Critical Care Ultrasound
Here to stay or just another fad?

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@Echotrainer

Conflicts of interest

I have received technical support for courses from GE Healthcare

I have received equipment loans from Imacor inc

I run not for profit Echocardiography courses

Institutional alliances as President of ACTA

Faculty for ESA and ESICM ultrasound and echo courses

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Scope of this talk

- Spectrum of Ultrasound in Critical Care
- Evidence base for Ultrasound
- International Perspective on Echocardiography
- Echocardiography for monitoring and management in critical care
- Future directions

Ultrasound

- Diagnostic tool
- Monitoring device
- Provides point of care patient management

Critical Care

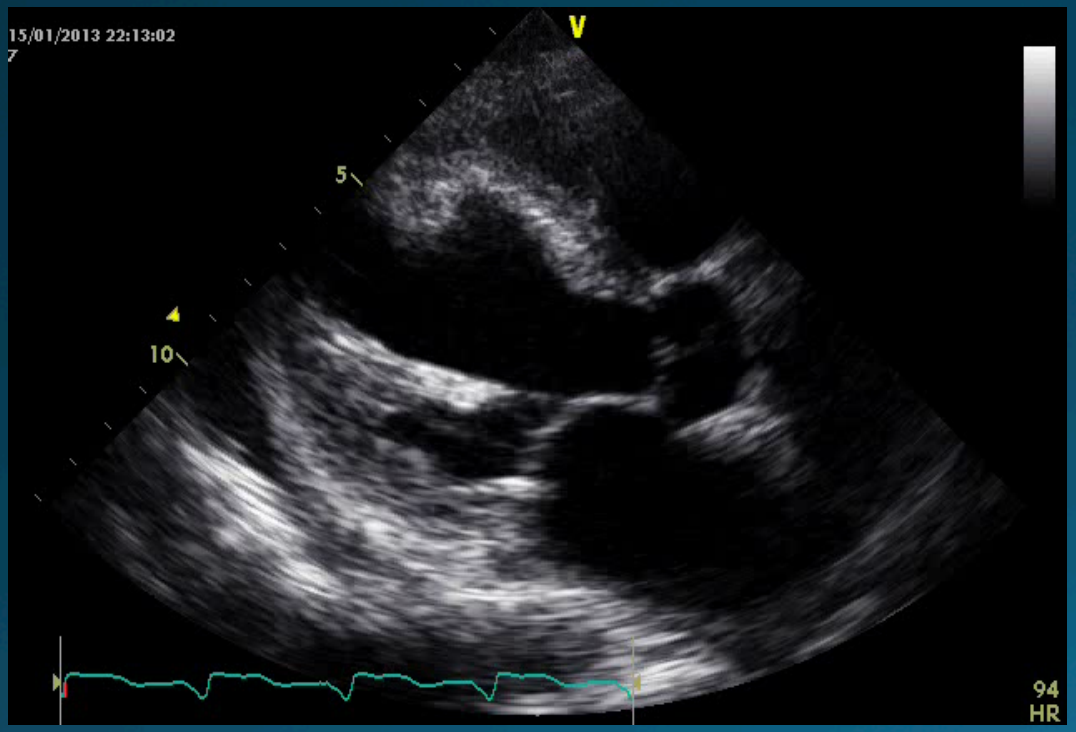
- Hi tech complex environment
- Patients have multi organ dysfunction with rapid changes to their conditions
- Cardiac and circulatory failure is common
- Mechanical support, inotropes and fluid therapy
- High level of monitoring
- Philosophy

Spectrum of Ultrasound in Critical Care

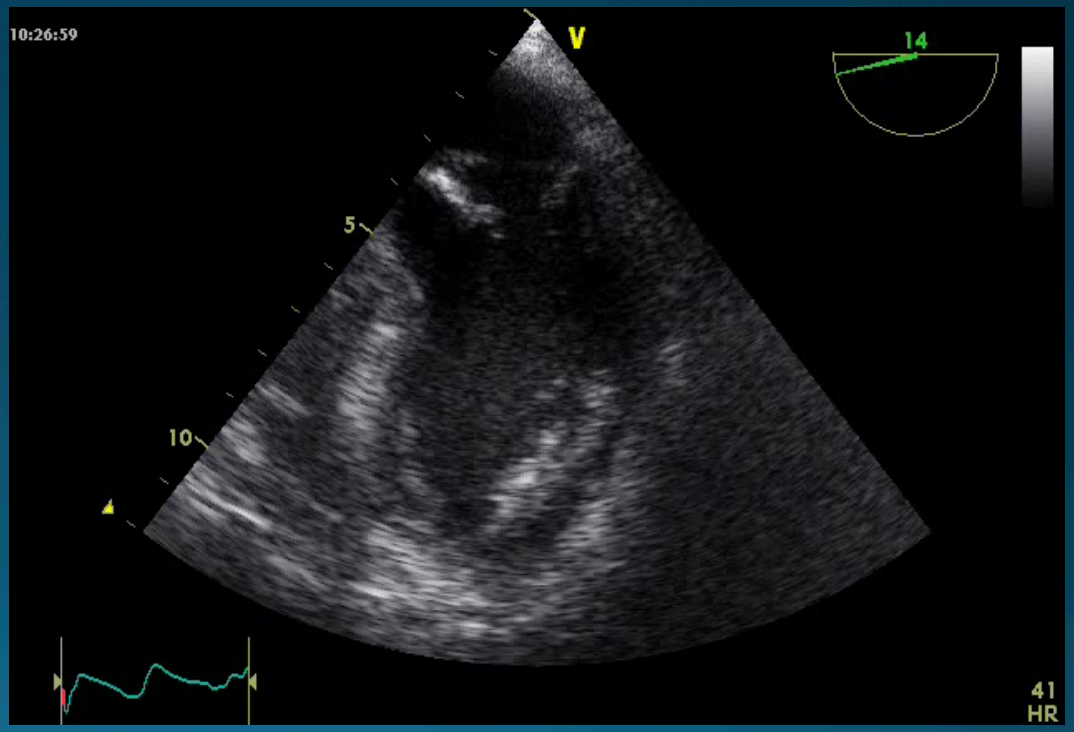
- Cardiac Ultrasound - Echocardiography
- Lung Ultrasound
- Vascular Ultrasound
- Abdominal Ultrasound

Cardiac Ultrasound - Echocardiography

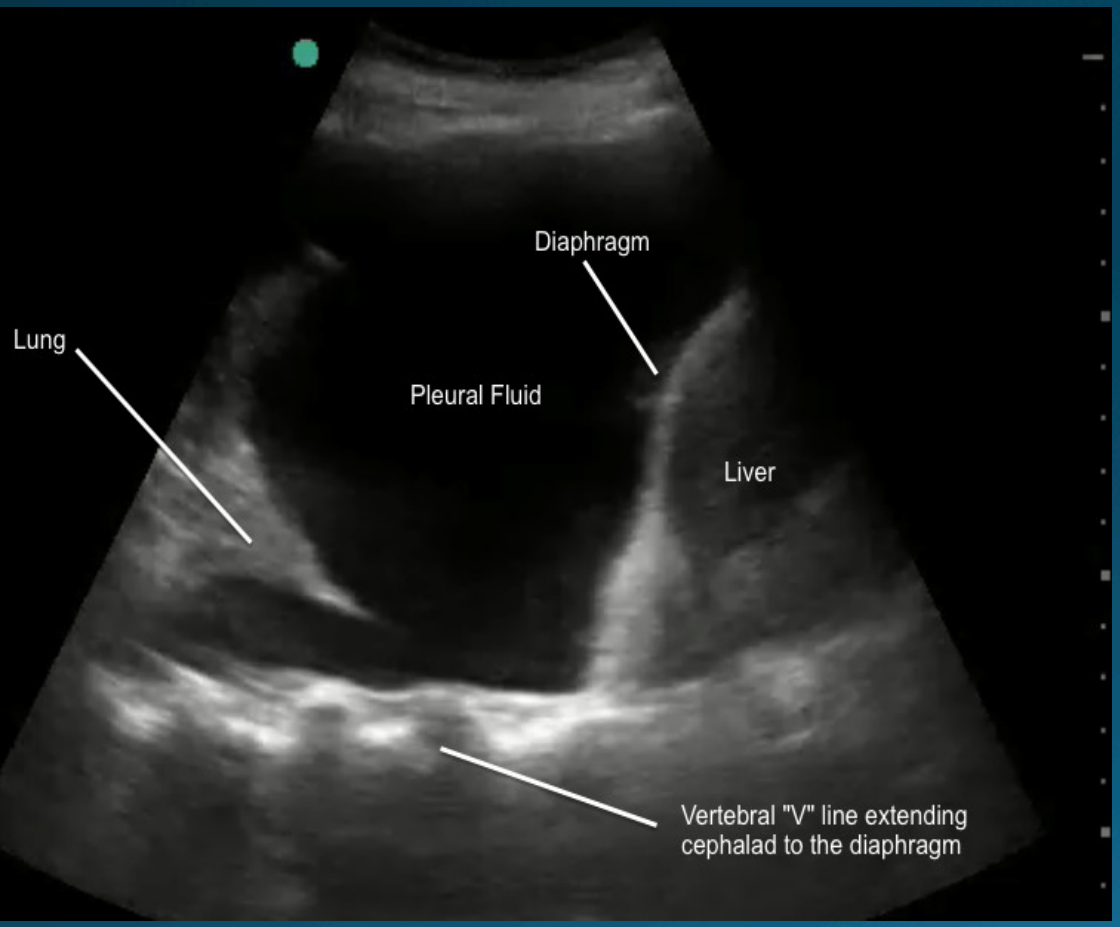
TTE

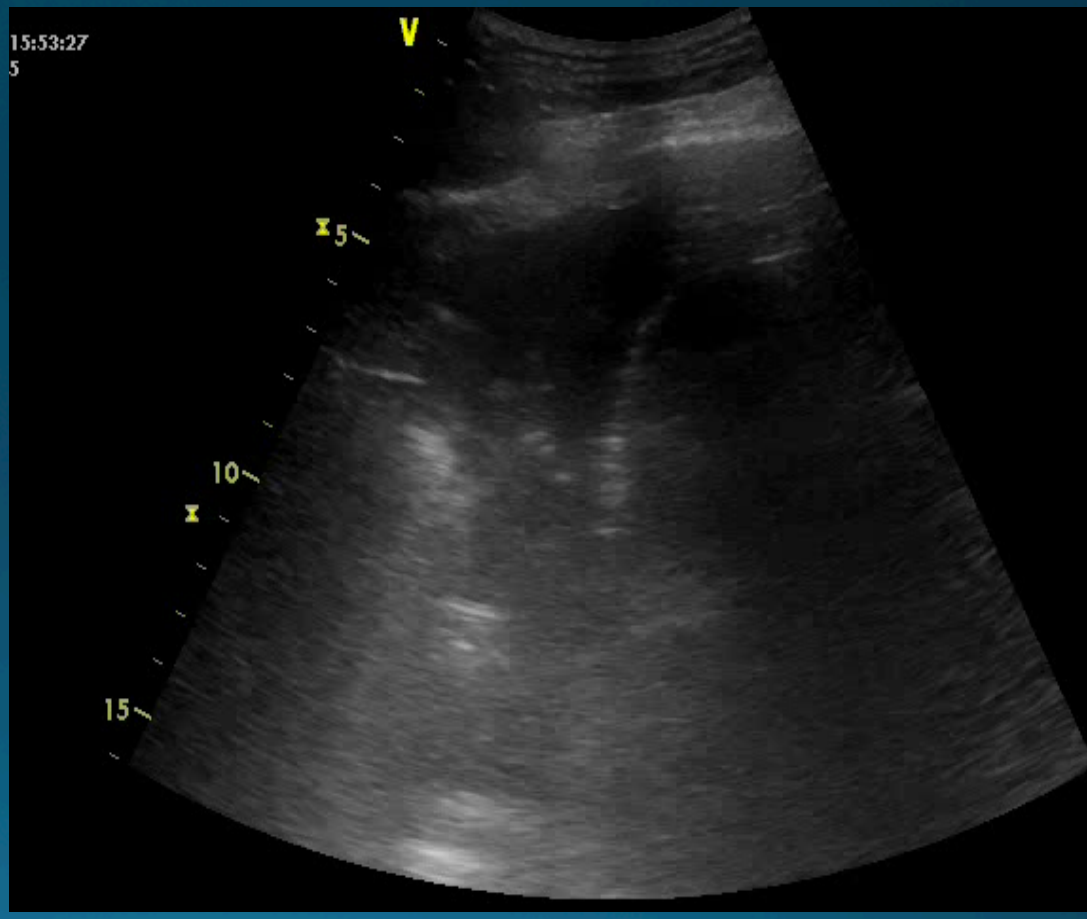


TOE



Lung Ultrasound





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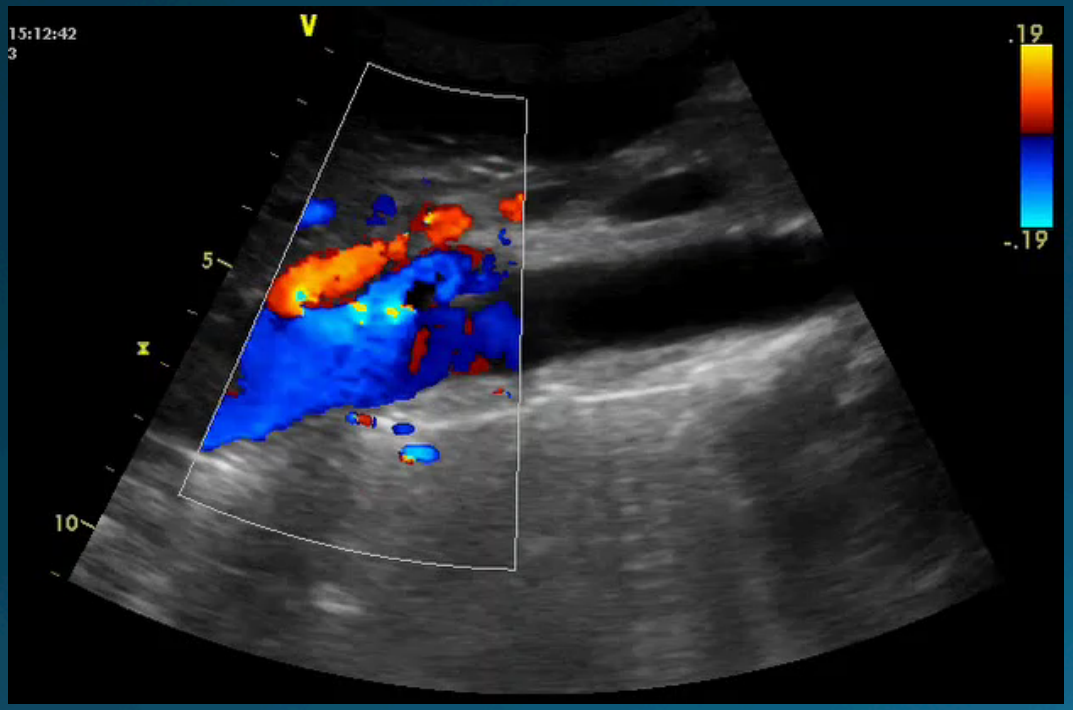
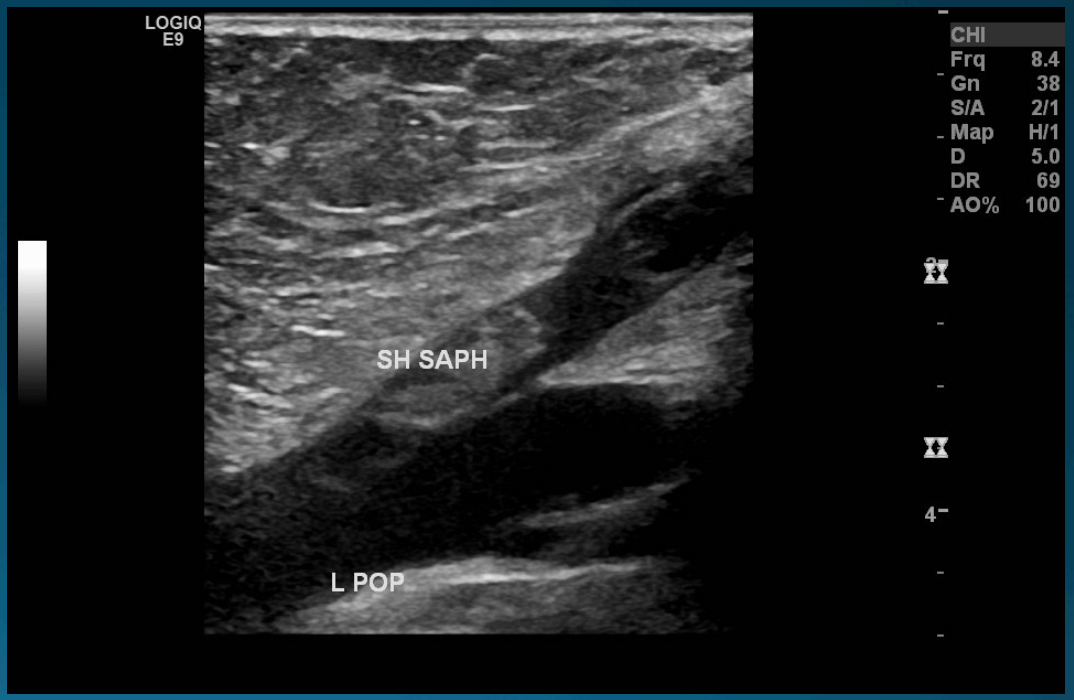
Vascular Ultrasound

Arteries



Veins



Abdominal Ultrasound

Evidence

There is a tipping point at which the uptake of a highly functional technology, such as the mobile phone, can be observed to behave almost like the spread of an epidemic

Malcolm Gladwell *The Tipping Point*

Evidence

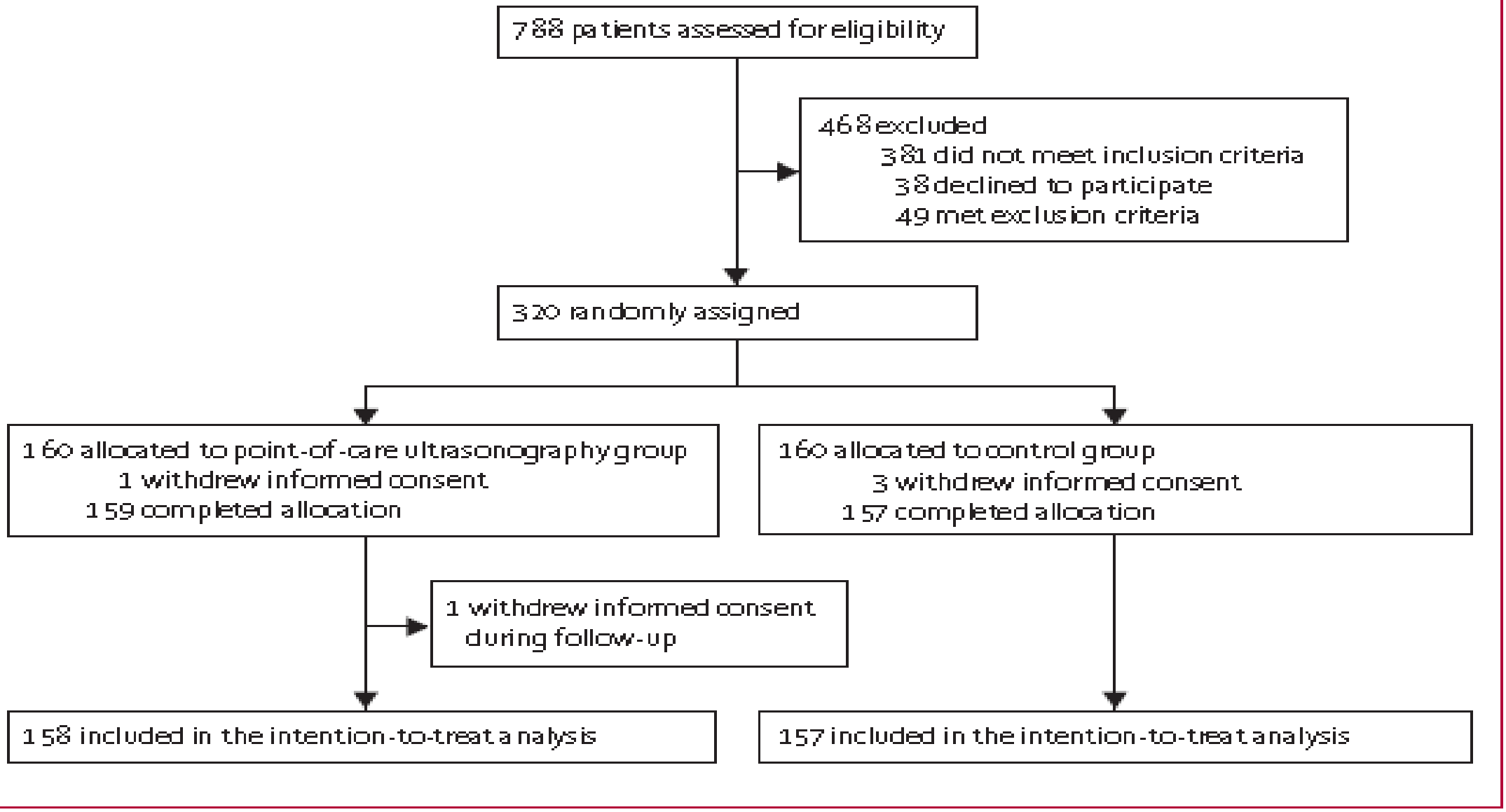
The conflicting subjective and objective results of the current study, despite an intense, methodical collection of data from a relatively large population, confirms that measuring the effectiveness of interventions to reduce rare, but important events is practically difficult. Improved methods for evaluation of new standards and monitoring equipment are needed if we are to rely upon more than intermediate outcome measures and subjective assessments to judge the effectiveness of implementing costly practices and technologies.

oller et al (1993). Randomized evaluation of pulse oximetry in 20,802 atients. Anaesthesiology 78:445-453

Evidence

aursen C B, Sloth E, Lassen AT et al. (2014). Point-of-care ultrasonography
n patients admitted with respiratory symptoms: a single-blind, randomised
ontrolled trial.

ancet Respir Med 2(8): 638-646.


788 patients assessed for eligibility
468 excluded
381 did not meet inclusion criteria
38 declined to participate
49 met exclusion criteria
320 randomly assigned
160 allocated to point-of-care ultrasonography group
1 withdrew informed consent
159 completed allocation
160 allocated to control group
3 withdrew informed consent
157 completed allocation
1 withdrew informed consent during follow-up
158 included in the intention-to-treat analysis
157 included in the intention-to-treat analysis

ntary diagnostic tests ordered 4 h after admission to emergency department					
e chest	13 (8·2%; 3·9 to 12·6)	3 (1·9%; 0 to 4·1)	0·01	6·3% (1·4 to 11·8)	4·30 (0·55
rasound by radiologist	1 (0·6%; 0 to 1·9)	0 (0%; 0 to 1·9)	0·32	0·6% (–1·8 to 3·5)	..
ion-perfusion scan	5 (3·2%; 0·4 to 5·9)	2 (1·3%; 0 to 3·0)	0·26	1·9% (–1·8 to 6·0)	2·48 (0·29
diography by a cardiologist	16 (10·1%; 5·4 to 14·9)	6 (3·8%; 0·8 to 6·9)	0·03	6·3% (0·6 to 12·4)	2·65 (0·61
aphy of the deep veins by radiologist	2 (1·3%; 0 to 3·0)	1 (0·6%; 0 to 1·9)	0·57	0·6% (–2·4 to 3·9)	1·99 (0·12
tic thoracocentesis	9 (5·7%; 2·0 to 9·3)	0 (0%; 0 to 1·9)	0·002	5·7% (2·1 to 10·5)	..
diagnostic testing ordered ‡‡					
dered during stay in the emergency department	63 (6·6%; 5·1 to 8·2)	34 (3·6%; 2·4 to 4·8)	0·04	3·0% (1·0 to 5·1)	1·84 (0·87
dered during entire hospital stay	85 (9·0%; 7·1 to 10·8)	70 (7·4%; 5·8 to 9·1)	0·16	1·5% (–1·0 to 4·0)	1·21 (0·80

gs Between Dec 7, 2011, and March 15, 2013, 320 patients were randomly assigned to the control group (n=
oint-of-care ultrasonography group (n=160). 158 patients in the point-of-care ultrasonography group and 1
ntrol group were analysed. 4 h after admission to the emergency department, 139 patients (88·0%; 95
93·1) in the point-of-care ultrasonography group versus 100 (63·7%; 56·1–71·3) in the control group had co
mptive diagnoses (p<0·0001). The absolute and relative effects were 24·3% (95% CI 15·0–33·1) and
1·31), respectively. No adverse events were reported.

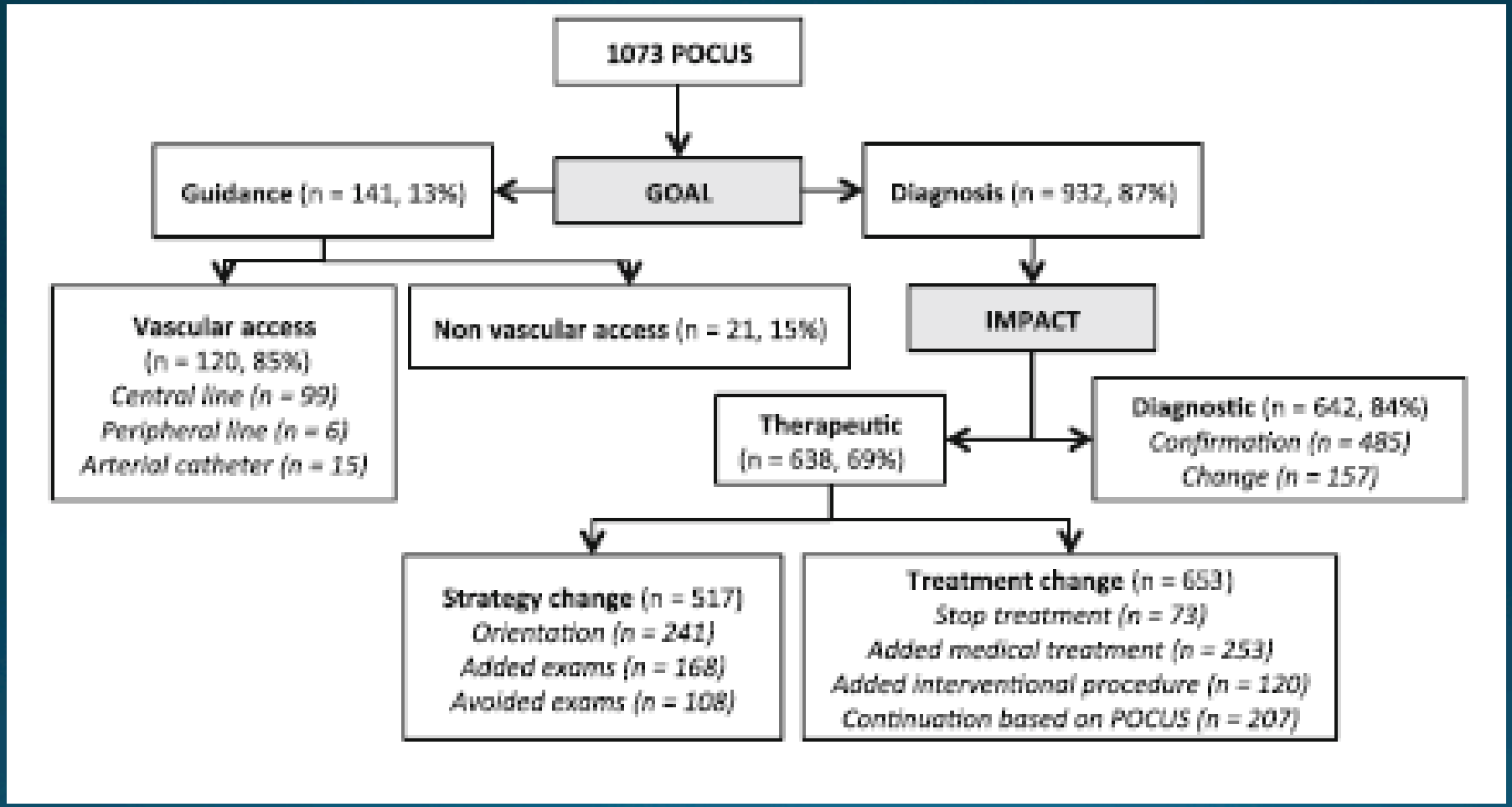
care unit					
rred to intensive care unit during hospital stay	4 (2·5%; 0·1 to 5·0)	5 (3·2%; 0·4 to 6·0)	0·75	0·7% (−5·0 to 3·6)	0·79 (0·25 to 3
(days)					
of hospital stay	3 (1 to 59)	3 (1 to 56)	0·93	0% (−25 to 20)	0·95 (0·76 to 1
l-free days	24 (0 to 29)	25 (0 to 29)	0·38	−1% (−10 to 9)	1·07 (0·86 to 1
ion within 30 days	36 (22·8%; 16·2 to 29·4)	41 (26·1%; 19·2 to 33·1)	0·49	3·3% (−6·2 to 12·7)	0·87 (0·71 to 1·
ital	13 (8·2%; 3·9 to 12·6)	8 (5·1%; 1·6 to 8·6)	0·27	−3·1% (−9·0 to 2·6)	1·61 (0·52 to 2
	19 (12·0%; 6·9 to 17·2)	11 (7·0%; 3·0 to 11·0)	0·13	−5·0% (−12·0 to 1·6)	1·72 (0·62 to 2

retation Point-of-care ultrasonography is a feasible, radiation free, diagnostic test, which alongside stan
ostic tests is superior to standard diagnostic tests alone for establishing a correct diagnosis within 4 h. It sh
fore be considered for routine use as part of the standard diagnostic tests in the emergency departmen
nts admitted with respiratory symptoms.

Evidence

Zieleskiewicz L, Muller L, Lakhal K et al. (2015). Point-of-care ultrasound in intensive care units: assessment of 1073 procedures in a multicentric, prospective, observational study

ntensive Care Med 41(9): 1638-1647.


1073 POCUS
GOAL
Guidance (n = 141, 13%)
Diagnosis (n = 932, 87%)
Vascular access
(n = 120, 85%)
Central line (n = 99)
Peripheral line (n = 6)
Arterial catheter (n = 15)
Non vascular access (n = 21, 15%)
IMPACT
Therapeutic
(n = 638, 69%)
Diagnostic (n = 642, 84%)
Confirmation (n = 485)
Change (n = 157)
Strategy change (n = 517)
Orientation (n = 241)
Added exams (n = 168)
Avoided exams (n = 108)
Treatment change (n = 653)
Stop treatment (n = 73)
Added medical treatment (n = 253)
Added interventional procedure (n = 120)
Continuation based on POCUS (n = 207)

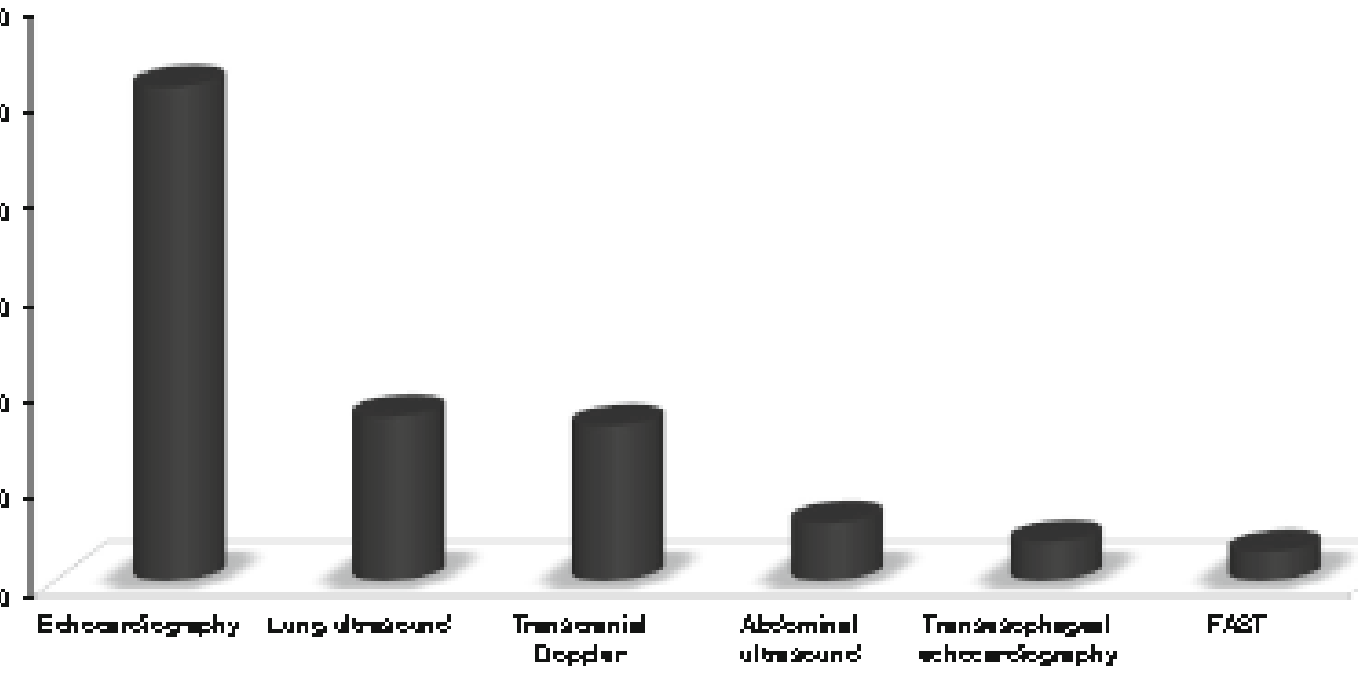


Table 2 Interventions associated with point-of-care ultras performance

Intervention	n = 37
Hemodynamics	
Fluid bolus	115 (31
Fluid depletion	80 (21
Catecholamines	43 (12
Pulmonary artery hypertension treatment	11 (2.
Invasive procedures	
Surgery/interventional radiology	13 (3.
Chest tube insertion	48 (13
Medical treatments	
Antibiotics	10 (2.
Sedation	6 (1.
Mechanical ventilation setting	9 (2.
Anticoagulation	7 (1.
Others (miscellaneous)	31 (8.

- Diagnostic impact in 84% of cases
- Change in diagnosis in 21% of cases
- Confirmation of suspected diagnosis in 63% of cases

Conclusions

'The impact of POCUS on both diagnosis and treatment of ICU patients seems critical'

Frankel H L, Kirkpatrick AW, Elbarbary M, et al. (2015). Guidelines for the Appropriate Use of Bedside General and Cardiac Ultrasonography in the Evaluation of Critically Ill Patients—Part I: General Ultrasonography.

Society of Critical Care Medicine (SCCM) Guidelines

Crit Care Med 43(11): 2479-2502.

BLE 6. Summary of Key Recommendations

pic	Overall Grade of Recommendation	Strength of Recommendation	Level of Qualit of Evidence
iagnosis of pleural effusion (ruling-in)	1-A	Strong	A
uidance of small pleural effusion drainage	1-B	Strong	B
ynamic vs static technique for pleural effusion drainage	N/A	N/A	N/A
iagnosis of pneumothorax	1-A	Strong	A
terstitial and parenchymal lung pathology	2-B	Conditional	B
scites (nontrauma setting)	1-B	Strong	B
calculous cholecystitis (by sonographer)	2-C	Conditional	C
calculous cholecystitis (by intensivist)	2-B	Conditional against	B
enal failure (mechanical causes)	2-C	Conditional	C
enal failure (by intensivist)	N/A	N/A	N/A
VT diagnosis	1-B	Strong	B
VT by intensivist	1-B	Strong	B

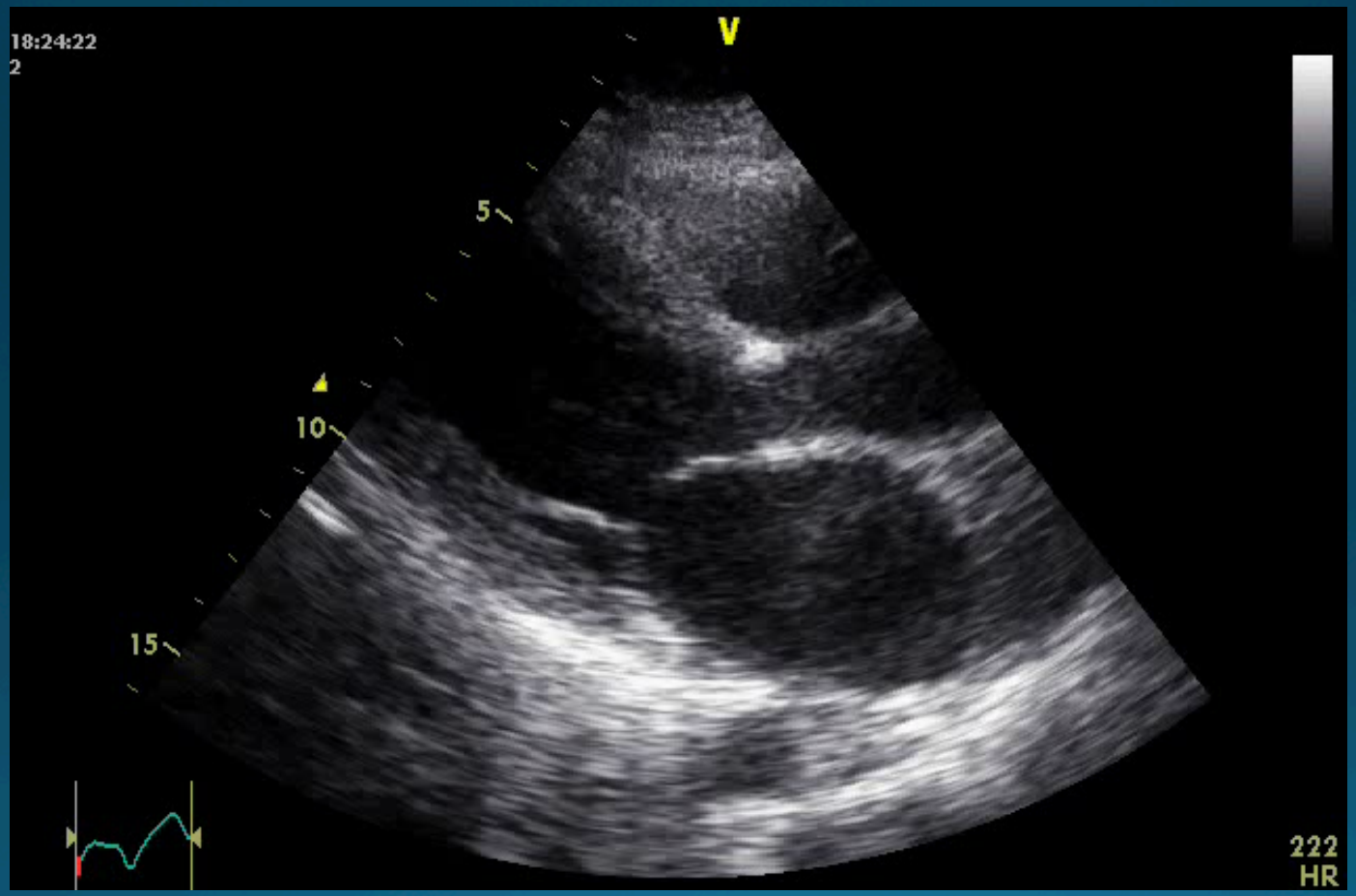
TABLE 6. Summary of Key Recommendations

Topic	Overall Grade of Recommendation	Strength of Recommendation	Level of Quality of Evidence
Central venous access			
General	1-A	Strong	A
Real time	1-B	Strong	B
Short axis	1-B	Strong	B
One operator	1-C	Strong	C
Use of Doppler	2-B	Conditional	B
Needle guide device	N/A	N/A	N/A
Postcannulation	2-B	Conditional	B
Access location			
Internal jugular	1-A	Strong	A
Subclavian/axillary	2-C	Conditional	C
Femoral	1-A	Strong	A
Others venous	2-B	Conditional	B
Others arterial	2-B	Conditional	B

DVT = deep venous thrombosis, N/A = not applicable.

Numbers indicate the strength of recommendation, where 1 = strong and 2 = weak/conditional. Letters indicate the level of quality of evidence, where A = high, B = moderate, and C = low.

Echocardiography



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echo research and practice | A Zafiropoulos and others | Critical care echo rounds | ID: 14-0052; December 2014 DOI: 10.1530/ERP-14-0052

ECHO EDUCATION

CRITICAL CARE ECHO ROUNDS

Echo in cardiac arrest

Andreas Zafiropoulos MA BMBch MRCP FRCA, Kaleab Asrress MA BMBch MRCP[1,2], Simon Redwood MD FRCP FACC FSCAI[3], Stuart Gillon MBChB MRCP FFICM[4] and David Walker MRCP FRCA FFICM[5,6]

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[6]University College, London, UK

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ajzafiropoulos@gmail.com

Critical Care Echo – UK Perspective

British Journal of Anaesthesia **102 (3):** 340–4 (2009)
doi:10.1093/bja/aen378 Advance Access publication January 18, 2009

BJA

CRITICAL CARE

Impact of echocardiography on patient management in the intensive care unit: an audit of district general hospital practice

R. M. L'E. Orme*, M. P. Oram and C. E. McKinstry

Results. Two hundred and fifty-eight echocardiograms were performed in 217 patients, of which 224 (86.8%) were performed by intensive care consultants. One hundred and eighty-seven studies (72.4%) were TTEs and 71 (27.8%) were TOEs. TTE provided diagnostic images in 91.3% of spontaneously breathing and 84.2% of mechanically ventilated patients. Management was changed directly as a result of information provided in 51.2% of studies. Changes included fluid administration, inotrope or drug therapy, and treatment limitation.

British Journal of Anaesthesia **109** (4): 490–2 (2012)
doi:10.1093/bja/aes323

EDITORIAL III

Critical care echocardiography: cleared for take up

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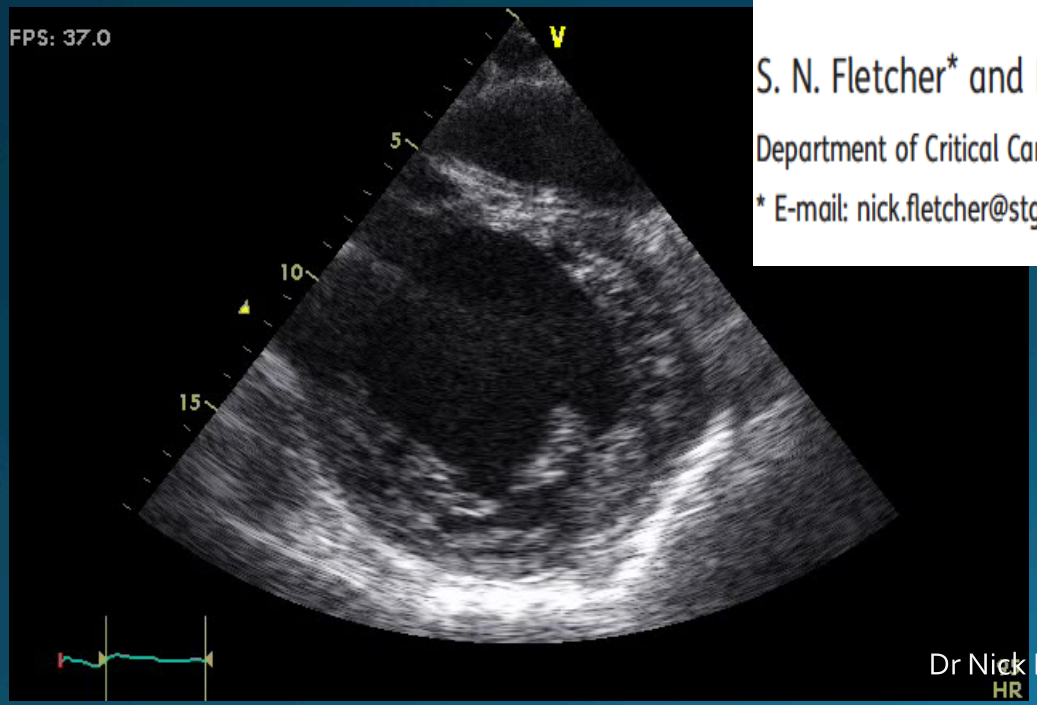

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Basic – FICE
Advanced - critical care echo accreditation

British Society of Echocardiography

Affiliated to the British Cardiac Society

intensive care society

w.ics.ac.uk/ics-homepage/accreditation-modules/focused-intensive-care-
o-fice

://www.bsecho.org/accreditation/types-of-accreditation/

General ultrasonography

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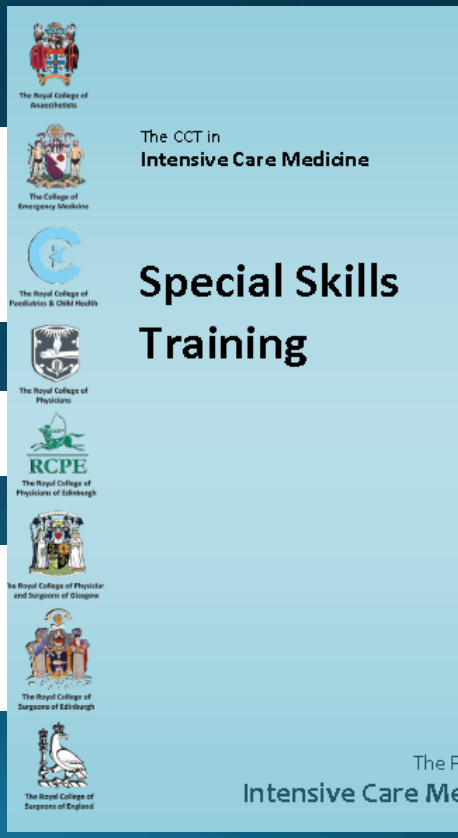
Critical Care Echo – UK Perspective

- Cardiac ICM sub speciality training FICM

rms a chest ultrasound to identify a pleural collection and features nsolidated lung	D, I, C	1
rms a focused transthoracic echo and interprets the results	D, I, C	1
ribes the indications for transoesophageal echocardiography and erstands the main imaging planes and common pathology	D, C, S	1



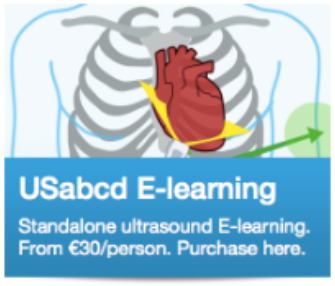
http://www.acta.org.uk/home/video.asp

ACTA :: Association of Card... | acta | Programme

was launched in June this year (2015) as a new interactive learning experience.

Click here for more details.

ECHO e-Learning



USabcd e-Learning Discount

ACTA members can get a 7.5% discount on any "stand-alone" e-learning product listed on www.usabcd.org. The courses are used in 25 countries and include "Basic FATE" by Prof. Erik Sloth as well as Physics, TOE, lung and abdominal ultrasound.

Use your ACTA member login to obtain your access coupon code for the discount.

Login to ACTA

Further details on how to register and purchase using your coupon:
http://usabcd.org/coupon

ECHO e-Learning

e-LfH
e-Learning for Healthcare

e-Learning for Healthcare

A new e-learning for healthcare resource from NHS Health Education England, in partnership with and endorsed by ACTA, is now available free of charge to anyone with an NHS email address. It covers the theoretical knowledge required prior to undertaking hands-on training in basic echo and lung ultrasound in intensive care.

22:47
10/11/2015

Critical Care Echo – International Perspective

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CHEST Consensus Statement

American College of Chest Physicians/ La Société de Réanimation de Langue Française Statement on Competence in Critical Care Ultrasonography*

Paul H. Mayo, MD; Yannick Beaulieu, MD; Peter Doelken, MD; David Feller-Kopman, MD; Christopher Harrod, MS; Adolfo Kaplan, MD; John Oropello, MD; Antoine Vieillard-Baron, MD; Olivier Axler, MD; Daniel Lichtenstein, MD; Eric Maury, MD; Michel Slama, MD; and Philippe Vignon, MD

Objective: **To define competence in critical care ultrasonography (CCUS).**
Design: **The statement is sponsored by the Critical Care NetWork of the American College of Chest Physicians (ACCP) in partnership with La Société de Réanimation de Langue Française (SRLF). The ACCP and the SRLF selected a panel of experts to review the field of CCUS and to develop a consensus statement on competence in CCUS.**
Results: **CCUS may be divided into general CCUS (thoracic, abdominal, and vascular), and echocardiography (basic and advanced). For each component part, the panel defined the specific skills that the intensivist should have to be competent in that aspect of CCUS.**
Conclusion: **In defining a reasonable minimum standard for CCUS, the statement serves as a guide for the intensivist to follow in achieving proficiency in the field.**
(CHEST 2009; 135:1050–1060)

Key words: critical care; echocardiography; imaging; ultrasonography

Abbreviations: ACCP = American College of Chest Physicians; CCE = critical care echocardiography; CCUS = critical care ultrasonography; GCCUS = general critical care ultrasonography; IVC = inferior vena cava; LV = left ventricle, ventricular; RV = right ventricle, ventricular; SRLF = La Société de Réanimation de Langue Française; TEE = transesophageal echocardiography; TTE = transthoracic echocardiography; 2D = two-dimensional

tensive Care Med (2014) 40:654–666
OI 10.1007/s00134-014-3228-5

CONFERENCE REPORTS AND EXPERT PANEL

xpert Round Table on
chocardiography in ICU

International consensus statement on training standards for advanced critical care echocardiography

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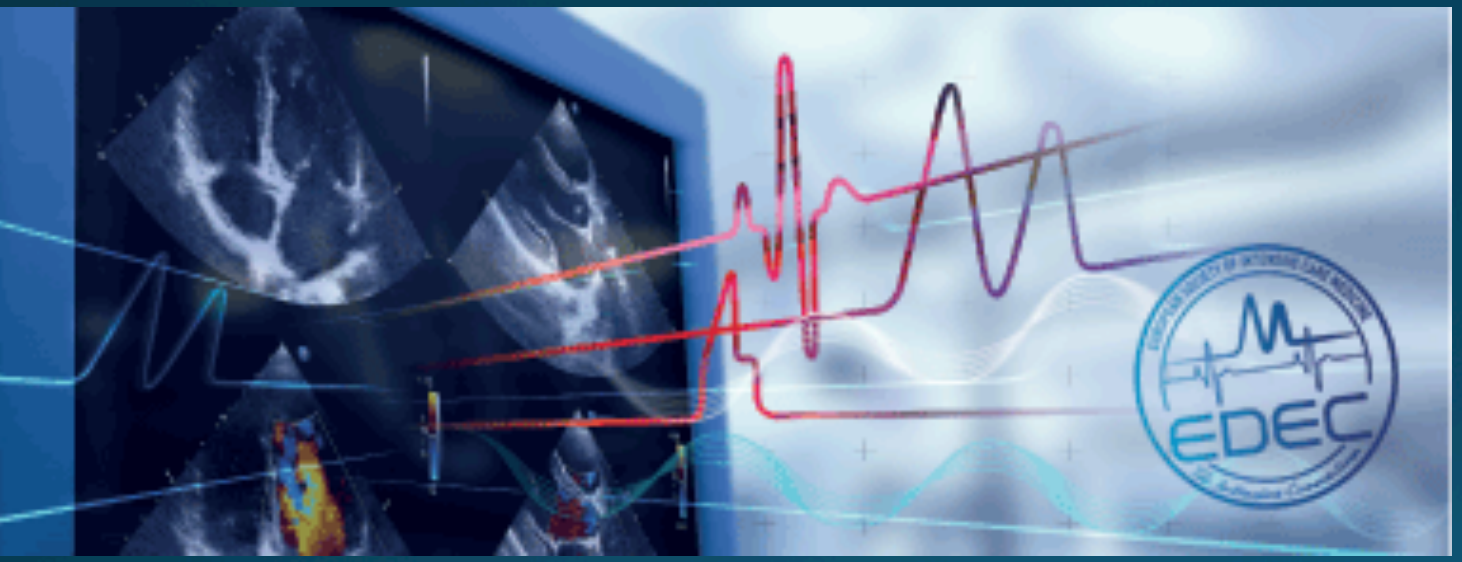
EDEC
European Diploma in EchoCardiography



ESICM
EUROPEAN SOCIETY OF INTENSIVE CARE MEDICINE

http://www.esicm.org/education/edec

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Diagnosis and Management in Critical Care

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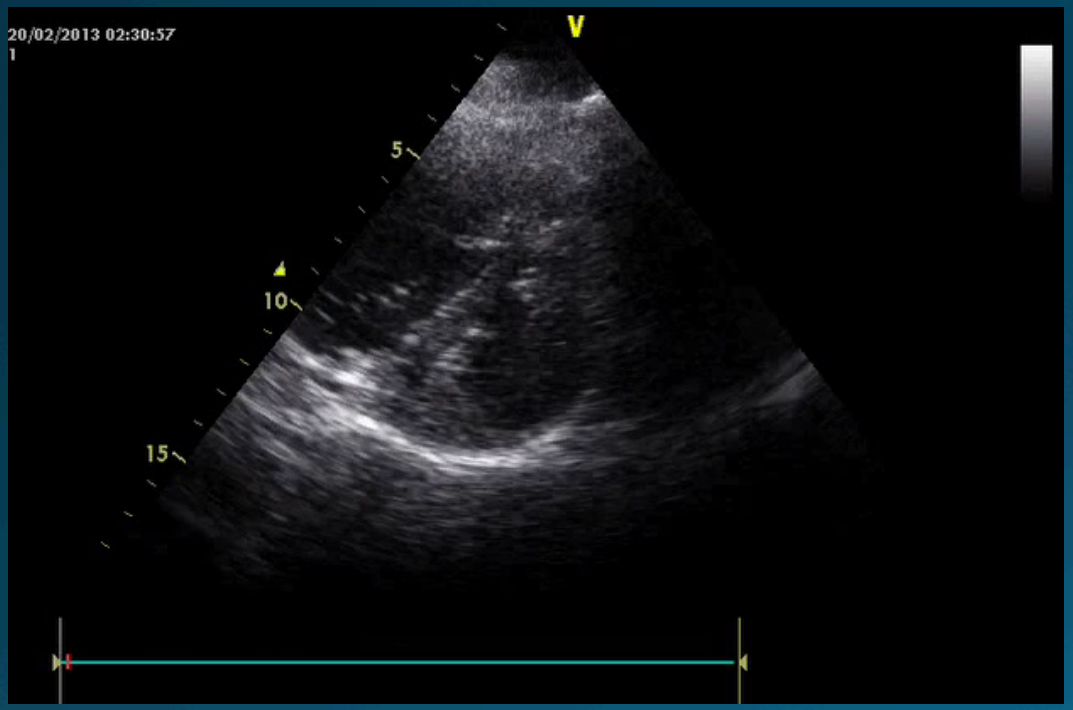
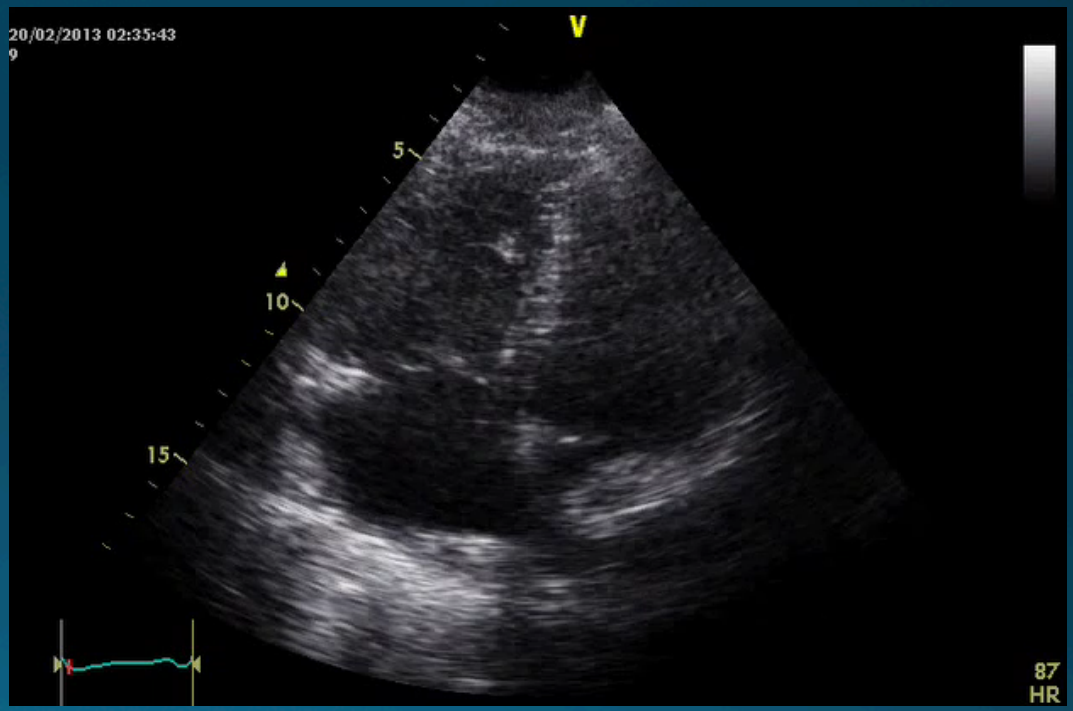
Diagnosis - Acute circulatory failure

- 50 year old female. Increasing dyspnoea though stable with bilateral infiltration on CXR. Hospital inpatient for 3 weeks in DGH. Transferred to tertiary thoracic surgery unit for pleural biopsy.
- Collapsed on ward 2 days post procedure at 22.00
- Tachycardia 130, BP unrecordable, hypoxic and raised lactate
- Diagnosis? Management?





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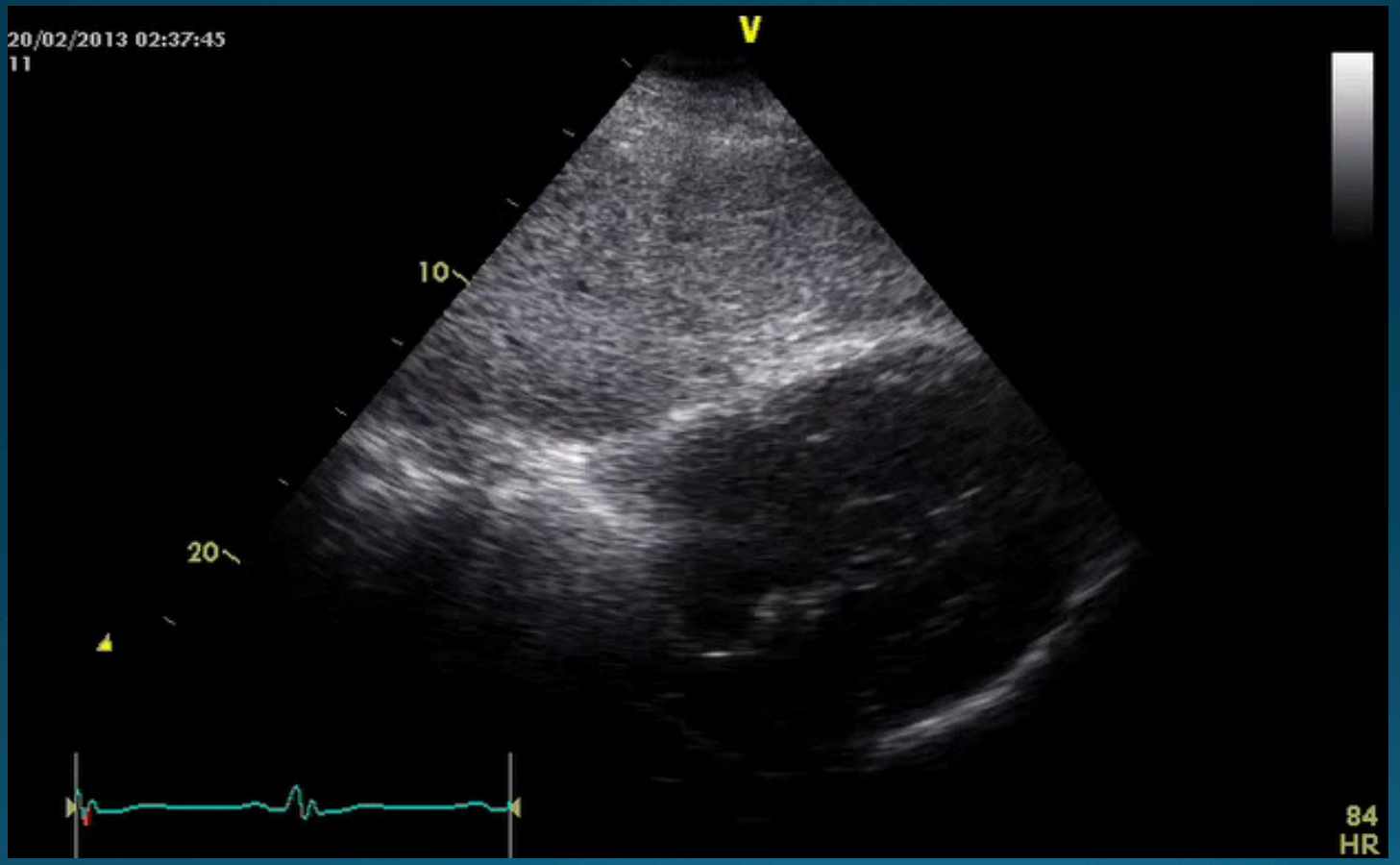

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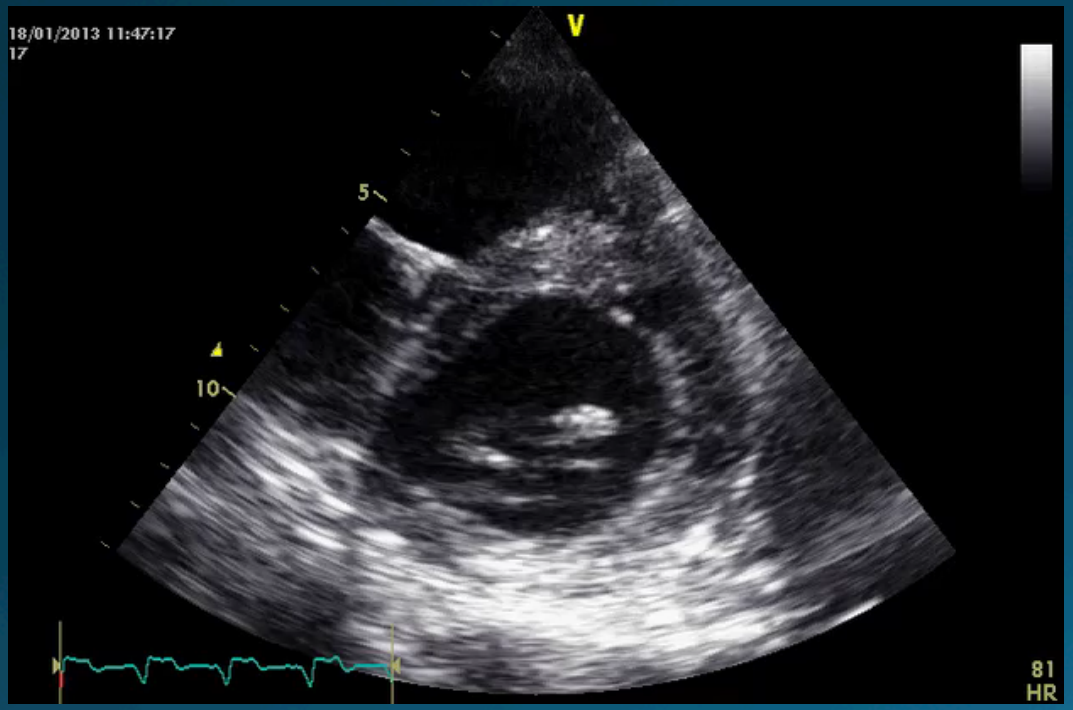
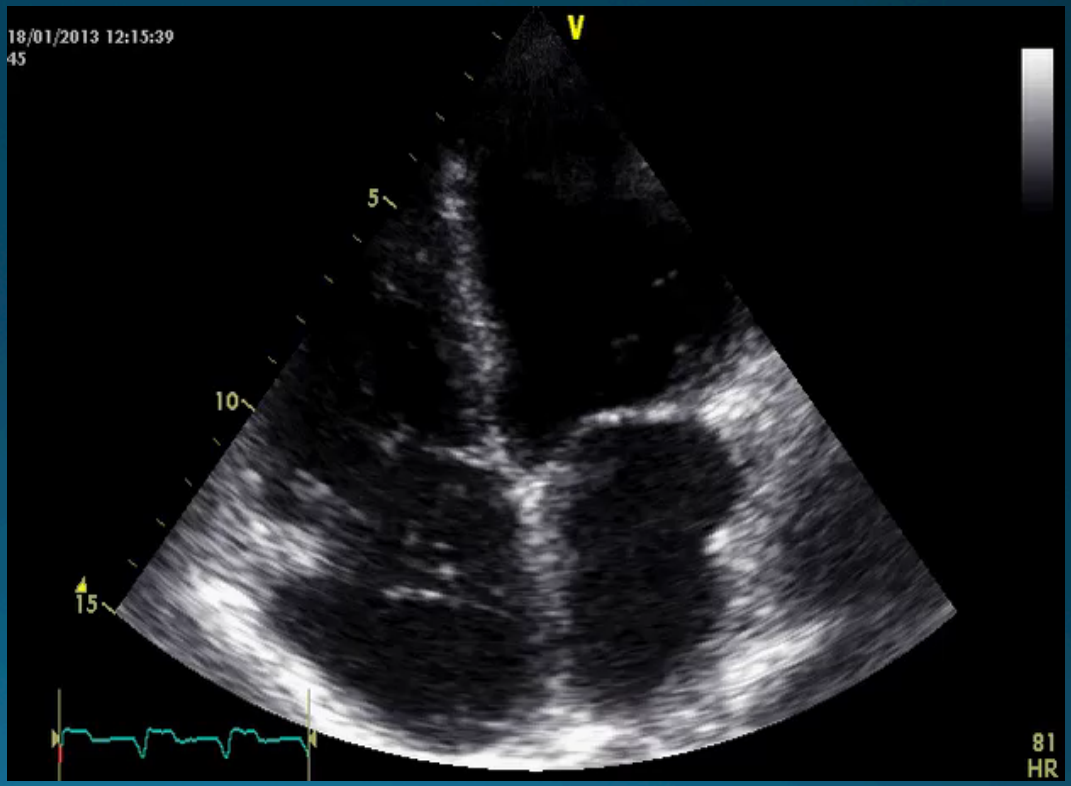
Diagnosis - Acute circulatory failure

- 70 years old man admitted to ICU with ACS with a stent to culprit lesion in LAD, pulmonary oedema and renal failure
- Intubated and mechanically ventilated, renal impairment but stable and slowly improving
- Sudden deterioration at 02.00 - hypotensive with raised lactate and ECG changes.
- ? Cause, ? management





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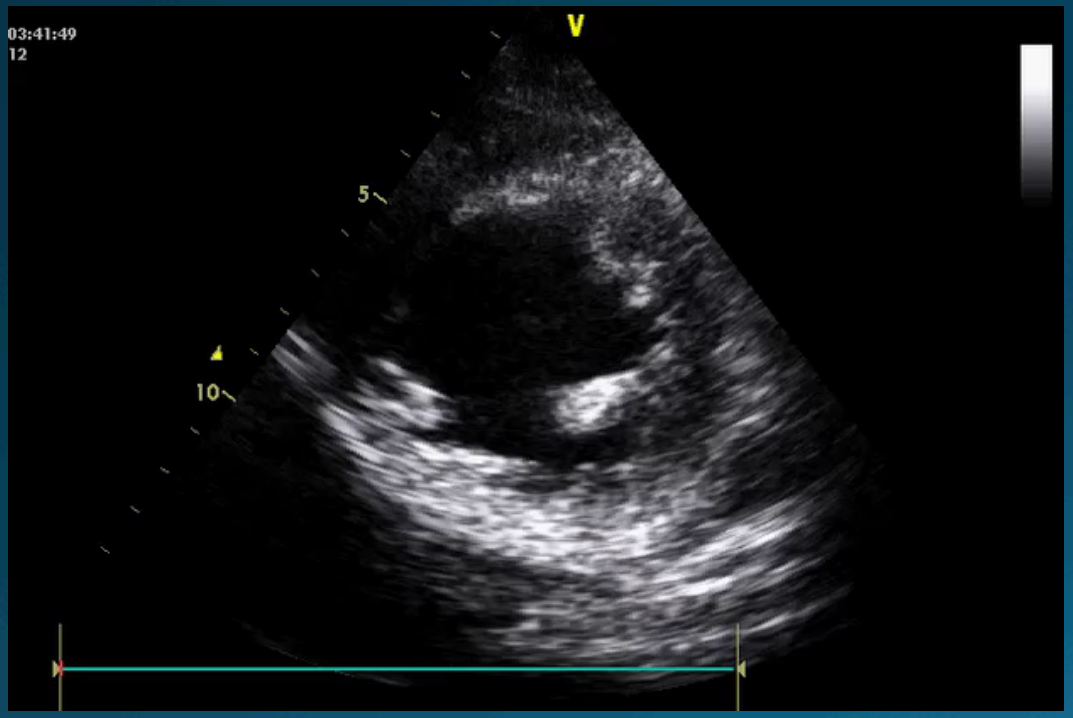

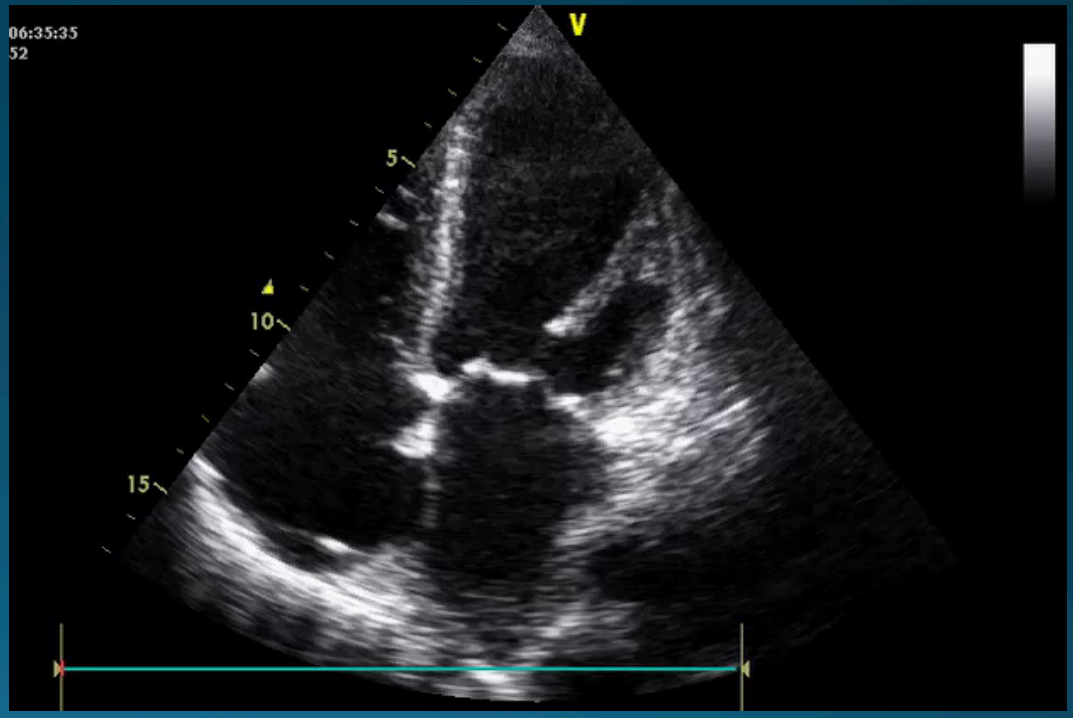

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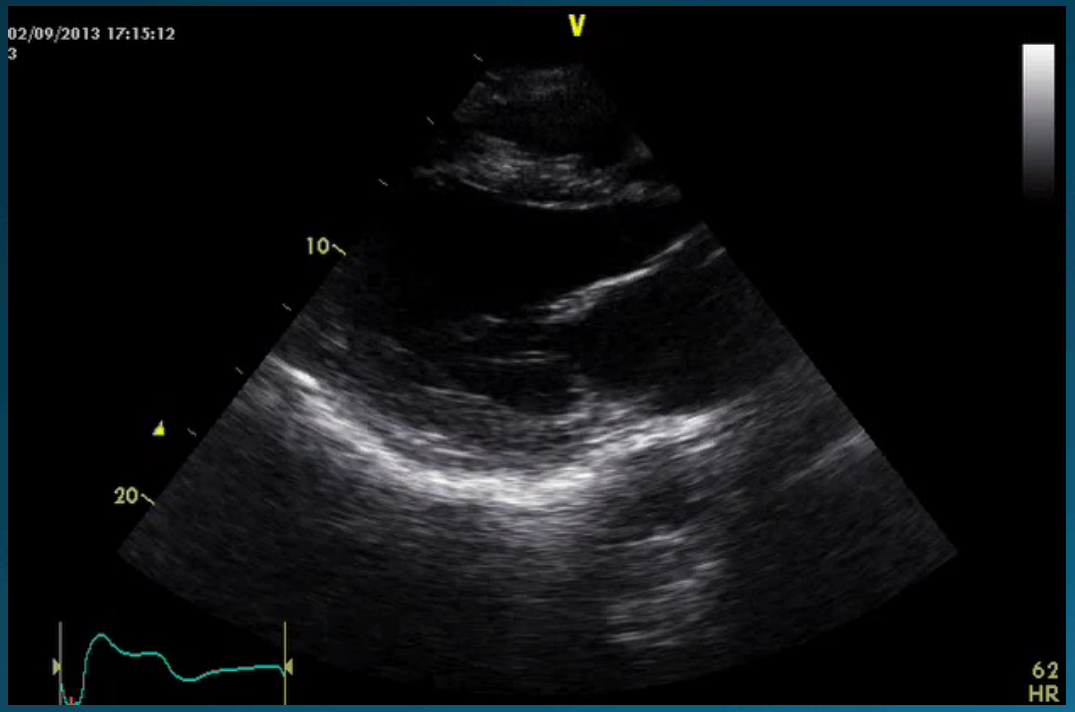
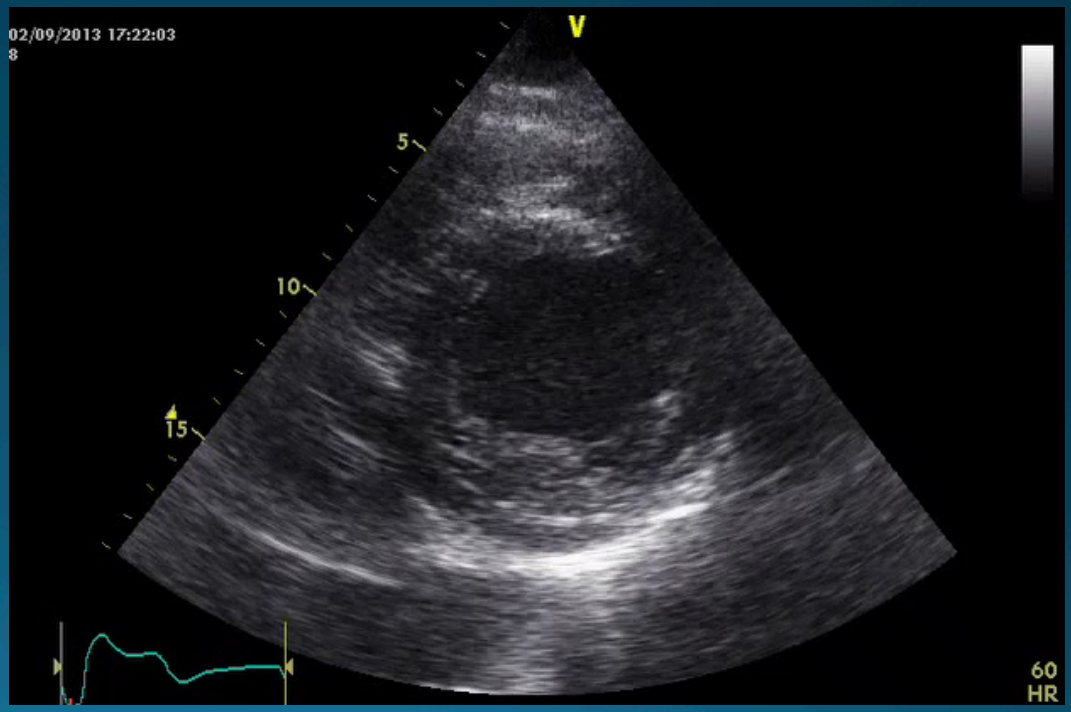
Diagnosis – Acute circulatory failure

- 72 year old man who had a tissue AVR 3 months ago admitted following OOHCA, presumed diagnosis arrythmogenic
- History of admission to local hospital following discharge from cardiac unit with septic episode of unknown origin
- Intubated and ventilated on noradrenaline support for hypotension
- TTE performed by ICU team to assess instability





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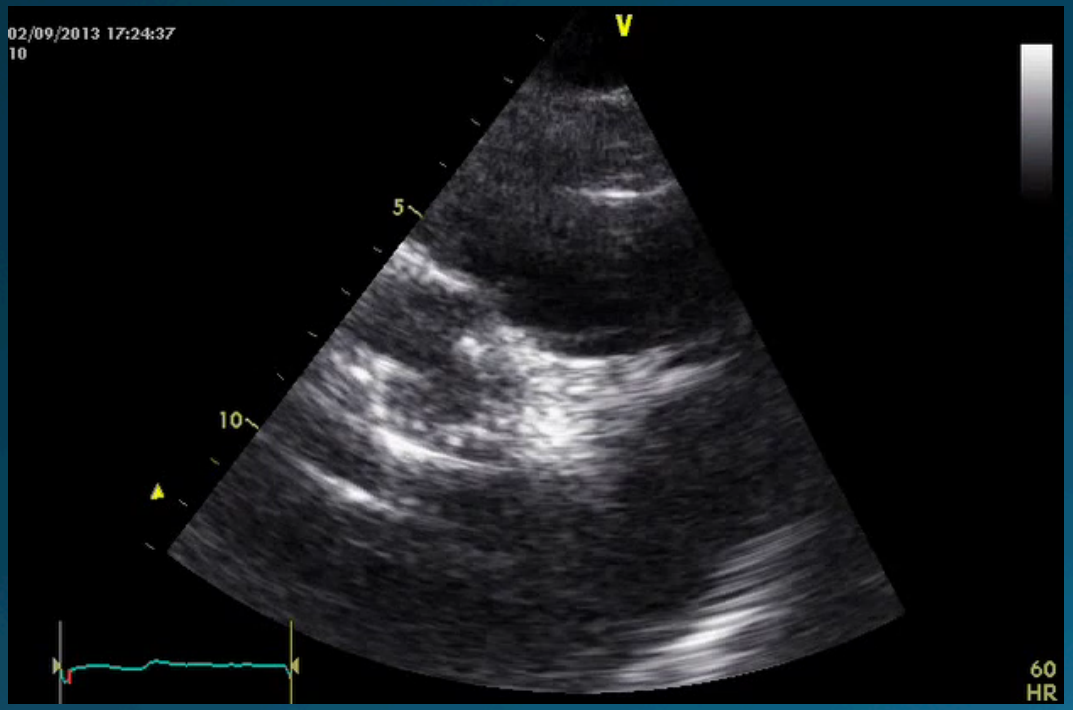

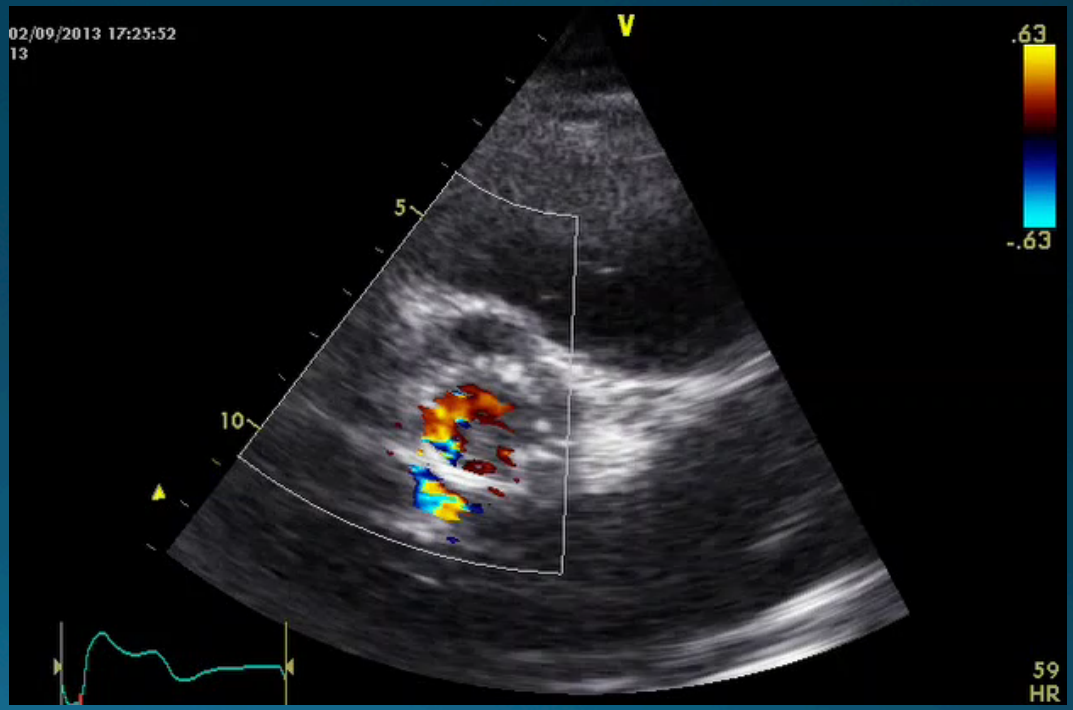

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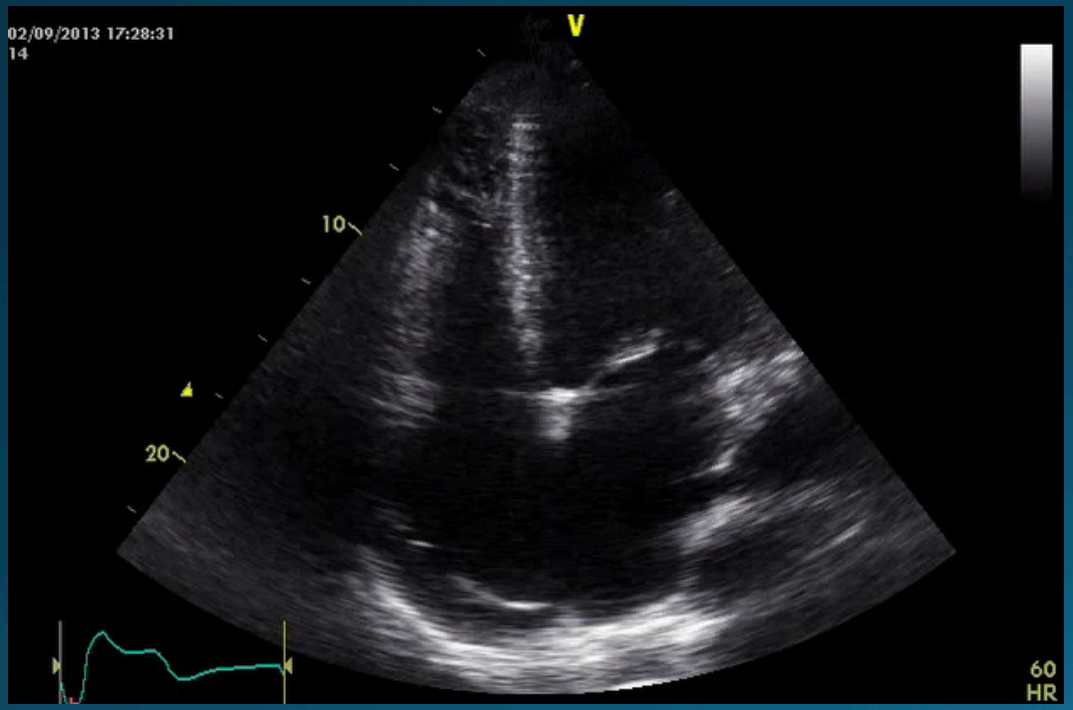

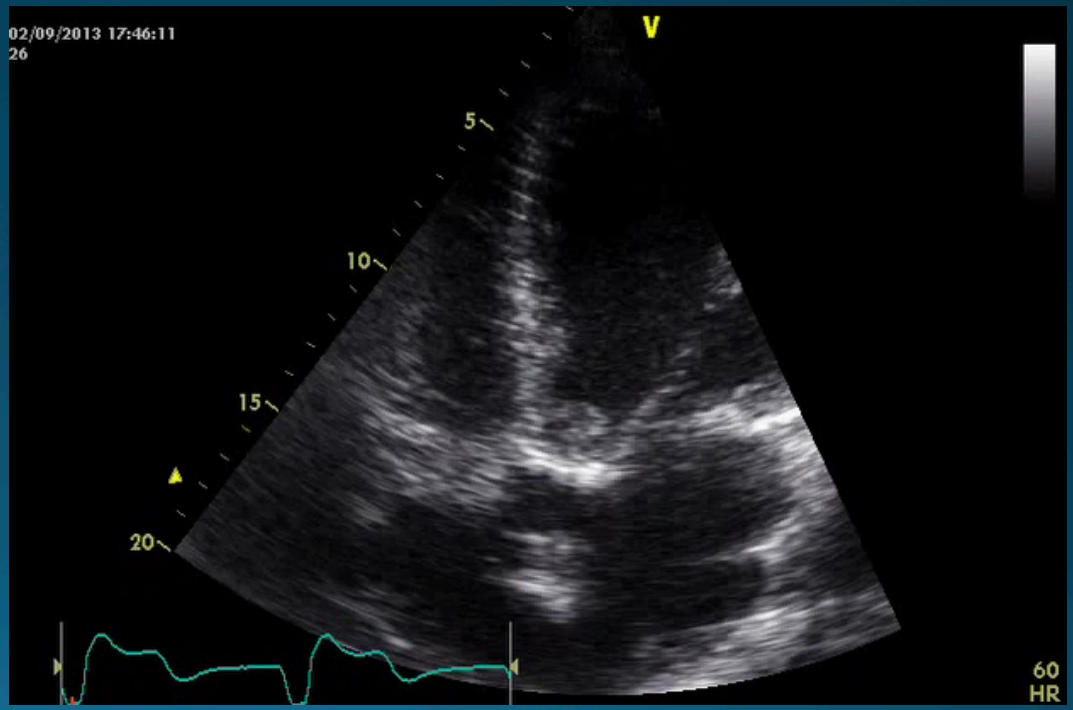

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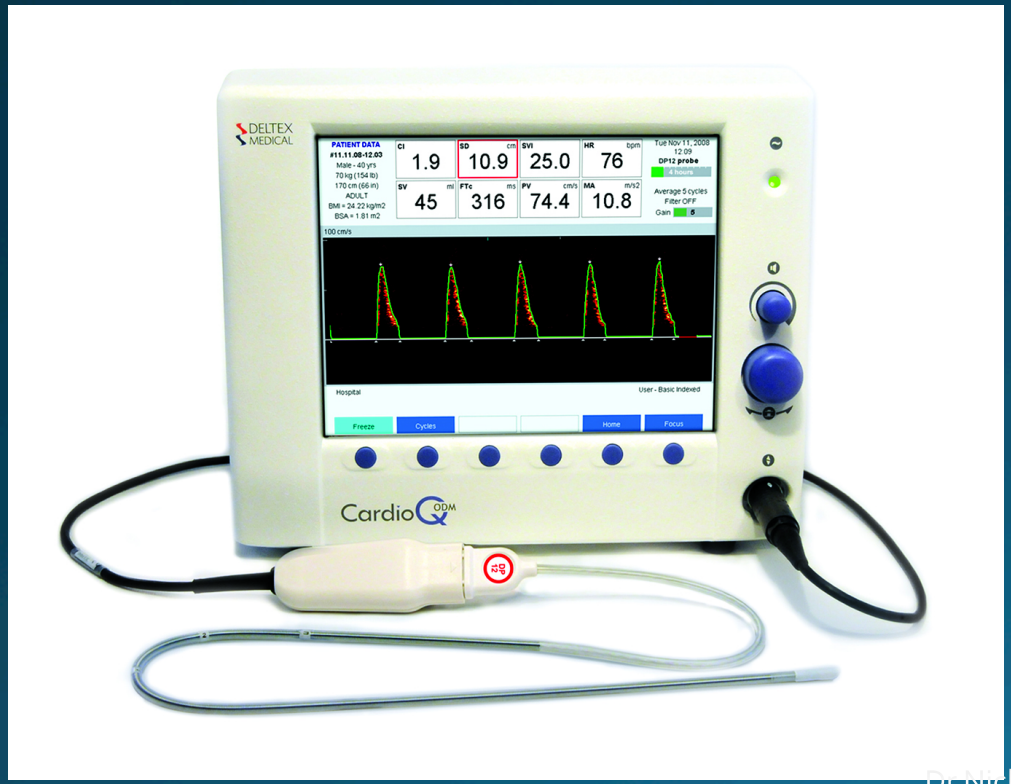
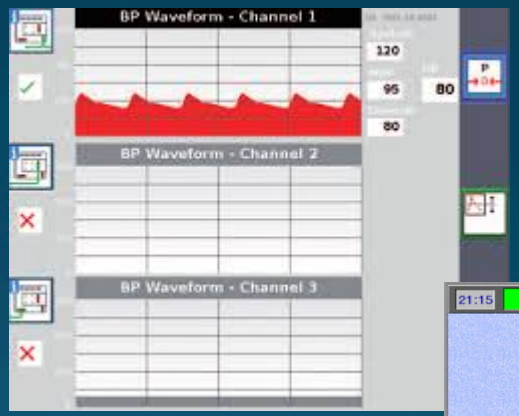
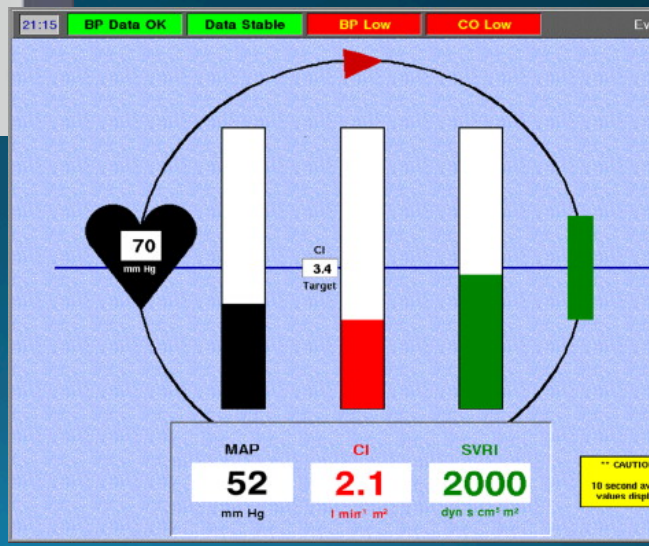
Assessment of circulation and volaemic status

Oesophageal doppler



Pulse waveform analysis





Assessment of ventricular performance

Continuous monitoring

- Stroke volume
- Cardiac output/index
- Stroke volume variation
- PA pressures
- PACWP
- SVR/SVRI

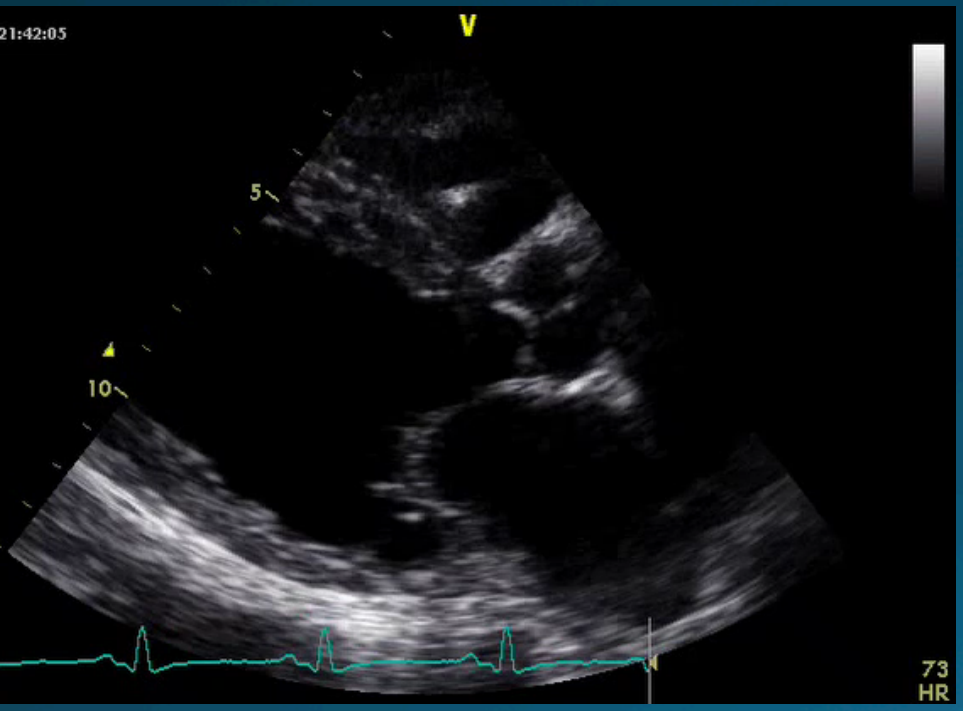
Echocardiography

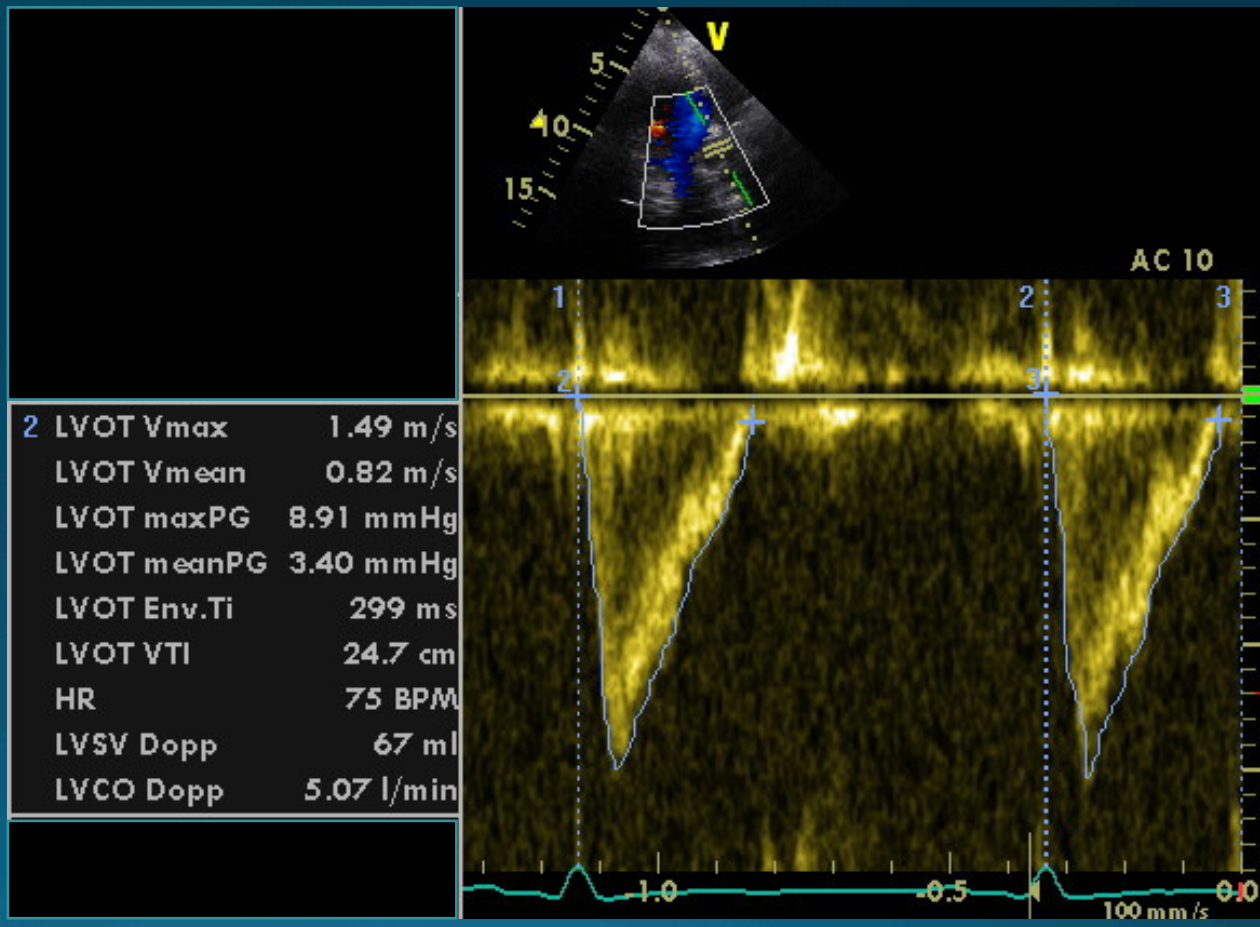
Semi-continuous monitoring

- VTI/stroke distance
- VTI respiratory variation
- Stroke volume
- Cardiac output/index
- PA pressures
- Ejection fraction
- dP/dt
- TDI S'
- Diastolic function
- Right Ventricular function
- Hepatic vein flow
- IVC respiratory variation
- SVC respiratory variation

LV assessment

oke volume assessment





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LV assessment

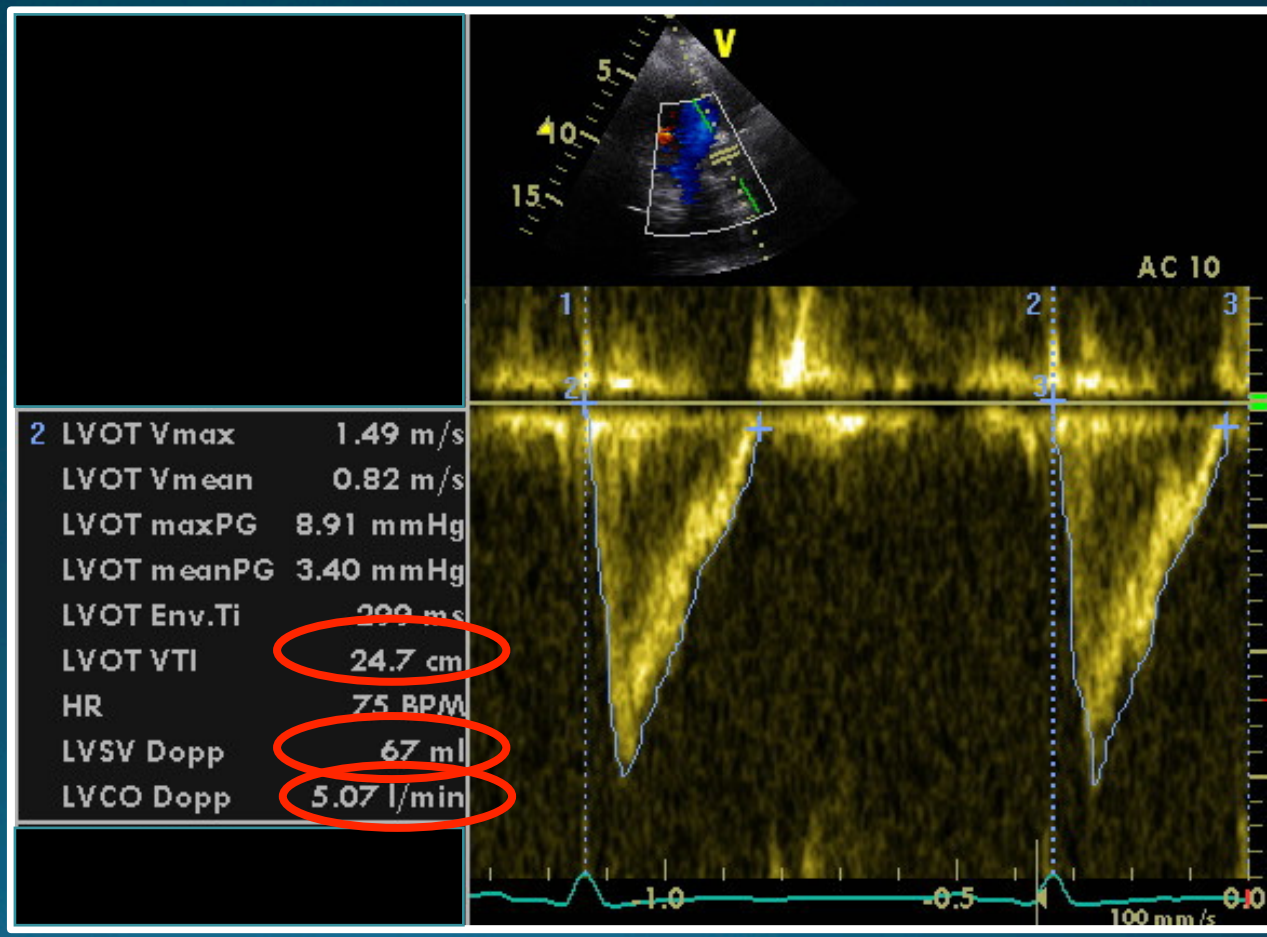
oke volume assessment

$V_{LVOT} = SD_{LVOT} \times Area_{LVOT}$

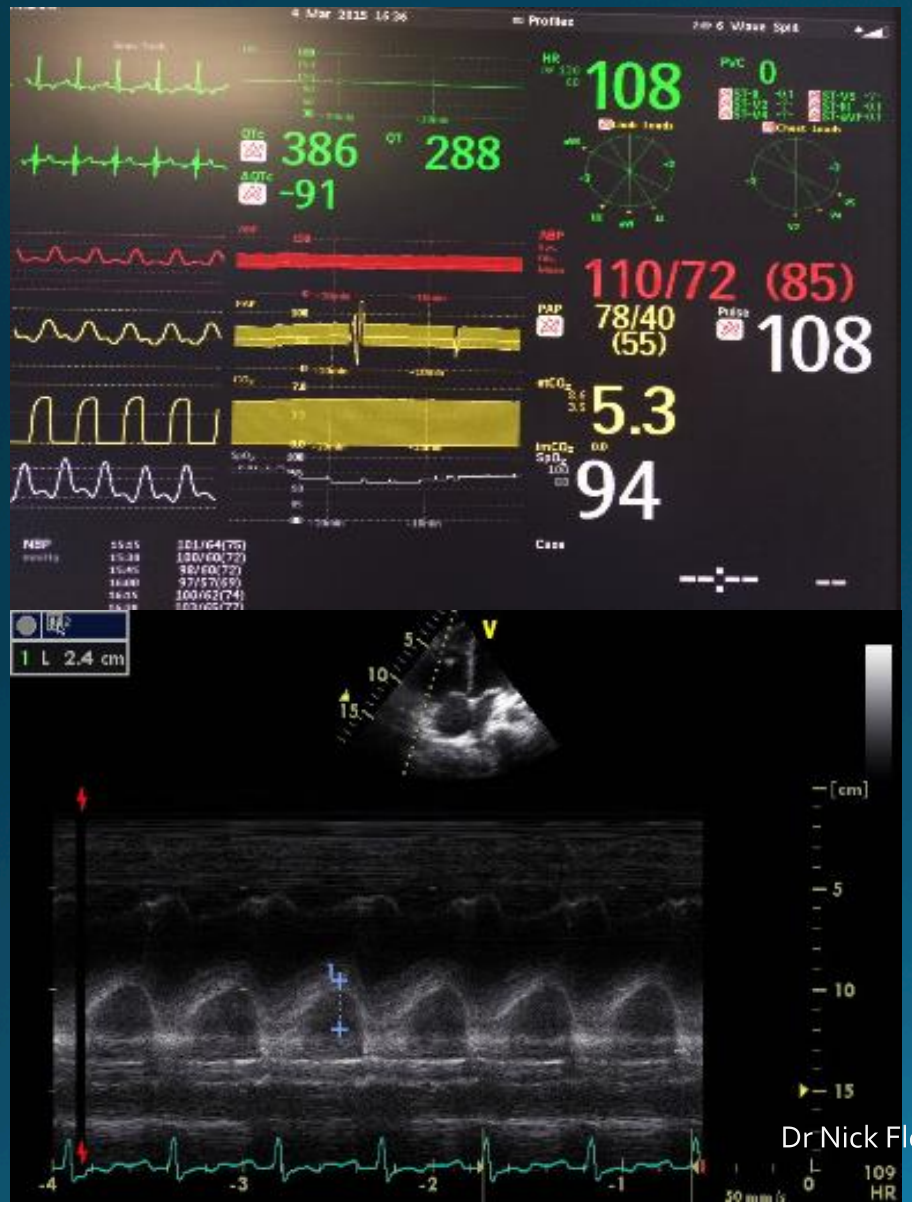
$V_{LVOT} = VTI_{LVOT} \times \pi r^2_{LVOT}$

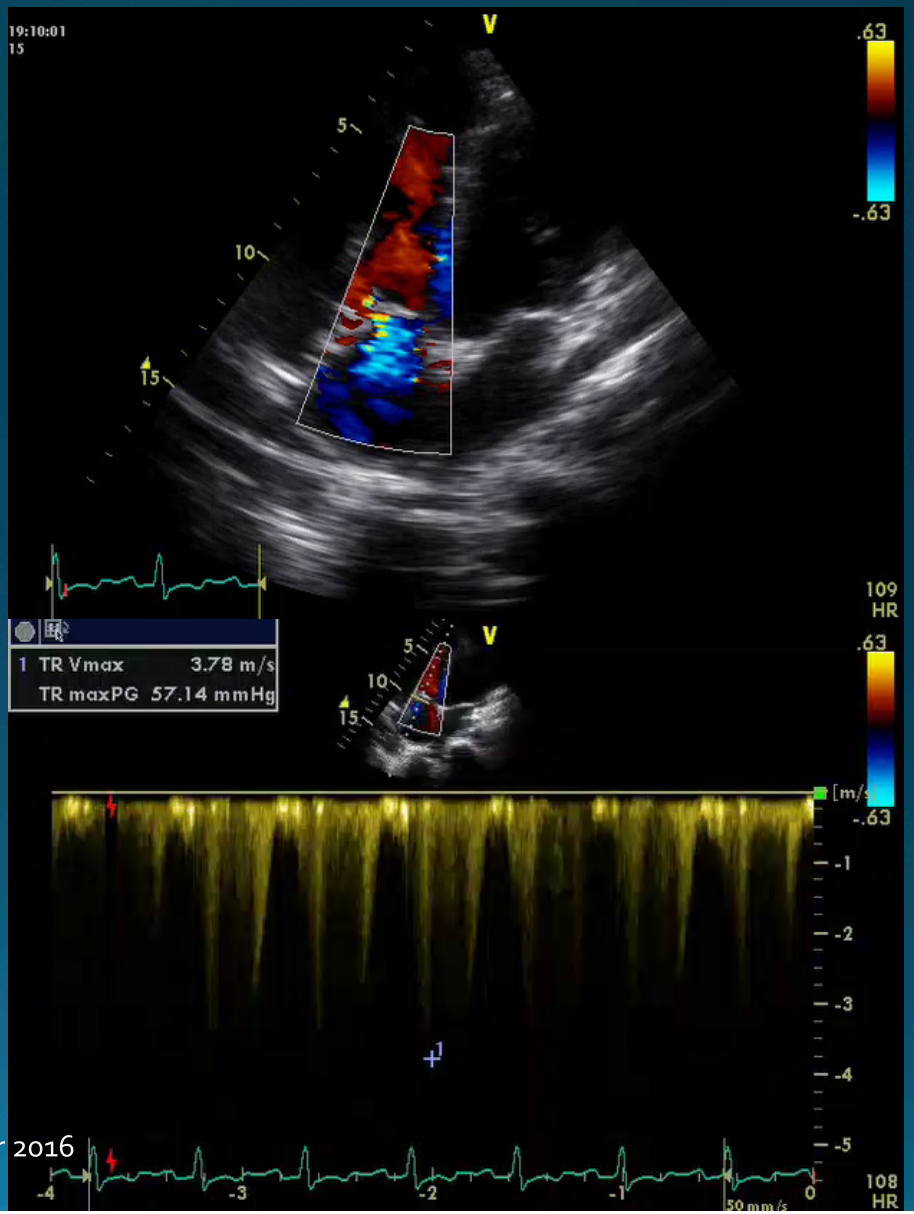
$V_{LVOT} = 24.7 \times \pi (1.9/2)^2$

$V_{LVOT} = 67$ mls



RV function and pulmonary haemodynamics





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Assessment of circulation and volume status

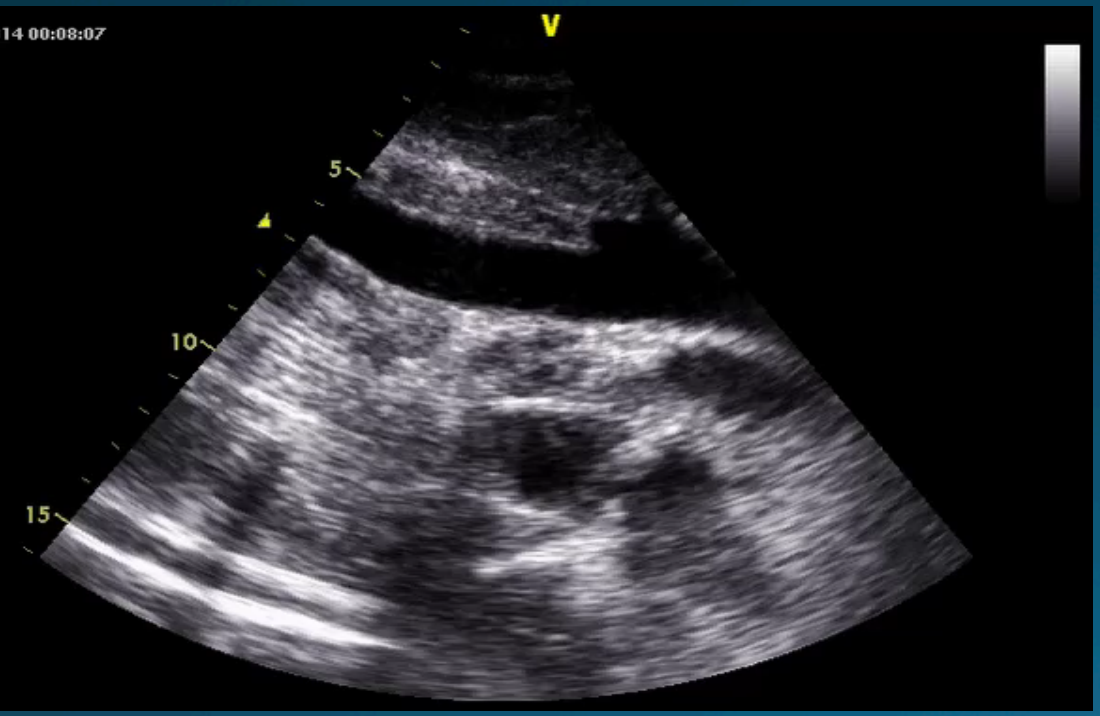
- LVEDD/LVEDA/LVEDAI/LVEDV(Simpsons)
- RVEDD and RVEDA
- IVC diameter
- IVC collapsibility (spontaneous respiration)

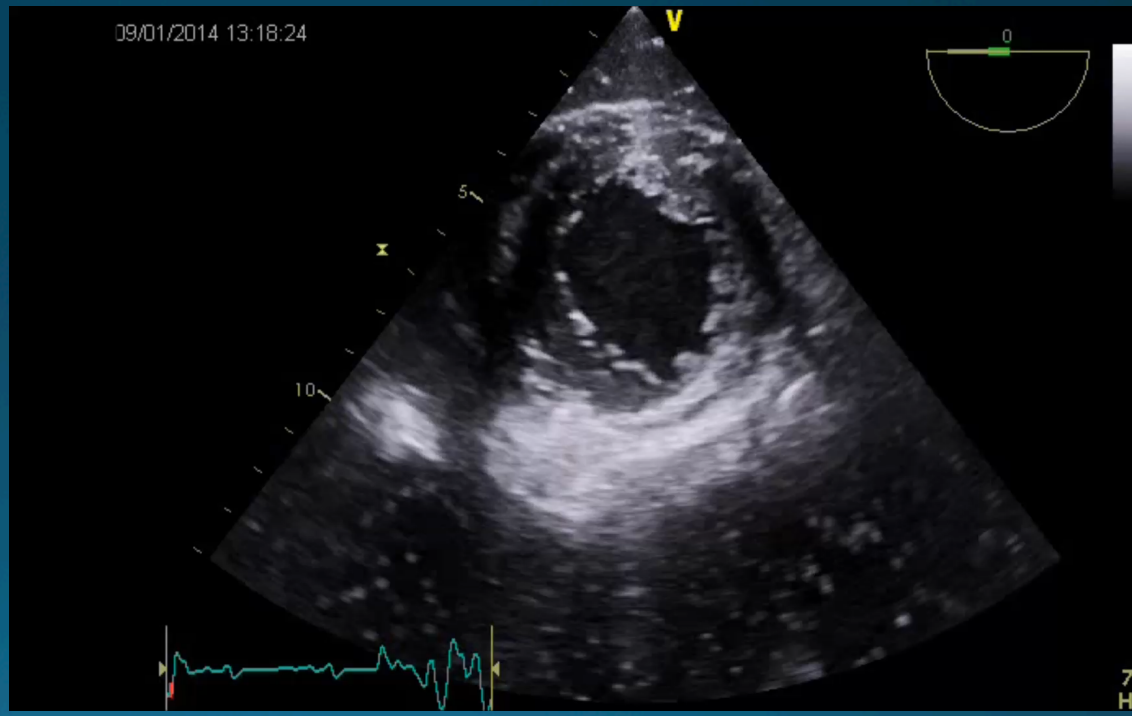
Static parameter

- IVC distensibility (mechanical ventilation)
- SVC collapsibility
- Aortic VTI

Dynamic parameter

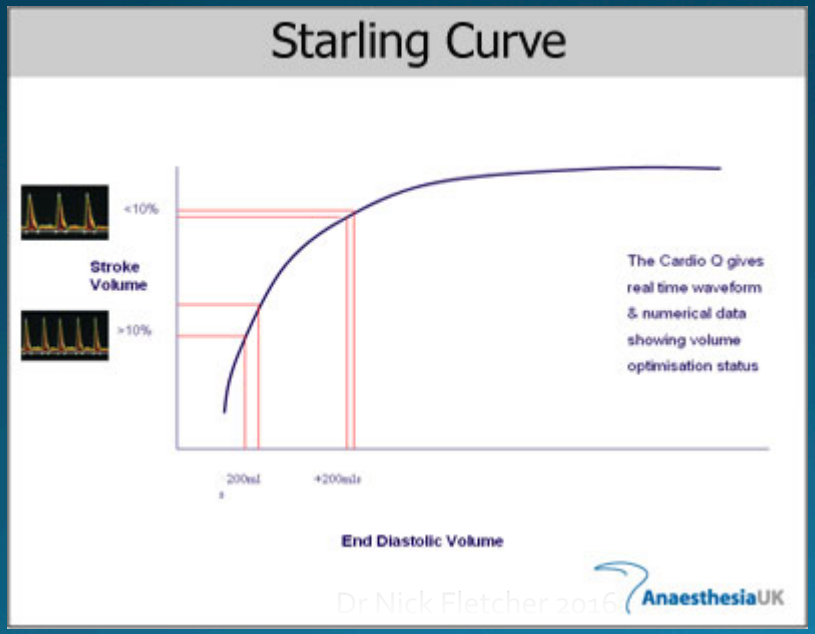
Echocardiography and volume status



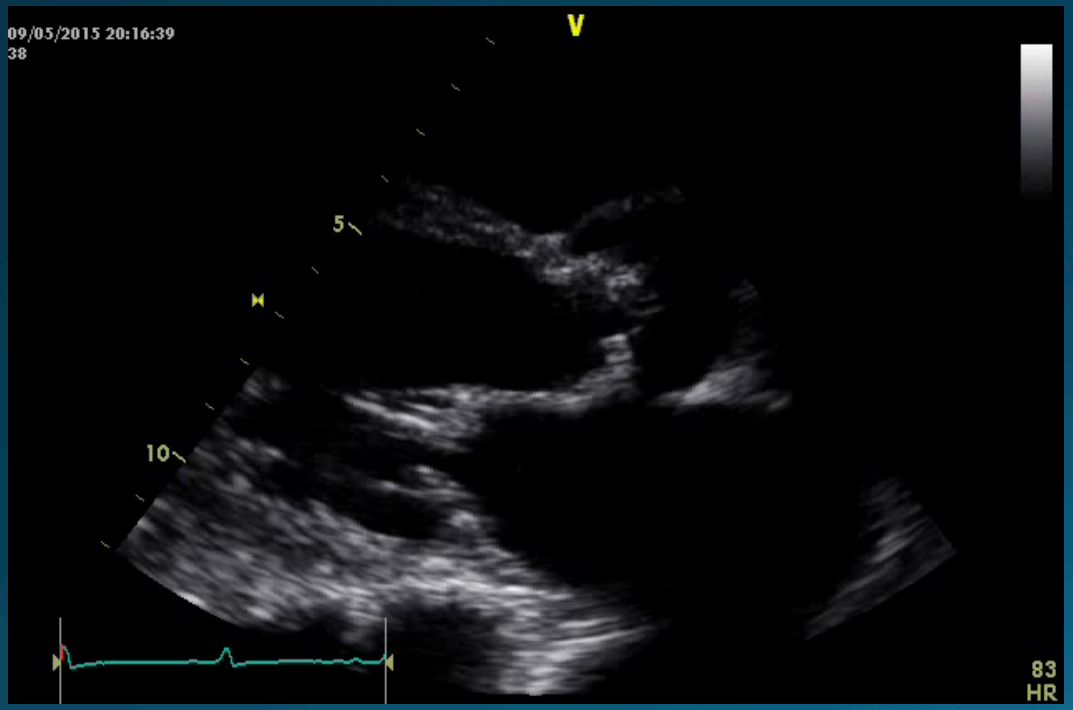


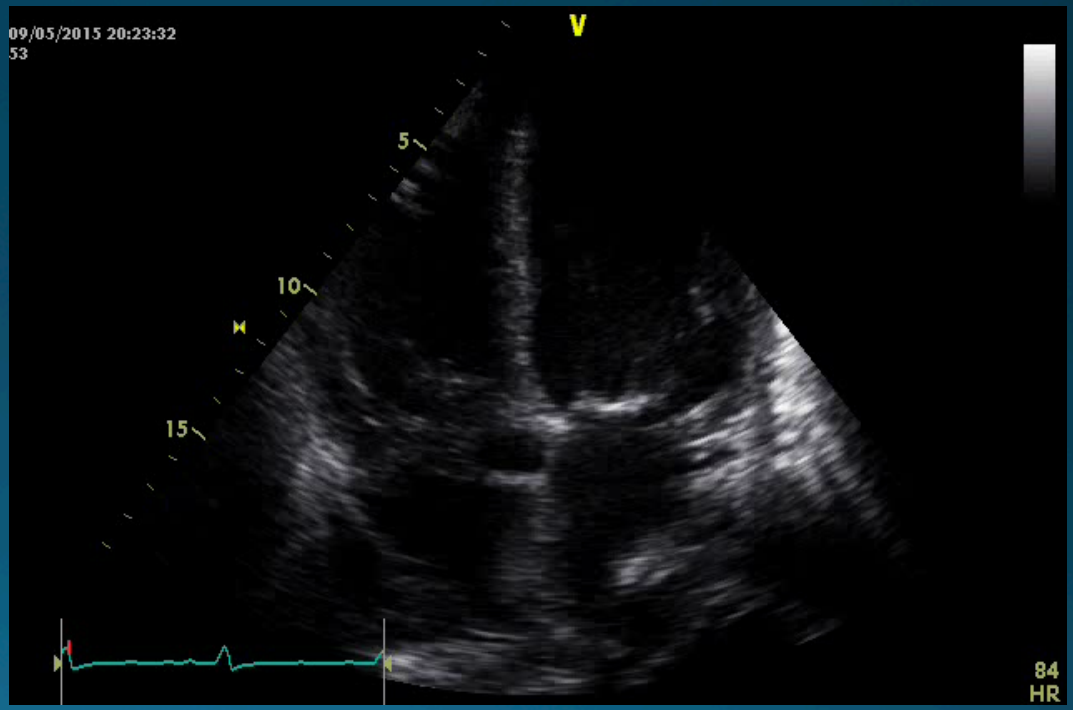
Dynamic indicators of volaemic status

- Manipulation of ventricular loading conditions
- Determines where the patient is on the Frank-Starling ventricular function curve – pre load dependent or independent
- Mechanical ventilation and passive leg raising can be used to predict fluid responsiveness in ICU

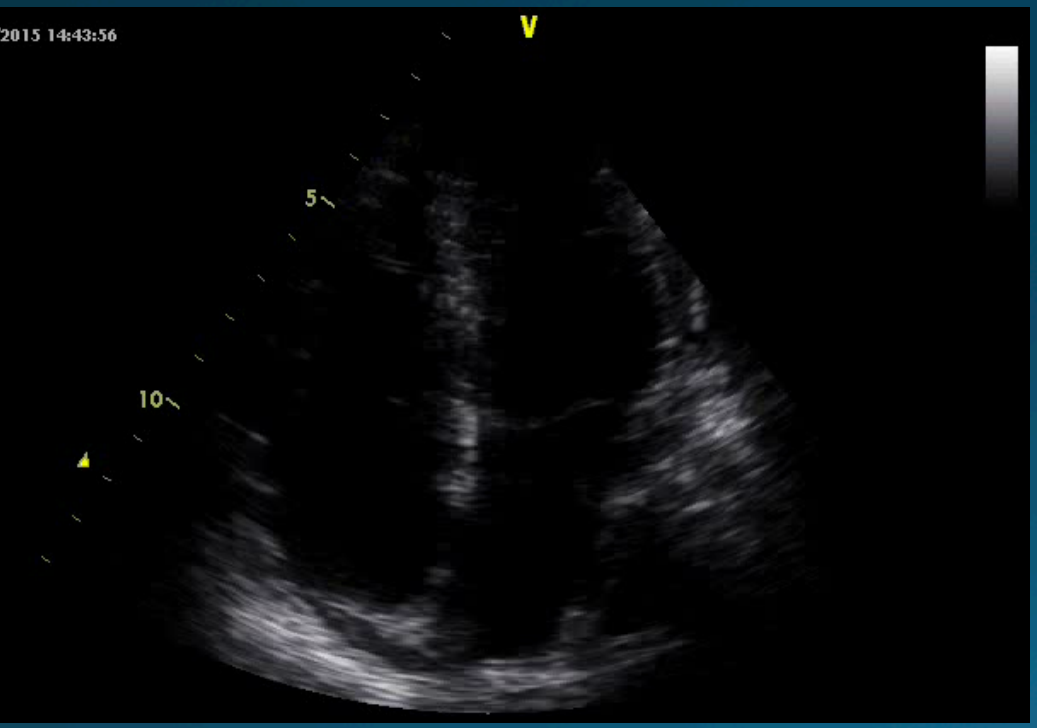


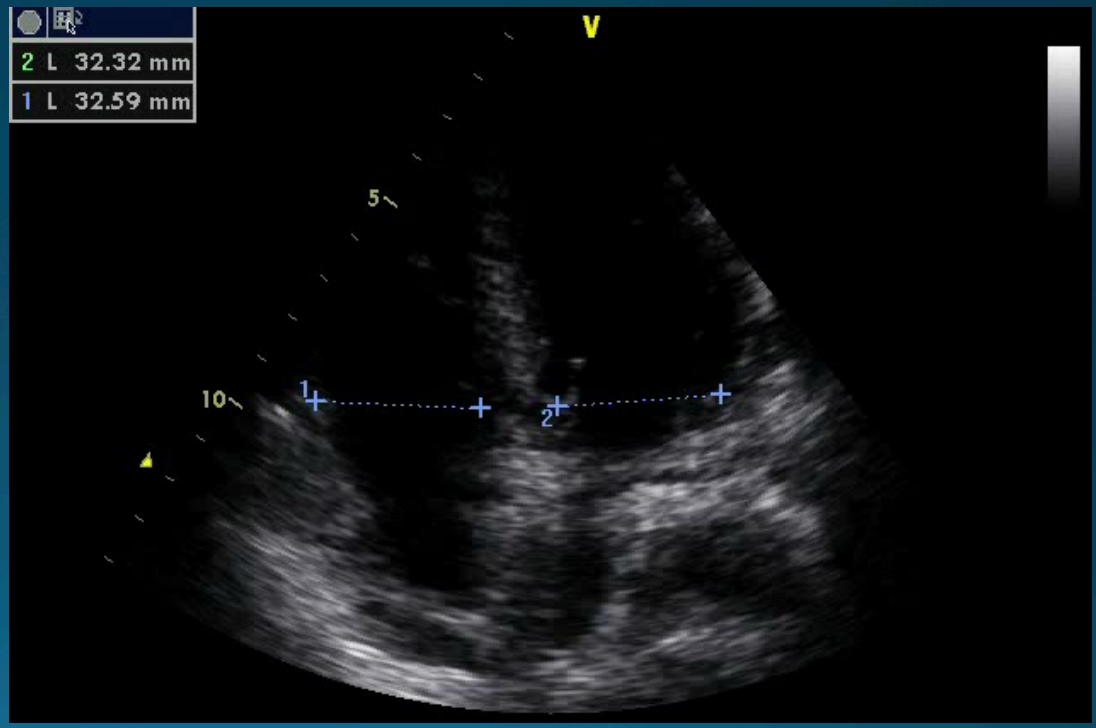
Acute Cardiology - Referred end stage AS



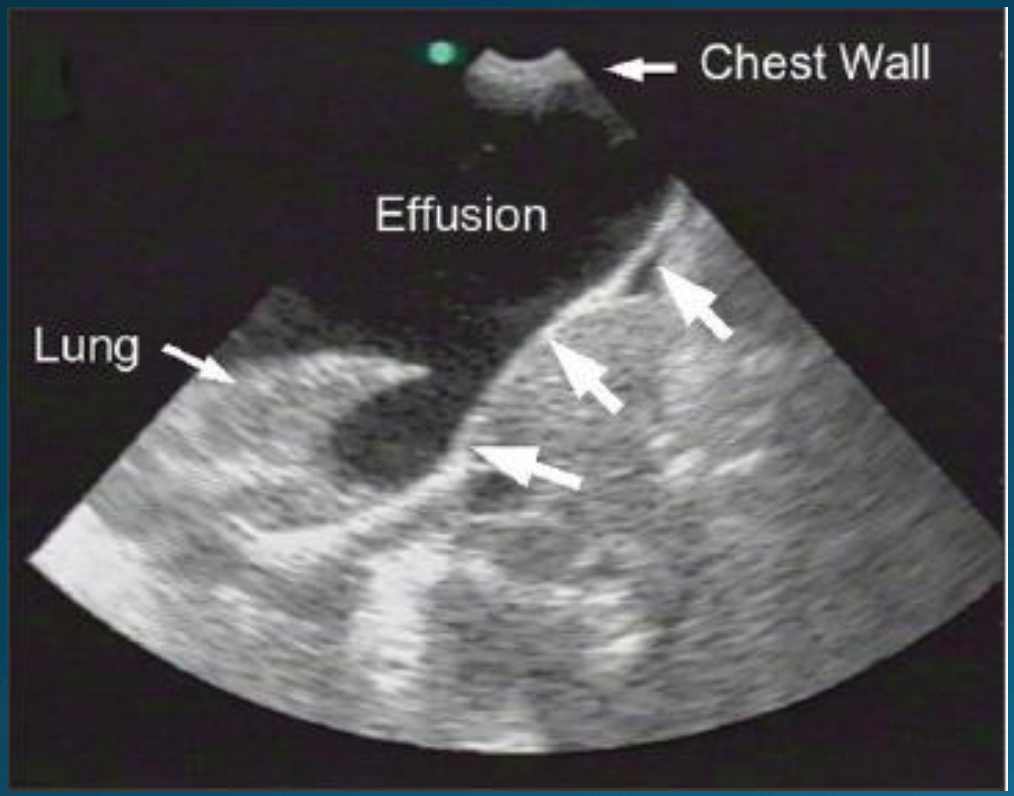


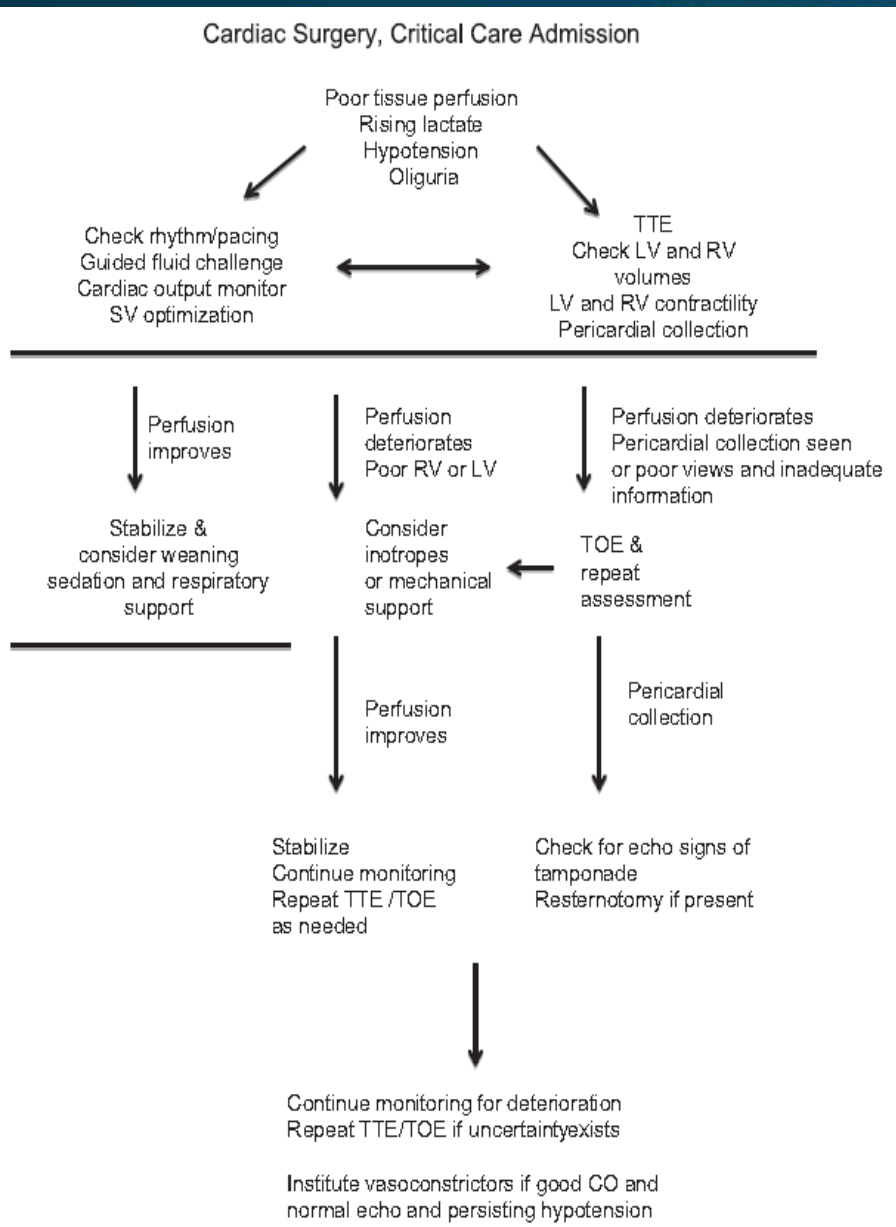
Acute Lung Injury HFOV



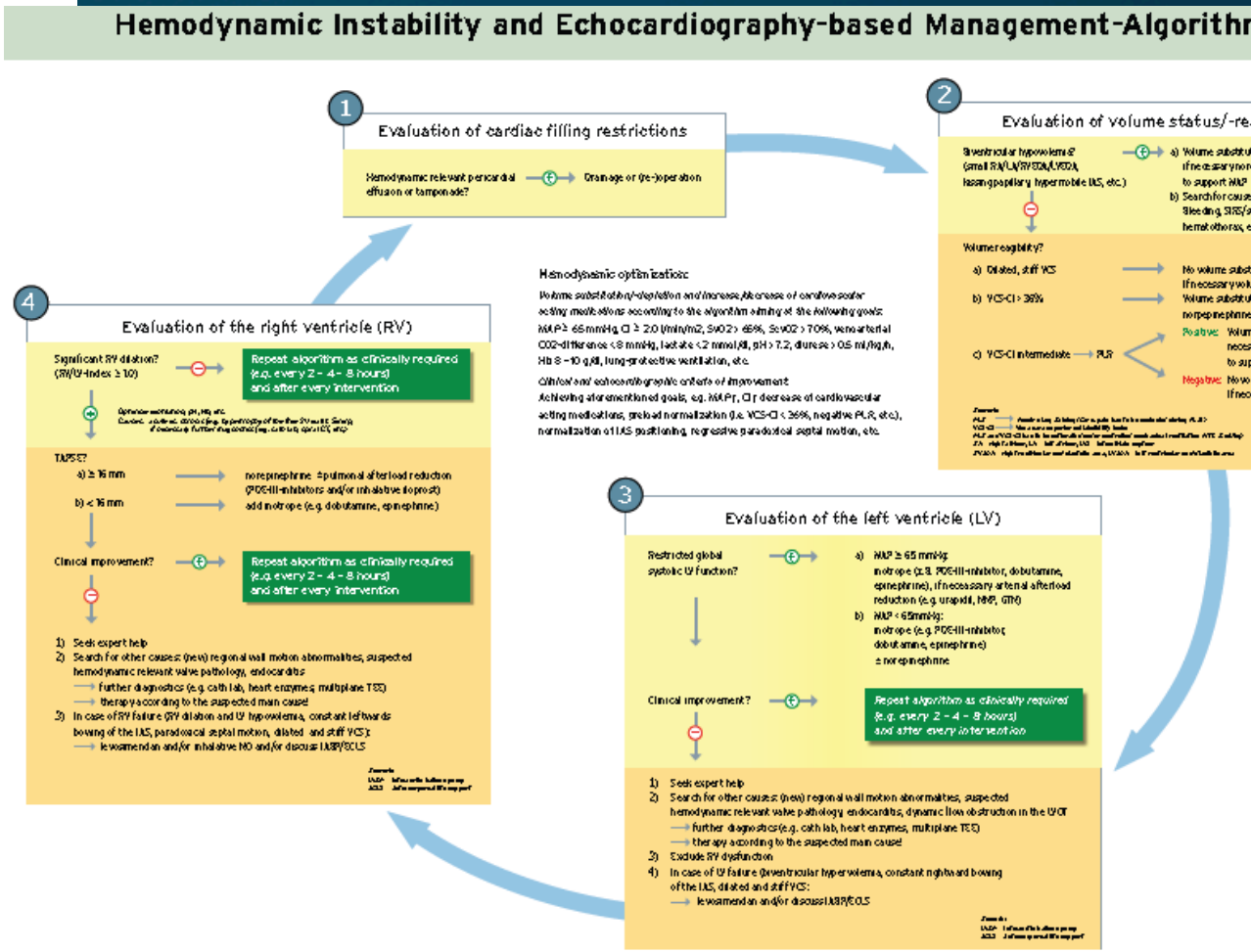


Lung Ultrasound





ig 8. **Algorithm suggesting the role of echocardiography in post-cardiac surgical hemodynamic management.**



Future directions

Semi-continuous mini TOE monitoring

Intensive Care Med
DOI 10.1007/s00134-012-2797-4

ORIGINAL

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Cyril Charron
Jean-Bernard Amiel
Cédric Esterez
François Leleu
Xavier Repesse
Philippe Vignon

A pilot study on safety and clinical utility of a single-use 72-hour indwelling transesophageal echocardiography probe

Initial Clinical Experience With a Miniaturized Transesophageal Echocardiography Probe in a Cardiac Intensive Care Unit

Nick Fletcher, MBBS, FRCA, FFICM,*† Martin Geisen, MD,* Hanif Meeran, MBBS, FRCA, FFICM,*†
Dominic Spray, MBBS, FRCA, FFICM,*† and Maurizio Cecconi, MD, MD(UK), FRCA, FFICM*†

Objective: To investigate the safety of a novel, miniaturized, monoplane transesophageal echocardiography probe (mTEE) and its potential as a hemodynamic monitoring tool.

Design: This was a retrospective analysis of the clinical evaluation of a disposable mTEE in ventilated patients with severe cardiogenic shock requiring hemodynamic support. mTEE assessment was performed by operators with mixed levels of TEE training. Information on hemodynamic interventions based on mTEE findings was recorded.

Setting: A tertiary university cardiac critical care unit.

Participants: Male and female critical care patients admitted to the unit with severe hemodynamic instability.

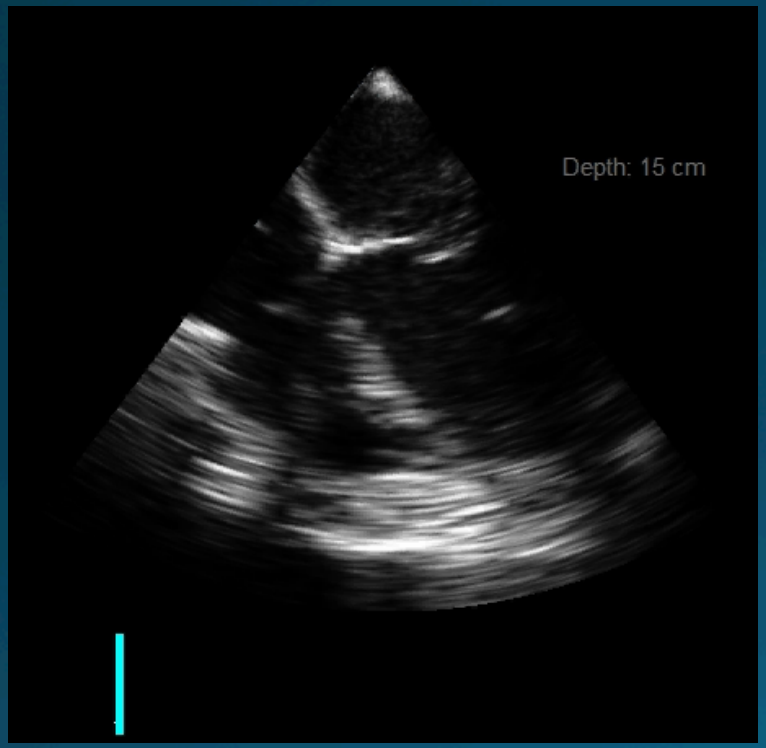
Interventions: Insertion of miniaturized disposable TEE probe and hemodynamic and other critical care interventions based on this and conventional monitoring.

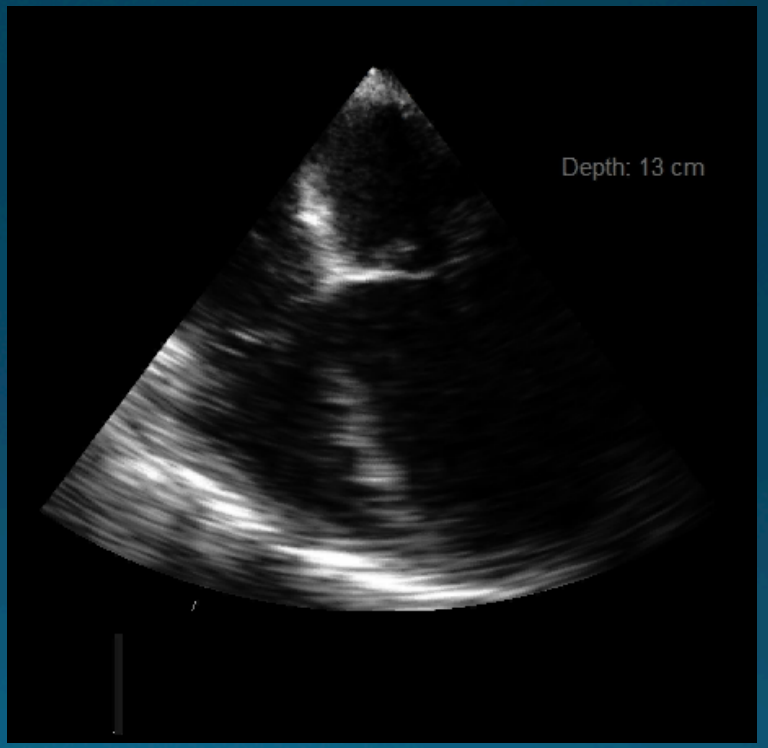
Measurements and Main Results: In 41 patients (51.2% female, 73.2% after cardiac surgery), hemodynamic support probe insertion was accomplished without major complications. A total of 195 mTEE studies were performed, resulting in changes in therapy in 37 (90.2%) patients based on mTEE findings, leading to an improvement in hemodynamic parameters in 33 (80.5%) patients. Right ventricular (RV) failure was diagnosed in 25 patients (67.6%) and mTEE had a direct therapeutic impact on management of RV failure in 17 patients (68 %).

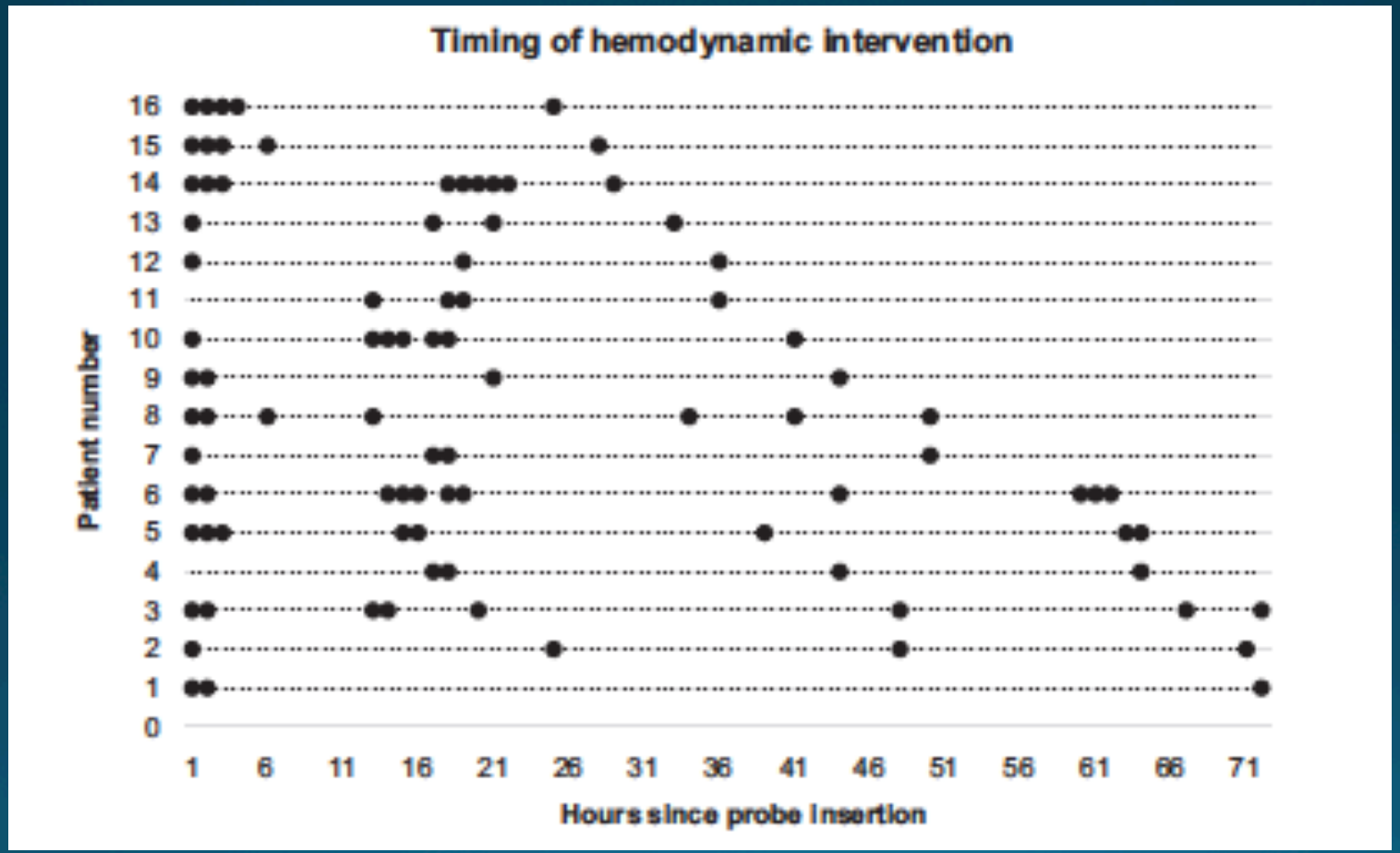
Conclusions: Insertion and operation of a novel, miniaturized transoesophageal echocardiography probe can be performed for up to 72 hours without major complications. Repeated assessment using this device provides complementary information to invasive monitoring in the majority of patients and has an impact on hemodynamic management.

KEY WORDS: echocardiography, transesophageal, hemodynamic, critical care, intensive care

RV failure post AVR







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tensive Care Med (2014) 40:654–666
OI 10.1007/s00134-014-3228-5

CONFERENCE REPORTS AND EXPERT PANEL

xpert Round Table on
chocardiography in ICU

International consensus statement on training standards for advanced critical care echocardiography

Dr Nick Fletcher 2016

Conclusions

- The use of ultrasound in critical care has passed a 'tipping point'
- Lung ultrasound is rapidly becoming a standard of care
- TTE is becoming embedded into curricula
- Time to put it in FFICM curriculum?
- How do we deliver a structured ICU ultrasound/echo service?

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