- Pelvic AP had a minimal therapeutic impact.
- In those patients with a normal LUS, the CXR marginally affected the management of patients.
- LUS based strategy involvi
  the WBCT should be invest



Injury. 2018 Oct;49(10):1774-80.

Blunt thoracic trauma

ORIGINAL ARTICLE Open Access

Value of point-of-care ultrasonography compared with computed tomography scan in detecting potential life-threatening conditions in blunt chest trauma patients

- Sonography versus CT scan
- Blunt chest trauma
- Bedside exam
- N = 157

Ultrasound J. 2020 Aug 4;12(1):36.

Blunt thoracic trauma

Assessment	Definition	Simple pneumothorax	Tension pneumothorax	Hemothorax	Massive hemothorax	Pulmonary contusion
Findings of physical examination						
Inspection	Chest expansion	Nl-↓	↓	↓	↓	Nl
	Trachea	Nl	Deviated	Nl	Deviated	Nl
	Jugular vein pressure	Nl	↑	Nl	↓	Nl
Percussion	The sound of striking 2 fingers on inter-costal spaces	Nl-hyperresonance	Hyperresonance	Nl-dull	Dull	Nl
Auscultation	To hear both sides comparatively and note sounds' quality	↓	Nl-dull	Nl-↓	↓	Nl-crackles
Findings of ultrasonography						
Pleural sliding	The shimmering movement of pari-etal pleura during inspiration	Lost in injured zone	Lost	Nl	May be Nl	Maybe falsely ↓
Seashore sign	Normal lung M-mode of sandy appear-ance above and parallel lines below	Lost in injured zone	Lost	Nl	May be Nl	May be Nl
Barcode/strato-sphere sign	Abnormal M-mode showing multiple parallel lines	+ in injured zone	+	–	–	May be falsely +
Lung point	The interface of normal lung and pneumothorax area in B-M mode	May be +	Often -	–	–	–
Sinusoid sign	The sinusoidal movement of the collapsed lung in the pleural fluid	–	–	+	+	–
V-line	Echogenic vertebral line with posterior shadow due to the transmission of ultrasound waves through the pleural fluid	–	–	May be +	+	–
B-lines/comet tails	Vertical echogenic artifact lines from the pleura to the screen edge, if mul-tiple, resulting from alveolo-interstitial syndrome (rocket sign)	Lost	Lost	Nl	May be Nl	↑
Peripheral paren-chymal lesions	Lung hepatization with subpleural hypoechoic foci and pleural line gap	–	–	–	–	+

Ultrasound J. 2020 Aug 4;12(1):36.

Blunt thoracic trauma

Type of injury	Diagnostic tool	Analysis	Point estimate	95% CI[a]
Pneumothorax	Sonography	Sensitivity, %	75.0	55.1–89.0
		Specificity, %	100	97.2–100
		PPV%	100	83.9–100
		NPV%	94.9	89.7–97.9
		Accuracy%	95.5	91.0–98.2
Hemothorax		Sensitivity, %	45.4	24.4–67.8
		Specificity, %	100	97.3–100
		PPV%	100	69.2–100
		NPV%	91.8	86.2–95.7
		Accuracy%	92.4	87.0–96.0
Contusion		Sensitivity, %	58.1	42.1–73.3
		Specificity, %	100	96.8–100
		PPV%	100	86.3–100
		NPV%	86.3	79.3–91.7
		Accuracy%	88.5	82.5–93.1
Pneumothorax, hemothorax and contusion	Physical exam and sonography	Sensitivity, %	91.5	81.3–97.2
		Specificity, %	90.8	83.3–95.7
		PPV	85.7	74.6–93.3
		NPV	94.7	88.0–98.3
		Accuracy	91.8	85.5–95.0

- LUS : high accuracy (91.8%)
- Positive predictive value: 100%
- POCUS : hemothorax & lung contusion, gold standard > CT

Ultrasound J. 2020 Aug 4;12(1):36.

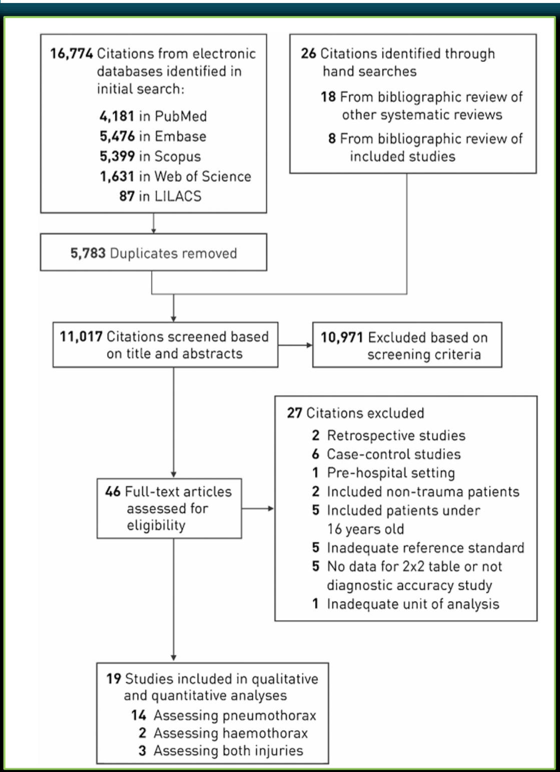
SR and MA

Review

Chest ultrasonography for the emergency diagnosis of traumatic pneumothorax and haemothorax: A systematic review and meta-analysis

Check for updates

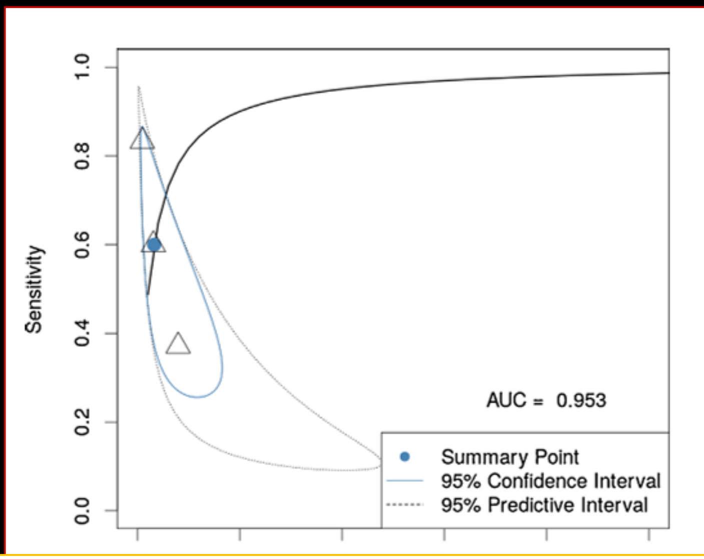
Leonardo Jönck Staub[a,f,*], Roberta Rodolfo Mazzali Biscaro[b], Erikson Kaszubowski[e], Rosemeri Maurici[c,d]

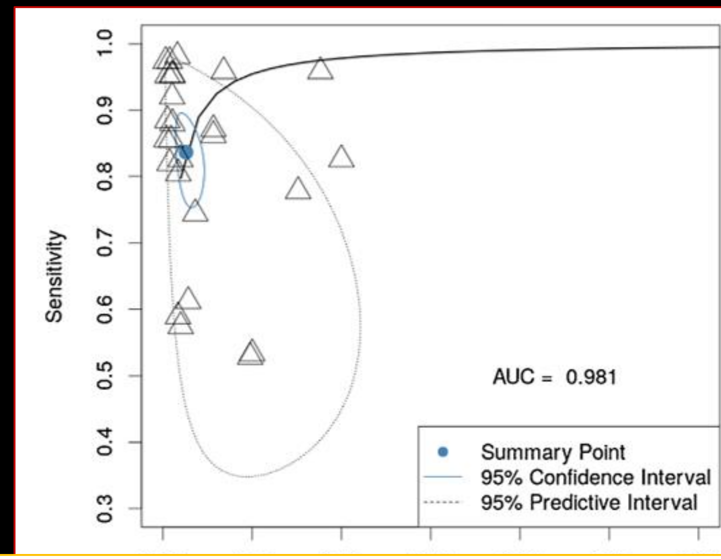


Study	Ultrasound transducer	Chest areas scanned	Target injury and sonographic pattern of positivity
Abbasi et al. [15]	Linear: 7.5 MHz	2nd to 4th intercostal spaces at the hemi-clavicular lines	Pneumothorax: absence of lung sliding and comet-tail artefacts
Blaivas et al. [28]	Micro-convex broadband: 2–4 MHz	2th intercostal spaces at hemi-clavicular lines 4th intercostal spaces at anterior axillar lines 6th intercostal spaces at mid axillar lines 6th intercostal spaces at posterior axillar lines	Pneumothorax: absence of lung sliding
Helland et al. [31]	Linear: 7.5 MHz	Patients were randomised to receive a one scan protocol in the 3rd intercostal space at hemi-clavicular line, or a 4 scans protocol in this point plus 3 other points, in each hemithorax	Pneumothorax: absence of lung sliding
Kaya et al. [17]	Linear: 7.5 MHz	2nd to 4th intercostal spaces at hemi-clavicular line 4th to 8th intercostal spaces at mid axillar lines	Pneumothorax: absence of lung sliding and comet-tail artefacts
Kirkpatrick et al. [18]	Linear: 5–10 MHz	E-FAST: 2nd intercostal spaces at hemi-clavicular lines 4th or 5th intercostal spaces at mid axillar lines	Pneumothorax: absence of lung sliding and comet-tail artefacts
Ku et al. [30]	Convex: 2–4 MHz	All intercostal spaces at hemi-clavicular lines At left: if heart was viewed, finished at anterior axillar line	Pneumothorax: absence of lung sliding and comet-tail artefacts, and lung point
Mumtaz et al. [20]	Linear: 5 MHz	E-FAST: 3rd and 4th intercostal spaces in hemi-clavicular lines	Pneumothorax: absence of lung sliding and comet-tail artefacts, and lung point*
Nagarsheth et al. [21]	Convex: 2.5 MHz, or Linear: 10.5 MHz	E-FAST: 2nd to 4th intercostal spaces at hemi-clavicular line	Pneumothorax: absence of lung sliding and no comet-tail artefacts
Nandipati et al. [22]	Linear: 7.5 MHz	E-FAST: 2nd intercostal spaces at hemi-clavicular lines	Pneumothorax: absence of lung sliding and no comet-tail artefacts
Rowan et al. [23]	Linear: 7.0 MHz	2nd to 4th intercostal spaces in anterior chest regions 6th to 8th intercostal spaces at mid axillar lines	Pneumothorax: absence of lung sliding and comet-tail artefact
Soldati et al. [24]	Convex 5.0 MHz	E-FAST: 3rd intercostal spaces to diaphragm at hemi-clavicular lines All intercostal spaces at para-sternal lines and mid axillar lines	Pneumothorax: absence of lung sliding and comet-tail artefact
Soldati et al. [25]	Convex: 3.5 MHz or 5.2 MHz	3rd intercostal spaces to down at hemi-clavicular lines All intercostal spaces at para-sternal lines and mid axillar lines	Pneumothorax: absence of lung sliding and comet-tail artefact, and lung point
Zhang et al. [26]	Convex: 3.5 MHz, or Linear: 7.5 MHz	Anterior, lateral and posterior chest regions	Pneumothorax: absence of lung sliding and no comet-tail artefacts
Ziapour et al. [27]	Linear: 9.0 MHz	3rd intercostal spaces at hemi-clavicular lines using two oblique scans	Pneumothorax: absence of lung sliding and comet-tail artefact
Hyacinthe et al. [16]	Convez: 2–5 MHz	Three areas (upper, mid and lower) in each anterior and lateral region.	Pneumothorax: absence of lung sliding and comet-tail artefacts, and the lung point Haemothorax: gravity dependent collection between diaphragm and pleura
Leblanc et al. [19]	1–5 MHz	Four areas in each hemithorax (not specified)	Pneumothorax: absence of lung sliding, comet-tail artefacts and lung pulse, and lung point Haemothorax: gravity dependent anechoic collection
Ojaghi-Haghighi et al. [29]	Convex: 5 MHz, and Linear: 6.5–9 MHz	E-FAST: locations of the scans were not described	Pneumothorax: no lung sliding and no comet-tail artefacts Haemothorax: anechoic area in pleural space
Brooks et al. [32]	Micro-convex: 2–4 MHz	E-FAST: oblique views in lateral-basal chest regions, using liver or spleen as window	Haemothorax: free fluid in the pleural space
Ma et al. [33]	2.5–3.5 MHz	E-FAST: oblique views in the lateral chest regions, using liver or spleen as window	Haemothorax: free fluid in the pleural space

Injury. 2018(49) 457-66.

SR and MA





Analysis	Sonographic sign	Number of studies and references	Confirmed/total analysed	Sensitivity (95%CI)	Specificity (95%CI)	Positive likelihood ratio (95%CI)	Negative likelihood ratio (95%CI)
Primary (by hemithorax)	Absence of lung sliding and comet tail artefacts*	13 [15–27]	415/2965	0.81 (0.71–0.88)	0.98 (0.97–0.99)	67.9 (26.3–148)	0.18 (0.11–0.29)
	Absence of lung sliding	1 [28]	53/352	0.98 (0.90–0.99)	0.99 (0.98–0.99)	293 (41.4–2076)	0.01 (0.002–0.13)
	Lung point	1 [20]	42/92	0.73 (0.57–0.86)	1.0 (0.92–1.0)	73.3 (4.7–1185)[a]	0.27 (0.16–0,44)
Secondary (by patient)	Absence of lung sliding and comet tail artefacts*	12 [15,17,18,20–24, 26,28–30]	385/1942	0.86 (0.77–0.91)	0.98 (0.97–0.99)	53.7 (29.7–91.6)	0.14 (0.08–0.23)
	Absence of lung sliding*	2 [28,31]	102/436	0.88 (0.20–0.99)	0.98 (0.96k0.99)	80.7 (6.3–249)	0.11 (0.004–0.82)
	Lung point	1 [20]	42/46	0.73 (0.57–0.86)	1.0 (0.39–1.0)	7.3 (0.5–102)[a]	0.29 (0.16–0.52)

CI = confidence interval

Injury. 2018(49) 457-66.

Traumatic pneumothorax

Cochrane
Library

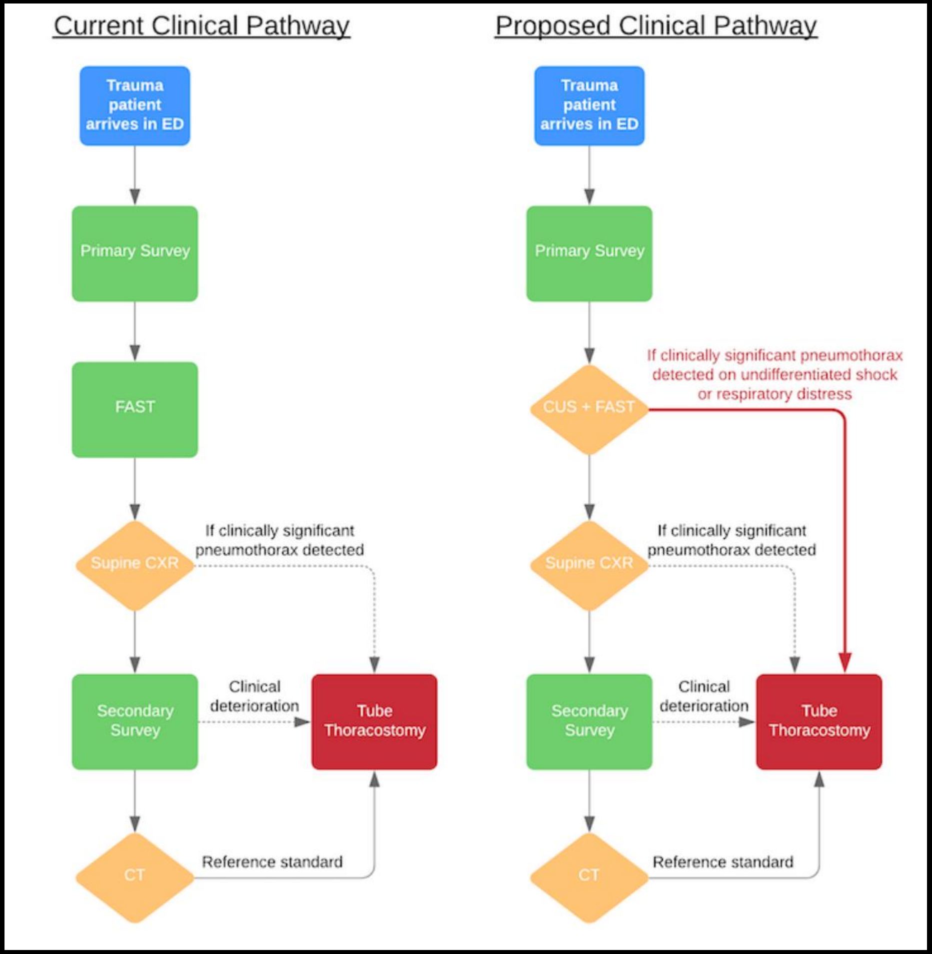
Cochrane Database of Systematic Reviews

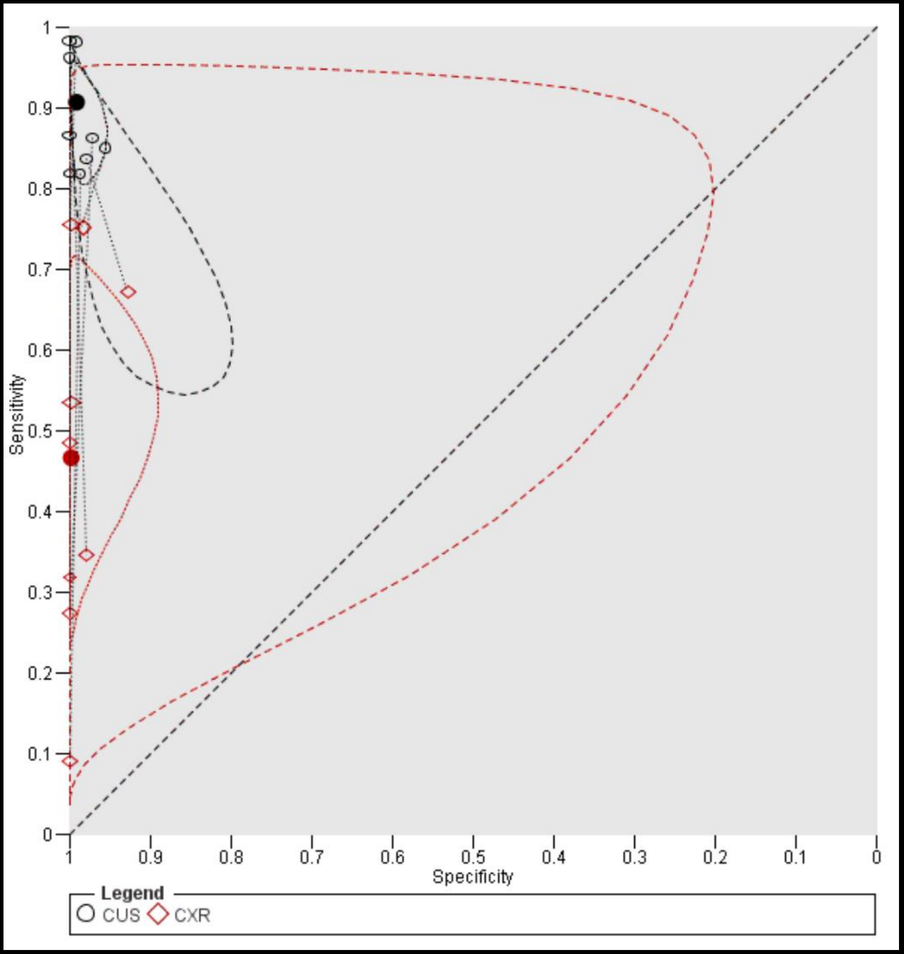
Chest ultrasonography versus supine chest radiography for diagnosis of pneumothorax in trauma patients in the emergency department (Review)

- 3 studies of which nine (410 traumatic pneumothorax patients out of 1,271 patients) used patients as the unit of analysis.

Cochrane Database Syst Rev. 2020 Jul 23;7(7):CD013031.

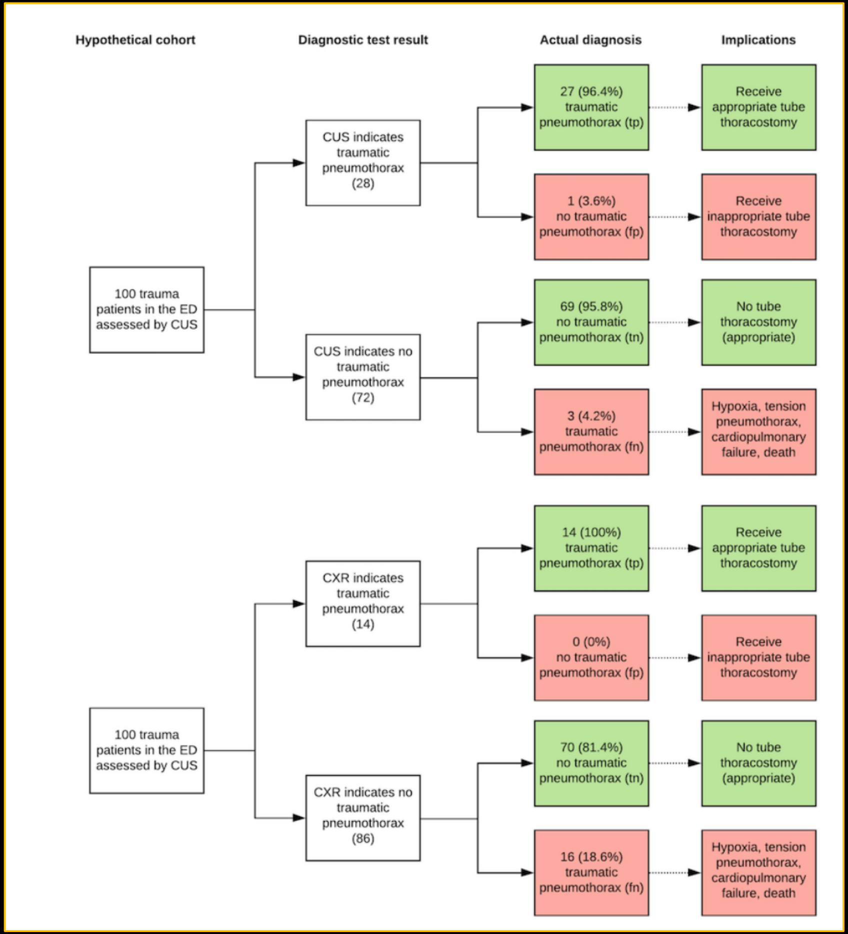
Pneumothorax





Cochrane Database Syst Rev. 2020 Jul 23;7(7):CD013031.

Pneumothorax



Conclusions

- The accuracy of LUS in trauma patients is superior to CXR, independent of the type of trauma, type of LUS operator, or type of LUS probe used.

Cochrane Database Syst Rev. 2020 Jul 23;7(7):CD013031.

GUIDELINES Open Access

The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

Imaging

Recommendation 8 We suggest the use of pre-hospital ultrasonography (PHUS) for the detection of haemo-/pneumothorax, haemopericardium and/or free abdominal fluid in patients with thoracoabdominal injuries, if feasible without delaying transport (Grade 2B).

We recommend the use of point-of-care ultrasonography (POCUS), including FAST, in patients with thoracoabdominal injuries (Grade 1C).

We recommend early imaging using contrast-enhanced whole-body CT (WBCT) for the detection and identification of the type of injury and the potential source of bleeding (Grade 1B).

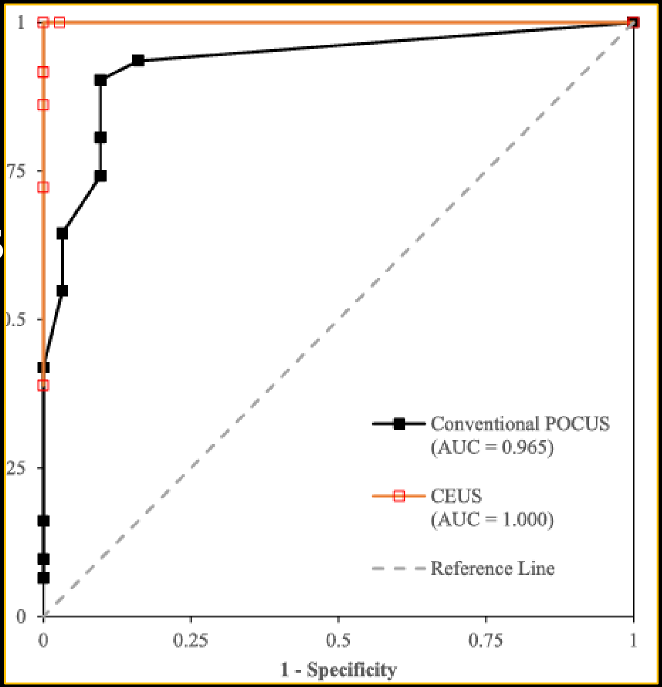
- POCUS remains for the detection of hemorrhage in pleural, pericardial cavity, with high specificity but overall variable to low sensitivity.

Crit Care. 2023 Mar 1;27(1):80.

CEUS

- Contrast-Enhanced Ultrasound
- Gas-filled microbubbles with a phospholipid shell
- Renal insufficiency, hypotension
- Abdominal trauma: SR and meta-analys
- Higher sensitivity (0.933 vs. 0.559; P <

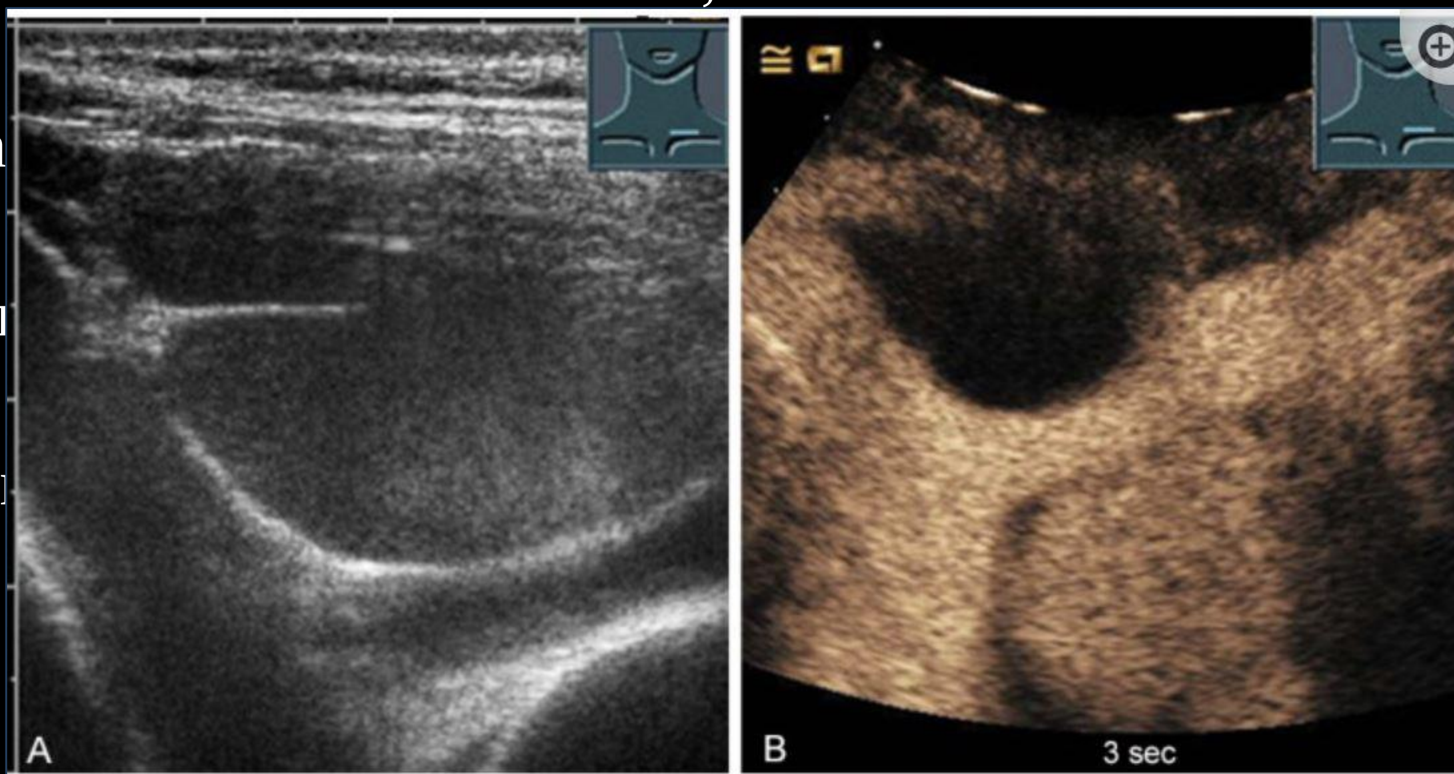
(0.995 vs. 0.979; P < 0.001)



BMC Emerg Med. 2023 Jan 27;23(1):8

CEUS

- Disease: mediastinal structure, etc
- Ch
- B-
- So
- 30



Diagnostics (Basel). 2023 Feb; 13(4): 767.

VIDEOS IN CLINICAL MEDICINE FREE PREVIEW

Ultrasound Guidance for Pleural-Catheter Placement

Adriano Peris, M.D., Lorenzo Tutino, M.D., Giovanni Cianchi, M.D., and Gianfranco Gensini, M.D.

- Not direct confirmation of device
- Real time intervention
- Operation → **Co**-Operation
- Diagnosis and Procedure

N Engl J Med 2018; 378:e19

Central Catheter Confirmation

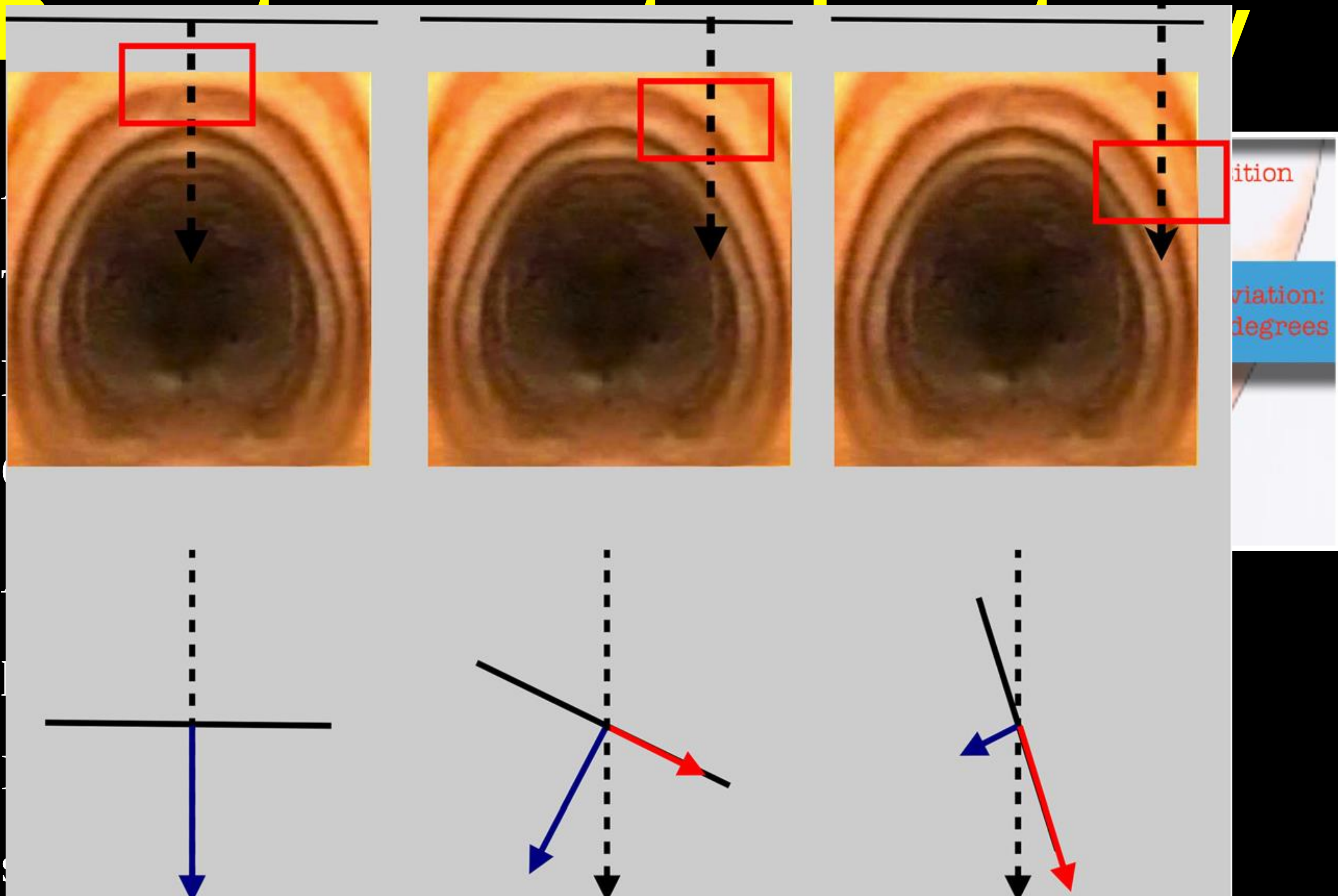
Reference	Feasibility (%)[a]	Incidence of Central Venous Catheter Malposition	Sensitivity (95% CI)[b]	Specificity (95% CI)[b]	Incidence of Pneumothorax	Chest Radiograph time (Minutes), Mean (SD)	Ultrasound time (Minutes), Mean (SD)
Vezzani et al (30)	89.2	0.28	0.93 (0.76–0.99)	0.96 (0.88–0.99)	0.04	83.0 (79.0)[c]	10.0 (5.0)
Maury et al (16)	98.8	0.11	1.00 (0.66–1.00)	1.00 (0.95–1.00)	0.01	80.3(66.7)[d]	6.8 (3.5)
Zanobetti et al (31)	100	0.55	0.92 (0.85–0.96)	0.89 (0.81–0.95)	0.02	65.0 (74.0)[e]	5.0 (3.0)
Cortellaro et al (32)	100	0.085	0.33 (0.04–0.78)	0.98 (0.92–1.00)	–	288.0 (216.0)[e]	4.0 (1.0)
Matsushima and Frankel (33)	71	0.17	0.50 (0.19–0.81)	0.98 (0.89–1.00)			
Bedel et al (34)	96	0.06	0.83 (0.36–1.00)	1.00 (0.96–1.00)			
Baviskar et al (35)	100	0.00	–	–			
Duran-Gehring et al (36)	92	0.065	0.33 (0.01–0.91)	1.00 (0.92–1.00)			
Weekes et al (37)	96.6	0.03	0.75 (0.19–0.99)	1.00 (0.97–1.00)	–	–	–
Wen et al (38)	100	0.01	1.00 (0.16–1.00)	1.00 (0.98–1.00)	–	28.3 (25.7)[c]	3.2 (1.1)
Syed et al (39)	100	0.50	1.00 (0.16–1.00)	1.00 (0.16–1.00)	–	–	–
Madhulika et al (40)	100	0.24	1.00 (0.86–1.00)	1.00 (0.95–1.00)	0.00	–	–
Gekle et al (41)	100	0.00	–	–	–	30.0 (–)[f]	8.9
Weekes et al (42)	97.4	0.03	0.75 (0.19–0.99)	1.00 (0.98–1.00)	0.00	20.0 (30.0)[c] median (IQR)	1.1 (0.7) median (IQR)
Meggiolaro et al (43)	100	0.45	0.53 (0.38–0.68)	0.95 (0.86–0.99)	0.00	67.0 (42.0–84.0)[e] median (IQR)	10.0 (7.0–20.0) median (IQR)

Conclusions: Bedside ultrasound is faster than radiography at identifying pneumothorax after central venous catheter insertion. When a central venous catheter malposition exists, bedside ultrasound will identify four out of every five earlier than chest radiography. (*Crit Care Med* 2017; 45:715–724)

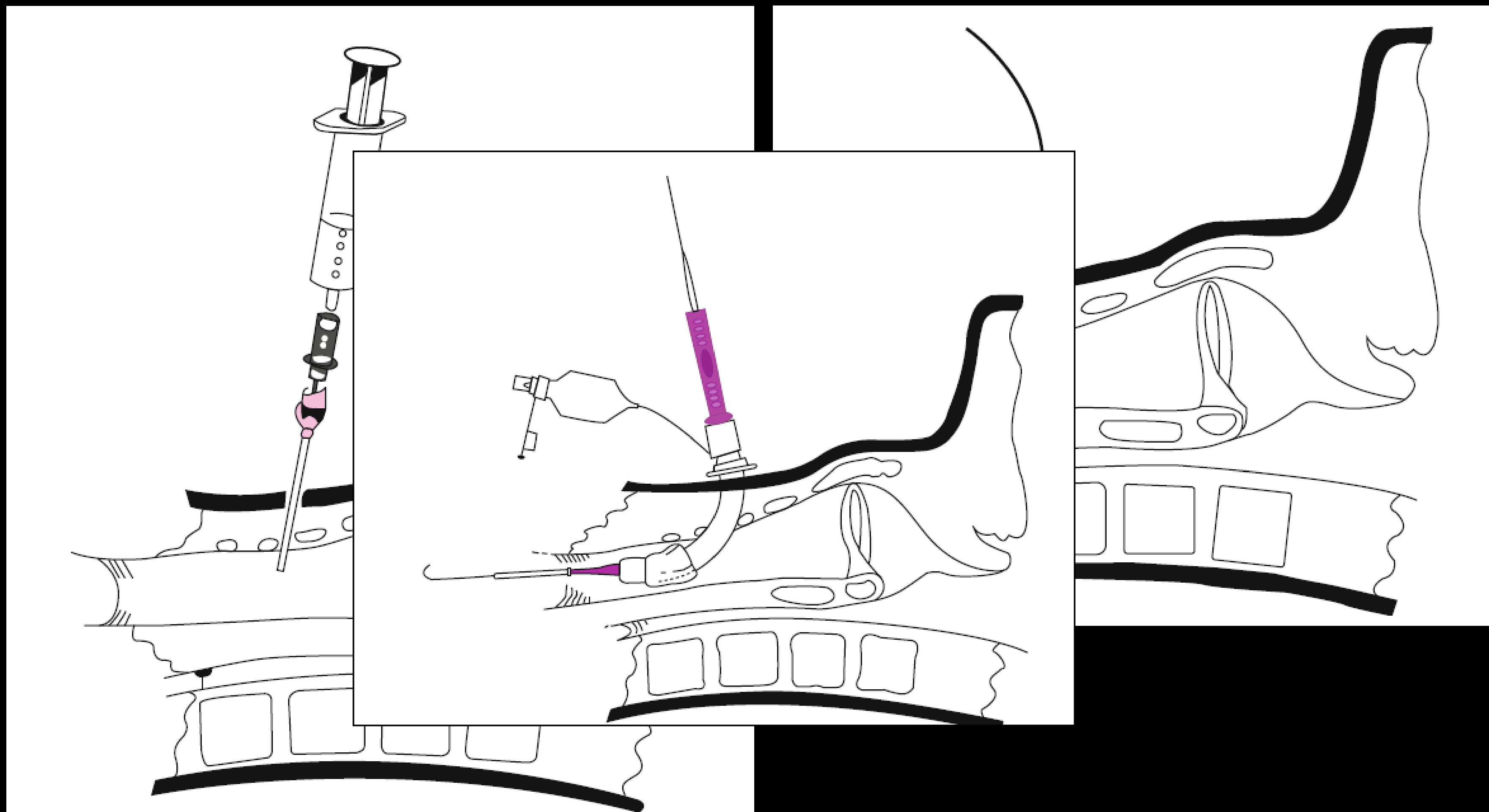
Crit Care Med. 2017 Apr;45(4):715-24. : A Systematic Review and Meta-Analysis.

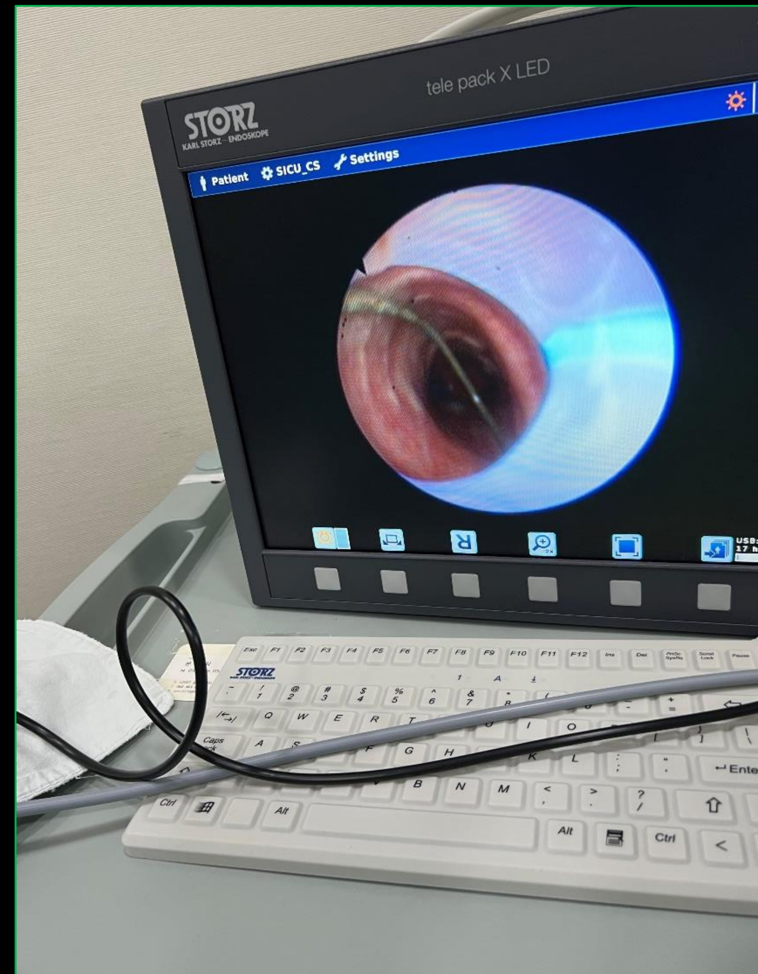
Endotracheal tube

- Accurate intubation
- Most reliable confirmation
  - ETCO2 : not available - cardiac arrest, PE
- Transtracheal direct scan
  - Hyperechoic reverberation sign in trachea
- Transthoracic indirect scan
  - Check the lung sliding



Crit Care. 2014:18(5):514.





tele pack X LED
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KARL STORZ - ENDOSKOPE
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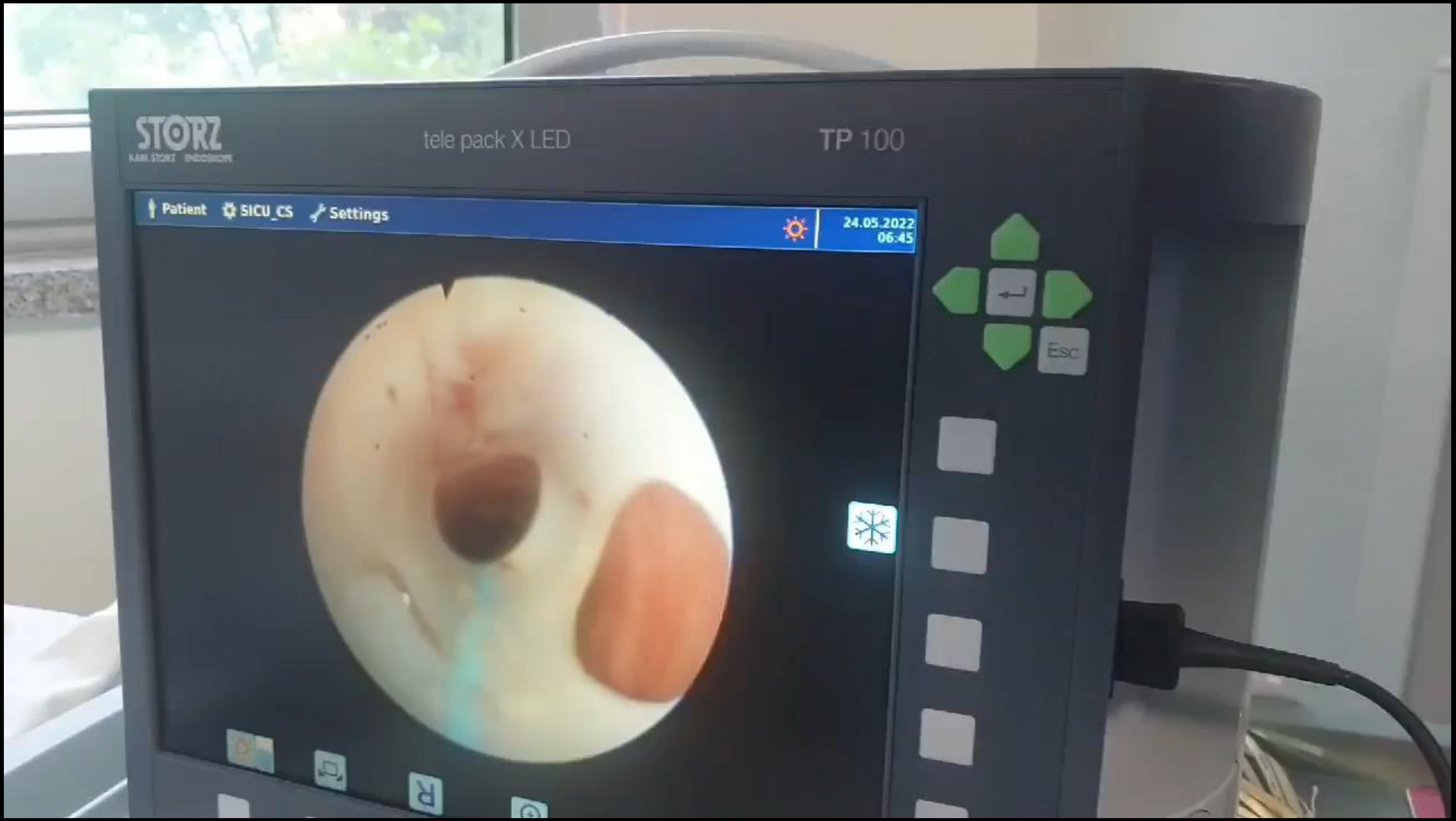
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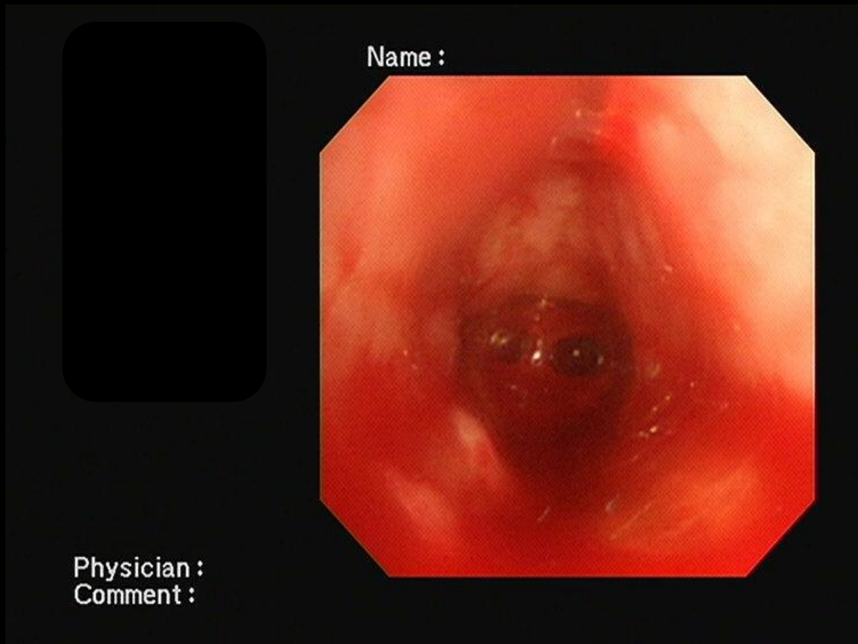
Name :
Physician :
Comment :

Shock evaluation

Dan L. Longo, M.D., *Editor*

Hemorrhagic Shock

Jeremy W. Cannon, M.D.

Rapid Identification of Hemorrhagic Shock

- Prehospital history of major blood loss and treatment with anticoagulants or antiplatelets
- Physical examination, radiographs, and ultrasonography of the torso (FAST) to determine sources of bleeding
- Laboratory work (blood type, blood gas with lactate, CBC, electrolytes, coagulation studies, and TEG or TEM)
- Immediate resuscitation for patients in shock with the use of rapid infuser and fluid warmer
- Early massive-transfusion-protocol activation for patients in shock

Posthemostasis

- Reassess patient for ongoing bleeding, coagulopathy, and unpaid oxygen debt
- Perform repeat laboratory tests (blood gas with lactate, CBC, electrolytes, coagulation studies, and TEG or TEM)
- Transfusions should be compatible with blood group if possible
- Avoid over- or under-resuscitation
- Perform ultrasonography to assess intravascular volume status and cardiac function

N Engl J Med 2018:378:370-9.

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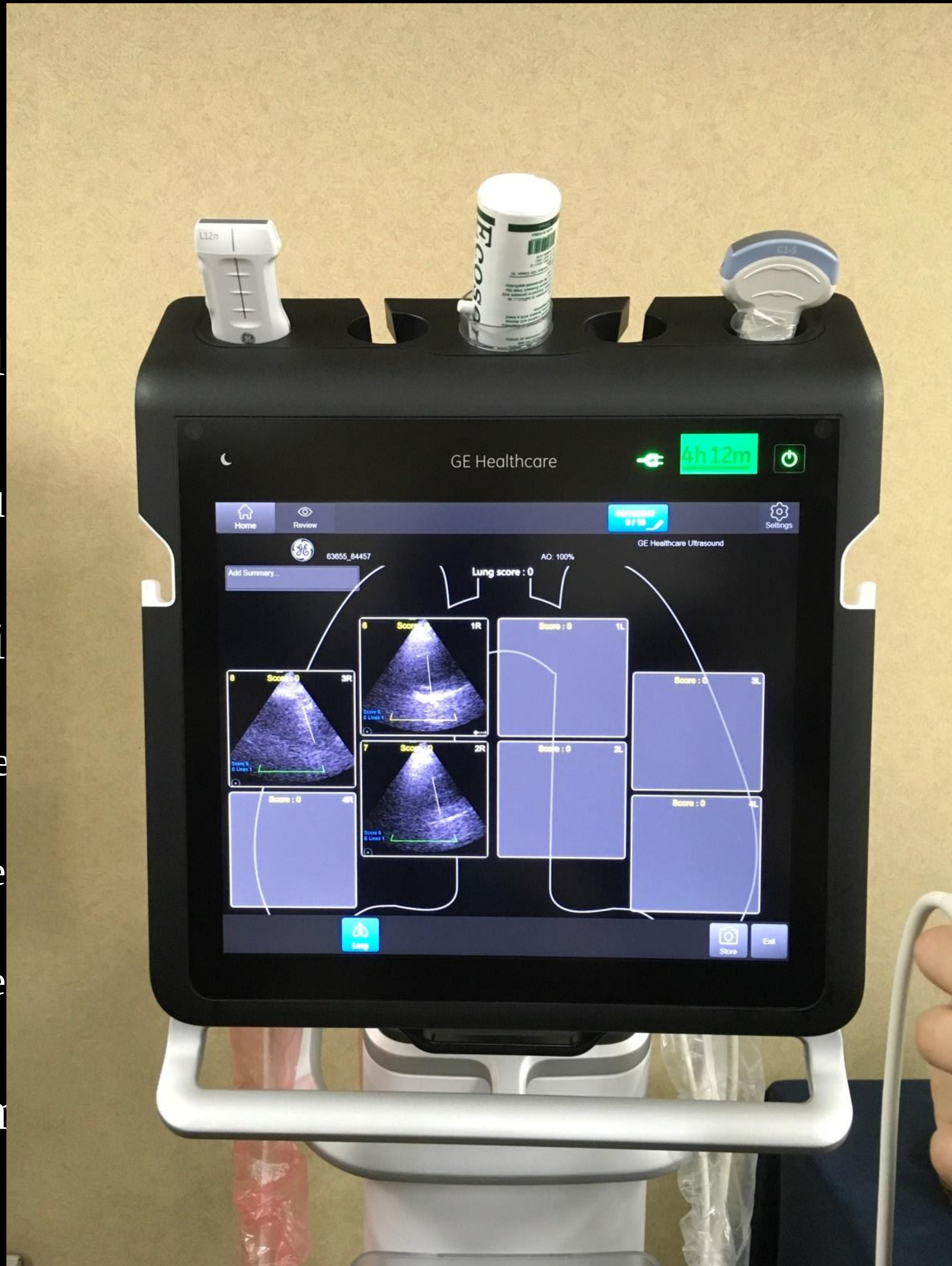
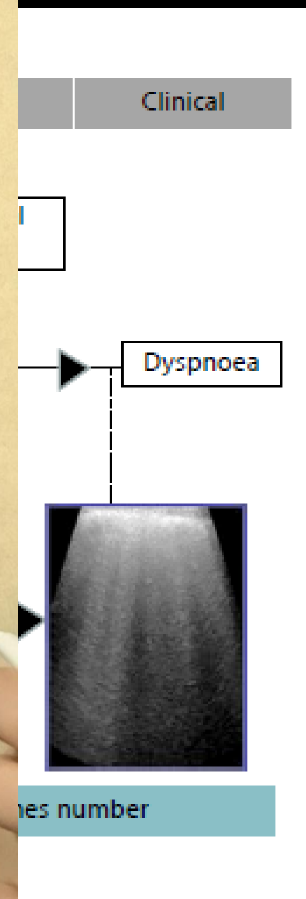




Lung Ultrasound in Hemodialysis. Blood Purif. 2017;44(1):1-7.

Shock evaluation

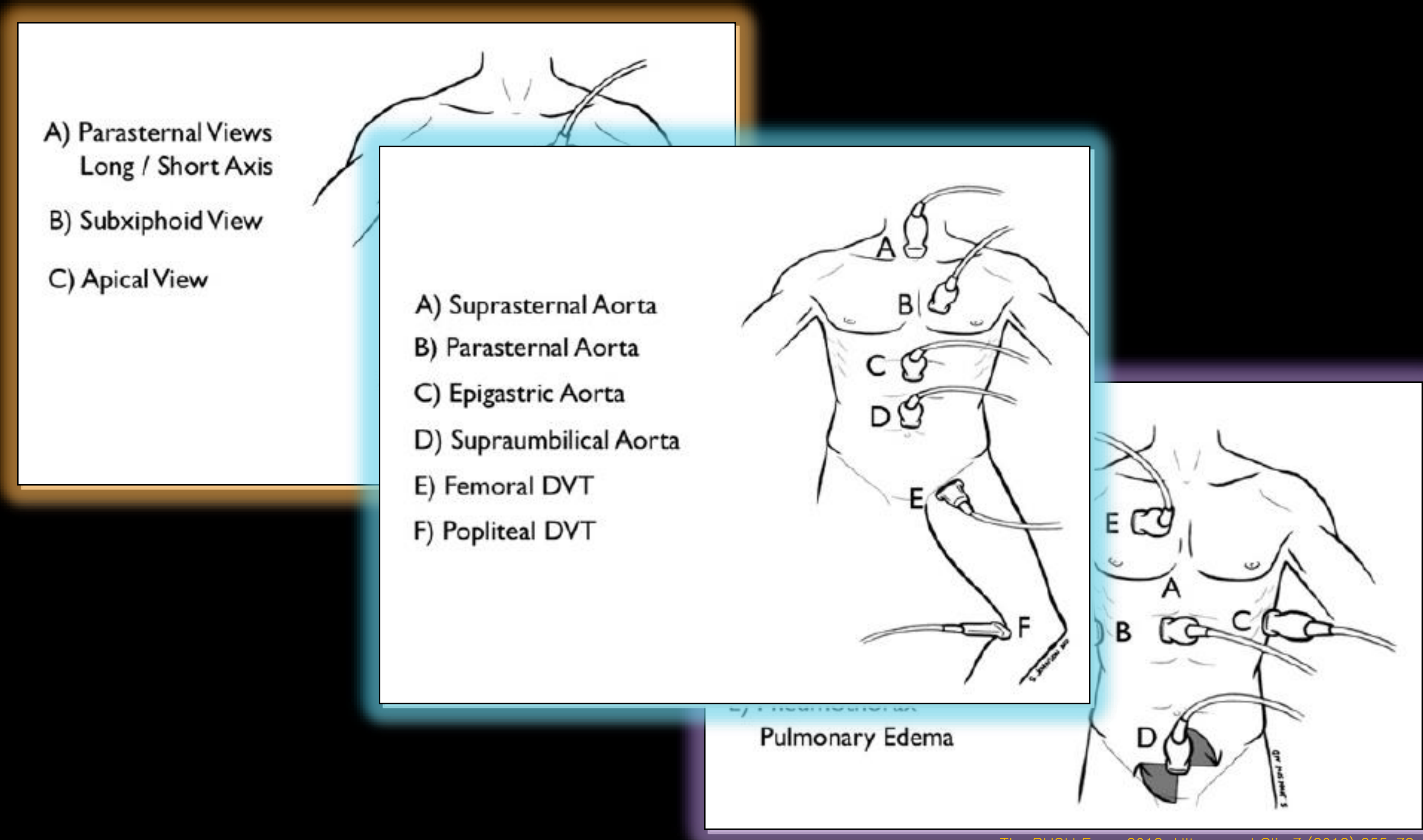
Authors	Titles	Focus	Target
Breitkreutz R. et al. Resuscitation. 2010 Nov;81(11):1527-33.	Focused echocardiographic evaluation in life support and peri-resuscitation of emergency patients: a prospective trial. (FEEL)	Tamponade Hypovolemia Embolsim	Peri resuscitation care
Gunst M, et al. J Am Coll Surg. 2008 Sep;207(3):e1-3.	Bedside Echocardiographic Assessment for Trauma/Critical Care. (The BEAT)	Beat Effusion Volume : IVC	Trauma

RUSH exam

	Hypovolemia	Distributive	Obstructive	Cardiogenic
Pump	Hyperdynamic heart	Hyperdynamic heart Poor contractility	Tamponade RV strain Poor contractility	Poor contractility
Tank	Collasping IVC Peritoneal/pleural fluid	Normal IVC Peritoneal/pleural fluid	Large IVC	Large, non-collasping IVC Pleural effusion
Pipe	Aorta dissection/aneurysm	Normal	DVT	Normal

The RUSH exam. Emerg Med Clin North Am. 2010 Feb;28(1):29-56.

RUSH protocol



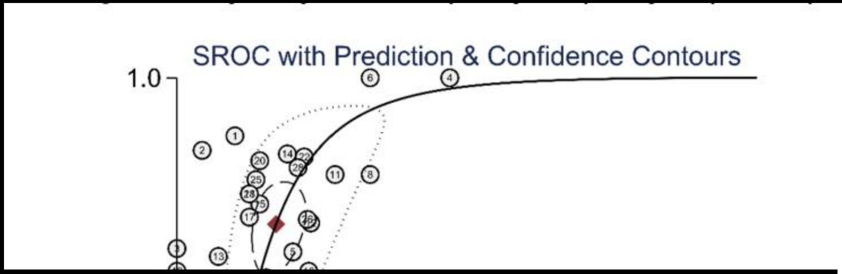
The RUSH Exam 2012. Ultrasound Clin 7 (2012) 255-78.

Volume status

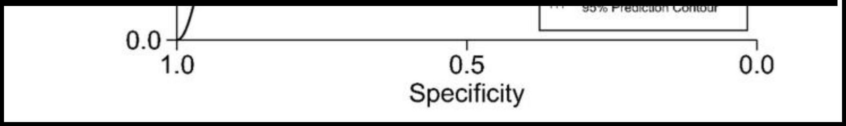
Article

Diagnostic Accuracy of Ultrasonographic Respiratory Variation in the Inferior Vena Cava, Subclavian Vein, Internal Jugular Vein, and Femoral Vein Diameter to Predict Fluid Responsiveness: A Systematic Review and Meta-Analysis

Author	Year	Target Vein	TP	FP	FN	TN	Sen	Spe	AUROC	*n*	Threshold (Index Test)
Barbier [21]	2004	IVC	9	1	1	9	0.90	0.90	0.910	20	ΔIVC = 18%
Feissel [22]	2004	IVC	14	1	2	22	0.88	0.96	NR	39	ΔIVC = 12%
Moretti [23]	2010	IVC	12	0	5	12	0.71	1.00	0.902	29	ΔIVC = 16%
Machare-Delgado [24]	2011	IVC	8	8	0	9	1.00	0.53	0.816	25	ΔIVC = 12%
Muller [25]	2012	IVC	14	4	6	16	0.70	0.80	0.770	40	ΔIVC = 40%
Lanspa [26]	2013	IVC	5	3	0	6	1.00	0.67	0.840	14	ΔIVC = 15%
Charbonneau [27]	2014	IVC	10	7	16	11	0.38	0.61	0.430	44	ΔIVC = 21%
de Valk [28]	2014	IVC	10	11	2	22	0.83	0.67	0.741	45	ΔIVC = 36.5%
Guarracino [29]	2014	IJV	24	1	6	19	0.80	0.95	0.915	50	ΔIJV = 18%
Airapetian [30]	2015	IVC	9	1	20	29	0.31	0.97	0.620	59	ΔIVC = 49%
de Oliveira [31]	2016	IVC	6	0	3	11	0.67	1.00	0.840	20	ΔIVC = 16%
Sobczk [32]	2016	IVC	20	3	4	8	0.83	0.73	0.739	35	ΔIVC = 18%
Yao [46]	2019	IVC	17	3	20	27	0.46	0.90	0.702	67	ΔIVC = 25.6%
Zhang [47]	2019	IVC	47	6	10	38	0.82	0.86	0.815	101	ΔIVC = 14.5%
Caplan [48]	2020	IVC	31	9	10	31	0.76	0.77	0.820	81	ΔIVC = 20%
McGregor [49]	2020	IVC	9	4	10	7	0.47	0.64	0.464	30	ΔIVC = 40%
Blavius [50]	2021	IVC—training set	71	19	13	72	0.85	0.79	0.820	175	ΔIVC = 25%
		IVC—test set	8	0	1	11	0.89	1.00	0.940	20	ΔIVC = 25%



SR and MA suggest that the ultras. measurement of the respiratory variation in the <u>diameter of the IVC</u> has a diagnostic accuracy for predicting fluid responsiveness in critically ill patients.



CT versus US in IVC

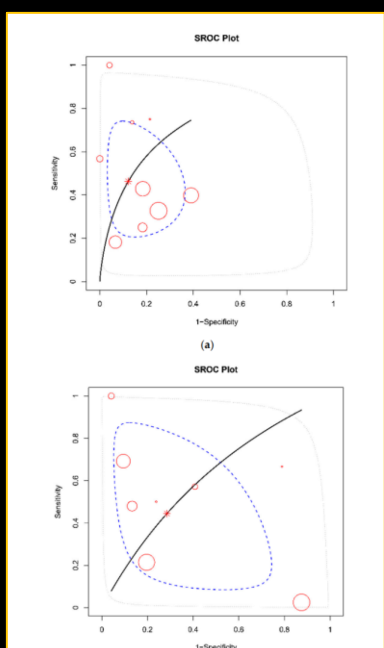
diagnostics

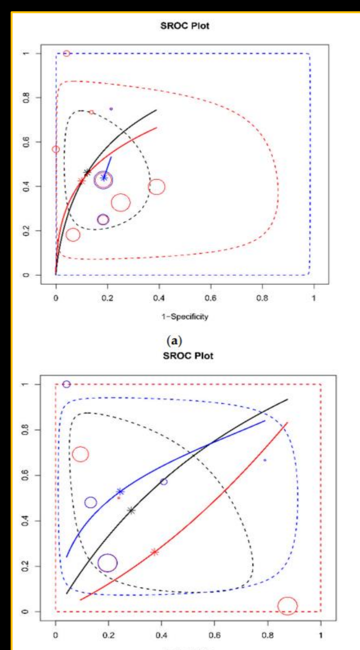
MDPI

Article

Flat Inferior Vena Cava on Computed Tomography for Predicting Shock and Mortality in Trauma: A Meta-Analysis

Do Wan Kim [1,†], Hee Seon Yoo [2,†] and Wu Seong Kang [3,*]

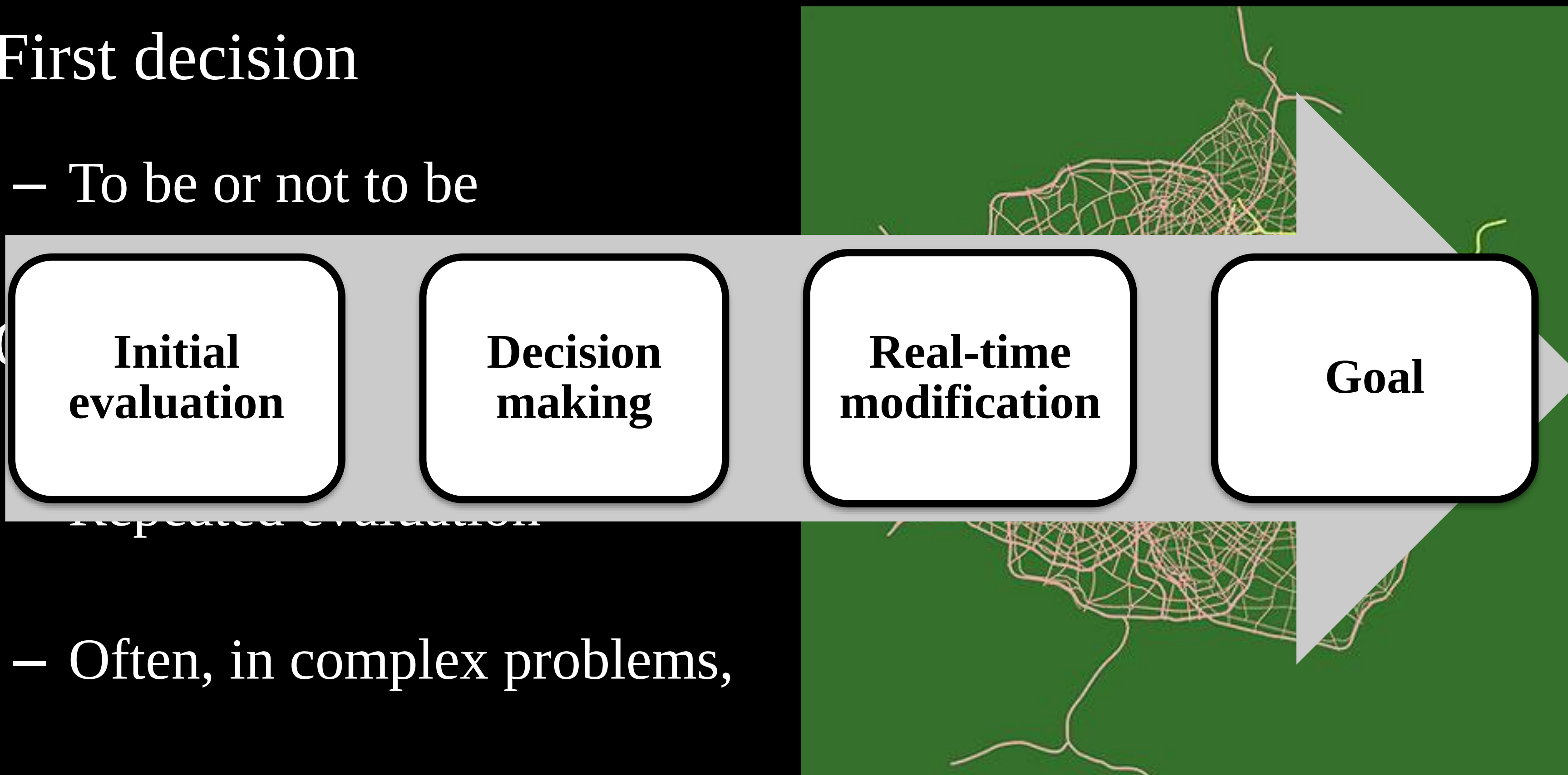




- A flat IVC in trauma patients on CT, in terms of the development of shock, provides acceptable diagnostic accuracy with high specificity even with low sensitivity.

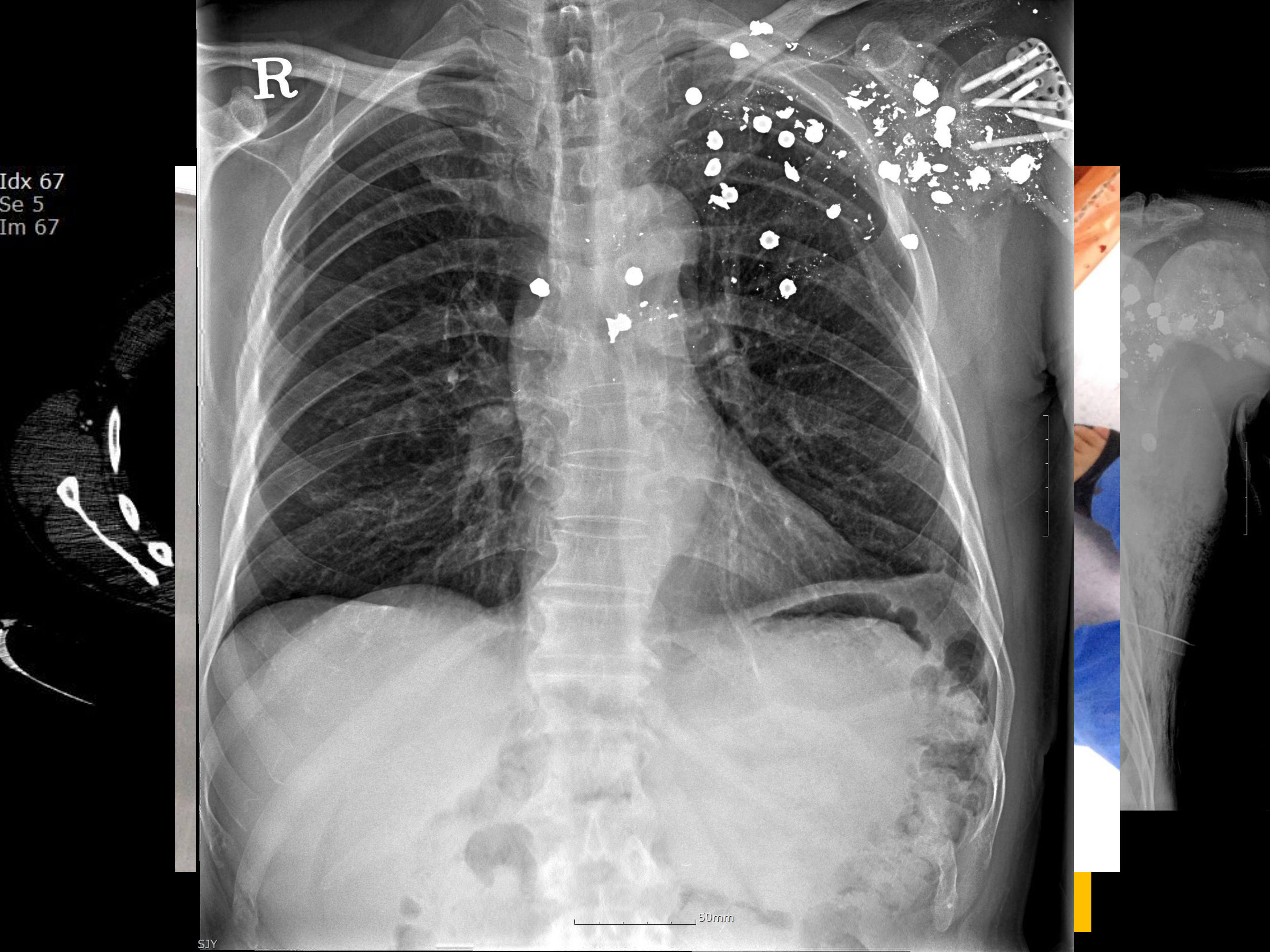
Assessment of stage

- First decision
  - To be or not to be



  - Repeated evaluation
  - Often, in complex problems, we can get answers simply

CASE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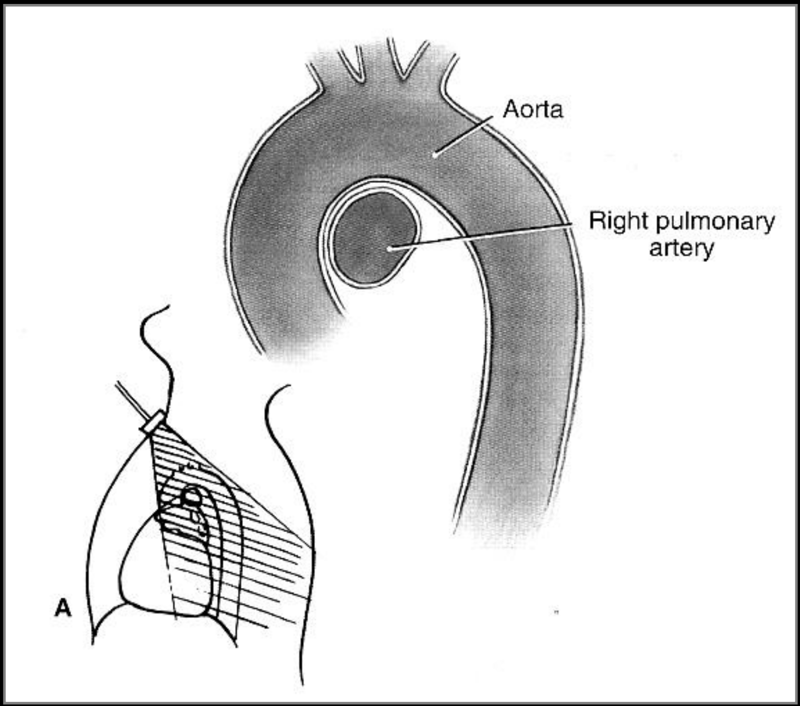
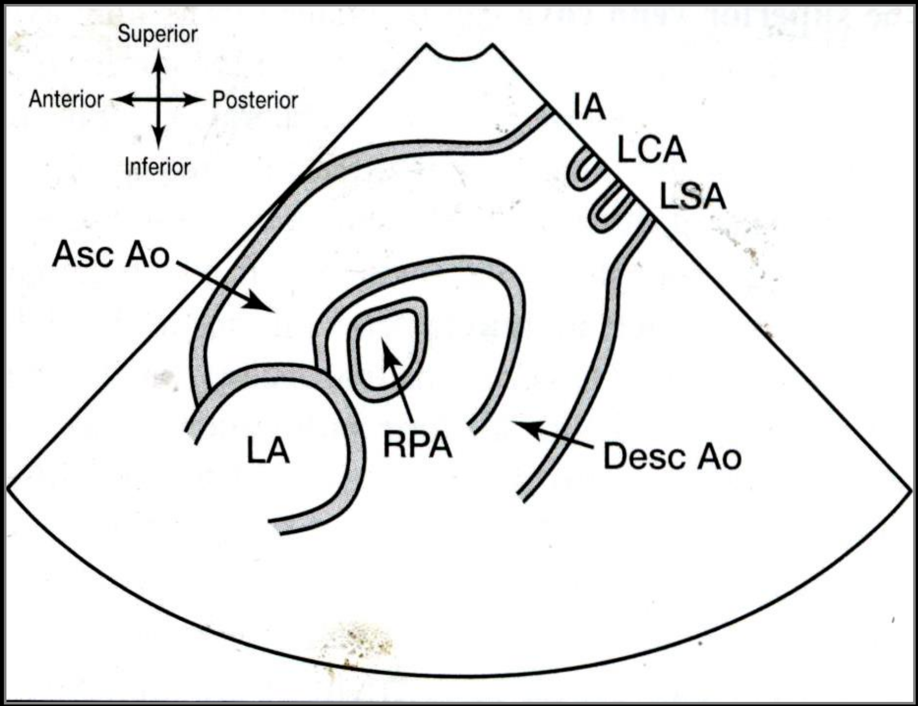
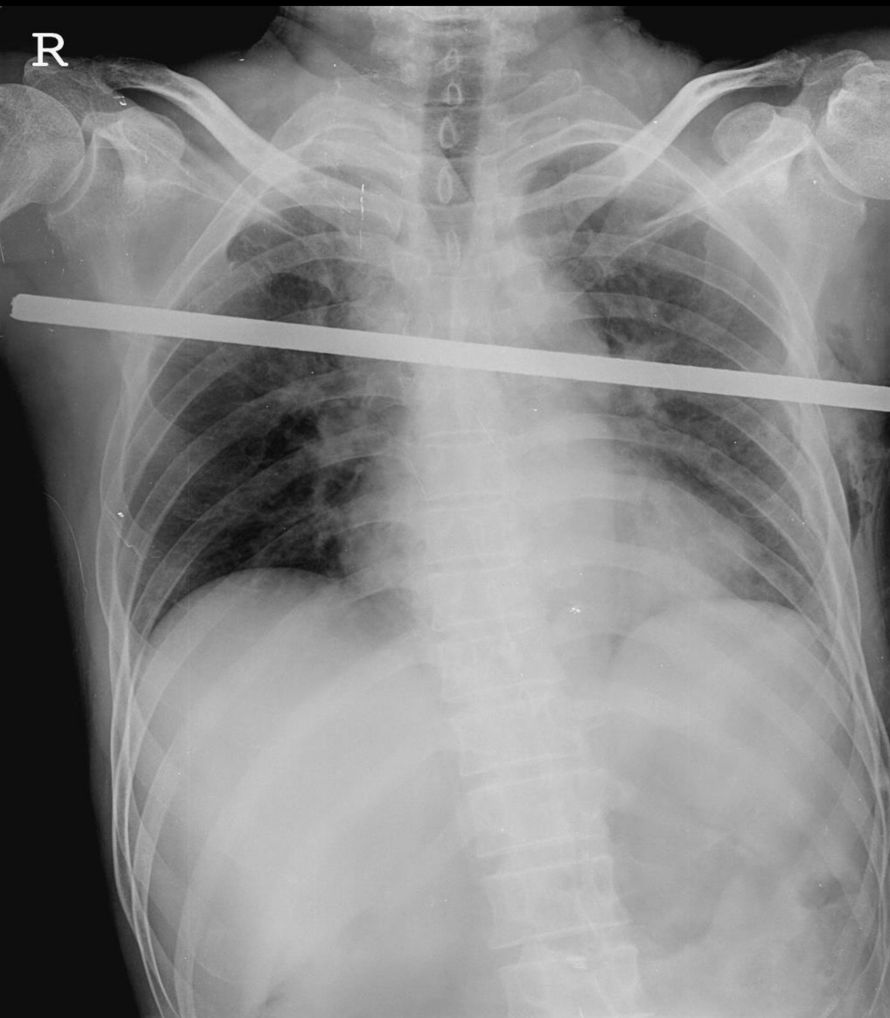


Aorta
Right pulmonary artery
A



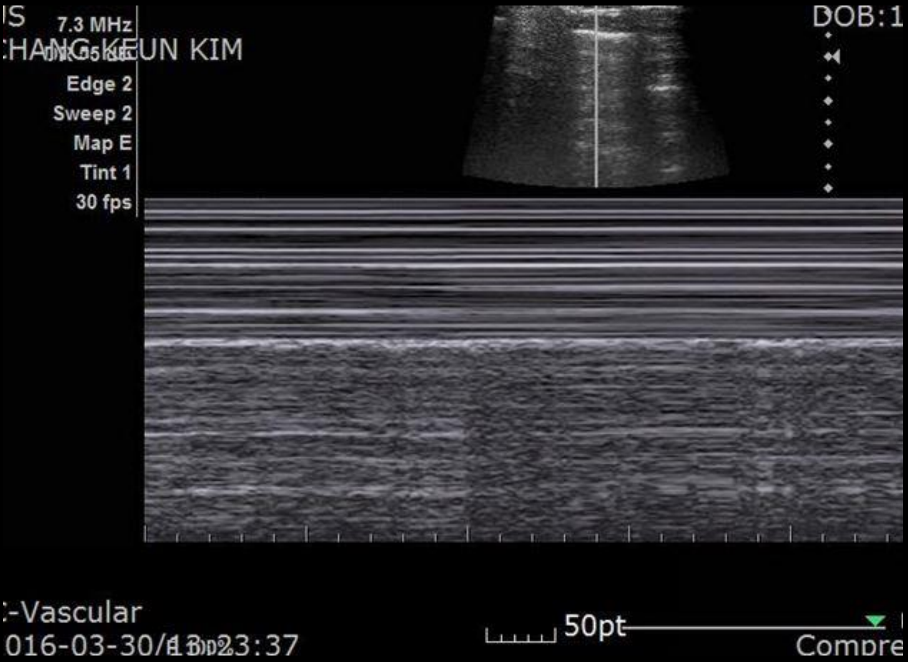
Superior
Anterior
Posterior
Inferior
IA
LCA
LSA
Asc Ao
LA
RPA
Desc Ao

AIN 50
CMP 70
97BPM
6CM
25HZ
2.1 4.2



67/M – Transmediastianl penetrating injury

Evaluation



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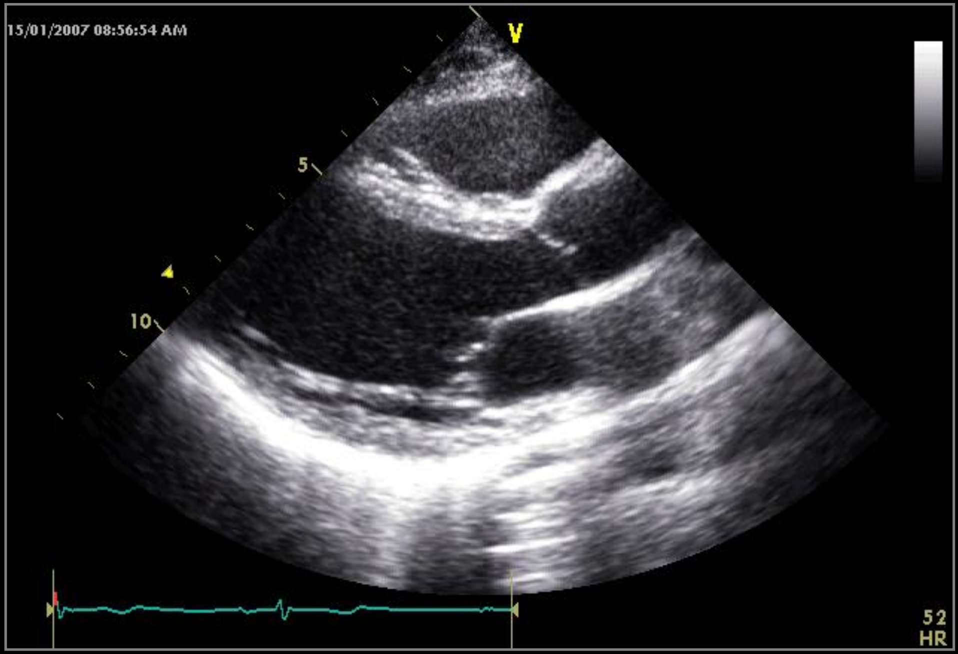

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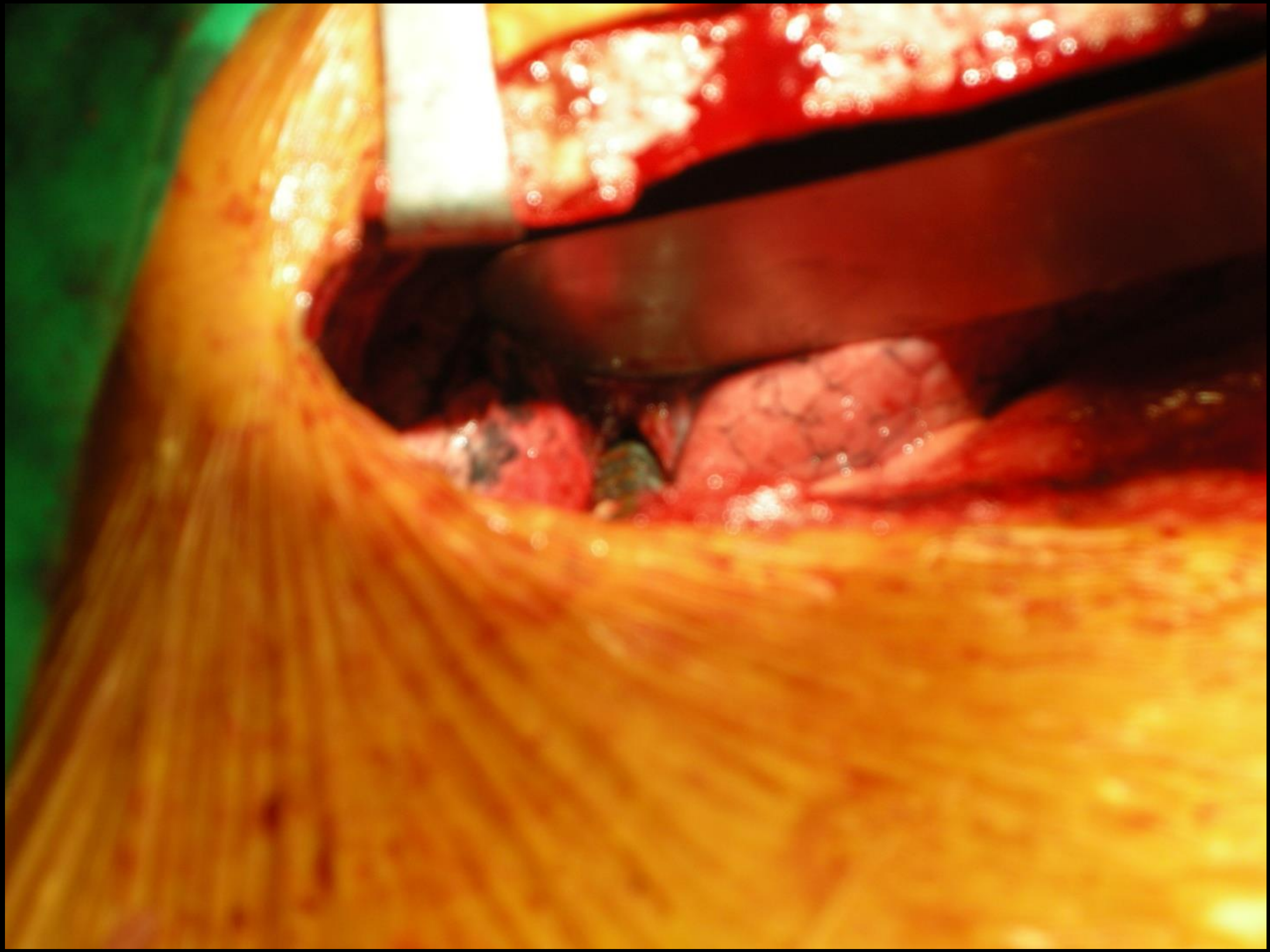
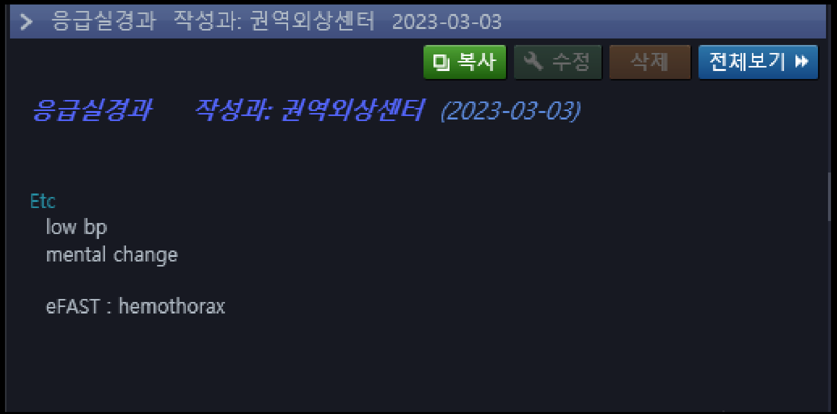
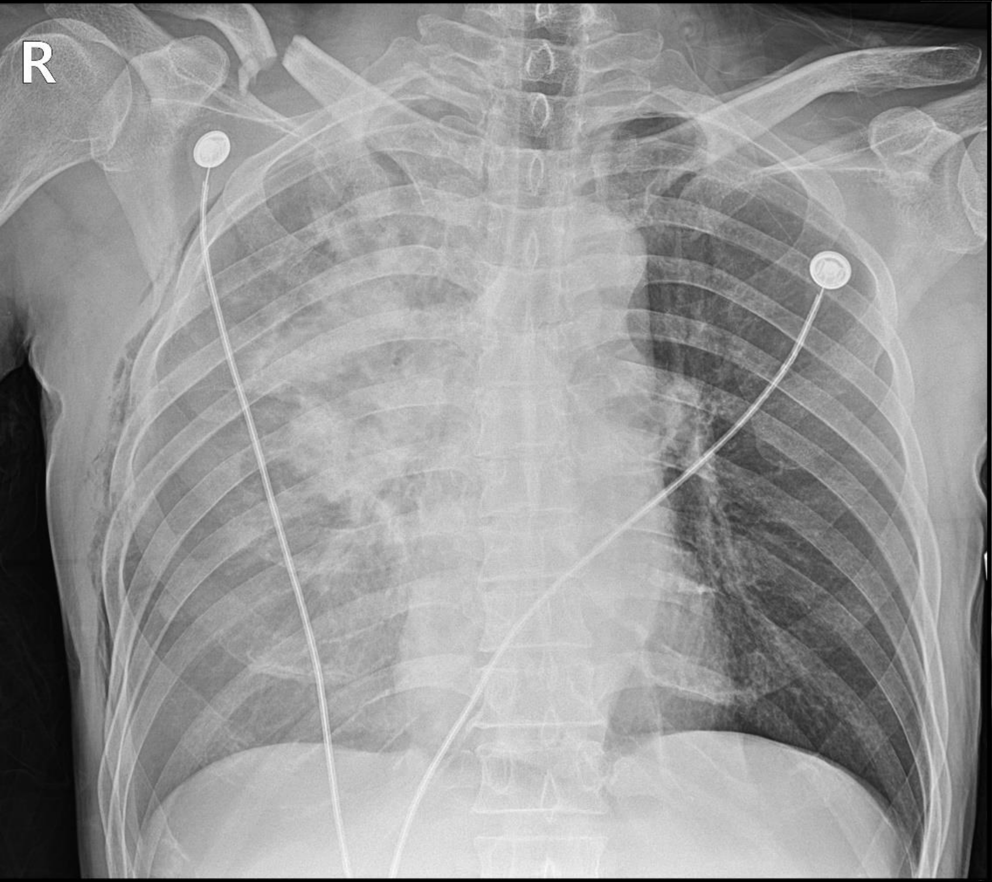


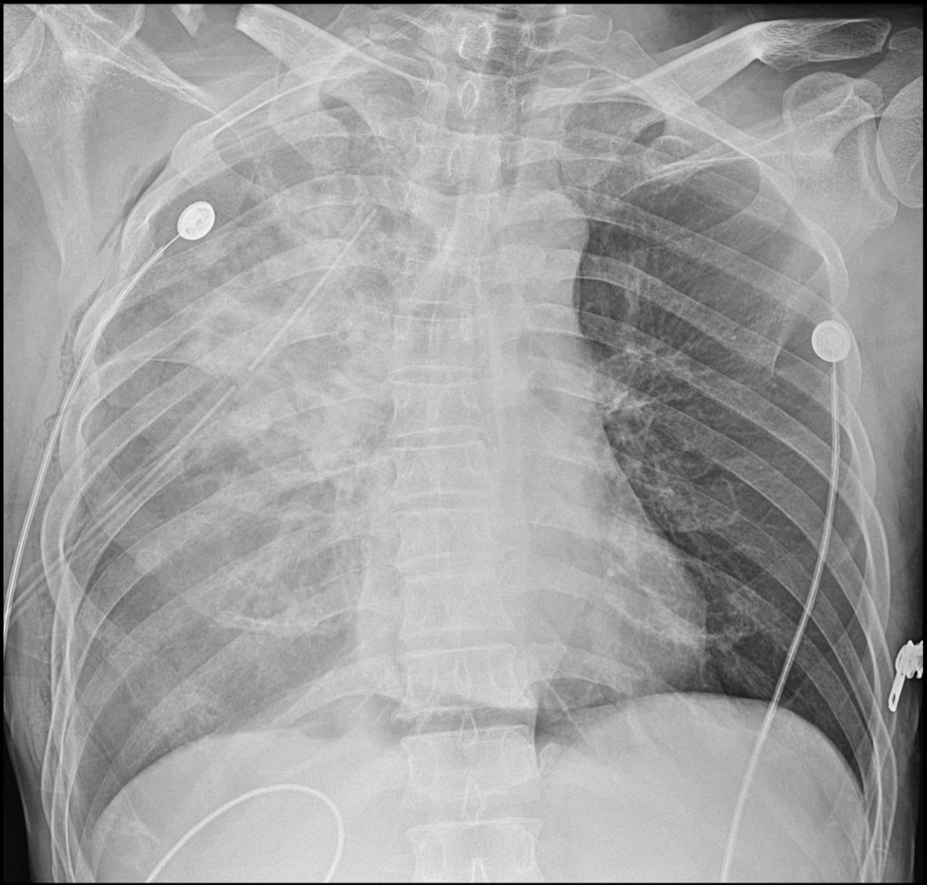
49/M

- Motorcycle accident
- 70/30 mmHg , 94/ min
- eFAST – right hemothorax
- Closed thoracostomy – 2000cc drain

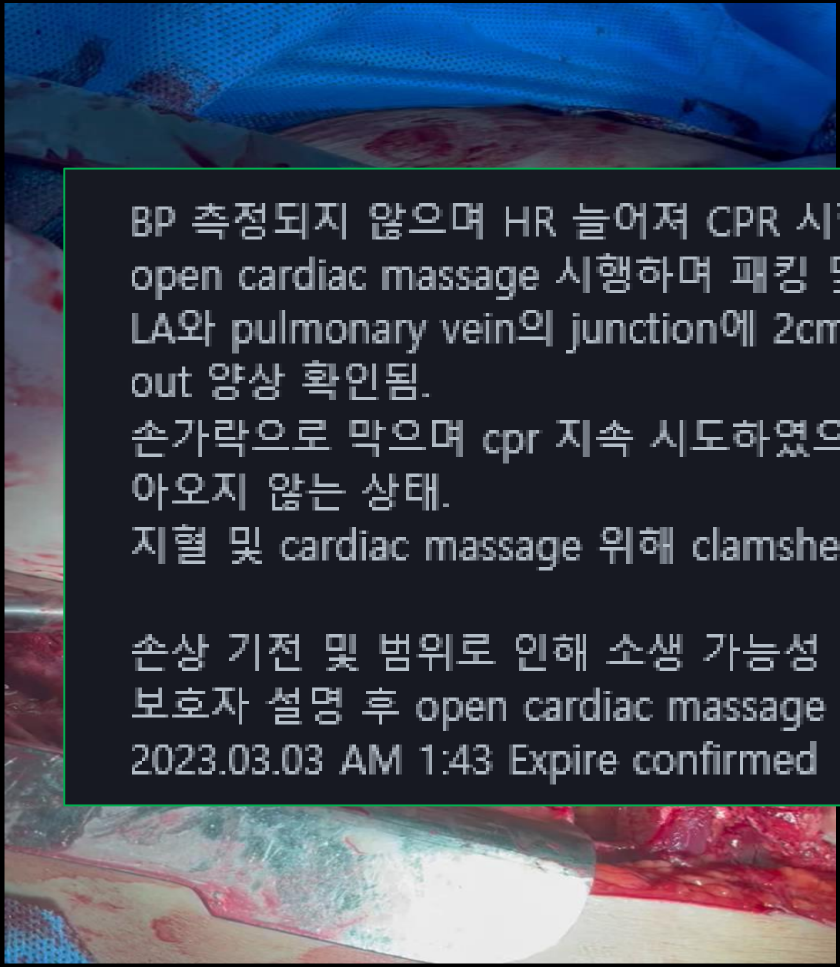


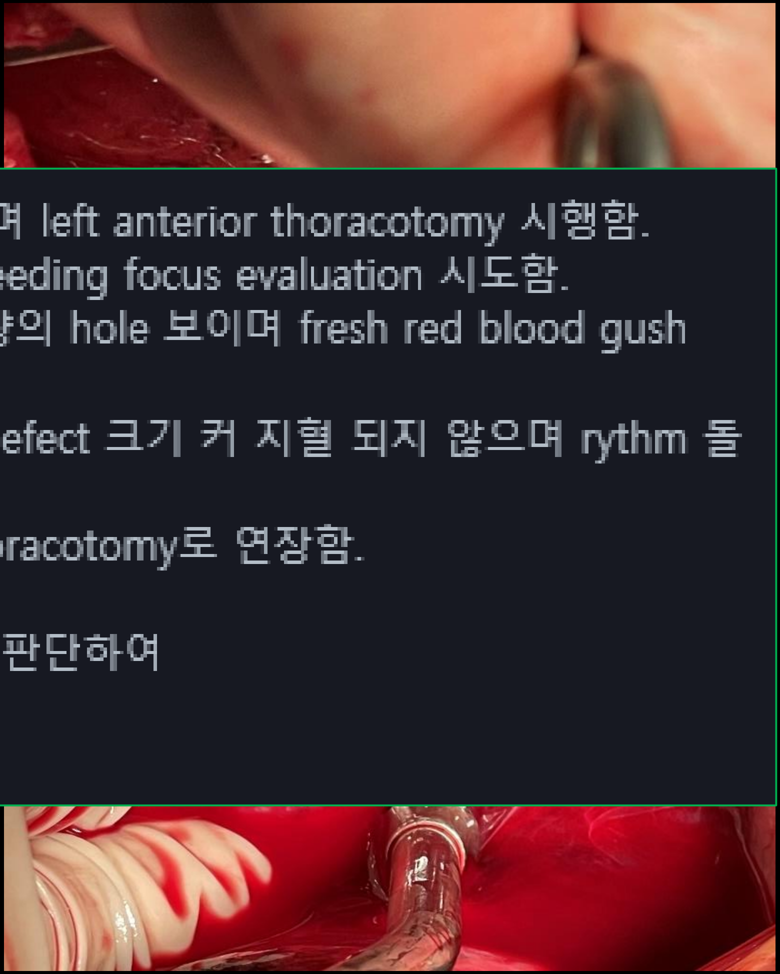
49/M





49/M



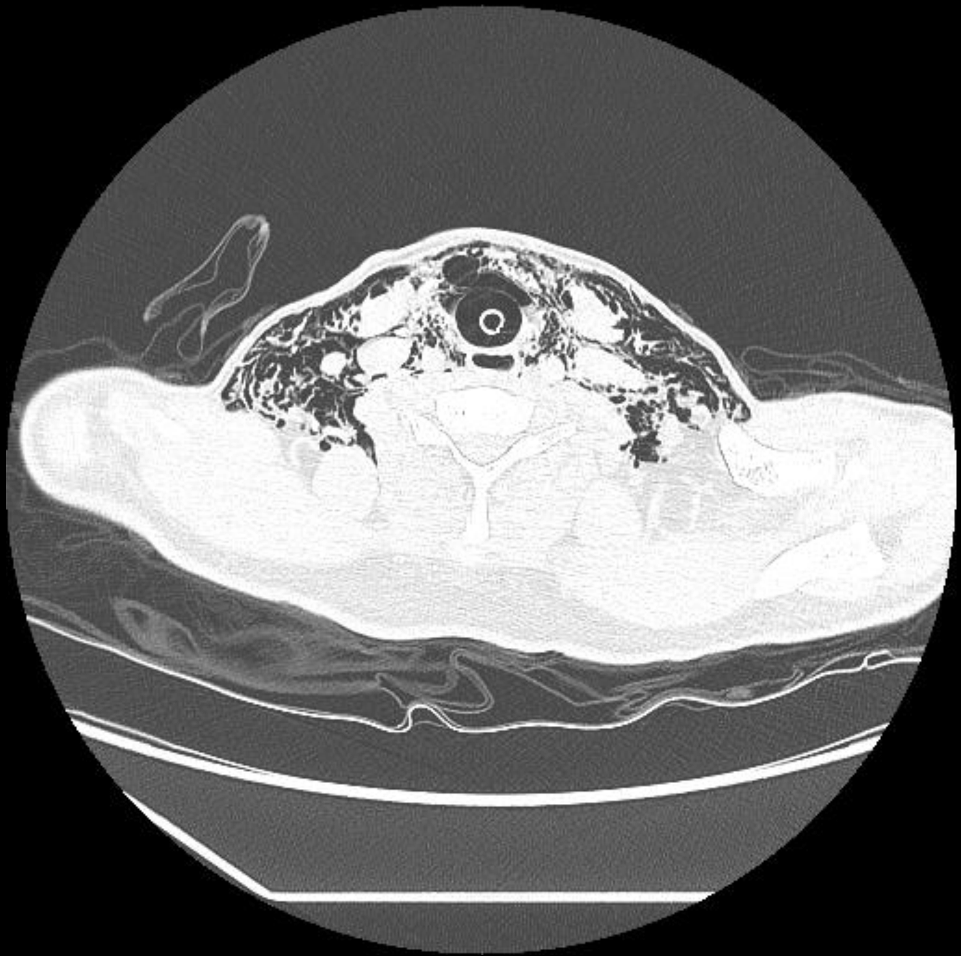


BP 측정되지 않으며 HR 늘어져 CPR 시행하며 left anterior thoracotomy 시행함.
open cardiac massage 시행하며 패킹 및 bleeding focus evaluation 시도함.
LA와 pulmonary vein의 junction에 2cm 가량의 hole 보이며 fresh red blood gush out 양상 확인됨.
손가락으로 막으며 cpr 지속 시도하였으나 defect 크기 커 지혈 되지 않으며 rythm 돌아오지 않는 상태.
지혈 및 cardiac massage 위해 clamshell thoracotomy로 연장함.

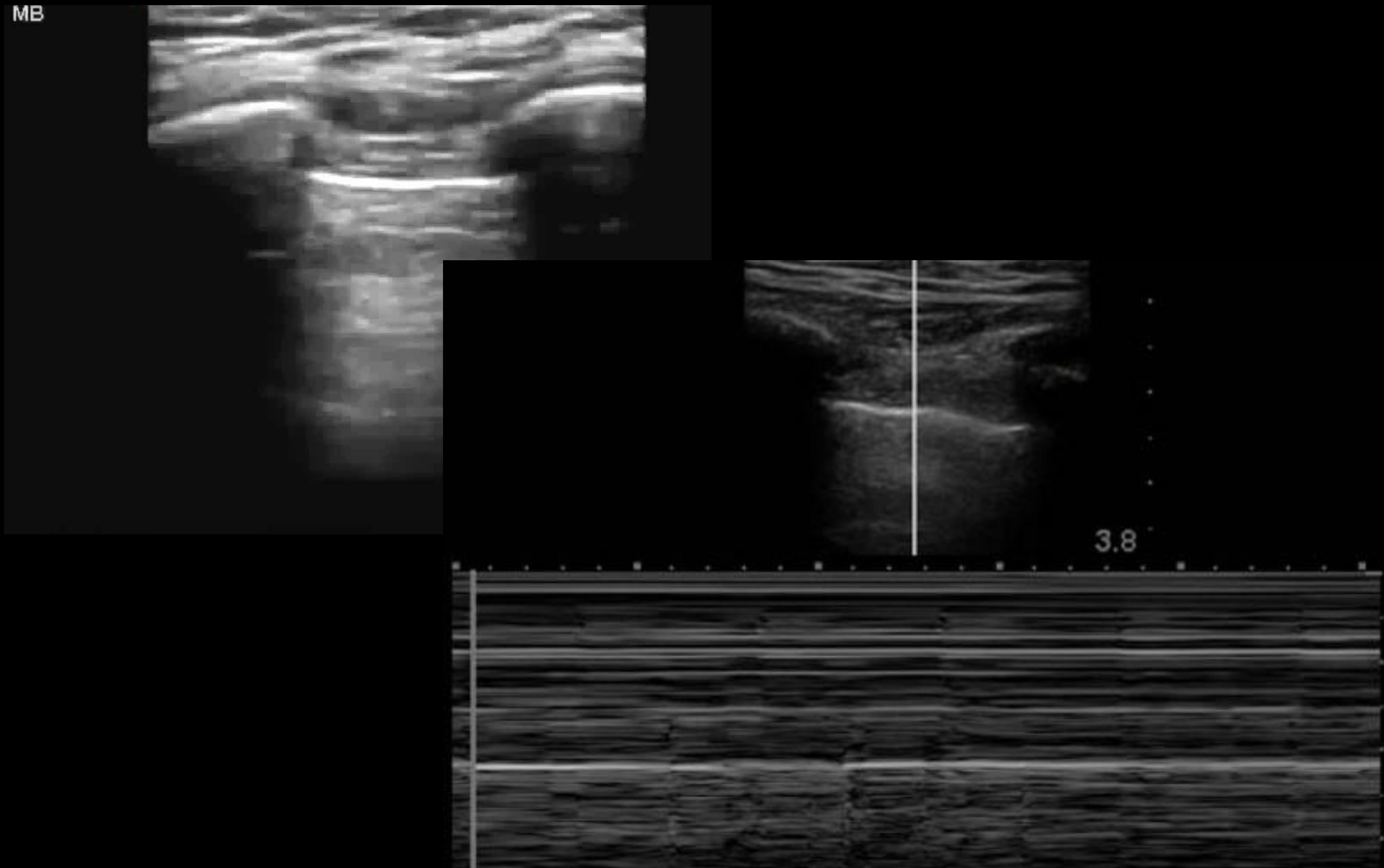
손상 기전 및 범위로 인해 소생 가능성 없음 판단하여
보호자 설명 후 open cardiac massage 중단
2023.03.03 AM 1:43 Expire confirmed

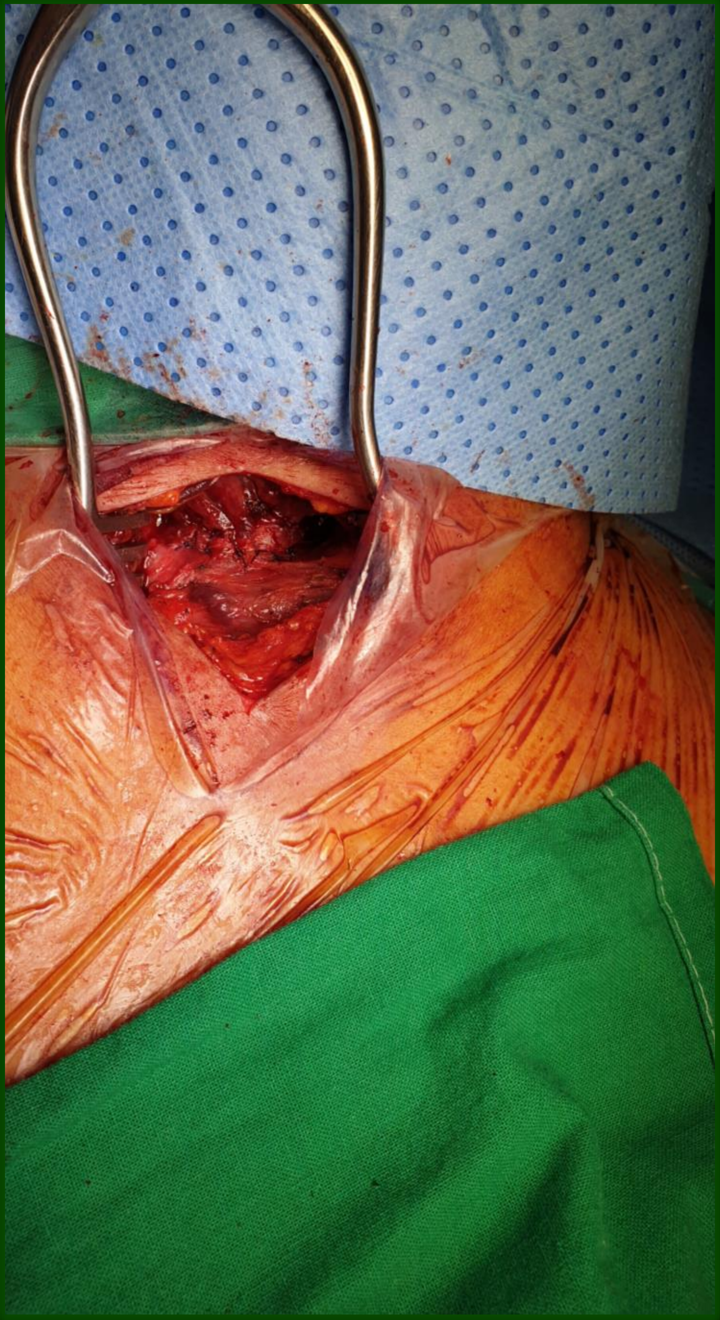
65/M

- Dyspnea
- Cultivator handle
- Thyroid cartilage fracture
- Trachea 1st ring – 4th ring fra



Pneumothorax





Case report | Open Access | Published: 21 September 2022

Successful treatment with femoro-femoral venovenous extracorporeal membrane oxygenation in traumatic tracheal injury: a case report

Haein Ko, Sang Gi Oh, Sang Yun Song, Kyo Seon Lee & Do Wan Kim

Journal of Cardiothoracic Surgery **17**, Article number: 238 (2022) | Cite this article

Limitation

- Only ultrasound ?
  - Combination with other diagnosis moda
- Combined with underlying disease
- Pericardium open: not a specialist ?
- Relatively lower specificity
- Repeated scan

경청해 주셔서 감사합니다.