FUSIC Heart ➤ FUSIC HD

A Structured Critical Care Ultrasound Training Pathway
Stepwise Accreditation

@NixLimerick

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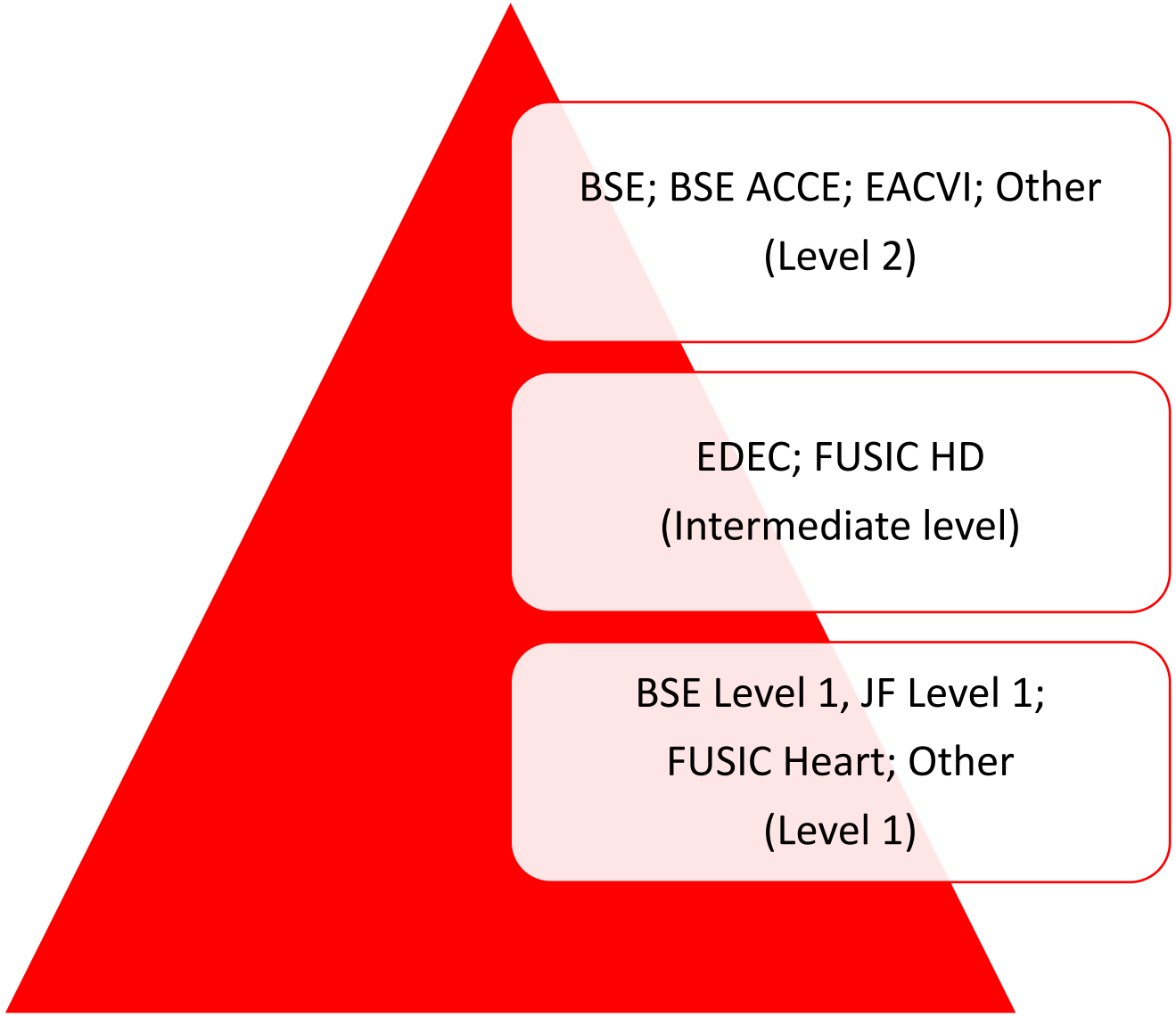
Overview

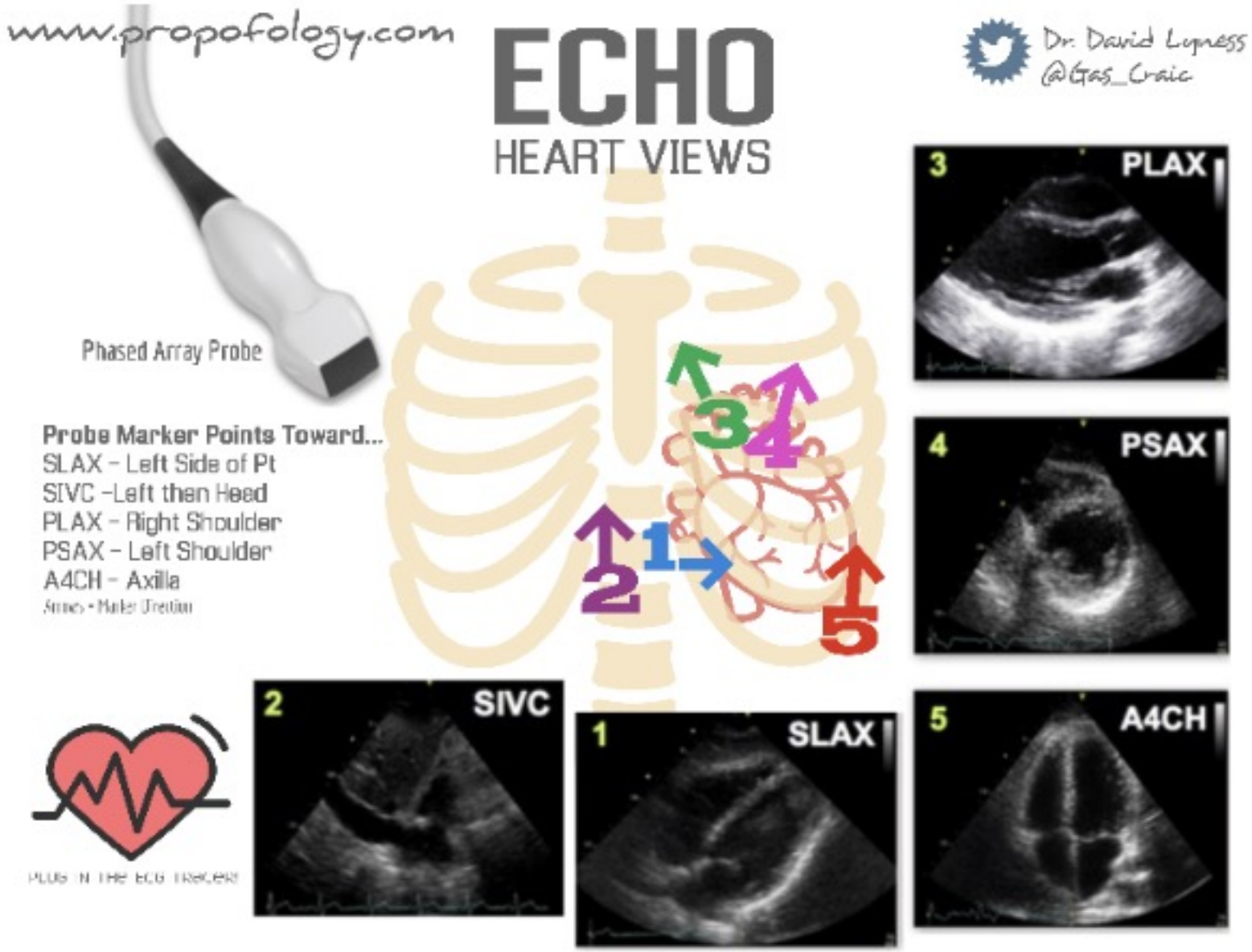
- Echo Accreditation for intensive care
- FUSIC Heart Image Set & workload
- The 5 FUSIC Heart questions
- The 10 FUSIC HD questions
- The FUSIC HD image set & workload
- Other accreditations in the FUSIC HD space and beyond
- The critical care echo educator
- Questions


BSE; BSE ACCE; EACVI; Other
(Level 2)
EDEC; FUSIC HD
(Intermediate level)
BSE Level 1, JF Level 1;
FUSIC Heart; Other
(Level 1)

FUSIC Heart

- Register with ICS – videos or course
- Find a mentor and supervisor (remote options available but on-site training in a centre with mentors and supervisor(s) preferable)
- First 10 scans supervised by mentor in person
- 50 cases with 4 scans – reviewed by mentor with overview of process by supervisor over 12 months
- Triggered assessment by supervisor (+/- mentor); Supervisor must have BSE L2 in TTE or equivalent or be an Intensivist with EDEC or Cardiologist with regular echo sessions
- Submit paperwork to ICS
- After 1 year of holding the accreditation can become a FUSIC Heart mentor

FUSIC Heart Image set

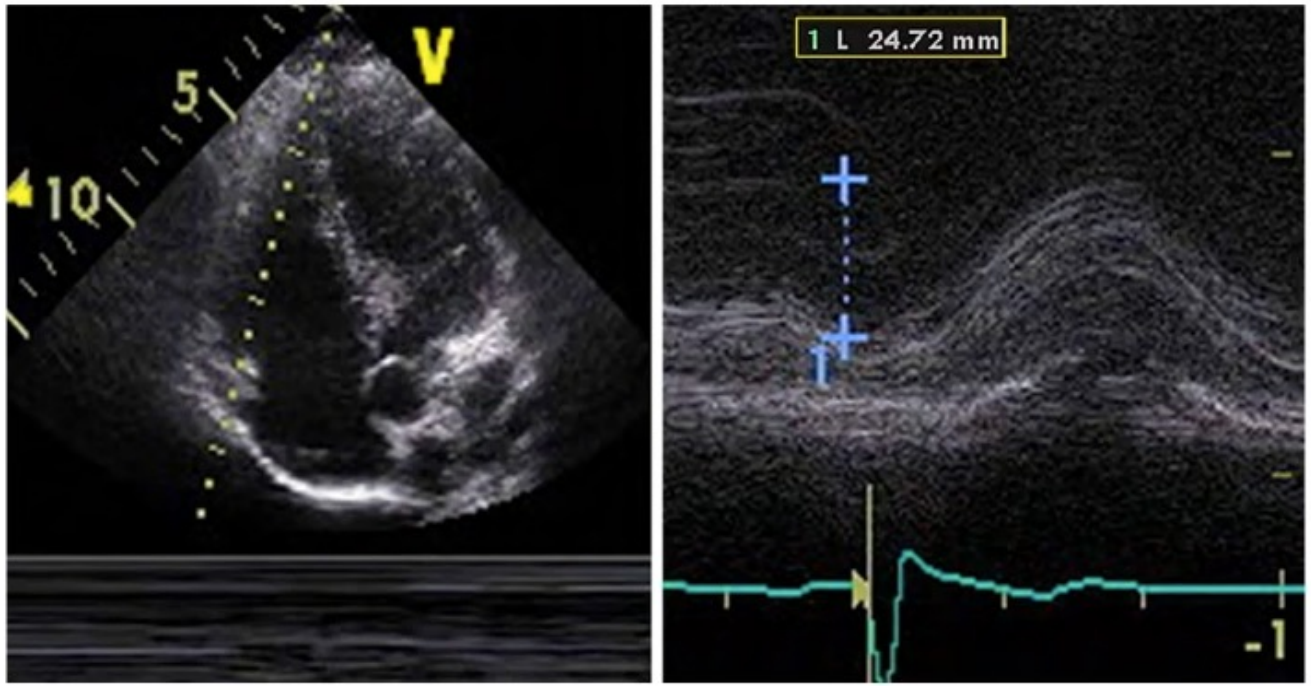


The FUSIC Heart curriculum includes 4 measurements
(TAPSE; LVIDd (LVEDD); MAPSE; IVC)

TAPSE (Tricuspid Annular Plane Systolic Excursion measurement)

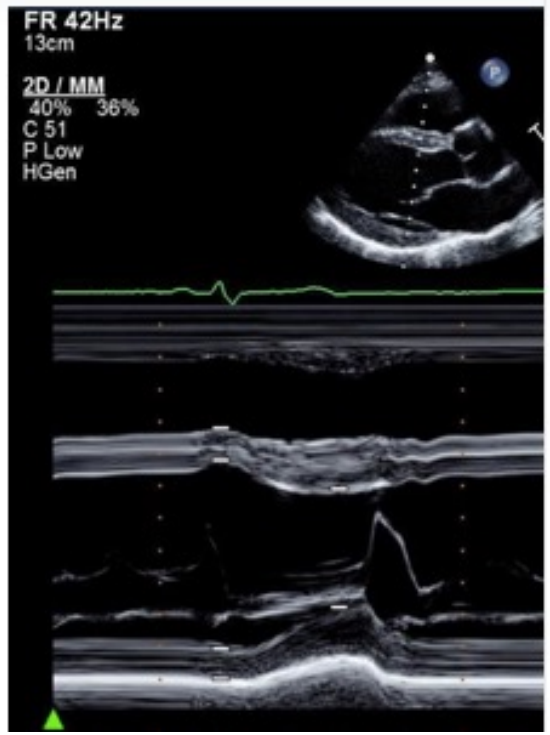
- M Mode through lateral annulus

RV function	
Fractional area change (%)	>35
TAPSE	>16



Screenshot from @cardiacACCP
FUSIC Heart Video
RV Assessment: TAPSE

The **Left Ventricular Internal Diastolic Diameter (LVIDd) measurement** can be done as a 2D measurement with the calipers. It is done at the end of diastole; the mitral valve (MV) has just closed - the LV is full.

PLAX (MM)	**LVIDd/s, IVSd, LVPWd (either/or 2D measurement)**	**Left ventricle, just distal to MV leaflet tips**	

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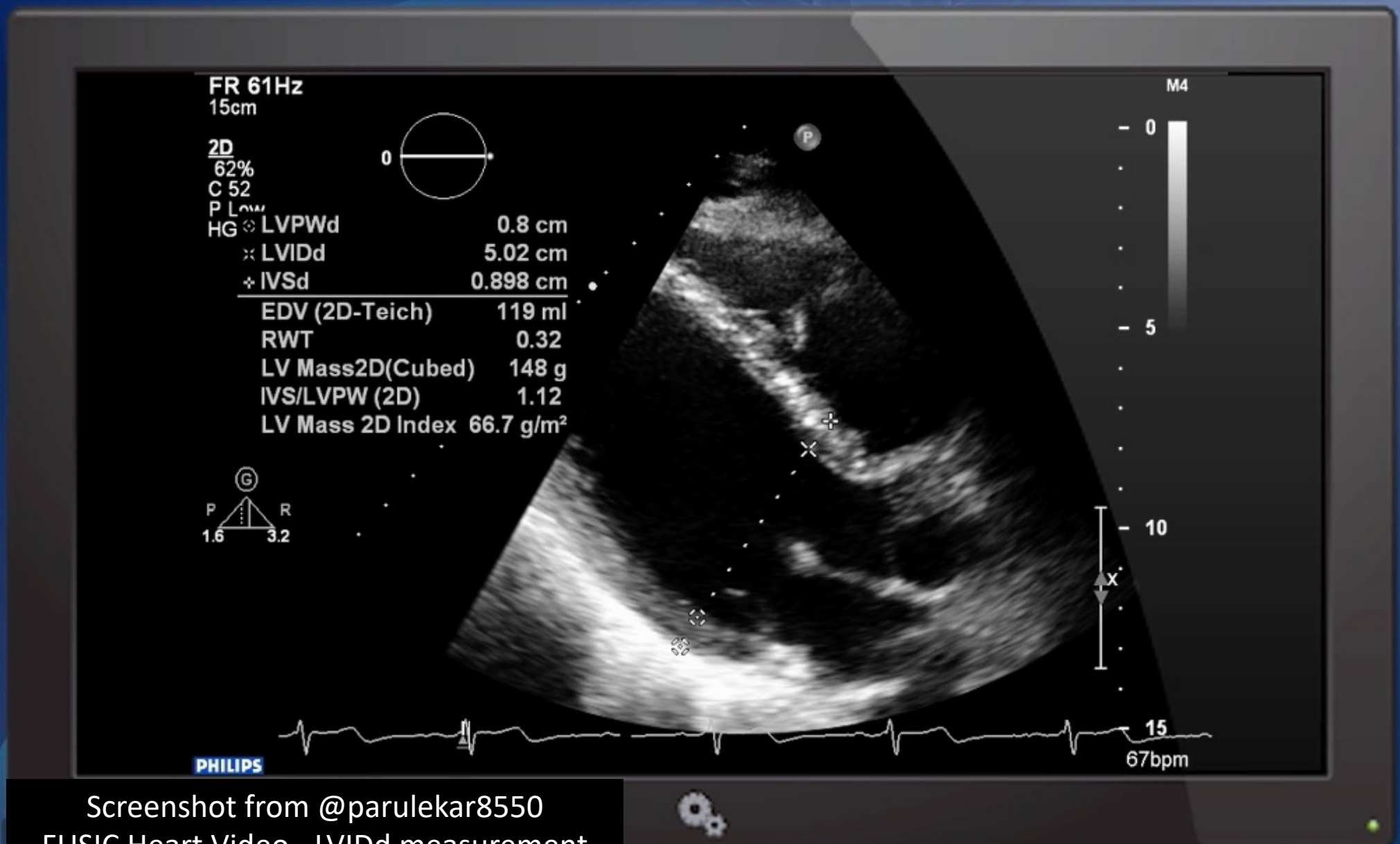
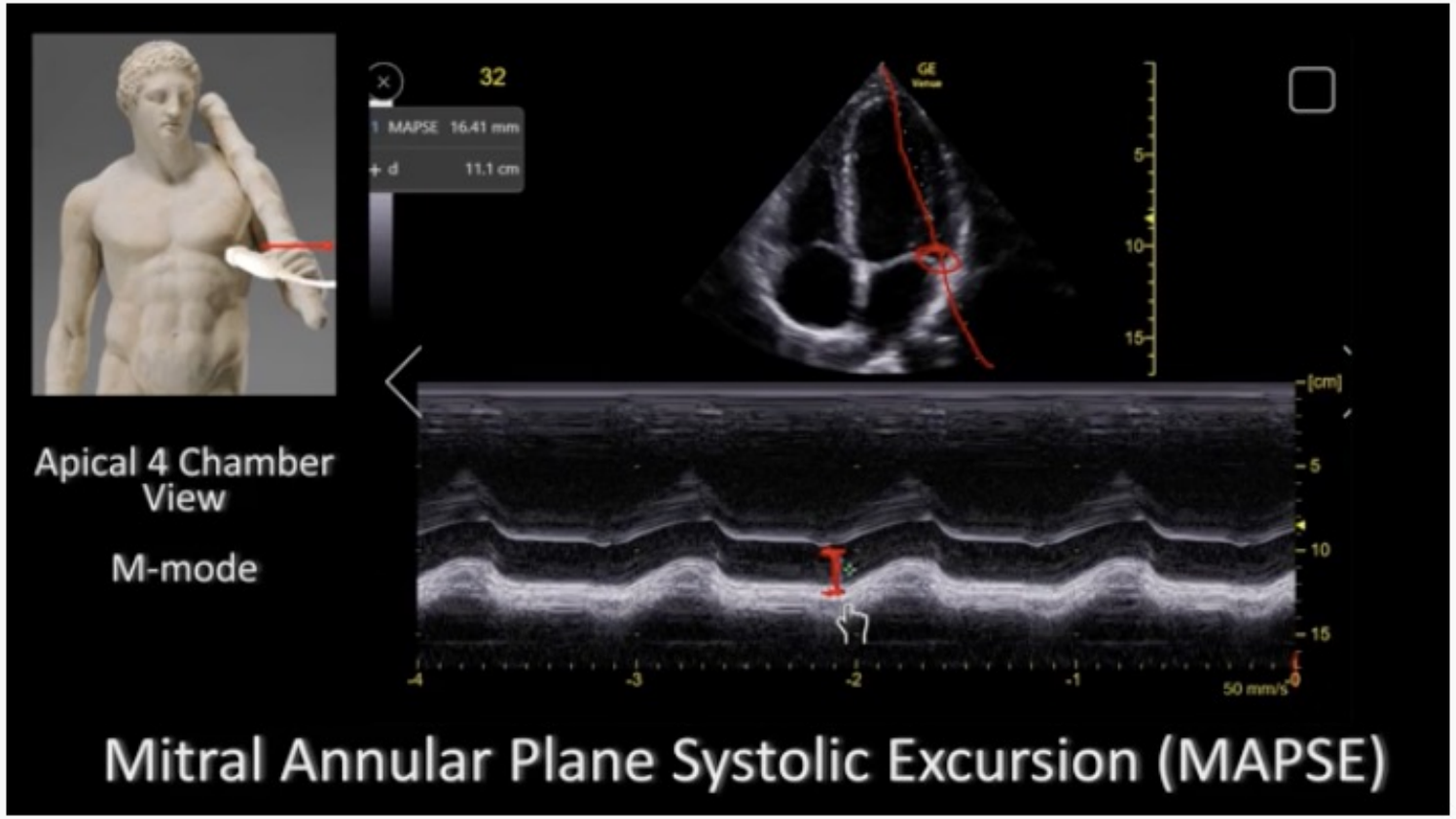


Screenshot from @parulekar8550
FUSIC Heart Video - LVIDd measurement

LV diameter PLAX view

LVIDd
Normal ref range:
3.7 - 5.6 cm Males
3.5 - 5.1 cm Females



Measure MAPSE. Perioperative & Critical Care ECHO / POCUS

3,035 views • Mar 4, 2020

45 0 SHARE SAVE ...

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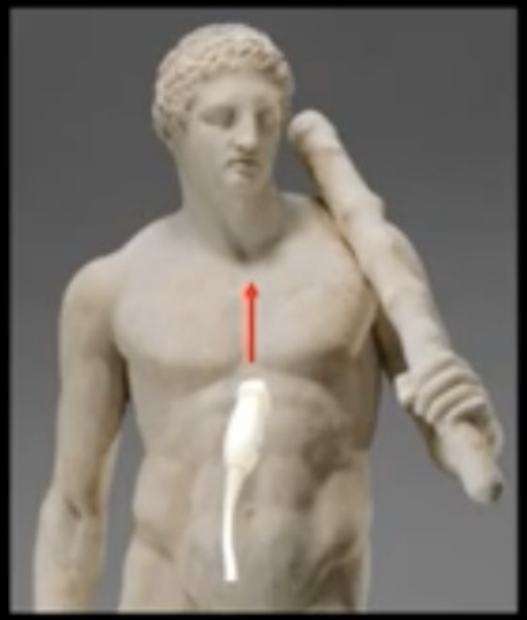
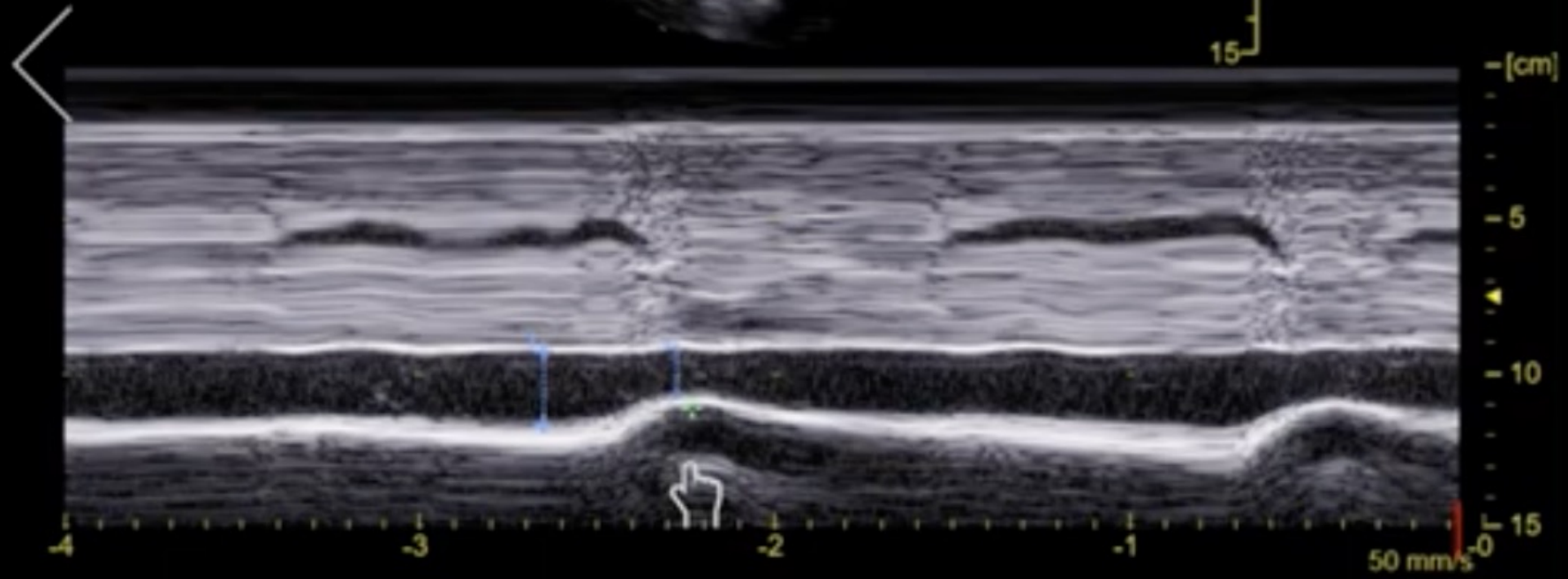
Learn how to measure the MAPSE (aka Mitral Annular Plane Systolic Excursion) from the A4C view using M-mode!





Inferior Vena Cava – Subcostal View

The 5 questions FUSIC Heart can answer:

- Is the left ventricle dilated and/or significantly impaired?
- Is the right ventricle dilated and/or significantly impaired?
- Are there features of low venous return?
- Is there a pericardial effusion?
- Is there a pleural effusion?

Cases expected to be included in the logbook From 2019 Domain Specific Knowledge part of FUSIC Heart curriculum

Recognition of pathology including:

- LV dilatation - LVEDD >6cm
- RV dilatation - RV >2/3 the basal width of the LV
- Ventricular dysfunction - reduction in wall thickening and motion, TAPSE, MAPSE
- Regional wall motion abnormalities - regional reduction in wall motion and thickening
- Fluid overload - RV dilatation, D shaped septum, paradoxical septal motion
- Pulmonary hypertension - RV dilatation, D shaped septum, paradoxical septal motion
- Features of low venous return (vasodilatation, hypovolaemia) - small, collapsing IVC, small, hyperdynamic LV and RV, papillary apposition in systole
- Pericardial collection - distinguish from pleural collection
- Pleural collection - distinguish from pericardial collection

Average time to completion

- Cardiology trainee 3-6 months
- ICU trainee 6-12 months

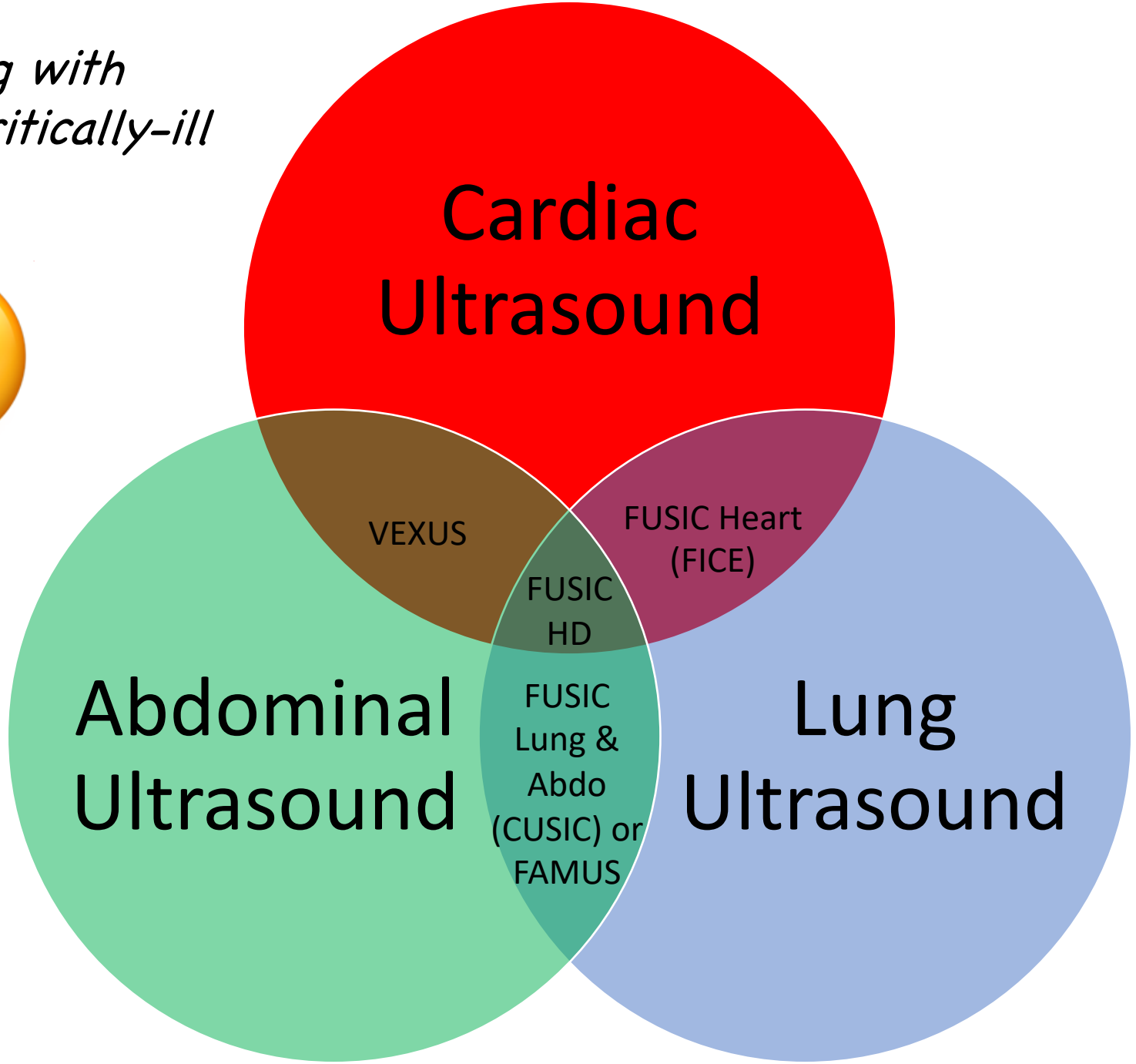
- Unless doing ICU on-call, unlikely to integrate into clinical practice
- Ideal for SAT 3-4 doing ICU module before 3rd on-call

Workload for FUSIC Heart Mentor …caveats

- 200 + scans to review per mentee; blocks of 5 cases max initially
- 5-7 group sessions to get started (specific teaching sessions with 1-2 learners per trainer
- Admin time
- Time to run a local FUSIC Heart course
- Time to keep up one's own skills (CME)

- Only 25 - 30% of ICU trainees (approx) see process to completion in UK
- Most underestimate self-directed work involved

"What is wrong with this shocked critically-ill patient?"



FUSIC Heart ➤ FUSIC HD (Haemodynamic)

FUSIC heart questions	Additional FUSIC HD questions
Is the left ventricle dilated and/or significantly impaired?	Is stroke volume abnormal?
Is the right ventricle dilated and/or significantly impaired?	Is stroke volume responsive to fluid, vasopressors or inotropes?
Are there features of low venous return?	Is the aorta abnormal?
Is there a pericardial effusion?	Is the aortic valve, mitral valve or tricuspid valve severely abnormal?
Is there a pleural effusion?	Is there systolic anterior motion of the mitral valve?
	Is there a regional wall motion abnormality?
	Are there features of raised left atrial pressure?
	Are there features of right ventricular impairment or raised pulmonary artery pressure?
	Are there features of tamponade?
	Is there venous congestion?

Pathologies detected by FUSIC HD	
Left ventricular disease	Left ventricular hypertrophy Dilatation Regional wall motion abnormalities Impaired systolic function (acute vs chronic) Raised left atrial pressure Left Ventricular Outflow Tract obstruction
Right ventricular disease	Right ventricular hypertrophy Dilatation Impaired systolic function (acute vs chronic) Raised pulmonary arterial pressure
Mitral valve disease	Significant thickening, calcification, restriction Significant prolapse Significant regurgitation Systolic anterior motion
Aortic valve disease	Significant thickening, calcification, restriction Significant regurgitation
Tricuspid valve disease	Significant thickening, calcification, restriction Significant regurgitation
Aortic disease	Root dilatation Thoracic dissection Abdominal aneurysm
Atrial disease	Dilatation
Pericardial disease	Cardiac tamponade
Volume overload	Raised intracardiac pressures Functional tricuspid regurgitation Enlarged inferior vena cava Pleural effusions Pericardial effusions Venous congestion
Reduced venous return	Hyperdynamic heart Fluid responsive volume-time integral/stroke volume Vasopressor responsive volume-time integral/stroke volume
Abnormal flow	Stroke volume Cardiac output
Venous congestion	Enlarged inferior vena cava Abnormal venous flows • Portal vein • Hepatic vein • Renal vein and artery

FUSIC heart views	Additional views for FUSIC HD
Parasternal long axis	Right ventricular inflow
Parasternal short axis	Right ventricular outflow
	Apical two-chamber
Apical 4 chamber	Apical three-chamber
Subcostal long axis	Subcostal short-axis
	Aortic views – Suprasternal, modified PLAX, modified SAX, modified A2C, abdominal aorta
	Hepatic
	Renal

Q7. Are there features of raised left atrial pressure

Being able to identify raised left atrial (LA) pressure is of key importance in critically ill patients. Ultrasound can help clinicians distinguish between cardiac and non-cardiac pulmonary oedema, avoid injudicious IV fluid administration, monitor the response to fluid administration or removal, and predict weaning failure.[15] However, rather than quantifying LA pressure, FUSIC HD aims to identify the likelihood of it being high, low or indeterminate in keeping with ASE guidance.[16] Our simplified algorithm is shown in Figure 1. It does not aim to quantify left ventricular diastolic function, which is more complex and esoteric.

The presence of B lines on lung ultrasound and bowing of the inter-atrial septum into the right atrium throughout the cardiac cycle make raised LA pressure almost certain. More detailed qualitative assessment of LA pressure can be done by measuring early mitral valve (MV) inflow velocity (E and A waves), which classifies the patient into a low, indeterminate or high risk profile. An indeterminate risk profile requires further measurement of LA size with 2D, TR Vmax with pulsed-wave (PW) Doppler, and early LV diastolic lengthening (e') with tissue Doppler imaging (TDI).

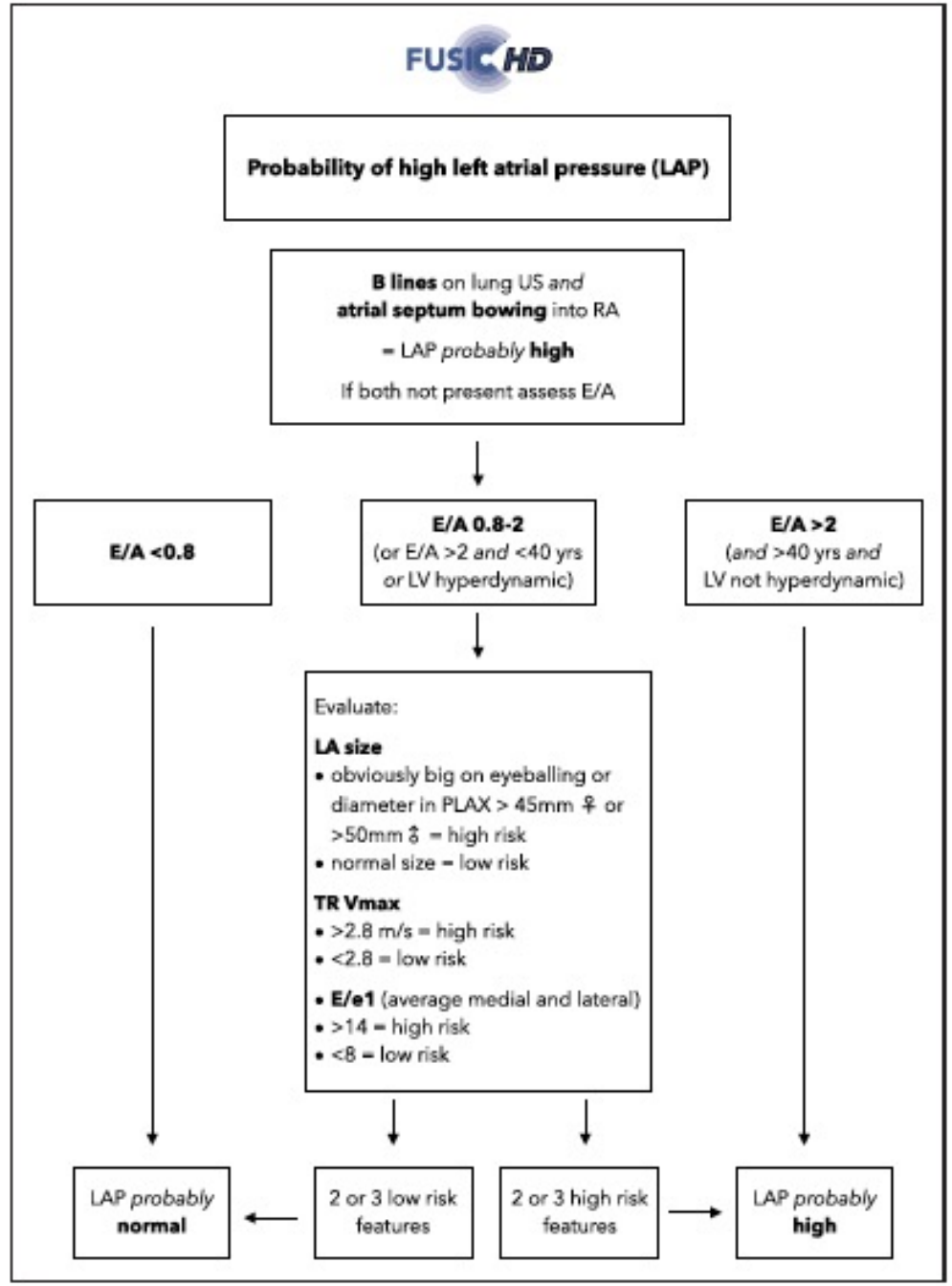


Figure 1. A pragmatic algorithm for estimating LAP, adapted and simplified from ASE guidelines.

FUSIC HD

Probability of high left atrial pressure (LAP)

B lines on lung US *and*
atrial septum bowing into RA

– LAP *probably* **high**

If both not present assess E/A

E/A <0.8

E/A 0.8-2
(or E/A >2 *and* <40 yrs
or LV hyperdynamic)

E/A >2
(*and* >40 yrs *and*
LV not hyperdynamic)

Evaluate:

LA size
- obviously big on eyeballing or diameter in PLAX > 45mm ♀ or >50mm ♂ = high risk
- normal size = low risk

TR Vmax
- >2.8 m/s = high risk
- <2.8 = low risk

- **E/e1** (average medial and lateral)
- >14 = high risk
- <8 = low risk

Evaluate:

LA size
- obviously big on eyeballing or diameter in PLAX > 45mm ♀ or >50mm ♂ = high risk
- normal size = low risk

TR Vmax
- >2.8 m/s = high risk
- <2.8 = low risk

- **E/e1** (average medial and lateral)
- >14 = high risk
- <8 = low risk

LAP *probably* **normal**

2 or 3 low risk features

2 or 3 high risk features

LAP *probably* **high**

PSAX apex	Inspect for twisting motion Inspect for RWMAs Inspect for pericardial effusion
A4C	Inspect all four chambers for size Inspect for pericardial effusion Inspect LV for systolic function Inspect for RWMAs Inspect RV for systolic function Measure RV/LV basal ratio Measure LA area end systole Measure TAPSE and MAPSE using M-mode Inspect MV and TV for general appearance (thickness, calcification, mobility) Inspect MV and TV for regurgitation using colour Doppler Measure TR Vmax (if present) using CW Doppler Measure E and A velocities using PW Doppler Measure e^1 using TDI at both the septal and lateral MV annuli (then average resul Calculate E/A and E/e^1 Measure LV S^1 using TDI at the lateral MV annulus Measure RV S^1 using TDI at the lateral TV annulus

FUSIC HD recognizes venous congestion

Q10. Is there venous congestion?

High venous pressures reduce organ blood flow, causing organ dysfunction and injury, and have been linked specifically with acute kidney injury[20] and post-operative delirium.[21] Central venous pressure (CVP) measurements of >8mmHg have been shown to be particularly harmful.[22] However, patients do not always have CVP monitoring and the absolute CVP value does not necessarily predict whether venous flow is affected. If CVP is unavailable, or if the effect CVP is having on the venous system is in doubt, then ultrasound should be used.

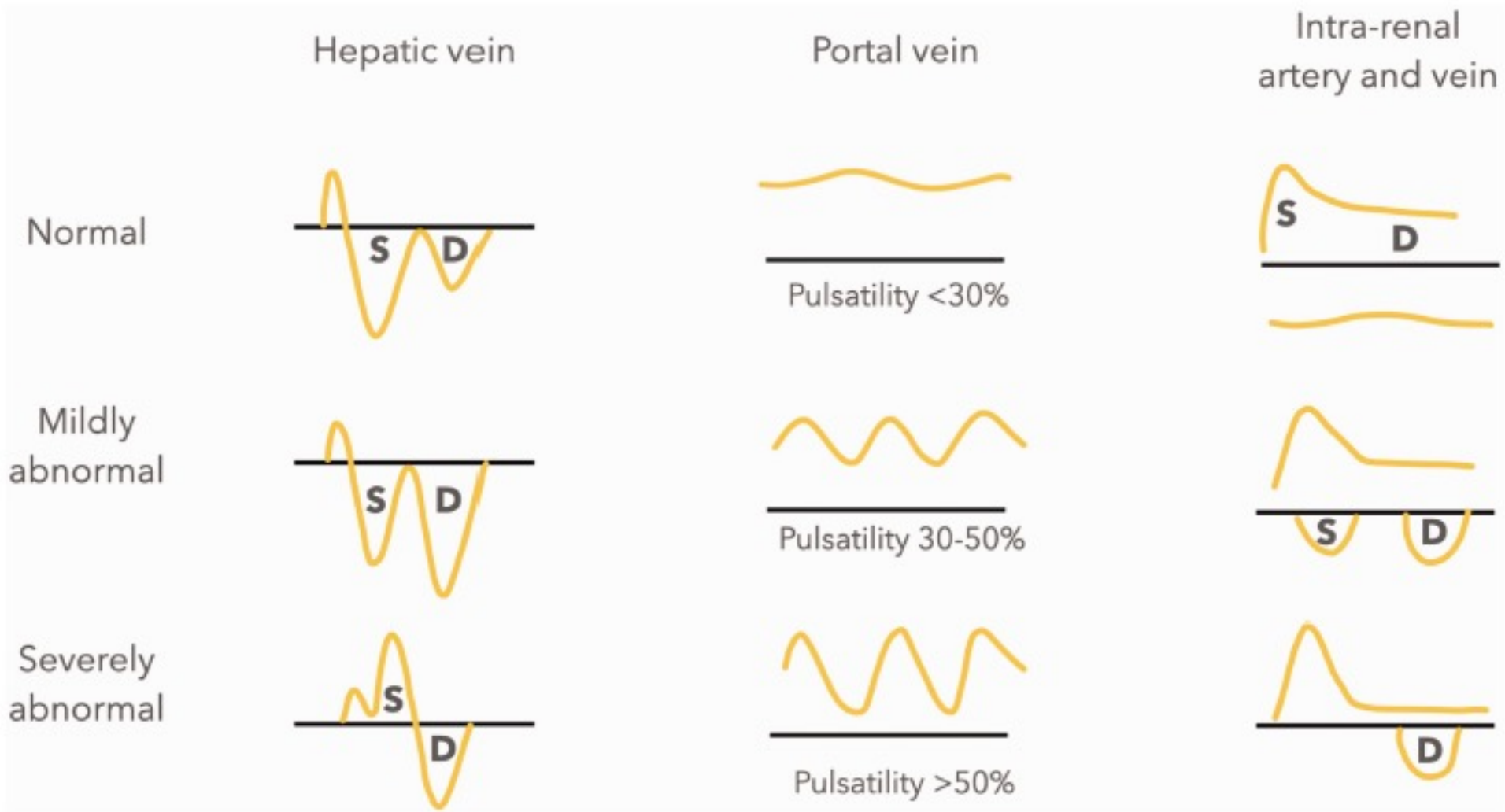
The method adopted for FUSIC HD – the venous excess ultrasound (VExUS) score (see Table 4) – has high specificity for predicting acute kidney injury, outperforming CVP and isolated inferior vena caval (IVC) measurements.[23] High venous pressures first manifest on ultrasound as IVC dilatation, then as flow abnormalities in the great veins when assessed with PW Doppler.[24] The hepatic vein, portal vein and renal veins are key targets for assessment. Figure 2 illustrates normal and abnormal venous Doppler patterns.

Heart disease, lung disease and volume overload are all causes of venous congestion, as high pressure anywhere downstream of the veins will result in high venous pressures. Causes therefore include LV failure, MR, pulmonary disease, RV failure, TR and pericardial effusions – all of which can be detected with ultrasound. Iatrogenic fluid overload is also a common cause in critically ill patients. Indications for venous congestion assessment include assessment of volume status, acute kidney injury, delirium, newly deranged LFTs, guidance of fluid removal, heart failure and a CVP >8 mmHg.

VExUS score	
Grading score	
Grade 0	**IVC <20 mm**
Grade 1	**IVC >20 mm *plus*** no or mild abnormalities in any pattern
Grade 2	**IVC >20 mm *plus*** severe abnormality in 1 pattern
Grade 3	**IVC >20 mm *plus*** severe abnormalities in >1 pattern
Abnormality patterns	
Hepatic vein	Mild – S < D
	Severe – S above baseline
Portal vein	Mild – PI 0.3–0.5
	Severe – PI > 0.5
Interlobar renal vein	Mild – Interrupted S and D phase
	Severe – Interrupted only D phase
Other causes for abnormal venous flow patterns	
Primary organ disease (hepatic, renal)	
Vessel thrombosis or stenosis	
Raised intra abdominal pressure	
Portal Vein PI >0.5 in young age, athletes, low BMI, hyperdynamic states	

IVC = inferior vena cava, S = systolic Doppler wave, D = diastolic Doppler wave, PI = pulsatility index.

IVC	Measure IVC diameter 1-4cm proximal to RA in long and short axis Inspect respiratory variation
Hepatic vein	Inspect flow pattern using colour Doppler Inspect waveform appearance using PW Doppler Measure S/D ratio
Portal vein	(Can be assessed subcostally, RUQ or mid-axillary) Inspect size and general appearance Inspect flow pattern (red, red/blue, blue) using colour Doppler Inspect flow pattern using PW Doppler Measure Pulsatility Index using PW Doppler
Renal	Inspect size and general appearance (e.g. hydronephrosis) Inspect interlobar vessels between medullary pyramids using colour Doppler Inspect arterial and venous flows and waveform appearance at segmental artery/vein using PW Doppler Measure Renal artery Resistive Index Measure Venous Impedance Index
Aorta modified PLAX	Modified PLAX Inspect aortic root Measure ascending aorta diameter (3-4cm from aortic valve)
Aorta suprasternal	Inspect aortic arch and great vessels Inspect flow pattern with colour Doppler


Hepatic vein
Portal vein
Intra-renal artery and vein
Normal
S
D
Pulsatility <30%
S
D
Mildly abnormal
S
D
Pulsatility 30-50%
S
D
Severely abnormal
S
D
Pulsatility >50%
D

FUSIC HD accreditation process	
Prerequisites	Independent competence in history taking, physical examination, interpreting clinical investigations, and understanding of disease processes in critically ill patients, AND . . . Accreditation in FUSIC Heart (formerly known as FICE) or BSE Level 1, AND . . . Accreditation in FUSIC Lung plus FUSIC Abdomen modules, *OR* FAMUS
Program components	Registration: with ICS FUSIC secretariat Course: these will be centrally-approved, but locally-run, and can be found on the FUSIC website Logbook: 50 full studies, of which at least 20 must be directly observed by a registered Mentor Assessment: this will be in the form of a centrally-run exam, involving a logbook and video case review, pathology spotter viva and practical skill assessment Timeline for completion: A total of 24 months for all components. However, the logbook must be collected (first scan to last scan) within 12 months
Supervisor requirements	Heart: BSE level 2 or equivalent; intensivist + EDEC; cardiologist + regular echo sessions Venous congestion: Radiologist; sonographer; intensivist with evidence of competence at VEXUS + approval by application to FUSIC HD sub-committee *A FUSIC HD Supervisor is responsible for signing off competencies and informal practical assessment before the candidate attends the exam*
Mentor requirements	Heart – BSE level 2 or equivalent; intensivist + EDEC; cardiologist + regular echo sessions; Intensivist with evidence of competence beyond FICE/level 1 + approval by application to FUSIC HD sub-committee Venous – Radiologist, sonographer, or intensivist with evidence of competence at VEXUS + approval by application to FUSIC HD sub-committee *A FUSIC HD Mentor is responsible for teaching FUSIC HD scanning, reviewing logbook cases, and linking candidates with a Supervisor*

FAMUS (Focused Acute Medicine Ultrasound), VEXUS (Venous Excess Ultrasound Score), EDEC (European Diploma in advanced critical care EchoCardiography), BSE (British Society Echocardiography).

Conclusion

FUSIC HD is a method by which the whole haemodynamic system can be assessed with ultrasound. It allows the bedside clinician to answer the key haemodynamic questions that matter when treating critically ill patients, many of which are difficult to answer by other means. It provides a structured framework and competencies, and enables accreditation by supervised practice, logbook collection and assessment by examination. Comprehensive details, including more detailed explanations of the clinical questions and how to perform a FUSIC HD scan, can be found on the ICS website.

European Diploma in advanced critical care EchoCardiography

EDEC is a curriculum in Echocardiography offered by ESICM to practitioners who have acquired a basic level of competence in critical care echocardiography (CCE) and would like to extend their competencies to an advanced level.

The **EDEC Guidelines** will provide you with more information on the examination as well as the requirements needed to sit the exam including the definition of supervisor and mentor.

Completion of EDEC training and competency-based testing designates that the intensivist is competent in advanced critical care echocardiography.

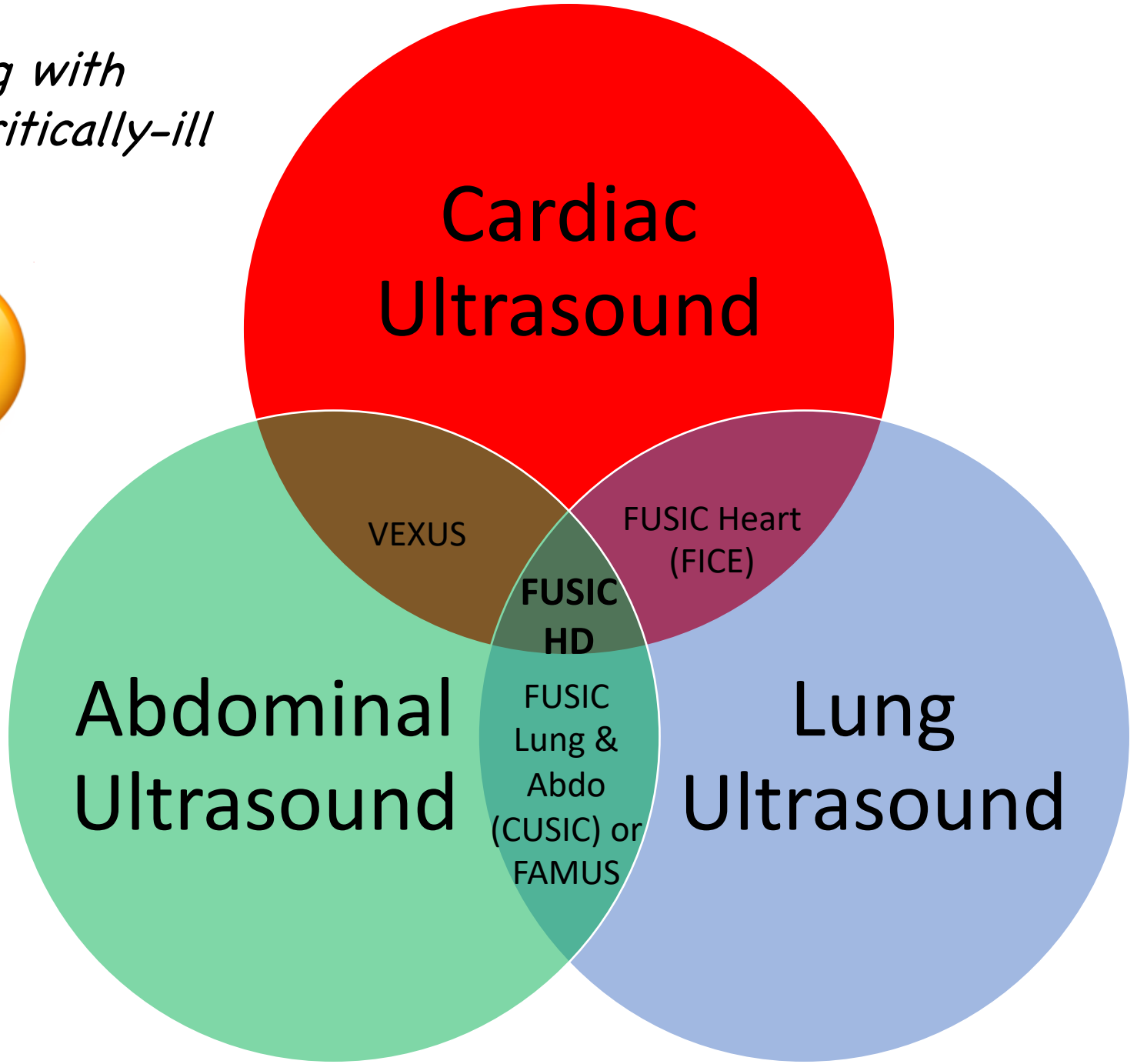
Entry Criteria

- Recognised intensivist (no longer in training)
- Certificate of attendance for a basic course in echocardiography in the last two years
- Identify potential mentor and supervisor for the completion of the curriculum. Click here for the list of the EDEC approved supervisors.

The Critical Care (TTE) Echo Educator

- Large ICUs are likely to need a L2 BSE certified Critical Care Educator or a L2 Cardiac Physiologist with dedicated Critical Care sessions to oversee their Echo Education programme & create strong links with Cardiology.
- The L2 BSE certified Critical Care Educator will need Echo sessions in their job plan to maintain their certification – they will need to work closely with Imaging Cardiologists.
- Time needs to be dedicated to teaching ICU trainees Level 1 echo (eg FUSIC Heart or BSE Level 1 or equivalent) – FUSIC HD or EDEC will allow future intensivists to do this well. It will also result in a better skill set when looking after critically unwell patients.
- There is an opportunity for Cardiologists, Cardiac Physiologists, Cardiac Anaesthetists with TTE experience, Intensivists, Radiologists & Sonographers to become involved in this educational pathway.

"What is wrong with this shocked critically-ill patient?"



FUSIC HD

Using whole body ultrasound to interrogate the haemodynamic system

Clinically Applied Ultrasound at the Point of Care