



I can't breathe

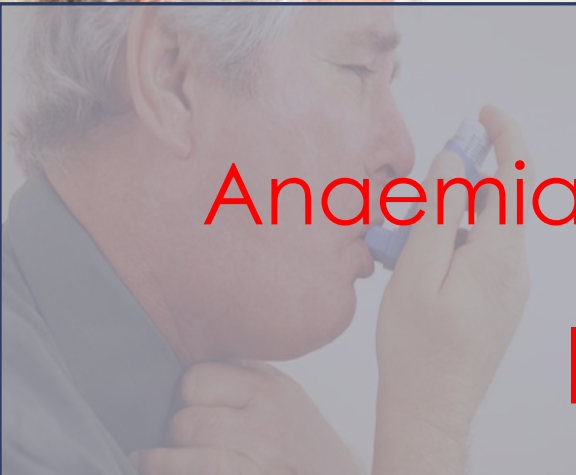
Ultrasound in acute dyspnoea

Dr Jasna Mamuza
Registrar in Emergency Medicine
Barts Health NHS Trust



AsthmaMomLife.blogspot.com

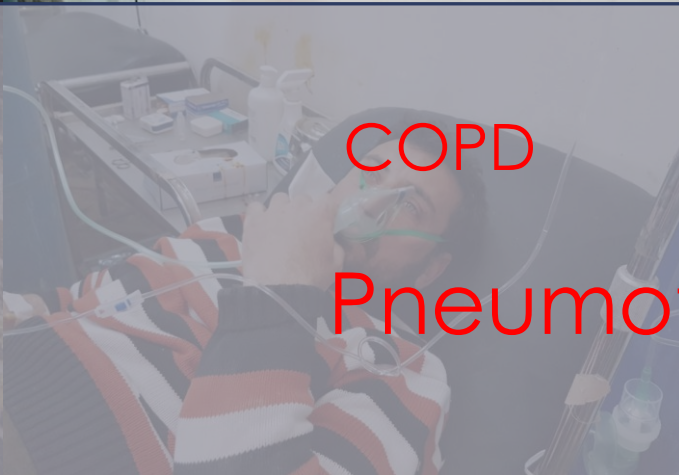


A close-up of a man's face as he uses a blue inhaler. The image is semi-transparent with a light blue tint.

Anaemia

A man in a dark jacket is coughing into his elbow. The image is semi-transparent with a light blue tint.

Pneumonia

A man is lying in a hospital bed, wearing an oxygen mask and connected to medical equipment. The image is semi-transparent with a light blue tint.

COPD

An older man is using a blue inhaler. The image is semi-transparent with a light blue tint.

Pneumothorax

A man in a white shirt is bending over, holding his back. The image is semi-transparent with a light blue tint.

Pleural effusion

A man in a hospital bed, wearing a blue and white striped shirt, looks unwell. The image is semi-transparent with a light blue tint.

Asthma

A close-up of a man's hands holding his chest, suggesting pain. The image is semi-transparent with a light blue tint.

Myocardial infarction

A man in a blue hoodie is bending over, holding his back. The image is semi-transparent with a light blue tint.

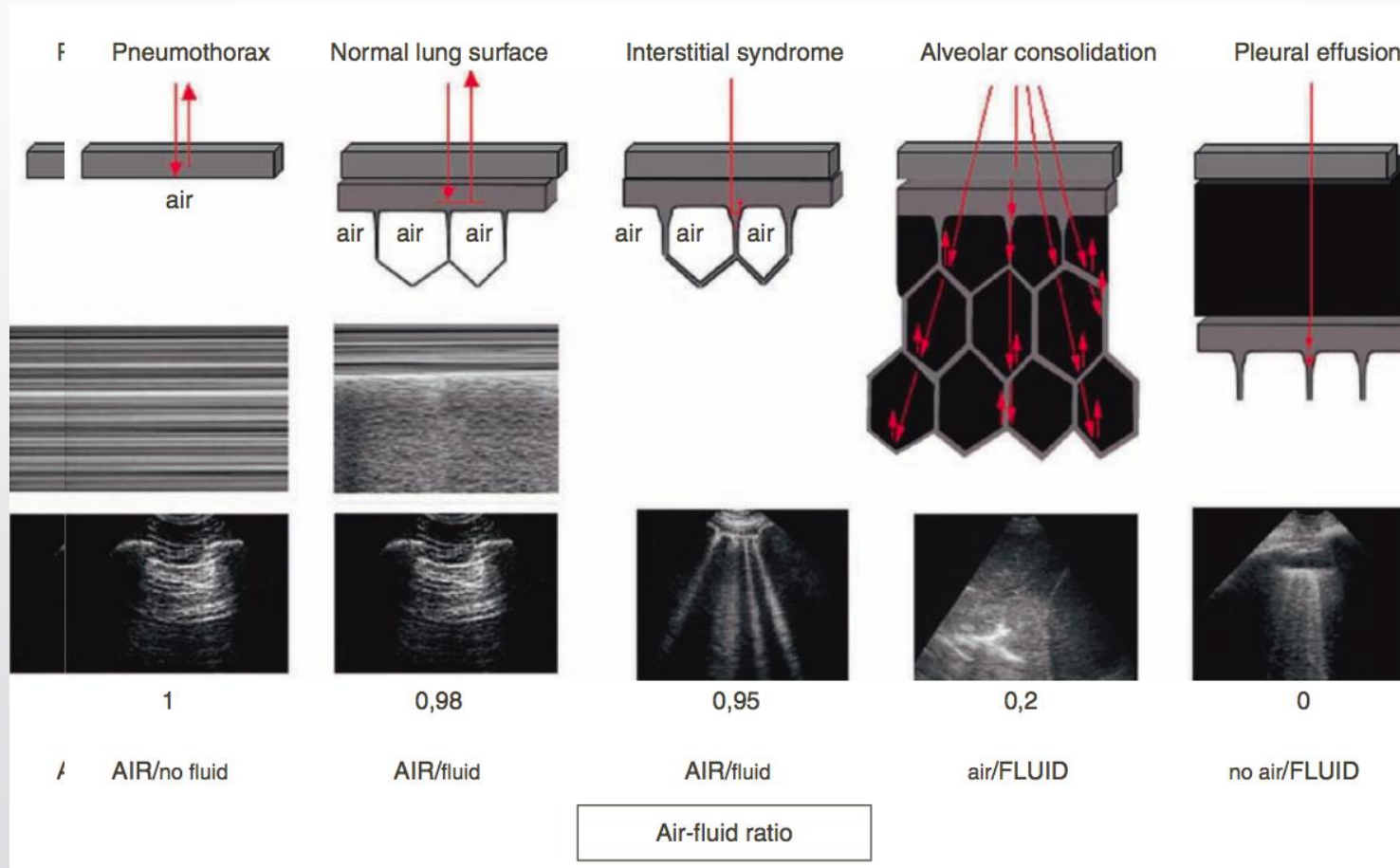
Heart failure

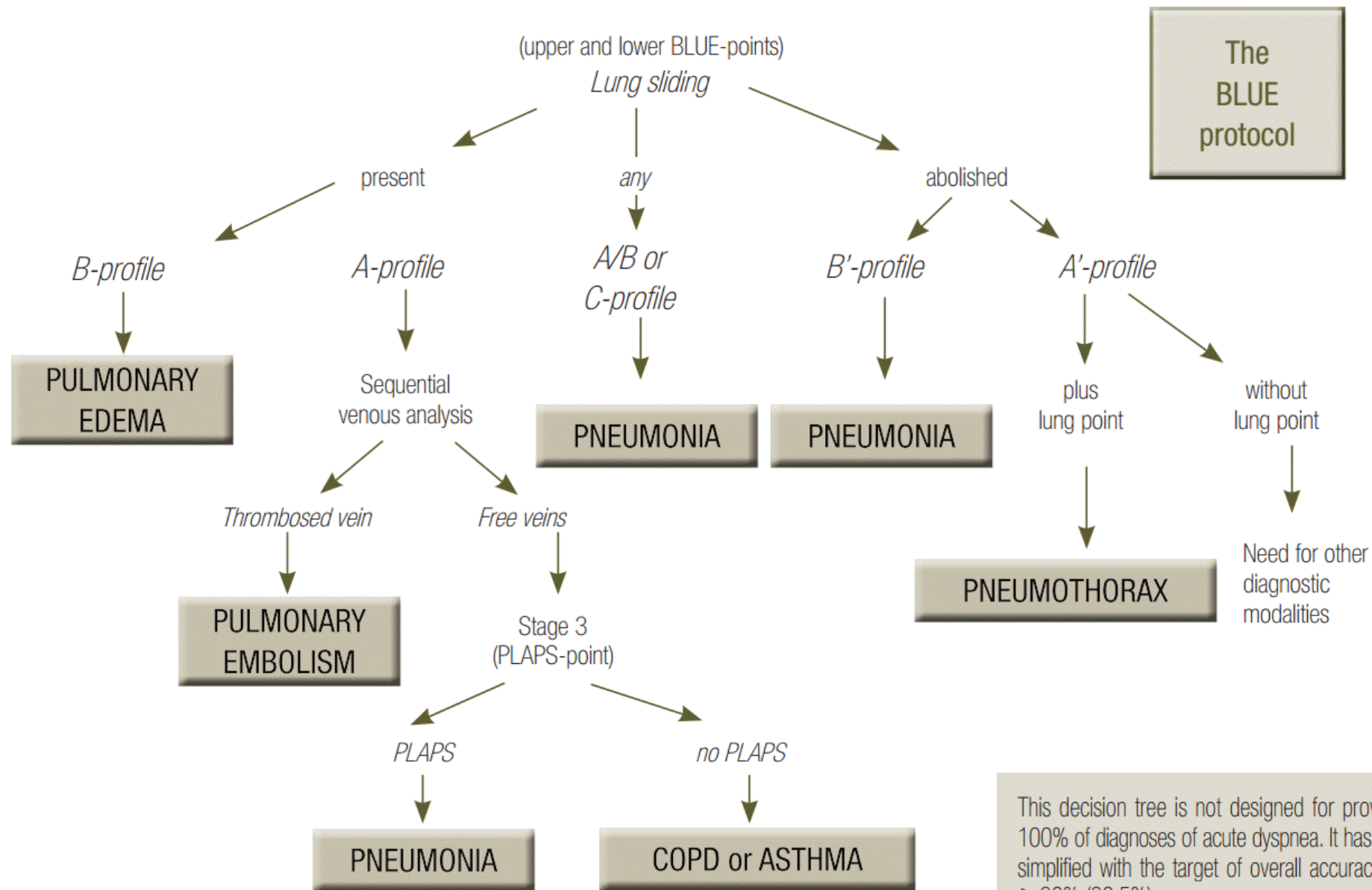
A woman is coughing into her elbow. The image is semi-transparent with a light blue tint.

Foreign object
inhalation

A man is lying in a hospital bed, wearing an oxygen mask. The image is semi-transparent with a light blue tint.

Pulmonary embolism





Normal Features

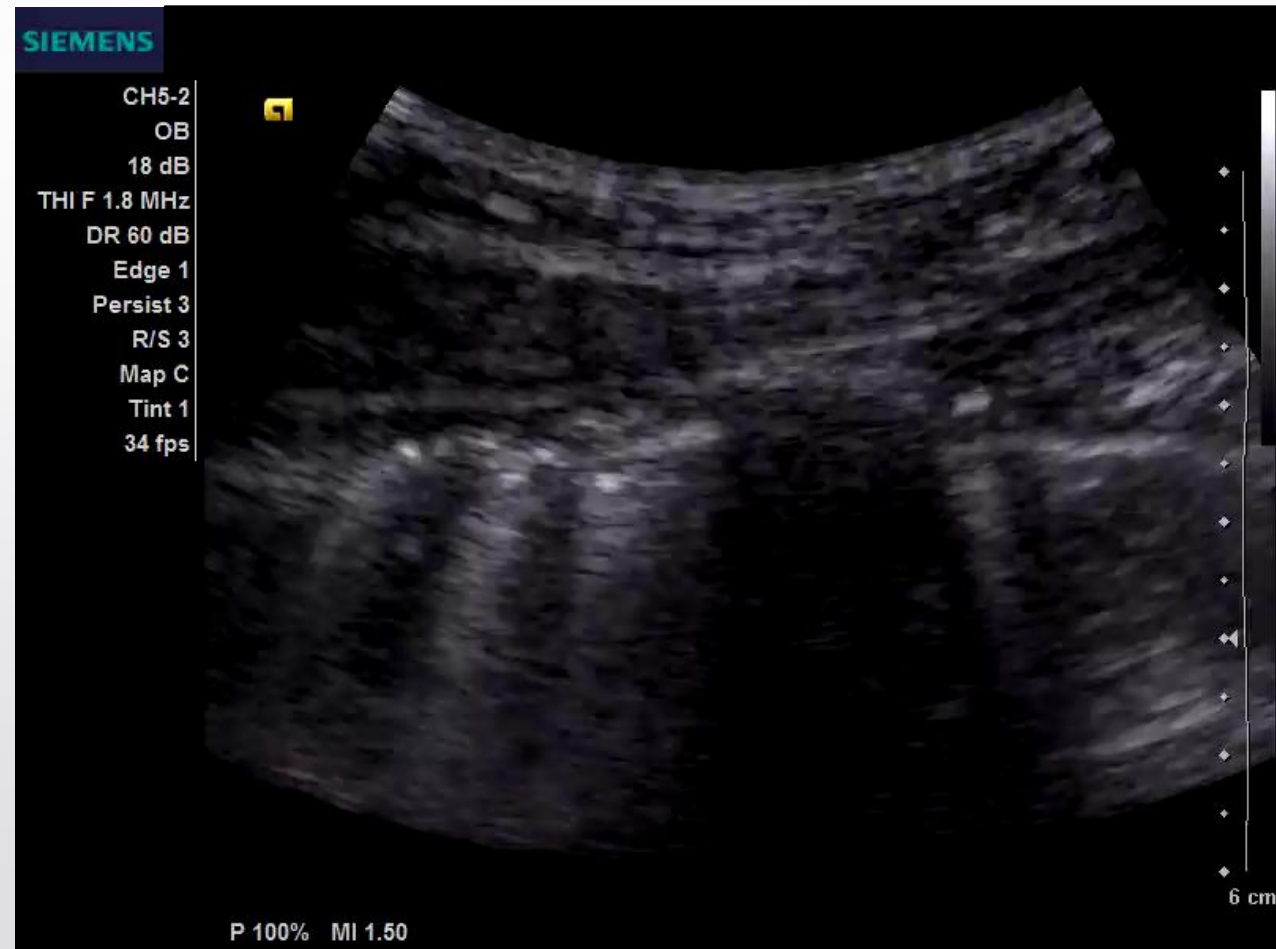
Pleura

Sliding of visceral against parietal pleura

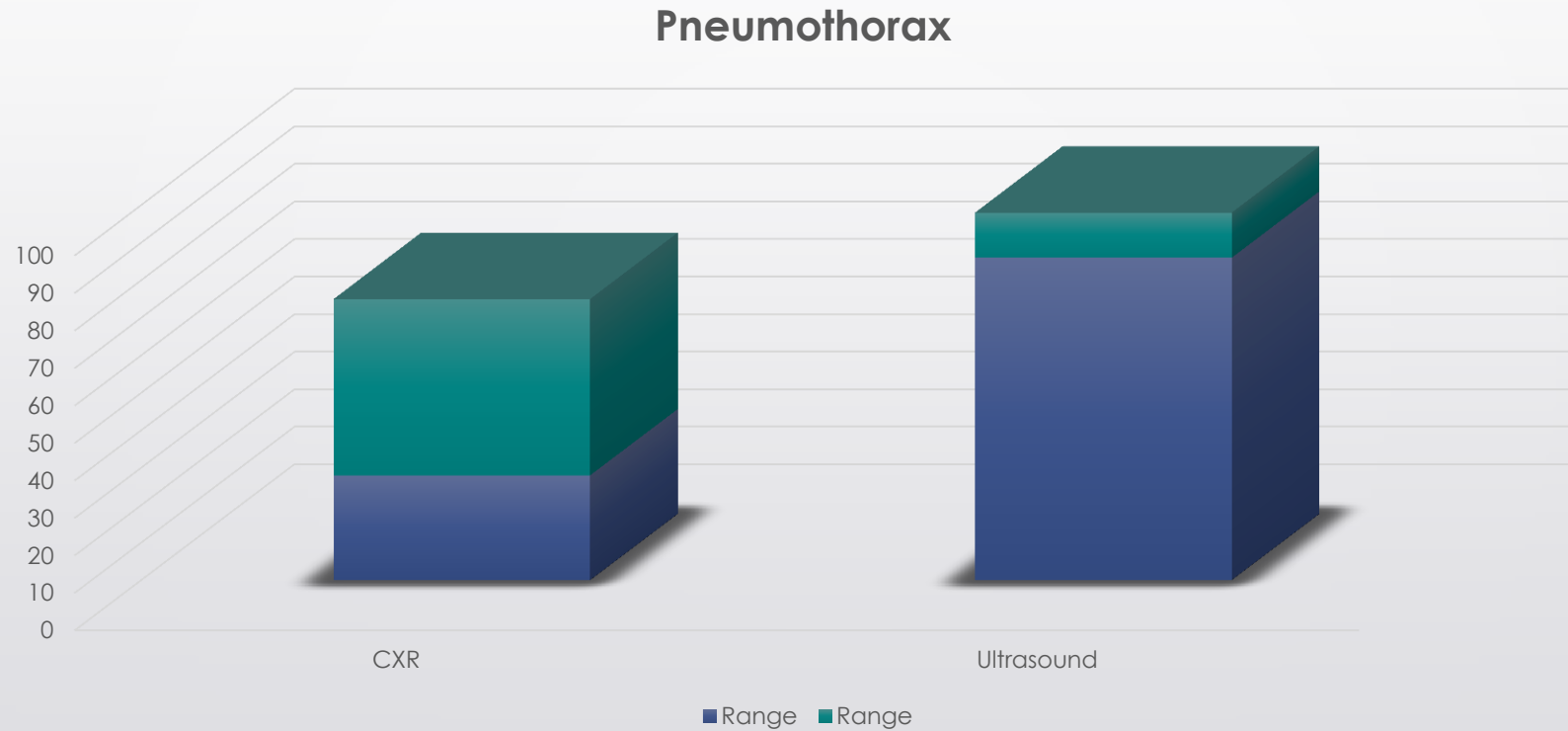
Greater in longitudinal vs. transverse plane

No significant pleural fluid

Artefactual A lines -
pleural reflection in 2/3
normal subjects and
most with Pneumothorax



Sensitivity of Chest XR and US for Pneumothorax



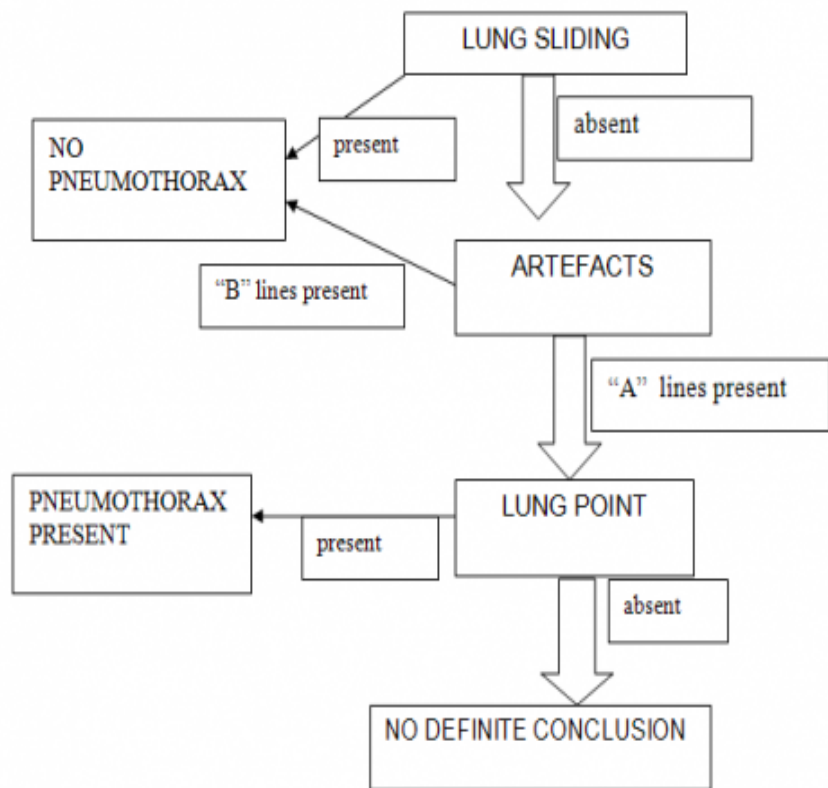


Fig.5 Algorithm for the ultrasound diagnosis of pneumothorax



Normal Features

Lung

Air scatters US waves

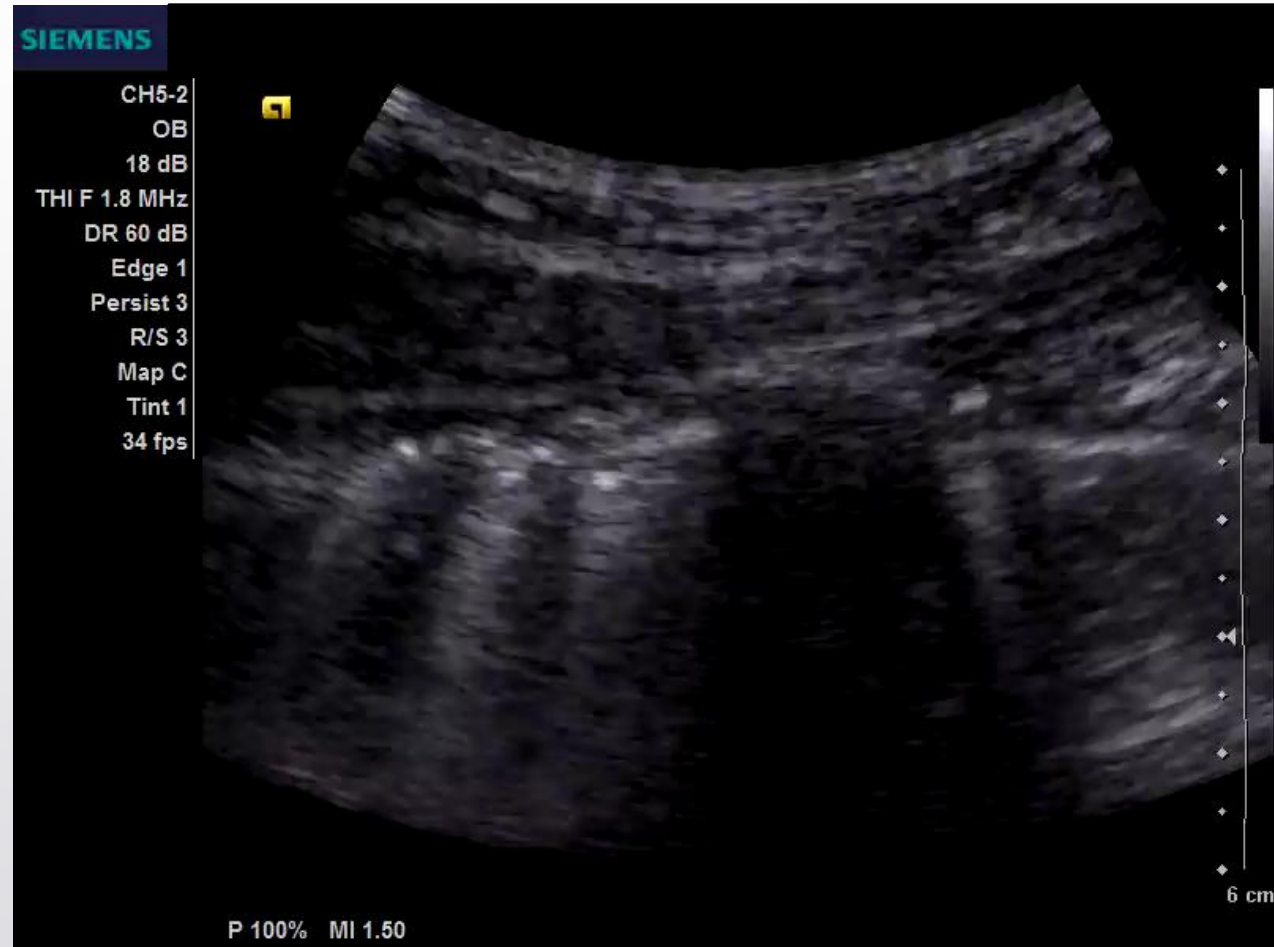
Lung parenchyma visible if edematous or consolidated

Z lines - do not move with inspiration/pleural sliding, do not reach screen end

E lines - vertical lines in soft tissue, small, SC emphysema

B lines (comet tails)

C lines, subpleural consolidation, effusion/hepatisation



Normal LUS

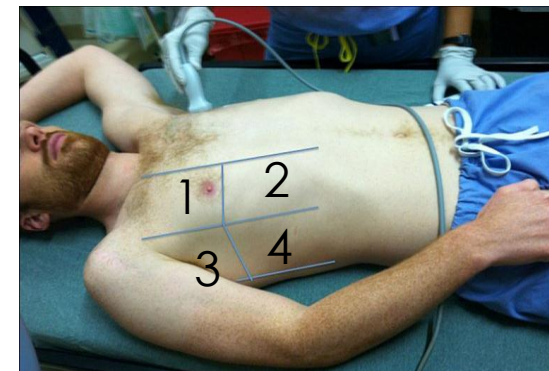


- Predominance of A-lines in the presence of lung sliding indicates an exacerbation of asthma or chronic obstructive pulmonary disease (COPD) (89% sensitivity and 97% specificity) Lichenstein D. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE Protocol. Chest 134(1):117-125, 2008.
- In patients with normal chest ultrasound scans, chest radiographs were normal in the majority (90%) of cases. This result suggests that in the ED, when chest ultrasonography is normal, the radiographic examination can be avoided in a large number of patients Zanolotti M. et al. Can Chest Ultrasonography Replace Standard Chest Radiography for Evaluation of Acute Dyspnea in the ED? Chest 139(5): 2011
- Anterolateral sonographic pattern without B lines rules out any radiologic alveolar consolidation with a specificity of 90% and a negative predictive value of 84% Volpicelli G. Detection of sonographic B-lines in patients with normal lung or radiographic alveolar consolidation. Med Sci Monit 2008; 14:CR122–CR128

Case scenario

- Pt woken up in the early hours gasping for air
Feeling feverish, Chesty cough
- sweaty, Sat O₂ 78% on RA, RR 28/min, tachy105/min
- o/e wheezy bilaterally
- PMH Asthma, Parkinsons disease, Epilepsy, Ca prostate,
Last ECHO 2016 EF 55-60%, concentric LVH, mild AS
VBG mild resp. acidosis
- Diff dg ?Asthma exacerb ?PE ?ADHF



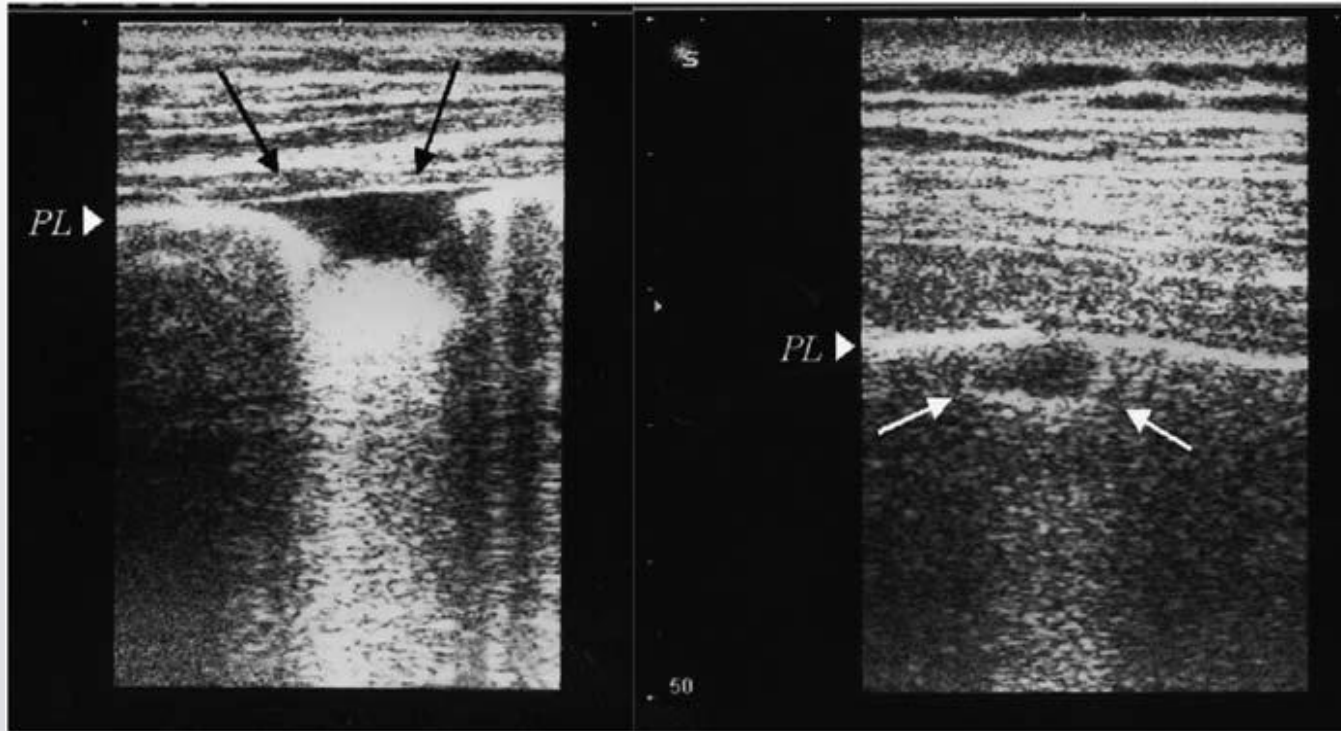


R

L

Alveolar consolidation

- Shape and margins



Alveolar consolidation

- Echotexture



Alveolar consolidation

- Bronchograms

In patients with alveolar consolidation displaying air bronchograms on an ultrasound:

- dynamic air bronchogram indicates pneumonia (distinguishing it from resorptive atelectasis)
- static air bronchograms are seen in most resorptive atelectases and 1/3 pneumonia

Dynamic air bronchogram has sensitivity 61%, specificity 94%, PPV 97%, NPV 43%

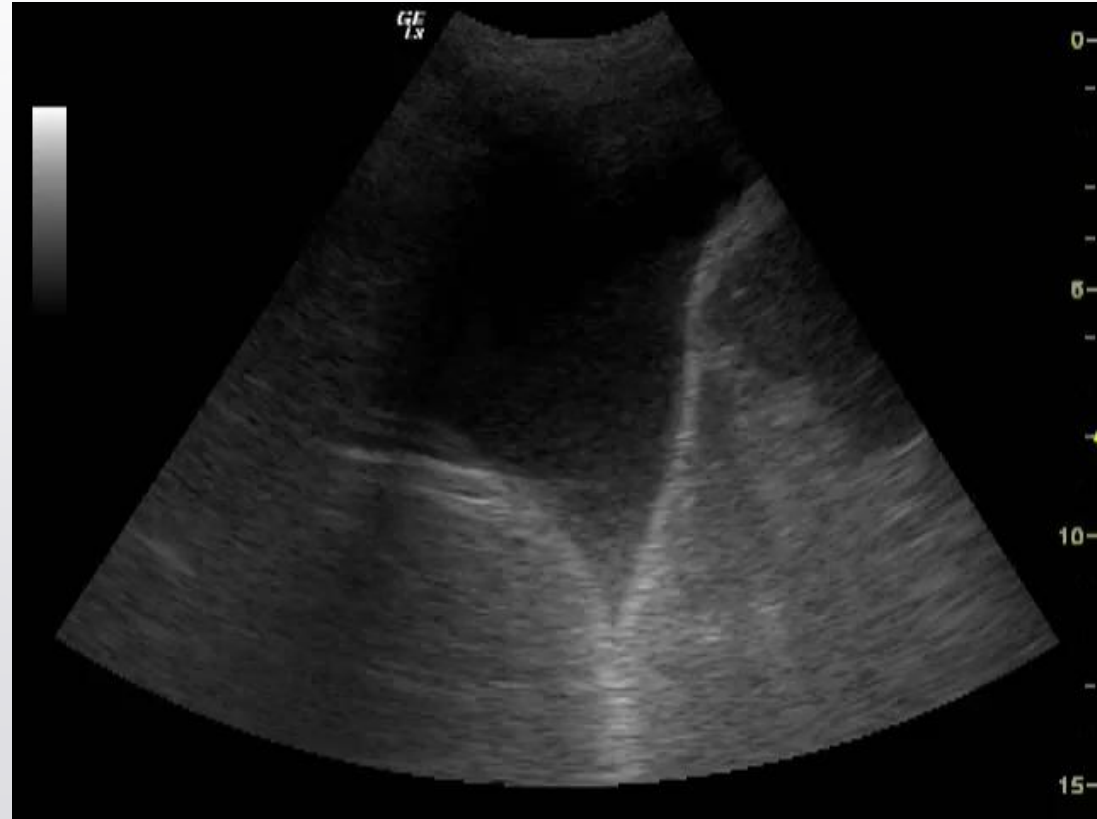
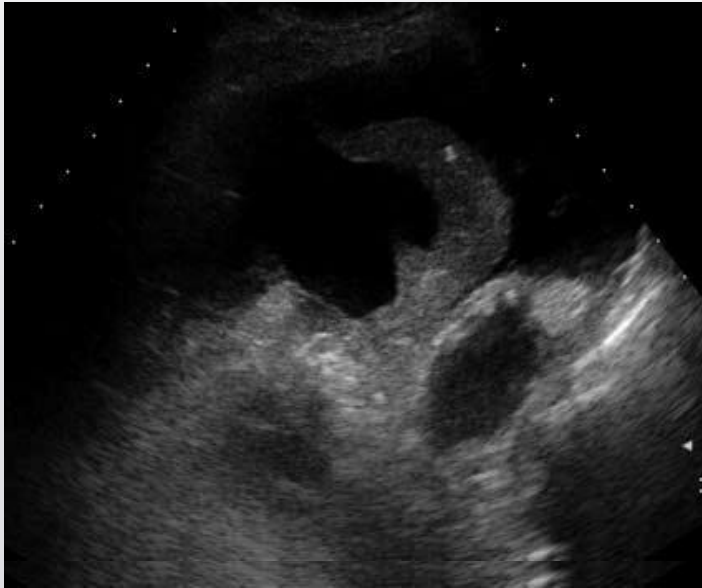
Lichtenstein D. The Dynamic Air Bronchogram : A Lung Ultrasound Sign of Alveolar Consolidation Ruling Out Atelectasis. Chest. 135 (6):1421-1425, 2009.



Alveolar consolidation



- Bronchograms
Compression atelectasis



Alveolar consolidation

- Lung pulse
- The characteristic vibration in rhythm with the heartbeat of the consolidated lung is called lung pulse and is a highly specific sign of **nonventilated lung** Lichtenstein D. The 'lung point': an ultrasound sign specific to pneumothorax. Intensive Care Med 2000; 26:1434-1440
- Atelectasis



LUS patterns of pneumonia

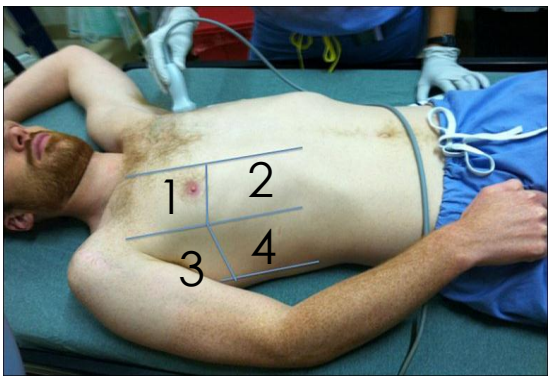
- Hypoechoic consolidated area of varying size and shape, with irregular borders. The echotexture can appear **homogeneous or inhomogeneous** Reissig A Transthoracic sonography in the diagnosis of pulmonary diseases: a systematic approach. Ultraschall Med 2009; 30: 438-454; quiz 455-456
- LUS reported as effective as chest CT in detecting **loculated effusion, lung necrosis or abscess** that results from complicated pneumonia in **children** Kurian J Comparison of ultrasound and CT in the evaluation of pneumonia complicated by parapneumonic effusion in children. AJR Am J Roentgenol 2009; 193: 1648-1654



Accuracy of LUS in Pneumonia



	Sensitivity	Specificity	Positive LRs	Negative LRs	AUROC
Alzahrani SA. Systematic review and meta-analysis for the use of ultrasound vs. radiology in dg pneumonia. Crit Ultrasound J. 2017	85%	93%	11.05	0.08	0.978
Hu QJ. Diagnostic performance of lung ultrasound in the diagnosis of pneumonia: a bivariate meta-analysis. Int Clin Exp Med. 2014	97%	94%	15.62	0.03	0.99



R

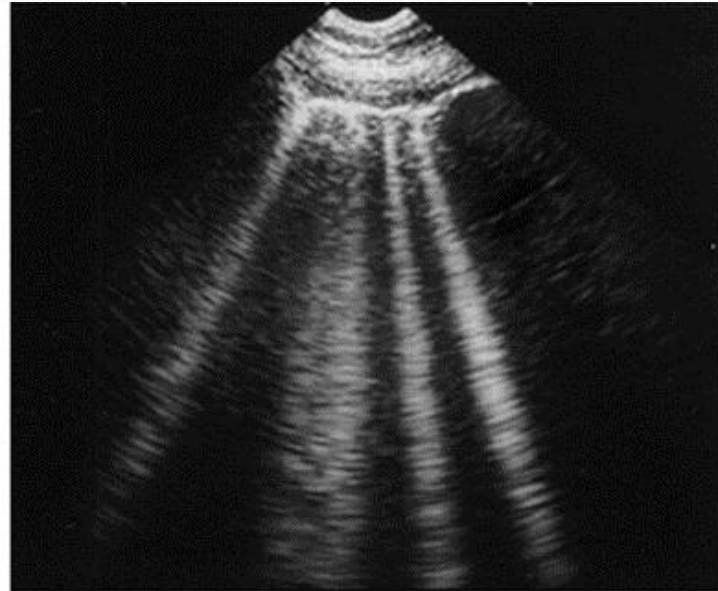
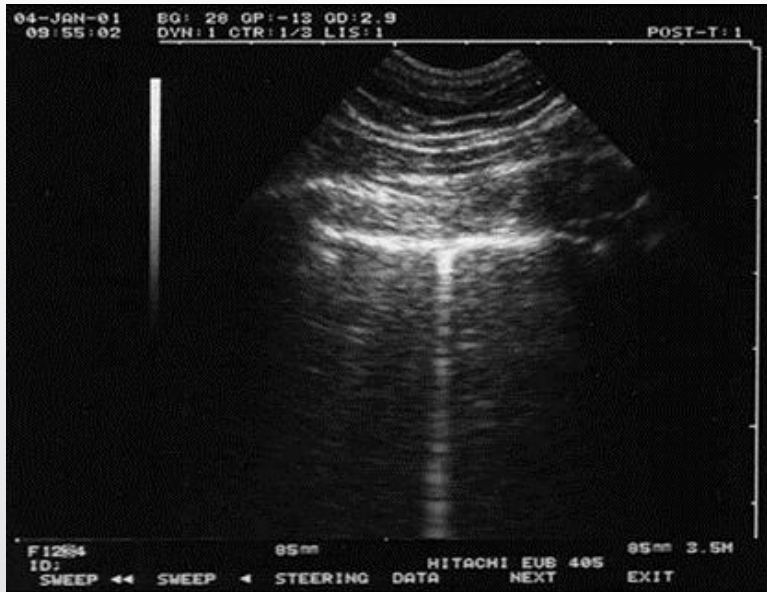
L

Interstitial syndrome



- Comet-tail artifact
- Arises from the pleural line
- Laser-like and hyperechoic
- Spreading to edge of the screen
- It erases A-lines
- It moves with lung sliding
- Present at the last intercostal space in 28% of normal subjects

Interstitial syndrome



Number of B lines correlates with severity of interstitial involvement

B-lines - Guide in Fluid management

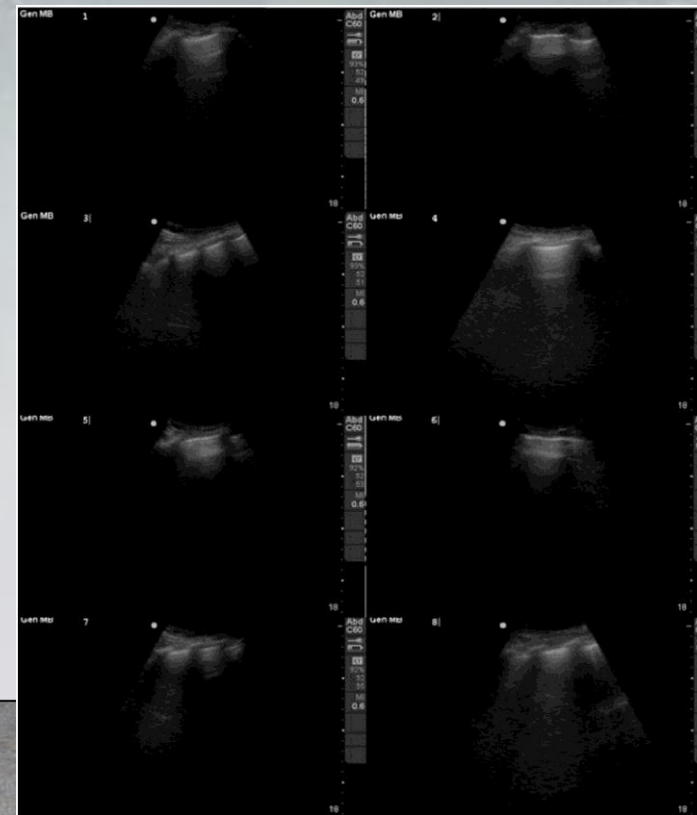
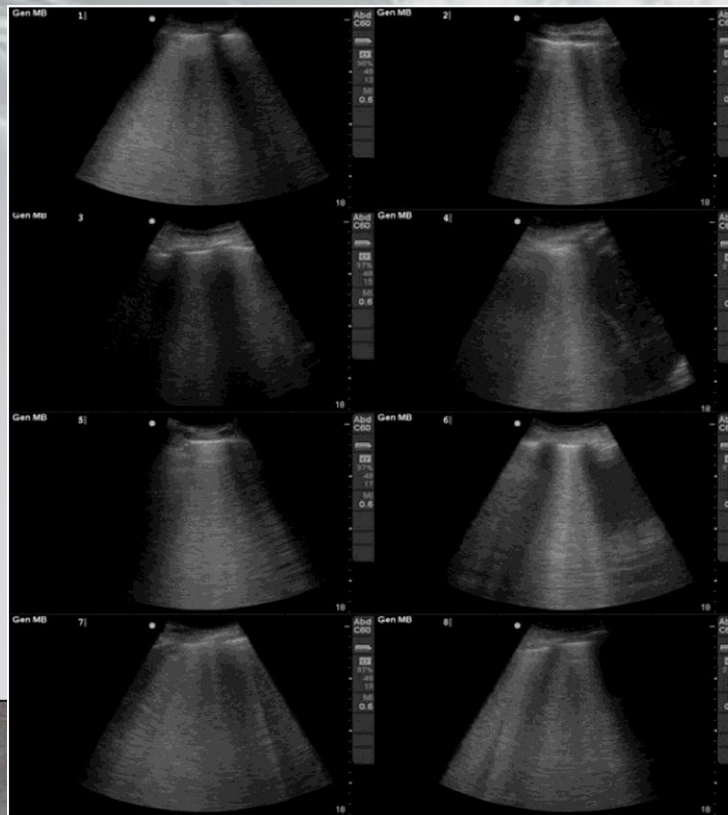


- B-line resolution occurs real-time as fluid is removed from the body. Thoracic ultrasound as a **useful method for evaluating real-time changes in EVLW** and in **assessing a patient's physiologic response to the removal of fluid**

Noble, V.E. Ultrasound assessment for extravascular lung water in patients undergoing hemodialysis: time course for resolution. Chest. 2009; 135: 1433–1439

B-lines - Guide in Fluid management

- Description of real-time resolution of B-lines during ED management of CHF, **within hours of initiation of treatment**. It demonstrates that in CHF, B-lines reflect acute rather than chronic changes within lung parenchyma Liteplo AS. Real-time resolution of sonographic B-lines in a patient with pulmonary edema on continuous positive airway pressure. Am J EmMed. 2010. 4: 541-8.



Accuracy of US in ADHF in the ED

- Martindale JL et al. Diagnosing Acute Heart Failure in the Emergency Department: A Systematic Review and Meta-analysis. Academic Emergency Medicine. 2016; 23(3):232-42.
- Lung US positive LR 7.4 (95% CI = 4.2 to 12.8)
- Reduced EF observed on bedside ECHO positive LR 4.1 (95% CI = 2.4 to 7.2)

Accuracy of US in ADHF in the ED

	Sensitivity	Specificity	+LR	-LR
Pivetta 2015	0.91	0.94	14	0.1
Piccoli 2012	0.91	0.95	19	0.1
Andreson 2013	0.34	0.91	10.7	0.72
Prosen 2011	1.00	0.95	20	0.00
Russell 2015	0.343	0.97	10.9	0.67
Liteplo 2009	0.58	0.85	3.9	0.5
Cibinel 2012	0.94	0.84	7.8	0.8
Ozkan 2015	1.00	0.80	5	0

	Sensitivity	Specificity	+LR	-LR
Pivetta 2015	0.91	0.94	14	0.1
Piccoli 2012	0.91	0.95	19	0.1
Andreson 2013	0.34	0.91	10.7	0.72
Prosen 2011	1.00	0.95	20	0.00
Russell 2015	0.343	0.97	10.9	0.67
Liteplo 2009	0.58	0.85	3.9	0.5
Cibinel 2012	0.94	0.84	7.8	0.8
Ozkan 2015	1.00	0.80	5	0

	Sensitivity	Specificity	+LR	-LR
Pivetta 2015	0.91	0.94	14	0.1
Piccoli 2012	0.61	0.95	19	0.1
Andreson 2013	0.34	0.91	10.7	0.72
Prosen 2011	1.00	0.95	6	0.00
Russell 2015	0.343	0.97	10.9	0.67
Liteplo 2009	0.58	0.85	3.9	0.5
Cibinel 2012	0.94	0.84	7.8	0.8
Ozkan 2015	1.00	0.80	5	0

Pos LR 15.7
Neg LR 0.25

	Sensitivity	Specificity	+LR	-LR
Pivetta Chest 2015	0.91	0.94	14	0.1
Piccoli J cardiac Failure 2012	0.91	0.95	19	0.1
Anderson Amer J Emerg Med 2013	0.91	0.91	10.7	0.72
Prosen Crit Care 2011	1.00	0.95	20	0.00
Liteplo Acad Emerg Med 2009 (JGEMS)	0.58	0.85	3.9	0.5
Cibinel Intern Emerg Med 2012	0.84	0.84	7.8	0.8
Chiem Acad Emerg Med 2015 (JGEMS)	1.00	0.80	5	0
Lichtenstein Chest 2008 (BLUE protocol)				0
Lichtnestein Intern Care med 1998	0.97	0.75	19.4	0.03
Gargani Emerg Med Fail 2008			6.3	0.27
Vitturi J Ultrasound 20122	0.97	0.70		0.04
Unluer Intern Emerg Nurs 2012	0.95	0.95	18.2	0.05

Specificity 0.76-1.00

Sensitivity 0.88-0.97

POS LR 4.6-33

NEG LR 0.8-0



“Because LUS B-lines do not provide sufficient evidence for the differential diagnosis of acute cardiogenic pulmonary edema versus primary respiratory disorders, great caution is warranted when this procedure is used.”

Sperandeo M et al. Assessment of ultrasound acoustic artifacts in patients with acute dyspnea: a multicenter study. Acta Radiologica 2012;53:885–892.

NCBI Resources How To

PubMed.gov
US National Library of Medicine
National Institutes of Health

PubMed Advanced

Format: Abstract Send to

Am J Emerg Med. 2013 Aug;31(8):1208-14. doi: 10.1016/j.ajem.2013.05.007. Epub 2013 Jun 13.

Diagnosing heart failure among acutely dyspneic patients with cardiac, inferior vena cava, and lung ultrasonography.

Anderson KL¹, Jeng KY, Fields JM, Panebianco NL, Dean AJ.

Author information

Abstract

BACKGROUND: Rapid diagnosis (dx) of acutely decompensated heart failure (ADHF) may be challenging in the emergency department (ED). Point-of-care ultrasonography (US) allows rapid determination of cardiac function, intravascular volume status, and presence of pulmonary edema. We test the diagnostic test characteristics of these 3 parameters in making the dx of ADHF among acutely dyspneic patients in the ED.

- Sensitivity and specificity for the presence of ADHF
- LVEF <40%: 74 and 74
- IVC – CI <20%: 52 and 86
- B-lines min 10: 70 and 75
- Combining modalities 36 and 100

Diagnostic Accuracy of Emergency Doppler Echocardiography for Identification of Acute Left Ventricular Heart Failure in Patients with Acute Dyspnea: Comparison with Boston Criteria and N-terminal Prohormone Brain Natriuretic Peptide

Peiman Nazerian, MD, Simone Vanni, MD, PhD, Maurizio Zanobetti, MD, Gianluca Polidori, MD, Giuseppe Pepe, MD, Roberto Federico, MD, Elisabetta Cangili MD, and Stefano Grifoni, MD

	Sensitivity, % (95% CI)	Specificity, % (95% CI)	+LR (95% CI)	-LR (95% CI)
Boston Clinical Criteria ≥ 8	86 (78–92)	51 (44–55)	1.74 (1.39–2.06)	0.28 (0.15–0.50)
Boston Clinical Criteria ≤ 4	100 (96–100)	14 (10–14)	1.16 (1.07–1.16)	0 (0.00–0.42)
NT-proBNP $\geq 2,200$ pg/mL	83 (75–89)	70 (64–75)	2.80 (2.06–3.63)	0.24 (0.14–0.40)
NT-proBNP ≤ 300 pg/mL	98 (93–100)	22 (18–23)	1.27 (1.13–1.30)	0.07 (0.01–0.38)
Reduced LVEF ($<50\%$)	63 (54–71)	76 (69–82)	2.66 (1.77–4.00)	0.48 (0.36–0.66)
Restrictive mitral pattern when feasible (125 patients)	82 (73–87)	90 (84–94)	8.27 (4.57–15.42)	0.21 (0.14–0.32)
Restrictive mitral pattern in all 145 patients*	69 (60–76)	79 (72–85)	3.27 (2.17–4.97)	0.40 (0.28–0.55)

NCBI Resources How To

PubMed.gov
US National Library of Medicine
National Institutes of Health

PubMed Advanced

Format: Abstract Send to

Acad Emerg Med. 2015 Feb;22(2):182-91. doi: 10.1111/acem.12570. Epub 2015 Jan 29.

Diagnosing acute heart failure in patients with undifferentiated dyspnea: a lung and cardiac ultrasound (LuCUS) protocol.

Russell FM¹, Ehrman RR, Cosby K, Ansari A, Tseeng S, Christain E, Baillitz J.

Author information

Abstract

OBJECTIVES: The primary goal of this study was to determine accuracy for diagnosing acutely decompensated heart failure (ADHF) in the undifferentiated dyspneic emergency department (ED) patient using a lung and cardiac ultrasound (LuCUS) protocol. Secondary objectives were to determine if US findings acutely change management and if findings are more accurate than clinical gestalt.

LuCUS protocol

Sensitivity 83%, Specificity 83%, pos LR 4.8, neg LR 0.20

47% percent of patients had changes in acute management

42% had changes in acute treatment

Overall, accuracy improved by 20% over clinical gestalt alone

Pulmonary embolism

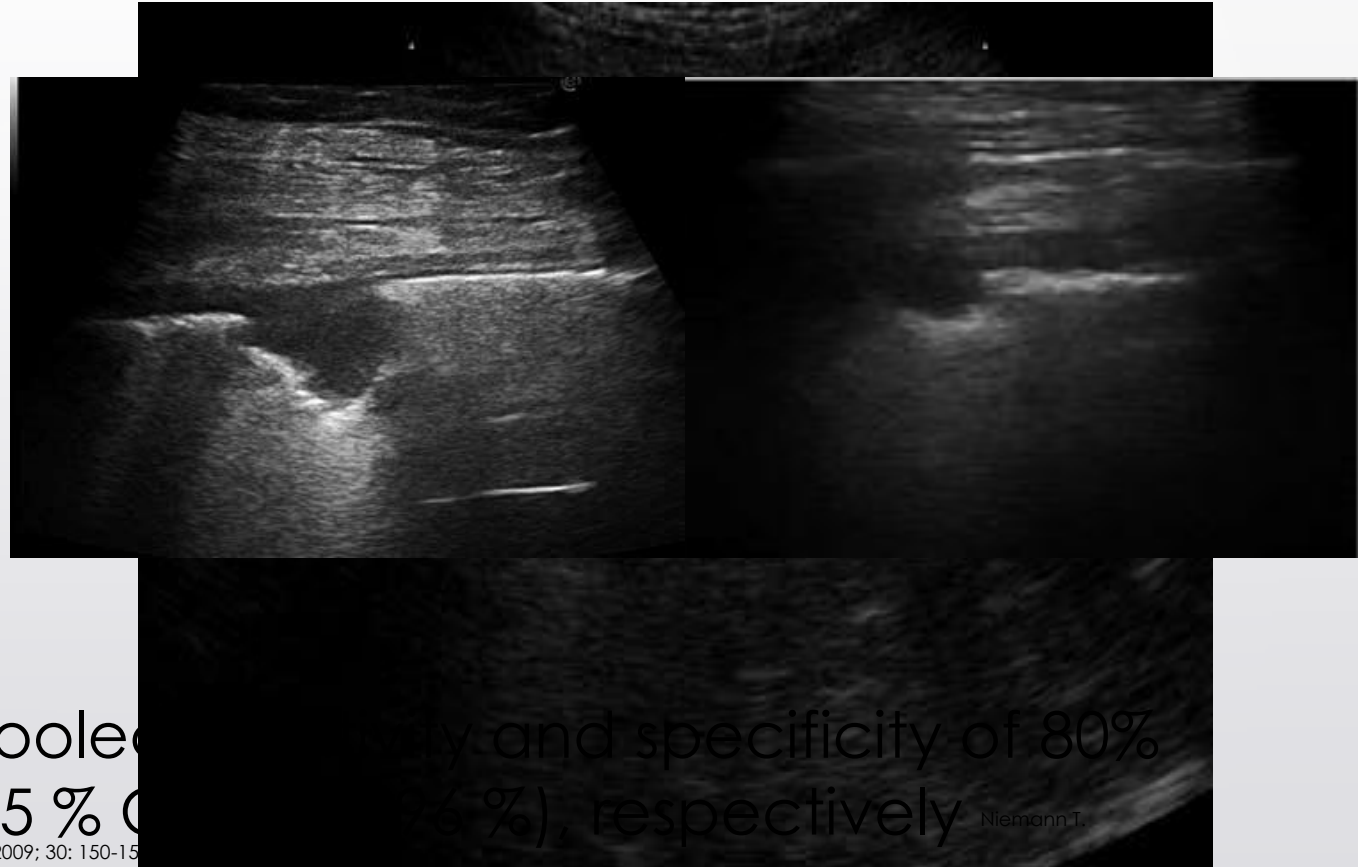


- Multiple, hypoechoic lesions
- Well demarcated
- Dorsal basal position, right lung
- Triangular/wedge, rounded or mixed
- Pleural/ basal effusion 80%, focal eff
- When the lesions are > 3 cm in size, central hyperechoic structures can be seen - segmental involvement

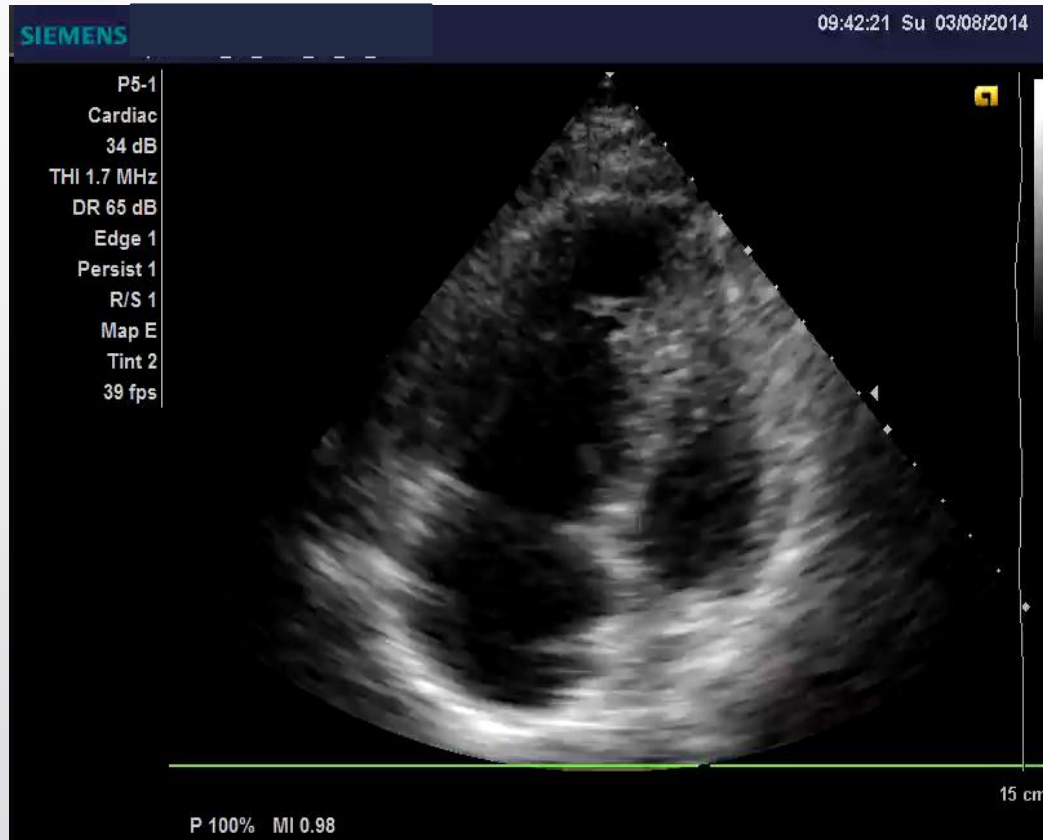
Mathis G et al. Thoracic ultrasound for diagnosing pulmonary

A meta-analysis has reported pooled sensitivity and specificity of 80% (95% CI: 75%, 83 %) and 93% (95 % CI: 86 %, 96 %), respectively

Transthoracic sonography for the detection of pulmonary embolism--a meta- analysis. Ultraschall Med 2009; 30: 150-15



Part of SHOCK scans



- The echo picture of pulmonary embolism is that of pressure (pressure) overload
- **Acute pressure overload** is LV:RV 1:0.6
If RV > LV of massive pulmonary embolism or ARDS (both are forms of acute cor pulmonale - IVC distension - ACP) and is the (Leg veins for DVT) commonest pattern of RV overload seen in critically ill patient

Pericardial effusion

SPECIAL ARTICLE

International Evidence-Based Recommendations for Focused Cardiac Ultrasound

Gabriele Via, MD, Arif Hussain, MD, Mike Wells, MD, BSc, BSc Hons, MBBCh, FCEM, Dip PEC, Robert Reardon, MD, Mahmoud ElBarbary, MD, Vicki E. Noble, MD, James W. Tsung, MD, MPH, Aleksandar N. Neskovic, MD, PhD, FESC, FACC, Susanna Price, MD, MBBS, BSc, MRCP, EDICM, PhD, FFICM, FESC, Achikam Oren-Grinberg, MD, MS, Andrew Liteplo, MD, RDMS, Ricardo Cordioli, MD, Nitha Naqvi, MD, MSc, MRCPCH, Philippe Rola, MD, Jan Poelaert, MD, PhD, Tatjana Golob Gulić, MD, Erik Sloth, MD, PhD, DMSc, Arthur Labovitz, MD, FACC, Bruce Kimura, MD, FACC, Raoul Breitzkreutz, MD, Navroz Masani, MBBS, FRCP, Justin Bowra, FAcem, CCPU, Daniel Talmor, MD, MPH, Fabio Guarracino, MD, Adrian Goudie, BMedSci(Hons), MBBS, FAcem DDU, Wang Xiaoting, MD, Rajesh Chawla, MD, FCCM, Maurizio Galderisi, MD, Micheal Blaivas, MD, FACEP, FAIUM, Tomislav Petrovic, MD, Enrico Storti, MD, Luca Neri, MD, and Lawrence Melniker, MD, MS, International Liaison Committee on Focused Cardiac UltraSound (ILC-FoCUS) for the International Conference on Focused Cardiac UltraSound (IC-FoCUS)

Background: Focused cardiac ultrasound (FoCUS) is a simplified, clinician-performed application of echocardiography that is rapidly expanding in use, especially in emergency and critical care medicine. Performed by appropriately trained clinicians, typically not cardiologists, FoCUS ascertains the essential information needed in critical scenarios for time-sensitive clinical decision making. A need exists for quality evidence-based review and clinical recommendations on its use.



European Heart Journal – Cardiovascular Imaging (2013) 14, 1–11
doi:10.1093/ehjci/jes193

RECOMMENDATIONS

Emergency echocardiography: the European Association of Cardiovascular Imaging recommendations

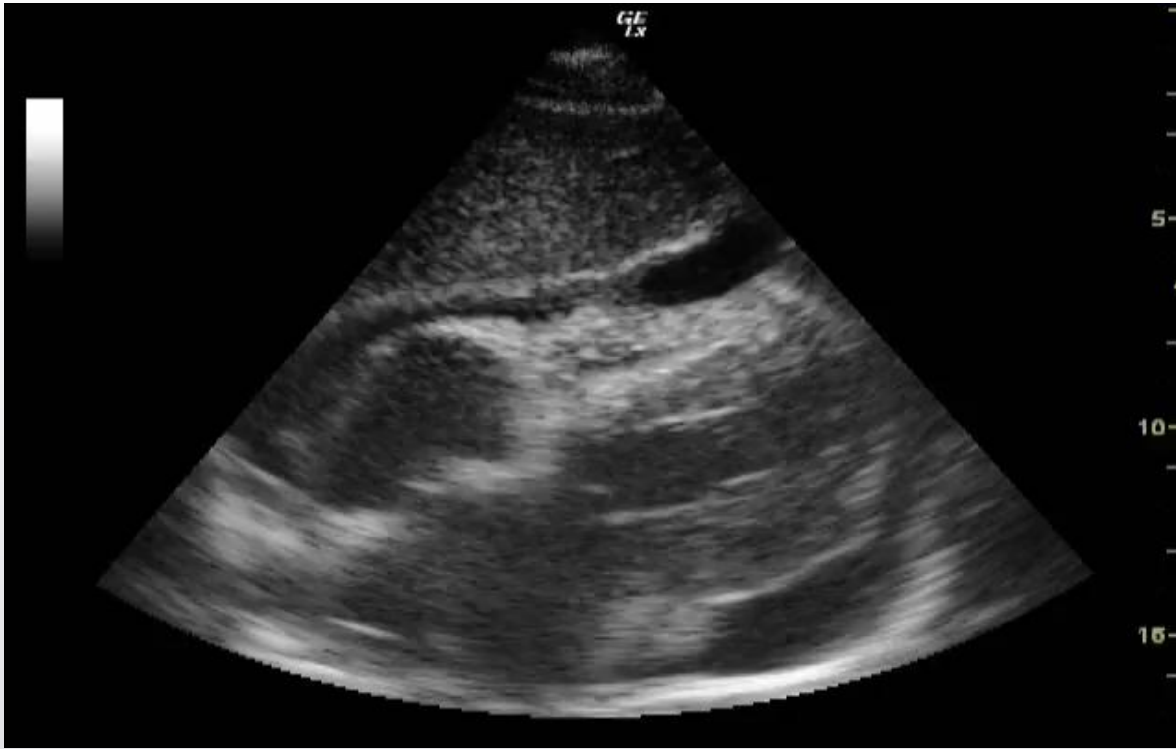
Aleksandar N. Neskovic^{1*}, Andreas Hagendorff², Patrizio Lancellotti³, Fabio Guarracino⁴, Albert Varga⁵, Bernard Cosyns⁶, Frank A. Flachskampf⁷, Bogdan A. Popescu⁸, Luna Gargani⁹, Jose Luis Zamorano¹⁰, and Luigi P. Badano¹¹, on behalf of the European Association of Cardiovascular Imaging[†]

¹University Clinical Hospital Center Zemun, Faculty of Medicine, University of Belgrade, Vukova 9, 11080 Belgrade, Serbia; ²Department für Innere Medizin, Neurologie und Dermatologie, Abteilung für Kardiologie und Angiologie, Universitätsklinikum Leipzig AöR, Leipzig, Germany; ³GIGA Cardiovascular Sciences, Heart Valve Clinic, University of Liège, Department of Cardiology, CHU Sart Tilman, Liège, Belgium; ⁴Department of Anaesthesia and Intensive Care Medicine, University Hospital of Pisa, Pisa, Italy; ⁵2nd Department of Medicine and Cardiology Center, University of Szeged, Szeged, Hungary; ⁶Universiteit Ziekenhuis Brussels, CHIREC Braine (Braine l'Alleud), Belgium; ⁷Uppsala University, Akademiska sjukhuset, Uppsala, Sweden; ⁸“Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania; ⁹Institute of Clinical Physiology, National Research Council, Pisa, Italy; ¹⁰Cardiology Department, University Hospital Ramón y Cajal, Madrid, Spain; and ¹¹Department of Cardiac, Thoracic and Vascular Sciences, University of Padua, Padua, Italy

Received 24 July 2012; accepted after revision 30 August 2012

- FoCUS risk-stratifies patients with pericardial effusion
- 1B: Strong Recommendation, with Very Good Agreement; Level B Evidence
- There is good evidence that pericardial effusions can be detected with high accuracy by clinicians trained in FoCUS

Tamponade physiology



Signs of tamponade:

At least >1 cm
collection

RV diastolic collapse

RA systolic collapse

'Swinging heart'

*It's not the volume
but speed at which
it accumulates*

Sensitivity 100% Specificity 96.9% accuracy 97.3%.

Mean time from scan-operation = 12.1 ± 5 minutes

Rozycki GS et al: The role of Ultrasound in patients with possible penetrating cardiac wounds: A prospective multicenter study. *J trauma* 46(4): 543-551, 1999



Focused Sonography of the Heart, Lungs, and Deep Veins Identifies Missed Life-Threatening Conditions in Admitted Patients With Acute Respiratory Symptoms

Christian B. Laursen, MD; Erik Sloth, MD, DrMedSc, PhD; Jess Lambrechtsen, MD, PhD; Annmarie Touborg Lassen, MD, DrMedSc, PhD; Poul Henning Madsen, MD; Daniel Pilsgaard Henriksen, MD; Jesper Rømhild Davidsen, MD, PhD; and Finn Rasmussen, MD, DrMedSc, PhD

- Focused sonography identified 14% with an acute life-threatening condition missed at the primary assessment
- Diagnostic performance of focused sonography for the diagnosis of an acute life-threatening condition was:
sensitivity 100%; specificity, 93.3%; PPV 76.7% NPV 100%



Point-of-care ultrasonography in patients admitted with respiratory symptoms: a single-blind, randomised controlled trial

Christian B Laursen, Erik Sloth, Annmarie Touborg Lassen, René dePont Christensen, Jess Lambrechtsen, Poul Henning Madsen, Daniel Pilsgaard Henriksen, Jesper Rømhild Davidsen, Finn Rasmussen

Summary

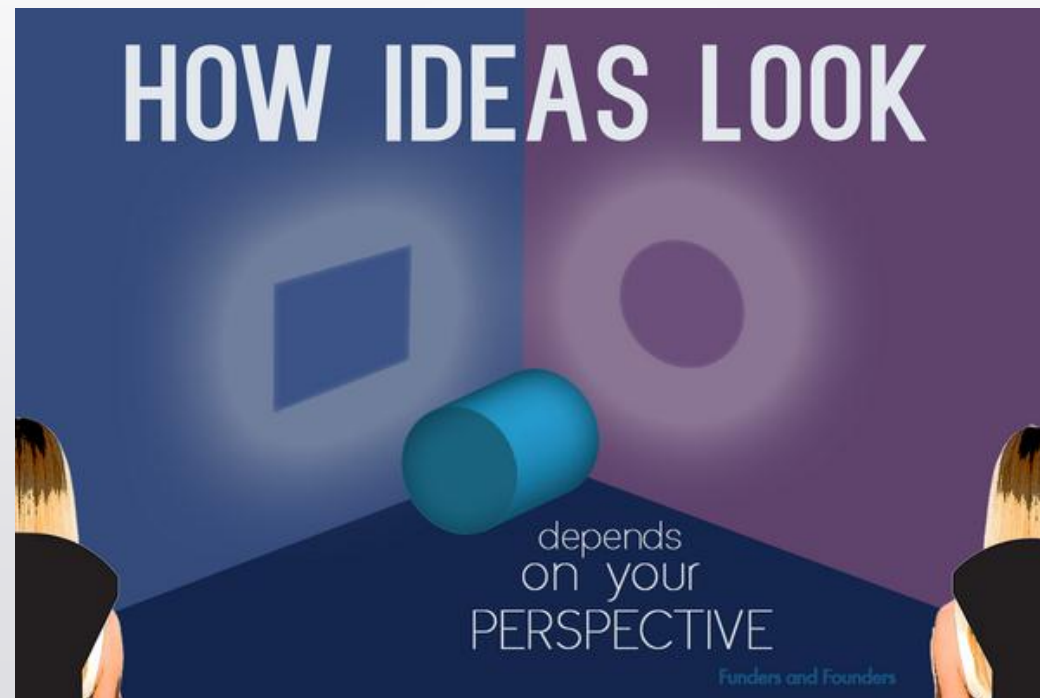
Lancet Respir Med 2014;
2: 638–46
Published Online
July 4, 2014
<http://dx.doi.org/10.1016/>

Background When used with standard diagnostic testing, point-of-care ultrasonography might improve the proportion of patients admitted with respiratory symptoms who are correctly diagnosed 4 h after admission to the emergency department. We therefore assessed point-of-care ultrasonography of the heart, lungs, and deep veins in addition to the usual initial diagnostic testing in this patient population.

4 h after admission to the emergency department,
88·0% in the point-of-care ultrasonography group versus 63·7% in the control group
had a correct diagnose

The absolute and relative effects were 24·3% (95% CI 15·0–33·1)

Context is everything...





Thank you for your attention