

Applying Hemodynamic Assessment in Congestion Management

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Sheraton Grand Jakarta, Gandaria City

Can we go home today?

65-year-old man with ADHF

Day 4

- Dyspnea improved
- Edema improved
- Weight ↓ 3 kg

POCUS:

- IVC 2.5 cm
- E/e' 18
- Diffuse B-lines

Discharge today?

Outline

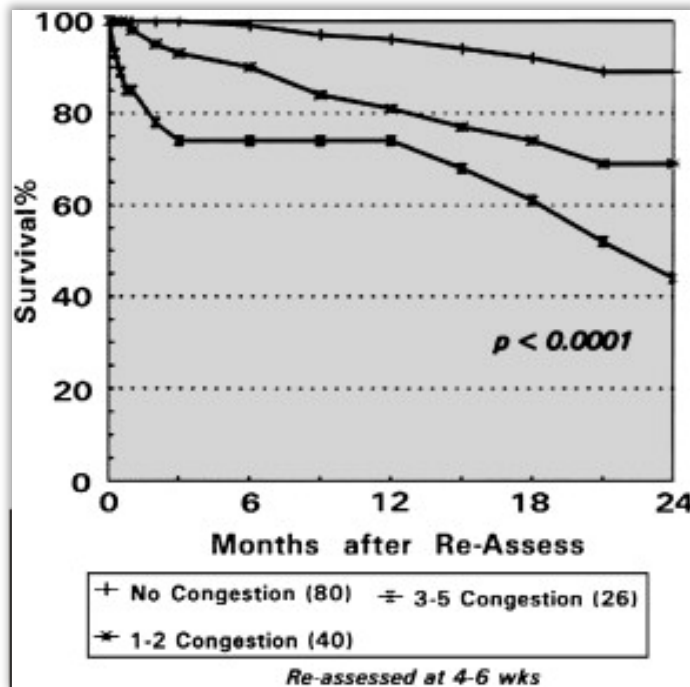
- Congestion continuum
- POCUS-based algorithm for HF
- Systemic and Hemodynamic Congestion
- Lung Ultrasound
- How to intergrate

Indonesian Symposium
on Heart Failure and
Cardiometabolic Disease

Why Residual Congestion Matters

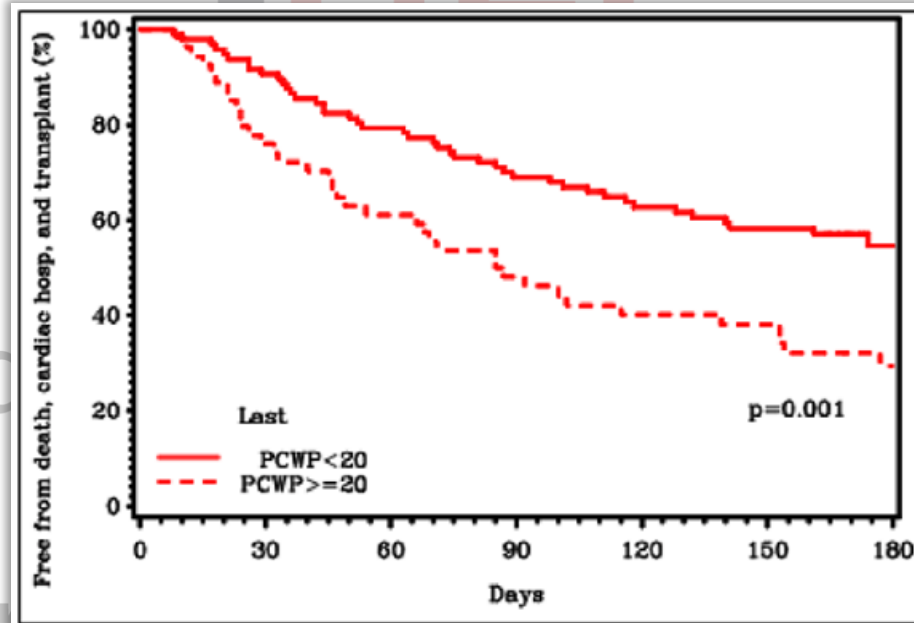
Many patients feel better before they are actually better.

Clinical Parameters



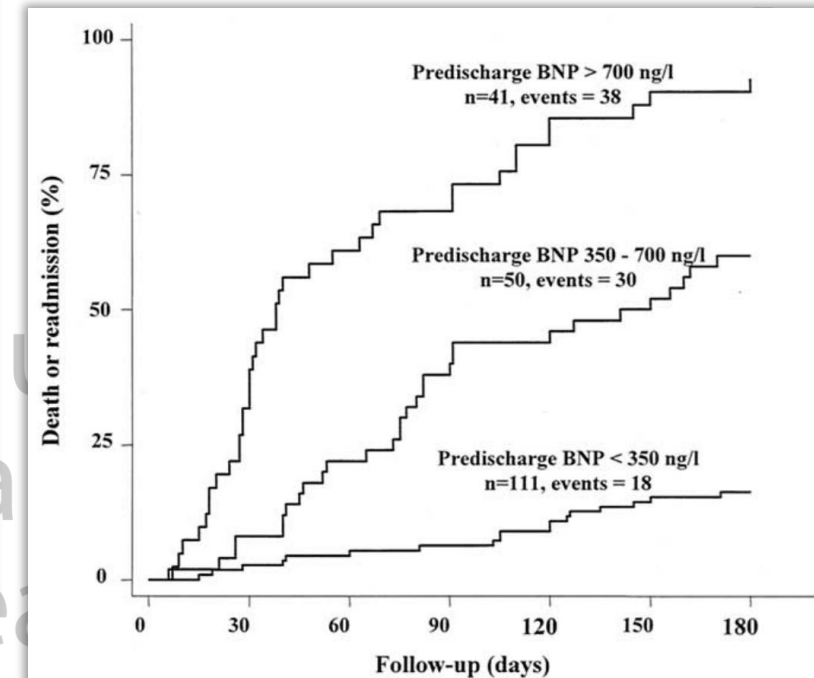
Lucas C, et al. Am Heart J 20000;840-7

Hemodinamically, PCWP



Cooper LB, et al. J Card Fail. 2016; 22(3): 182-9

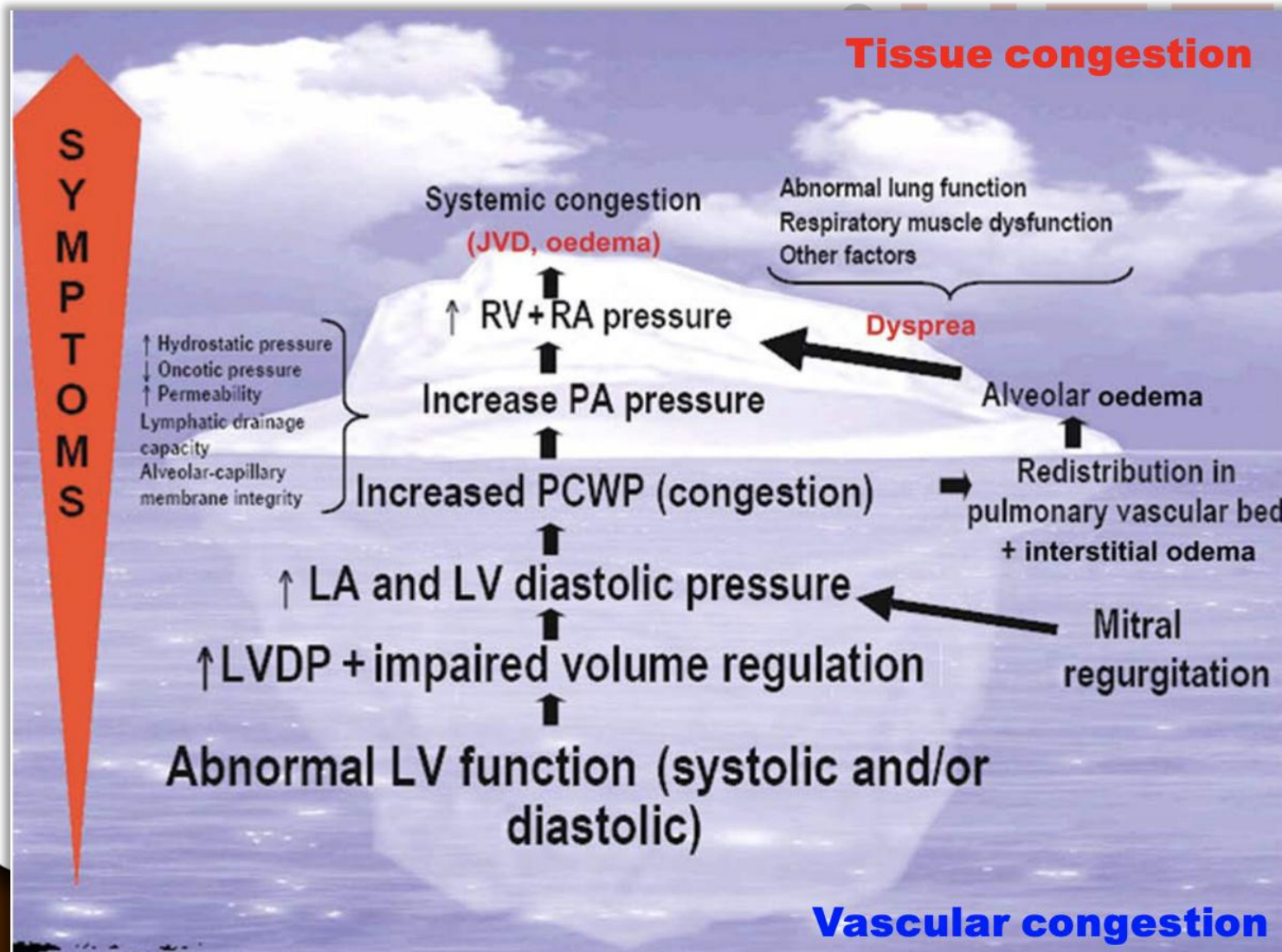
Biochemically, BNP



Logeart D, et al. JACC 2004; 43(4): 635-4

Are they truly decongested, or do they simply feel better?

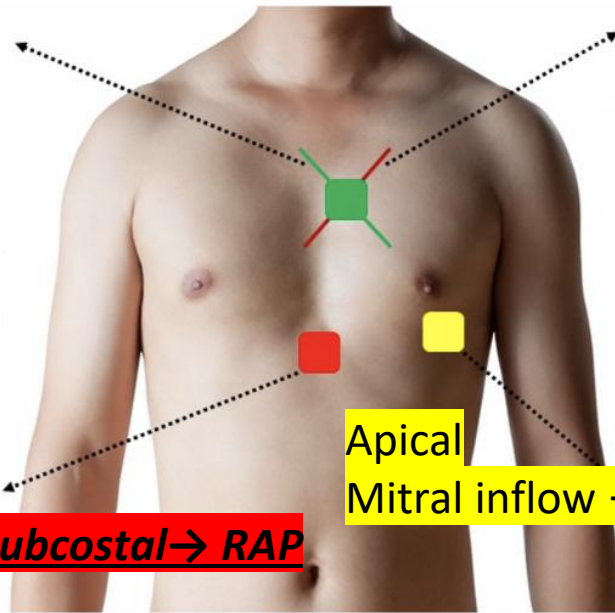
The Congestion continuum



Symptoms are late findings

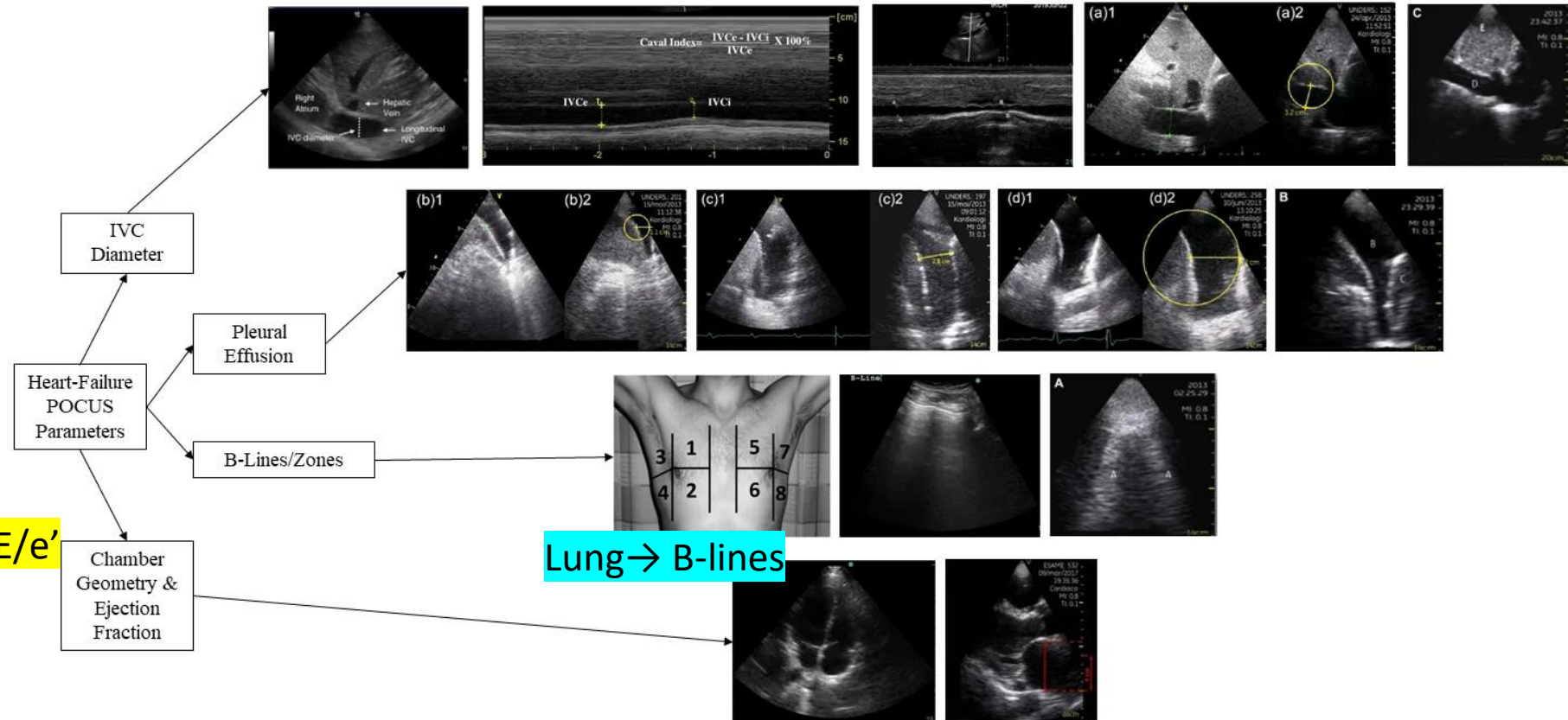
POCUS 5-minute hemodynamic assessment

THE BASIC VIEWS OF FoCUS



Apical
Mitral inflow → E/e'

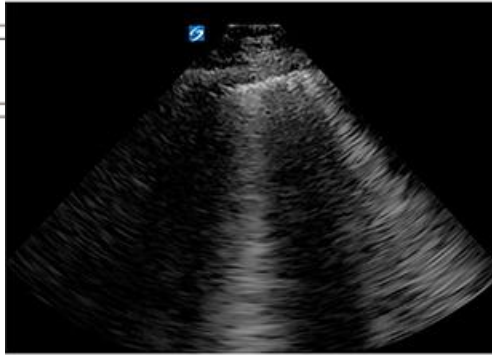
Subcostal → RAP



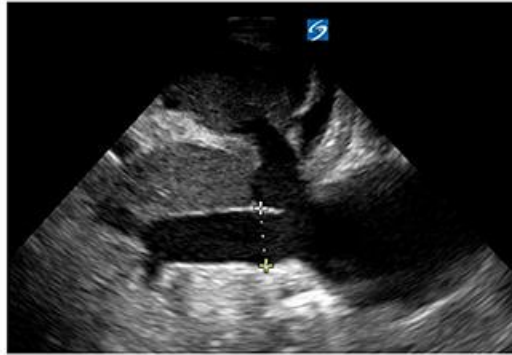
Lung → B-lines

POCUS-Based Diagnostic Algorithm for Acute Heart Failure (AHF)

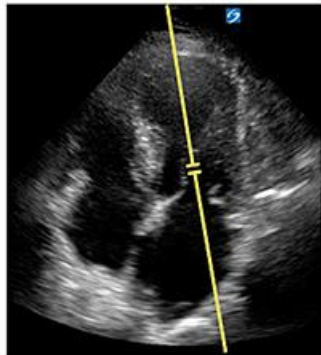
1) B lines on Lung Ultrasound



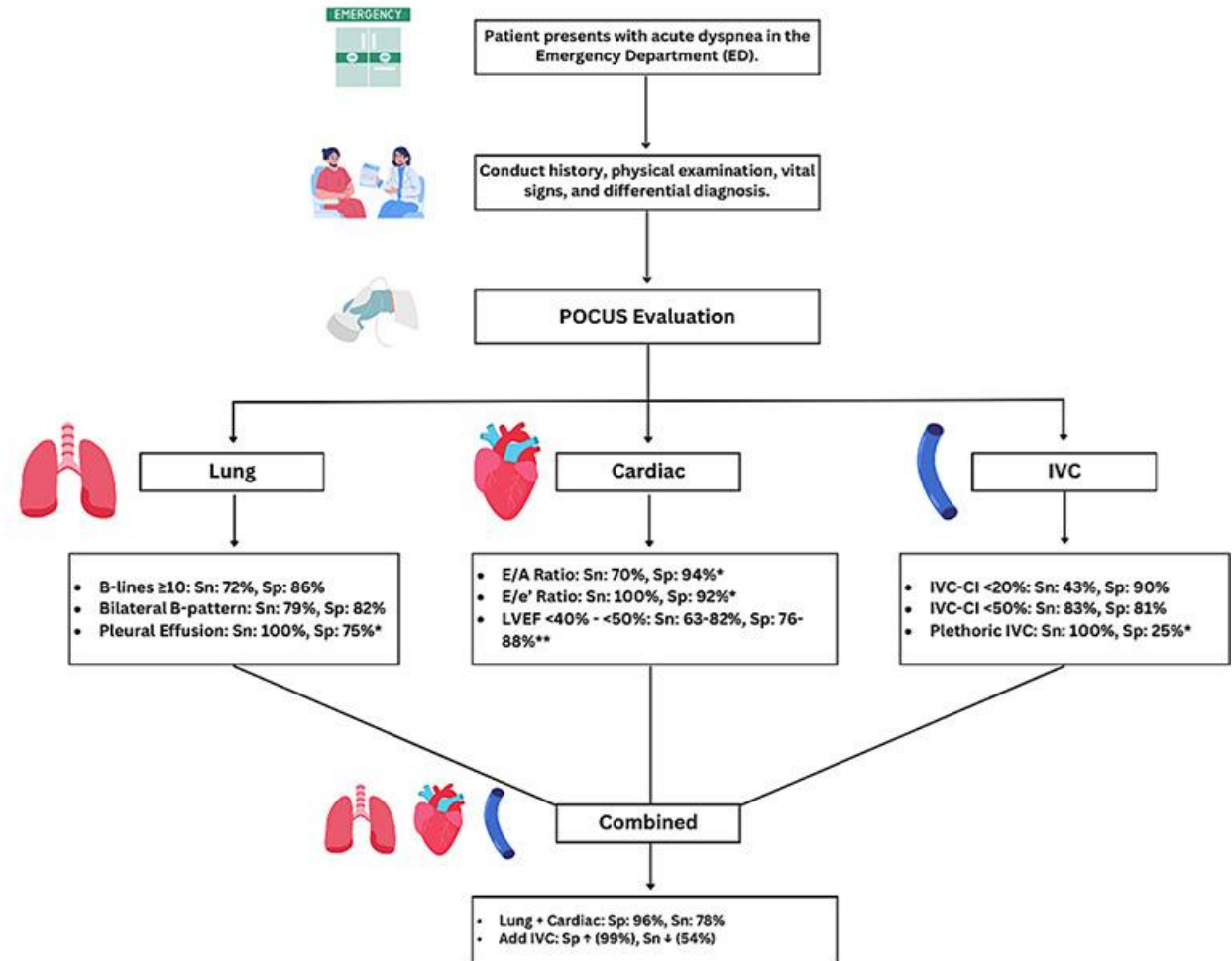
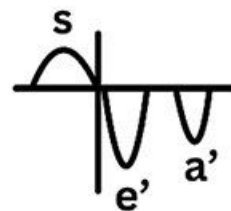
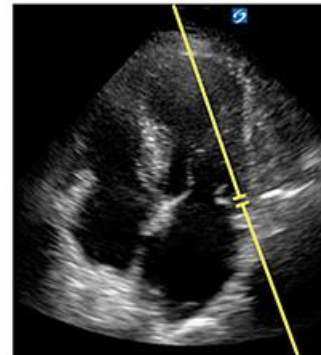
2) Dilated IVC with <50% Collapsibility Index



3) Mitral Inflow Velocity (Pulse Wave Doppler)



4) Mitral Annular Velocity (Tissue Doppler)



Systemic Congestion

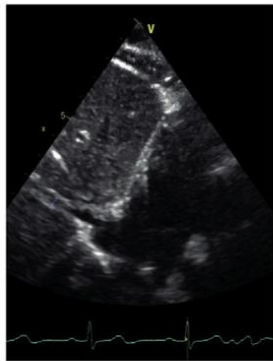
Looking Beyond Leg Edema

Normal right atrial pressure

Normal IVC diameter with normal (>50%) respiratory variations:



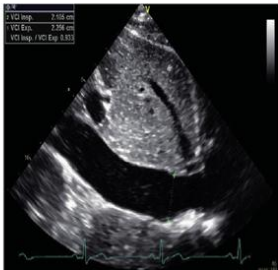
IVC = 1.1 cm in expiration



IVC < 0.5 cm in inspiration

Elevated right atrial pressure

Dilated IVC with reduced (<50%) respiratory variations:



IVC = 2.3 cm in expiration

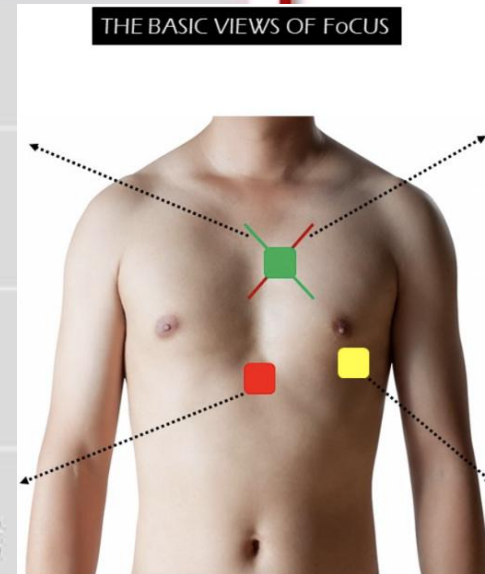


IVC = 2.0 cm in inspiration

	IVC Size	% Collapse	RA Pressure
Low	< 2.1 cm Normal	> 50% Normal	3 mmHg
Intermediate	< 2.1 cm Normal	< 50% Abnormal	8 mmHg
	> 2.1 cm Abnormal	> 50% Normal	8 mmHg
High	> 2.1 cm Abnormal	< 50% Abnormal	15 mmHg

RAP given after evaluation of IVC & collapsibility
IVC not visualized, RAP assumed 'Intermediate, 8mmHg'
Newest recommended guidelines from ASE

CARDIOSERV
INSPIRING EXCELLENCE IN IMAGING



Why RAP matters

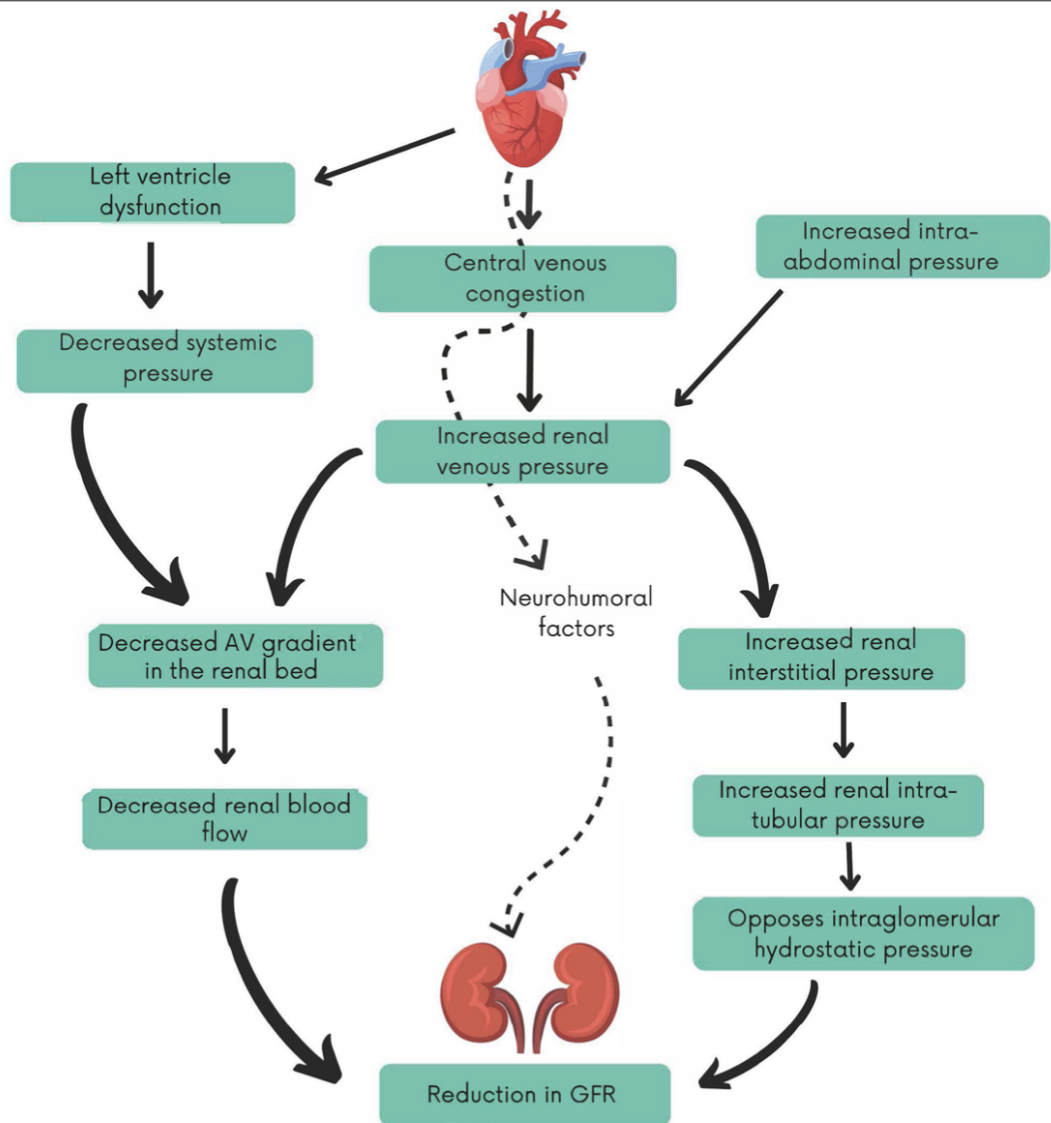


FIGURE 1 Ultrasound Patterns Across the Spectrum of RAP

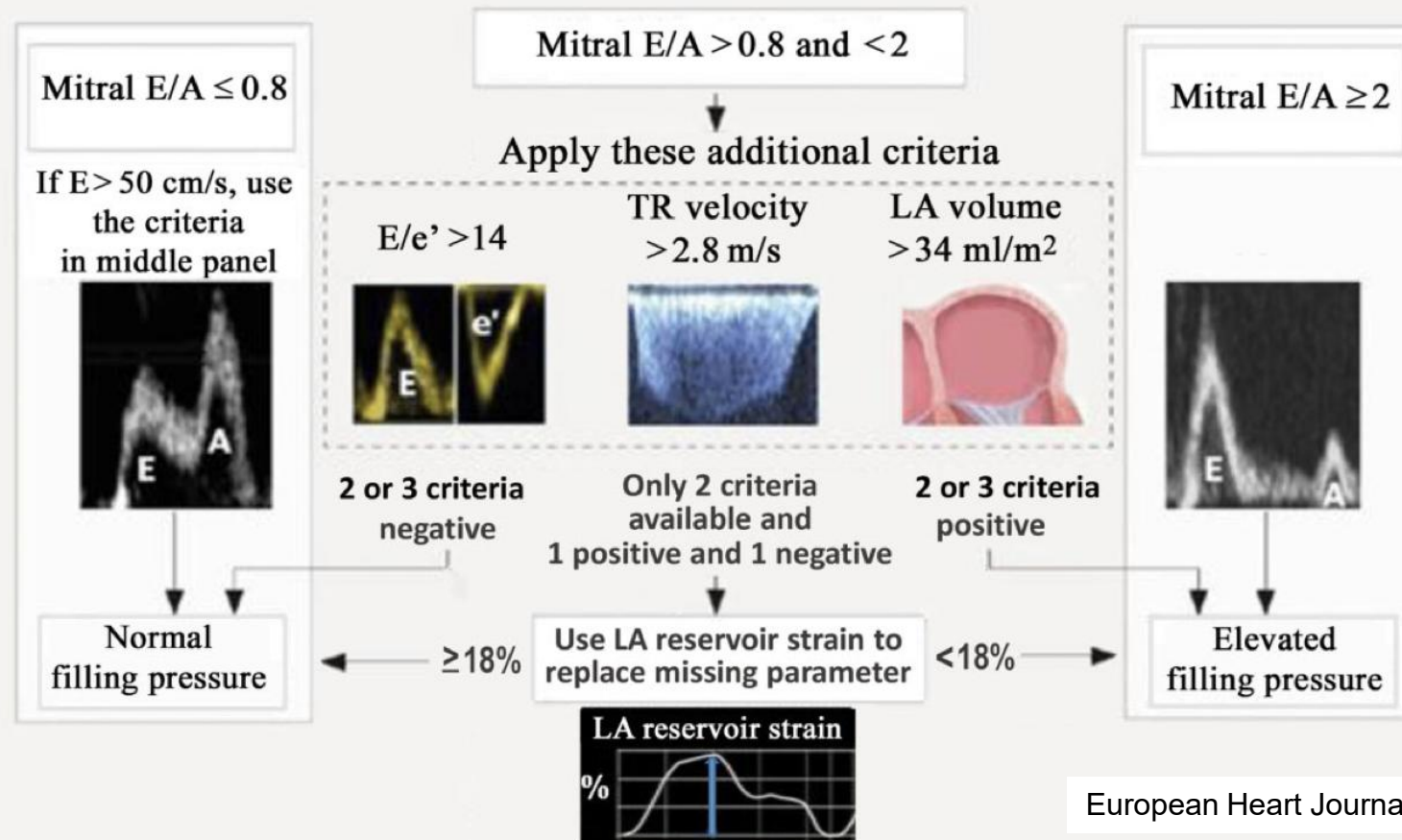
	Normal RAP	High RAP
Kidney		
Renal parenchymal vein	Continuous	Pulsatile, Biphasic, Monophasic
Renal artery	RI < 0.7	RI ≥ 0.80
Liver		
Hepatic vein	S/D ≥ 1	S/D < 1
Portal vein	Continuous	Pulsatile, To and fro
Inferior Vena Cava		
Diameter	≤ 21 mm	> 21 mm
Inspiration collapse	≥ 50%	< 50%, no respiratory change
Right Atrium		
RA volume index	< 35 ml/m ²	≥ 35 ml/m ²
Tricuspid inflow	E/A ratio	E/A ratio
Tissue Doppler imaging of tricuspid annular motion	E/e' ≤ 6	E/e' > 6

Hemodynamic Congestion

www.ihfcard.com

Congestion starts with pressure, not with symptoms.

Estimation of left ventricular pressure



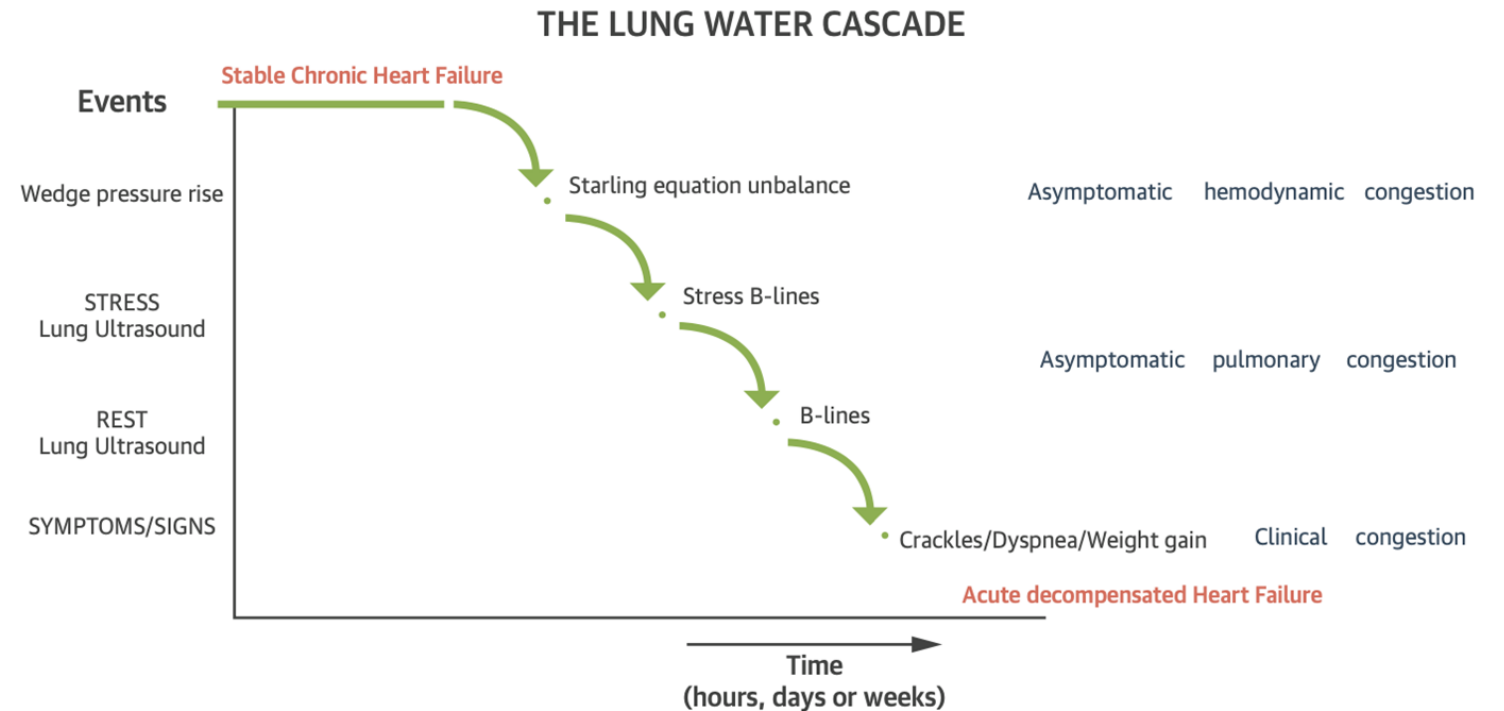
Caveat – Algorithm not to be applied in any of the following conditions:
No suspicion of heart disease; Atrial fibrillation; LBBB/CRT/RV pacing; HCM;
Severe MR/MS/MAC; MV prosthesis or repair; High output HF; LV assist device

European Heart Journal - Cardiovascular Imaging (2022) 23, e3

LUNG ULTRASOUND

The lung never lies.

FIGURE 4 The Lung Water Cascade



Hemodynamic congestion is the early event before the imaging sign (multiple B-lines) of pulmonary congestion. Stress B-lines are an earlier event than resting B-lines. Only after hours, days, or weeks is the clinical congestion apparent. The therapeutic countermeasures are likely more effective when initiated at the early, pre-symptomatic and pre-radiologic, silent stages of the cascade.



What are B-lines?

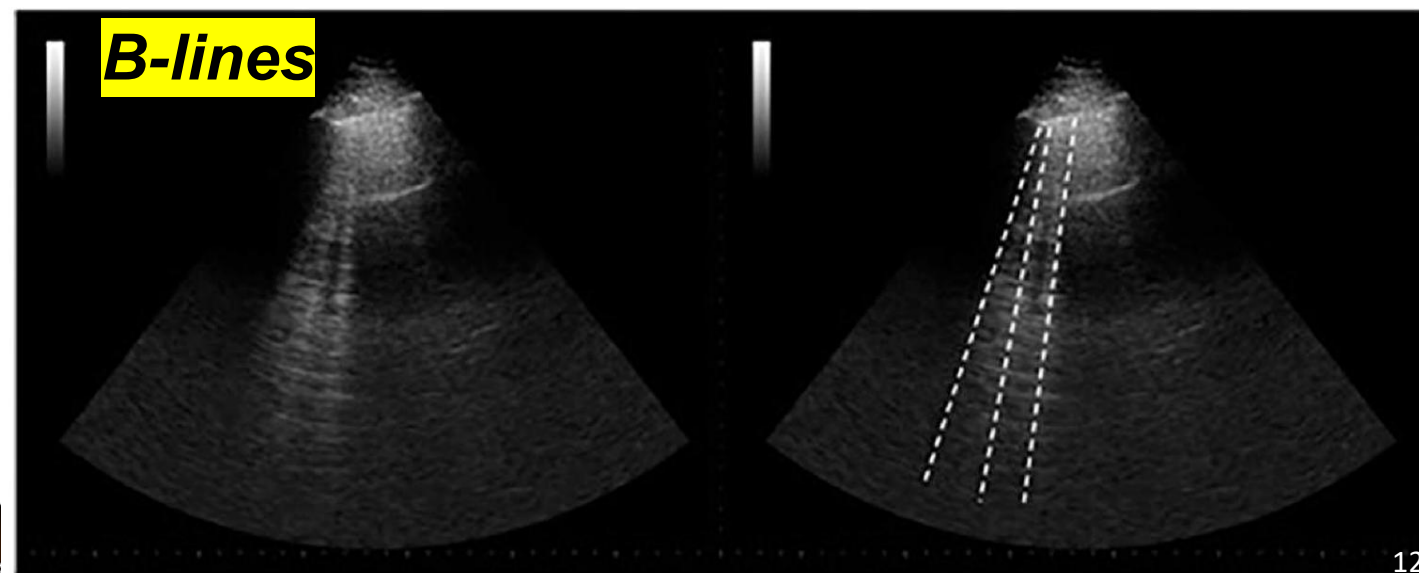
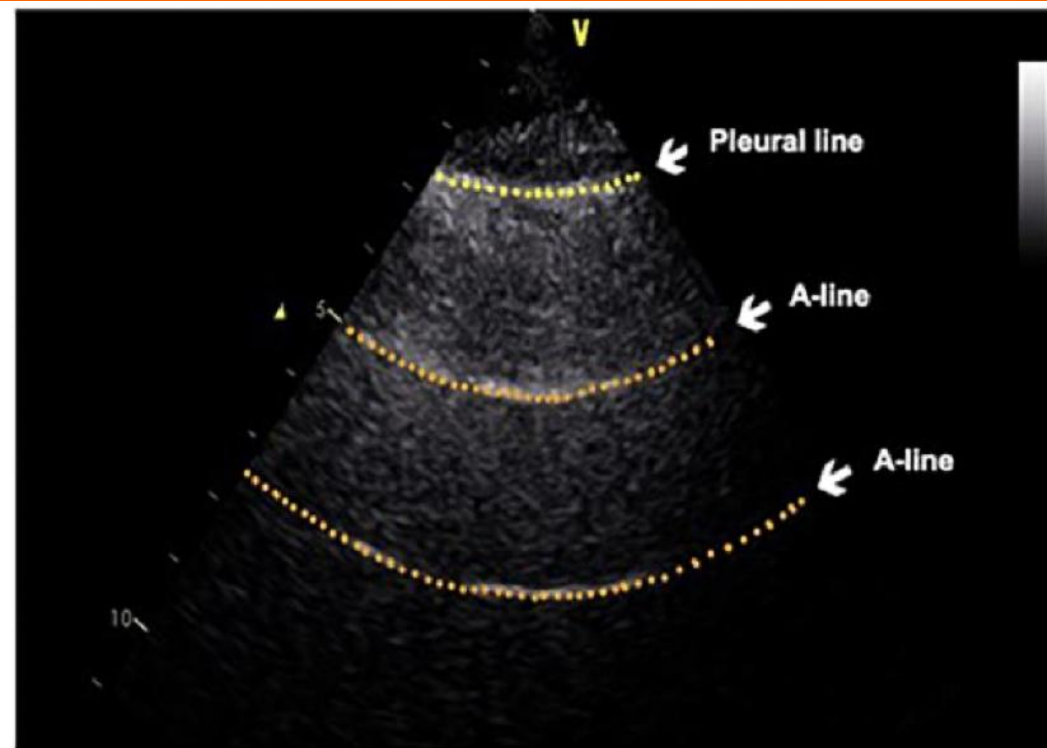
B-lines are:

- Vertical hyperechoic artifacts
- Arise from the pleural line
- Reach the bottom of the screen
- Move with lung sliding

They represent:

- Increased extravascular lung water
- Pulmonary congestion
- Interstitial edema

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CA

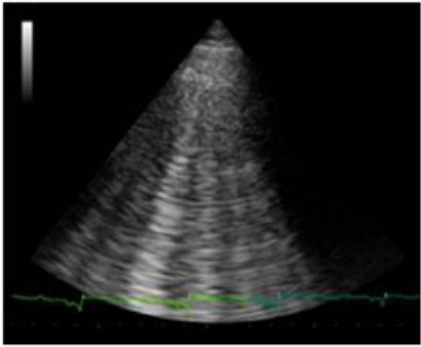
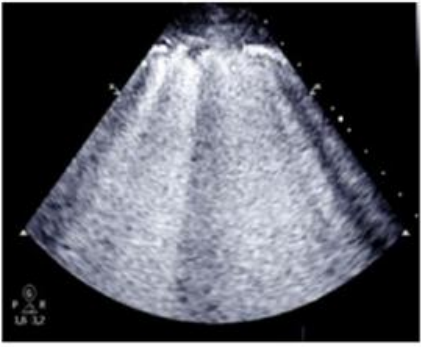
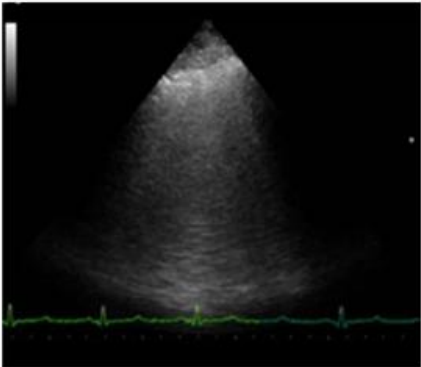
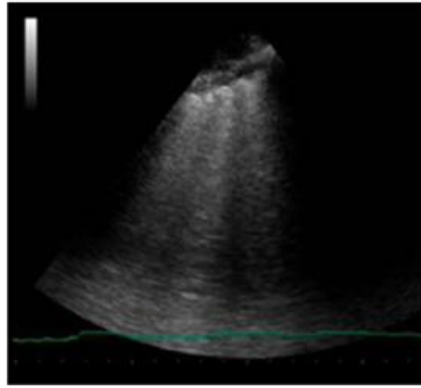


Not all B-lines mean Heart Failure

www.theheartd.com

B-lines tell us there is water in the lung. They do not tell us why.

Table 1 Different LUS features in different conditions where multiple B-lines are present

	Cardiogenic pulmonary oedema	ALI/ARDS	Interstitial pneumonia	Interstitial pulmonary fibrosis
				
B-lines distribution	• Homogeneous, gravity-related • No spared areas	• Patchy, non-gravity-related • Spared areas +++ • Grossly irregular and 'fragmented'	• Patchy, non-gravity-related • Spared areas ++ • Irregular and 'fragmented'	• Usually more numerous at lung bases • No spared areas
Pleural line appearance	• Usually thin and regular			
Consolidations	• Usually not present unless compressive atelectasis in large pleural effusions	• Frequent peripheral small consolidations and larger consolidations	• Usually not present	• Rarely present unless in acute phases (i.e. alveolitis), and small
Pleural effusion	• Frequent, variable size • Transudate, not complex appearance • Usually bilateral (often larger on the right side)	• Usually trivial/mild	• Usually trivial	• Rare, unless in very advanced cases or acute phases, and usually trivial/mild

ALI, acute lung injury; ARDS, acute respiratory distress syndrome.

***Heart failure usually wets the lungs evenly.
ARDS and pneumonia wet the lungs unevenly.***

Table 3 LUS in acute and chronic heart failure

	Aim	LUS picture	Advantages
Acute heart failure			
Diagnosis	Rule in and rule out acute left-sided HF in patients with dyspnoea.	Multiple, diffuse, bilateral B-lines rule in AHF. Absence of multiple, diffuse, bilateral B-lines rules out AHF.	LUS improves diagnostic accuracy compared with standard strategy (chest X-ray + NT-proBNP). LUS reduces time to correct diagnosis. LUS detects subclinical pulmonary congestion in patients with HF who have mild or absent signs and symptoms.
Monitoring	Monitor decongestion during AHF hospitalization.	Reduction of the number of B-lines. Reduction of the size of pleural effusion, if any.	Bedside monitoring to support decision-making in diuretic therapy and fluid management. A significant reduction of B-lines during hospitalization is associated with a lower risk of rehospitalization for AHF and death at 6 months.
Prognosis	Determine the timing of discharge. Detect persistent subclinical congestion at discharge to identify patients at higher risk of rehospitalization for AHF or death.	Persistent B-lines at discharge, even with resolved signs and symptoms of HF.	A high number of B-lines at discharge predict rehospitalization for AHF and death at 3 months.



Figure 6 Different LUS scanning protocols, ranging from 4 to 28 zones; the imaging protocol should be performed on both hemithoraces (in the 28-zone protocol, the left hemithorax does not include the fifth intercostal space).

8-Zone Protocol

4 zones per lung

This is probably the most practical protocol.

Advantages:

- ☐ Easy
- ☐ Fast
- ☐ Well validated in heart failure
- ☐ Commonly used in studies

28-Zone Protocol

Many scanning points across both lungs.

Advantages:

- Most sensitive
- Research standard

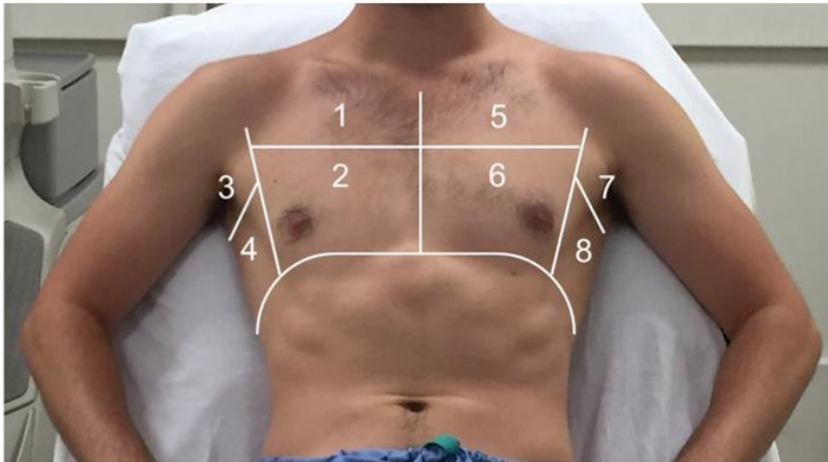
Limitation:

- ❓ Time-consuming
- ❓ Not practical for routine bedside assessment

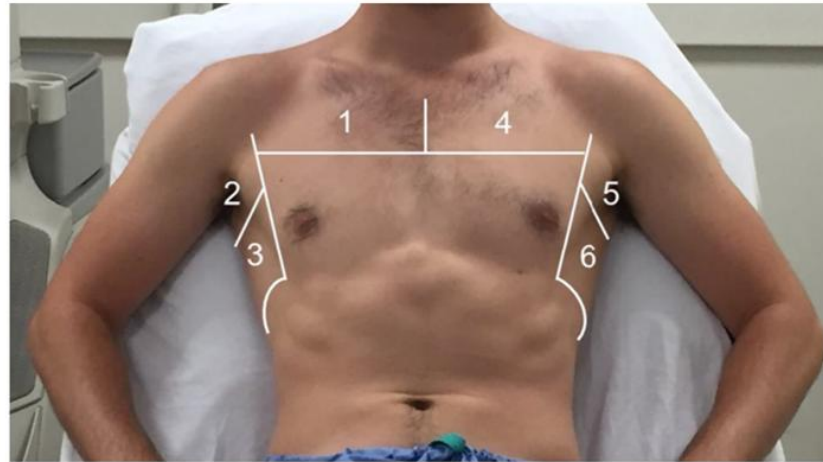
Where to Scan?



A 8 zone method



B 6 zone method



8-Zone Protocol (R & L)

Zone 1 – Right Upper Anterior

- Mid-clavicular line
- 2nd–3rd intercostal space

Zone 2 – Right Lower Anterior

- Mid-clavicular line
- 4th–5th intercostal space

Zone 3 – Right Upper Lateral

- Mid-axillary line
- Above the nipple level

Zone 4 – Right Lower Lateral

- Mid-axillary line
- Below the nipple level

Cardiometabolic Diseases

How many B-lines are too many before discharge?

Table 2 Overview of select pre-discharge imaging protocols and cut-off values in acute HF

Number of zones	B-line cut-off	Ultrasound equipment	HF readmission or death	Reference
4	≥7 B-lines	High-end system; phased-array	90 days: Adj. HR 3.03 (95% CI 1.45 to 6.31)	Platz 2019 ²⁷
8	≥1 zone with ≥3 B-lines (one positive zone) on each hemithorax	High-end system; phased-array	90 days: Adj. HR 3.30 (95% CI 1.00 to 10.91)	Coiro 2015 ³⁵
28	>15 B-lines	High-end system; phased-array	180 days: Adj. HR 11.74 (95% CI 1.30 to 106.16)	Gargani 2015 ³⁶

Adj., adjusted; CI, confidence interval; HF, heart failure; HR, hazard ratio.

European Heart Journal - Cardiovascular Imaging (2023) **24**, 1569–1582

More B-lines at discharge = Worse outcome

Normal Lung

A-lines dominate

0–2 B-lines

☐ No pulmonary congestion

Mild Congestion

3–5 B-lines

☐ Early pulmonary congestion

Moderate–Severe Congestion

5 B-lines or confluent B-lines ("white lung")

☐ Significant pulmonary congestion

Why Combine Echo and Lung Ultrasound?

Indonesian Symposium on Heart Failure and Cardiometabolic Disease

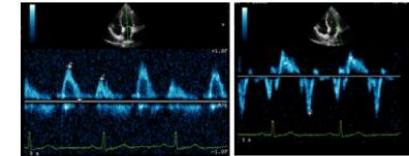
Pressure rises first, B-lines appear next, symptoms appear last.

Table 4 How to integrate echocardiographic and pulmonary findings to assess congestion status

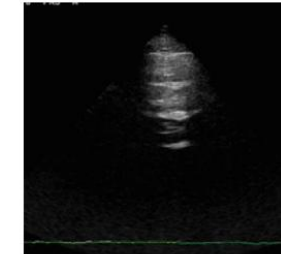
E/e' and other echocardiographic signs of increased left ventricular filling pressures

B-lines

Normal

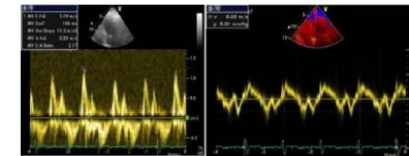


No B-lines

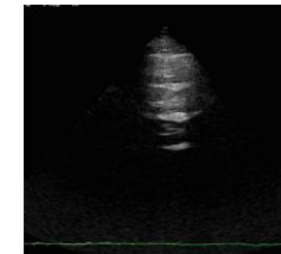


No congestion

Increased

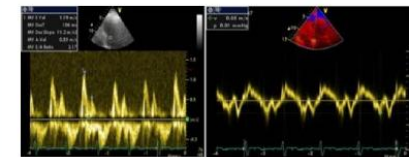


No B-lines

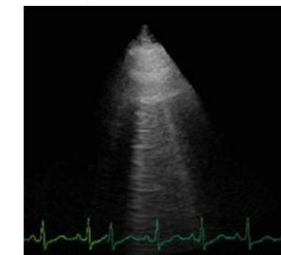


Haemodynamic congestion

Increased

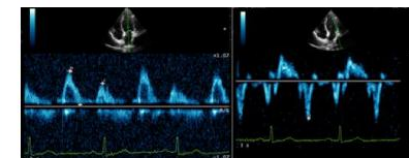


Multiple diffuse bilateral B-lines

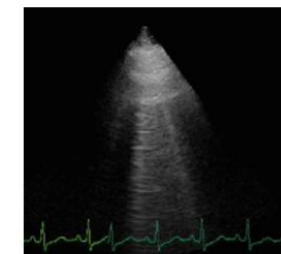


Haemodynamic and pulmonary congestion

Normal



Multiple diffuse bilateral B-lines



Pulmonary congestion without haemodynamic congestion (check for ALI/ARDS or other causes of B-lines)

So, can we go home today?

65-year-old man with ADHF

Day 4

- Dyspnea improved
- Edema improved
- Weight ↓ 3 kg

POCUS:

- IVC 2.5 cm
- E/e' 18
- Diffuse B-lines

Indonesian Symposium
on Heart Failure and
Cardiometabolic Disease **Most likely not,**

Keys Takeaway

- Congestion starts before symptoms.
- Congestion is elevated filling pressure.
- Assess both systemic and pulmonary congestion.
- Symptoms improve before congestion resolves.
- Aim for complete decongestion, not symptom relief alone.

The goal is not a lighter patient. The goal is a less congested patient.

THANK YOU

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