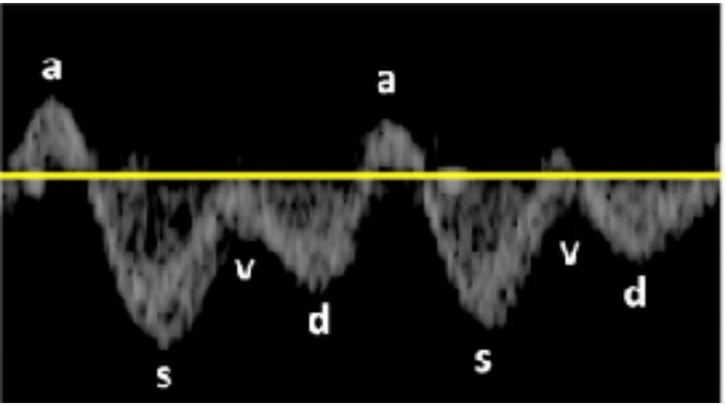
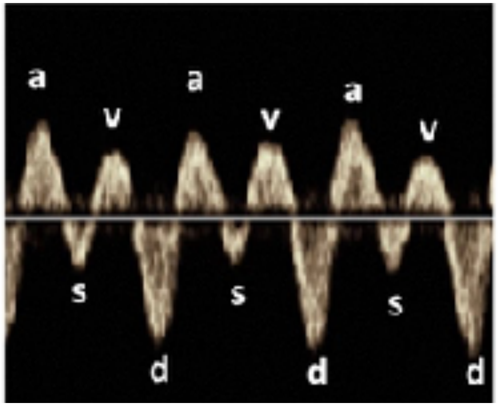
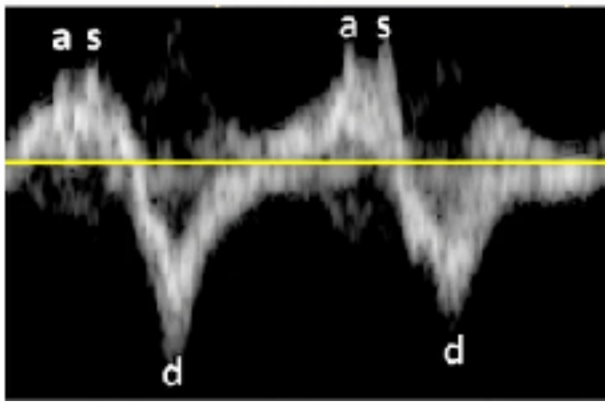
衛生福利部雙和醫院
(委託臺北醫學大學興建經營)
Taipei Medical University - Shuang Ho Hospital, Ministry of Health and Welfare

VExUS
Fluid Responsiveness







陳國智醫師 雙和醫院急診醫學科

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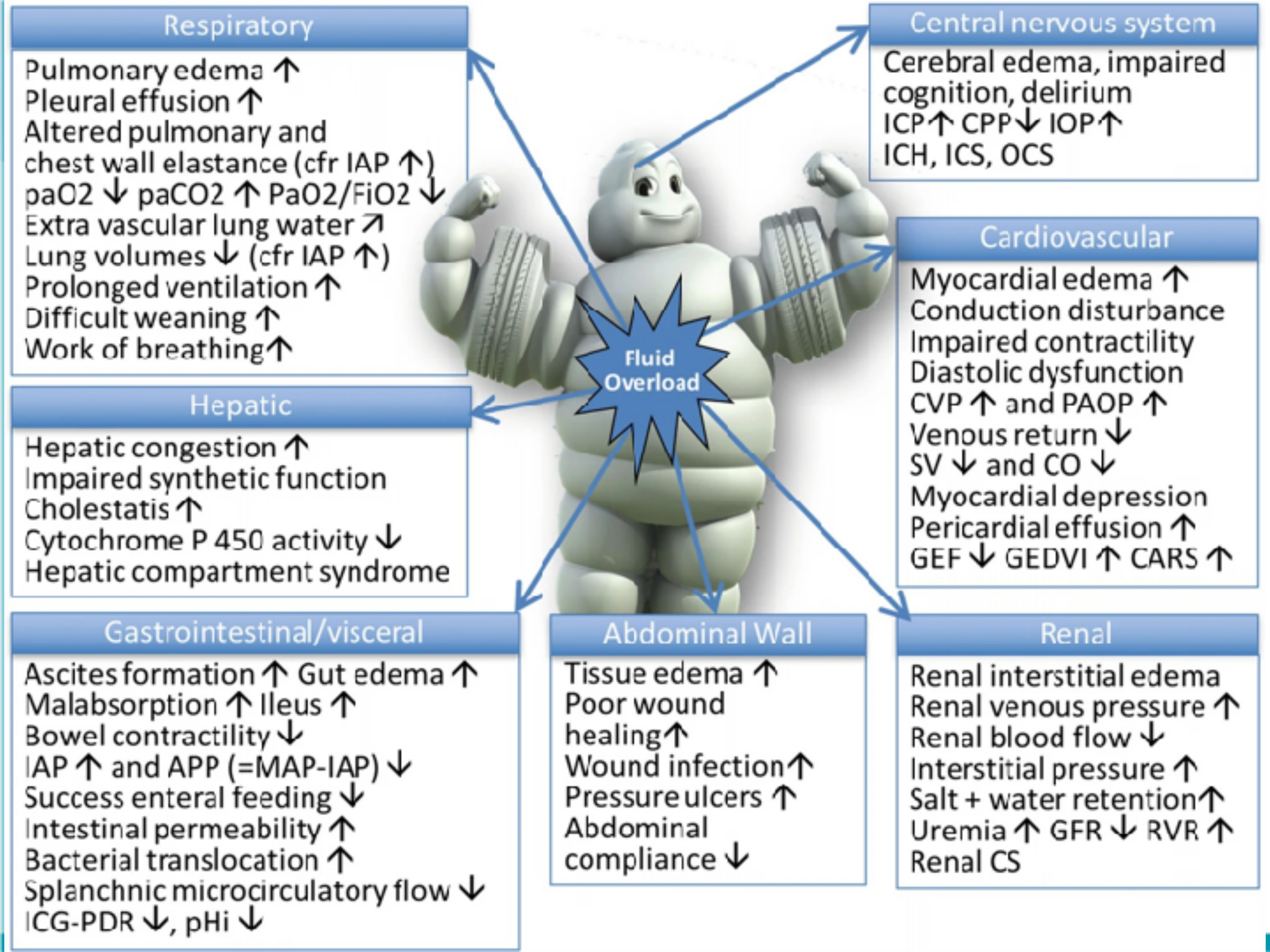
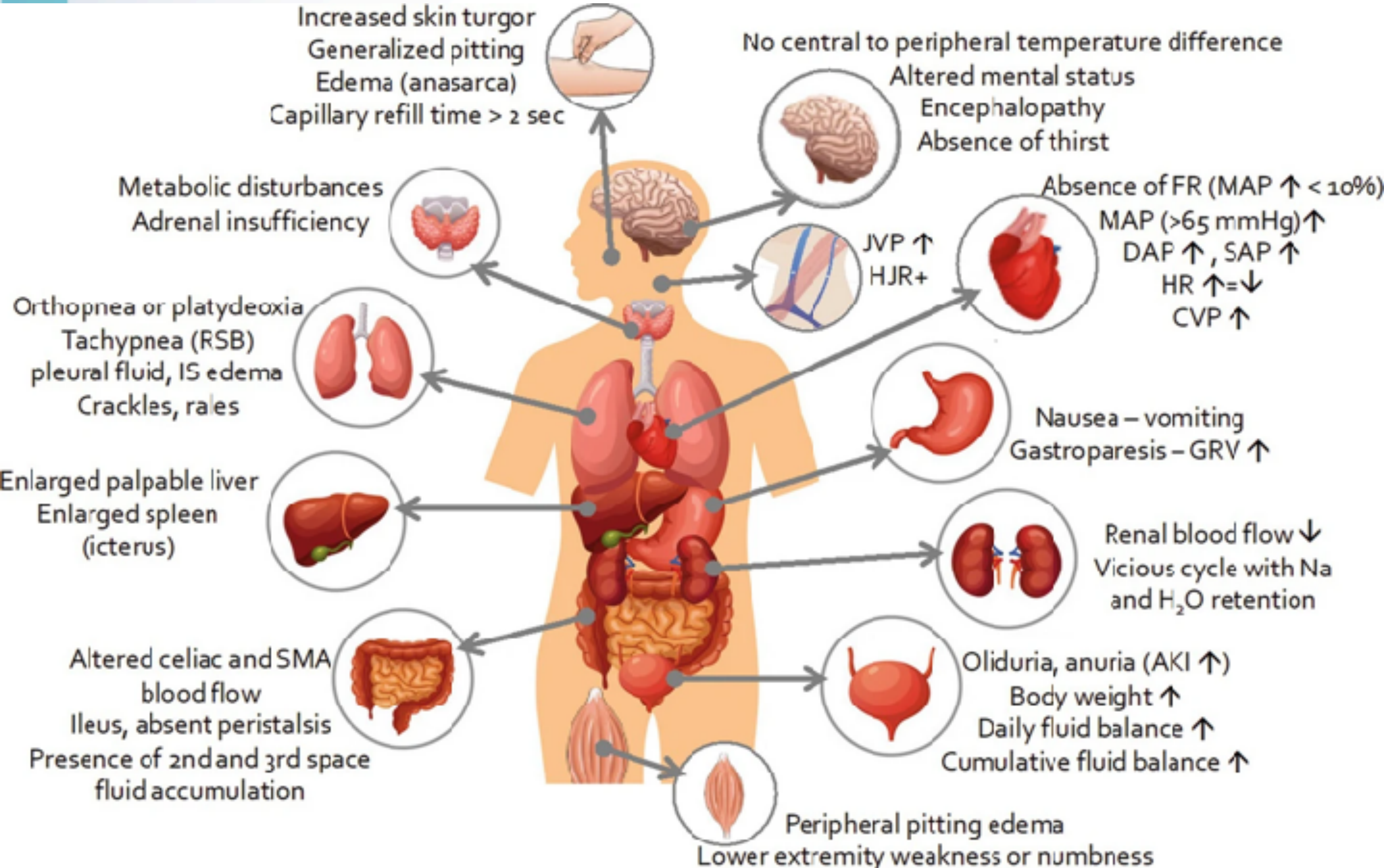
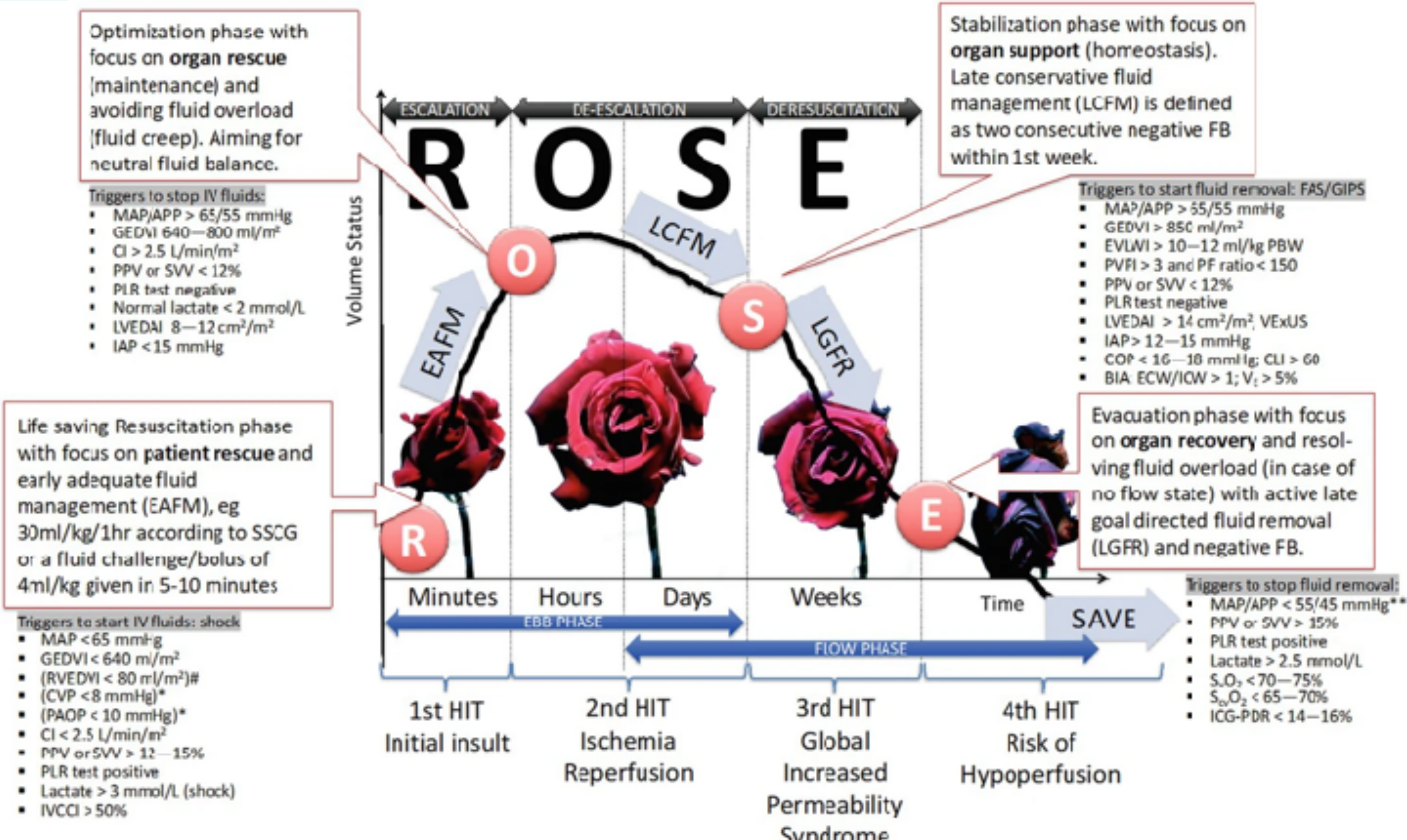

Respiratory
Pulmonary edema ↑
Pleural effusion ↑
Altered pulmonary and chest wall elastance (cfr IAP ↑)
paO2 ↓ paCO2 ↑ PaO2/FiO2 ↓
Extra vascular lung water ↗
Lung volumes ↓ (cfr IAP ↑)
Prolonged ventilation ↑
Difficult weaning ↑
Work of breathing ↑
Central nervous system
Cerebral edema, impaired cognition, delirium
ICP ↑ CPP ↓ IOP ↑
ICH, ICS, OCS
Fluid Overload
Cardiovascular
Myocardial edema ↑
Conduction disturbance
Impaired contractility
Diastolic dysfunction
CVP ↑ and PAOP ↑
Venous return ↓
SV ↓ and CO ↓
Myocardial depression
Pericardial effusion ↑
GEF ↓ GEDVI ↑ CARS ↑
Hepatic
Hepatic congestion ↑
Impaired synthetic function
Cholestatis ↑
Cytochrome P 450 activity ↓
Hepatic compartment syndrome
Gastrointestinal/visceral
Ascites formation ↑ Gut edema ↑
Malabsorption ↑ Ileus ↑
Bowel contractility ↓
IAP ↑ and APP (=MAP-IAP) ↓
Success enteral feeding ↓
Intestinal permeability ↑
Bacterial translocation ↑
Splanchnic microcirculatory flow ↓
ICG-PDR ↓, pHi ↓
Abdominal Wall
Tissue edema ↑
Poor wound healing ↑
Wound infection ↑
Pressure ulcers ↑
Abdominal compliance ↓
Renal
Renal interstitial edema
Renal venous pressure ↑
Renal blood flow ↓
Interstitial pressure ↑
Salt + water retention ↑
Uremia ↑ GFR ↓ RVR ↑
Renal CS

Hypervolemia and fluid accumulation s/s



Fluid accumulation syndrome - 4 phase



Rola et al. Ultrasound J (2021) 13:32
https://doi.org/10.1186/s13089-021-00232-8

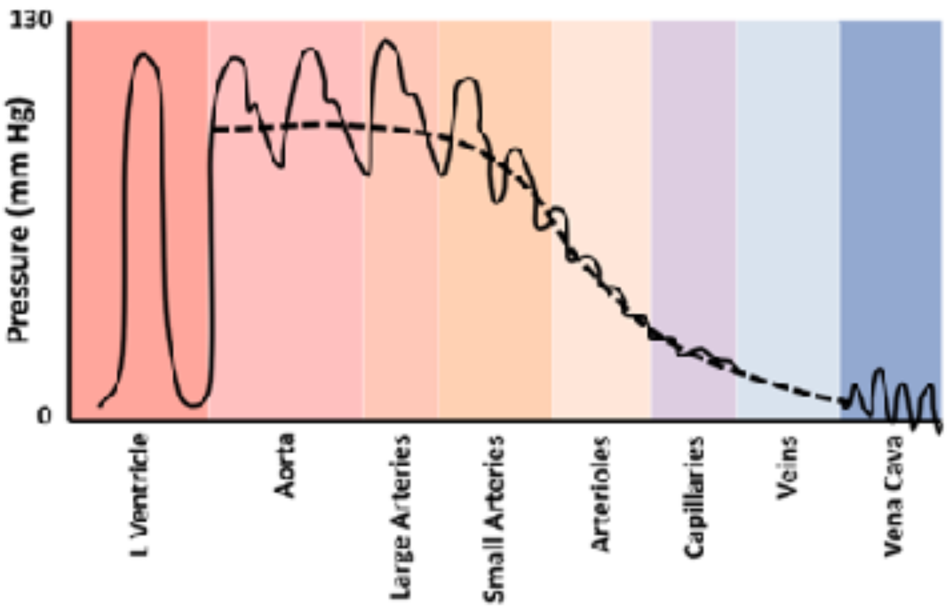
The Ultrasound Journal

CASE REPORT

Open Access

Clinical applications of the venous excess ultrasound (VExUS) score: conceptual review and case series

Philippe Rola[1*], Francisco Miralles-Aguiar[2], Eduardo Argaiz[3], William Beaubien-Souligny[4], Korbin Haycock[5], Timur Karimov[6], Vi Am Dinh[7] and Rory Spiegel[8]



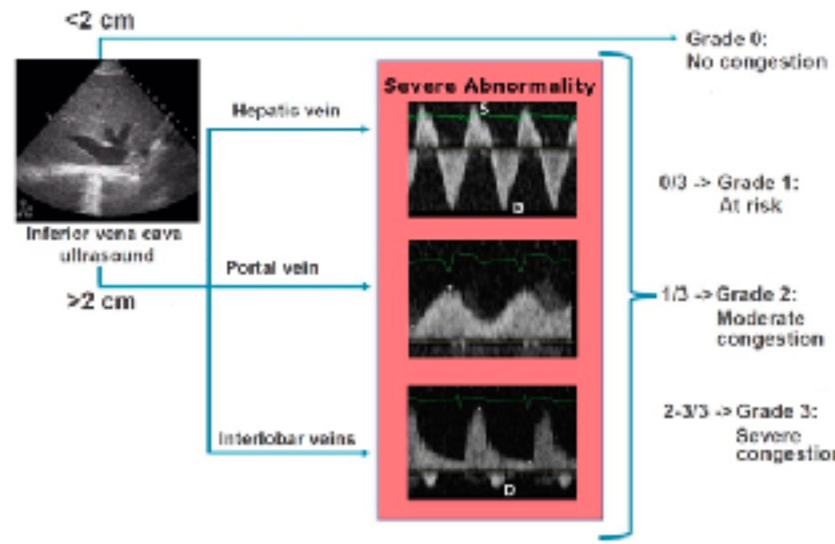
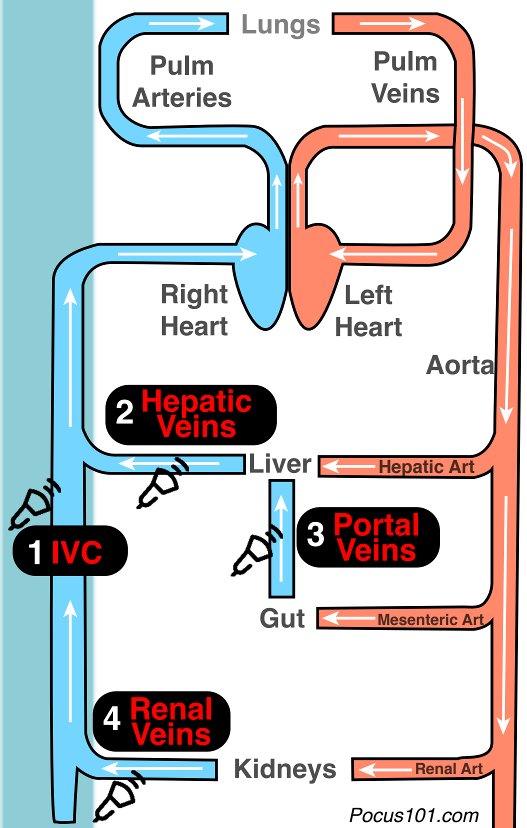
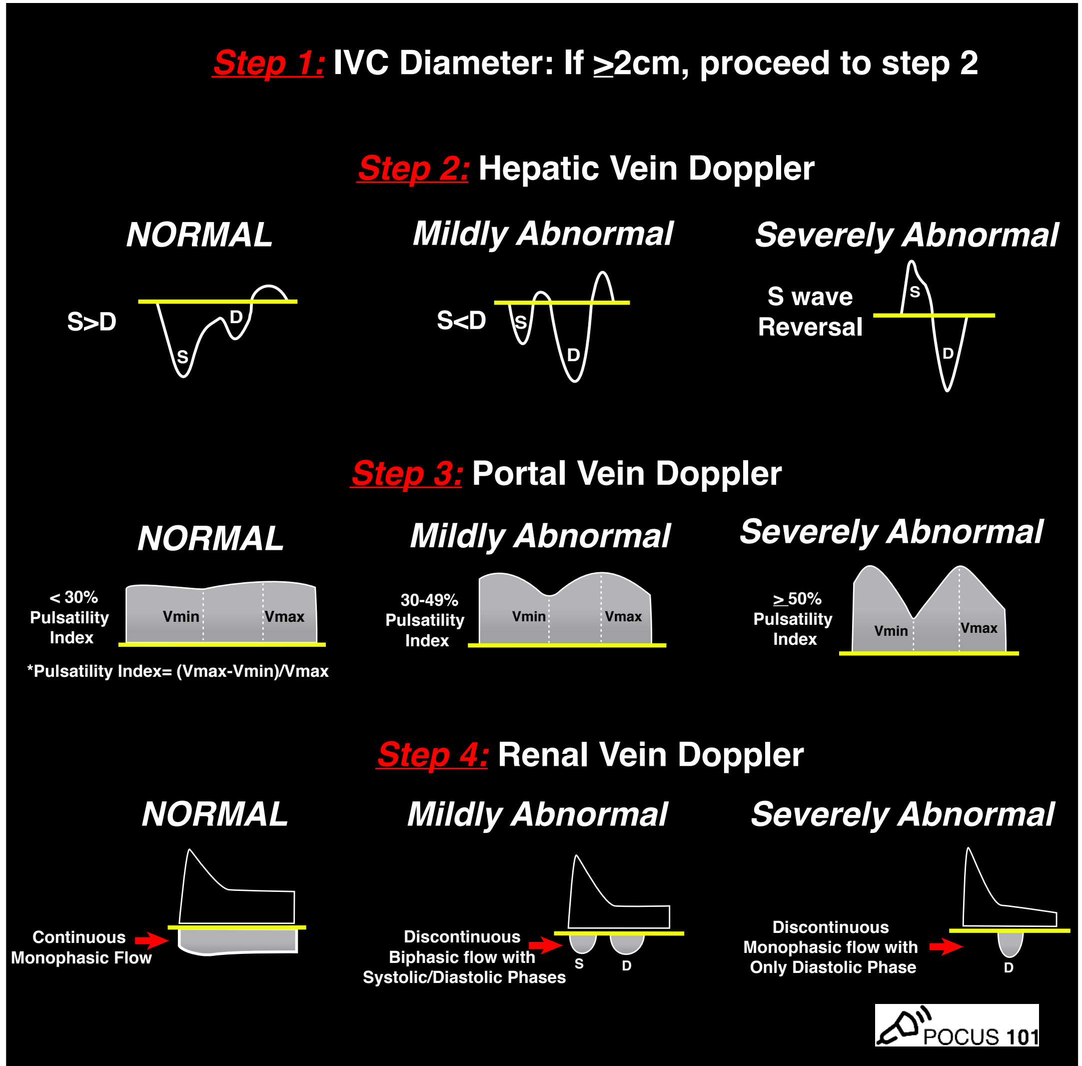


Fig. 7 Doppler profiles showing severe congestive patterns

VExUS protocol

Venous Excess Ultrasound VExUS





Interpretation

Grade 0
(no congestion)
IVC < 2cm

Grade 1
(Mild congestion)
IVC ≥2cm and any combo of Normal or Mildly Abnl Patterns

Grade 2
(Moderate congestion)
IVC ≥2cm and ONE Severely Abnl Pattern

Grade 3
(Severe congestion)
IVC ≥2cm and ≥ 2 Severely Abnl Patterns

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https://doi.org/10.1186/s13089-024-00396-z

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REVIEW Open Access

Decoding VExUS: a practical guide for ex… assess…

Taweevat Ass…

Rola et al. The Ultrasound Journal (2024) 16:49
https://doi.org/10.1186/s13089-024-00395-0

The Ultrasound Journal

SHORT COMMUNICATION Open Access

VExUS: common misconceptions, clinical use and future directi…

Philippe Rola[1*], Korbin Haycock[2,3], Fory Sp…

Abstract
There has been a significant interest in v… prominent, both in clinical practice and … clinicians which are also reflected in cert… to volume status, which is only one of th… context of certain pathologies, which ref… article we review the physiological basis … from the organs' standpoint and its role … these misconceptions for clinicians and f…

Klangthamneam et al.
The Ultrasound Journal (2024) 16:50
https://doi.org/10.1186/s13089-024-00357-y

The Ultrasound Journal

ORIGINAL ARTICLE Open Access

Correlation between right atrial pressure measured via right heart catheterization and venous excess ultrasound, inferior vena cava diameter, and ultrasound-measured jugular venous pressure: a prospective observational study

Suppawee Klangthamneam[1], Krissada Meemook[1], Tananchai Petnak[1], Anchana Sonkaew[1] and Taweevat Assavapokee[1*]

Assavapokee et al. The Ultrasound Journal (2024) 16:48
https://doi.org/10.1186/s13089-024-00396-z

The Ultrasound Journal

REVIEW

Open Access

Decoding VExUS: a practical guide for excelling in point-of-care ultrasound assessment of venous congestion

Taweevat Assavapokee[1*], Philippe Rola[2], Nicha Assavapokee[3] and Abhilash Koratala[4]

VExUS = Venous Excess Ultrasound

IVC - Inferior vena cava

HV - Hepatic vein

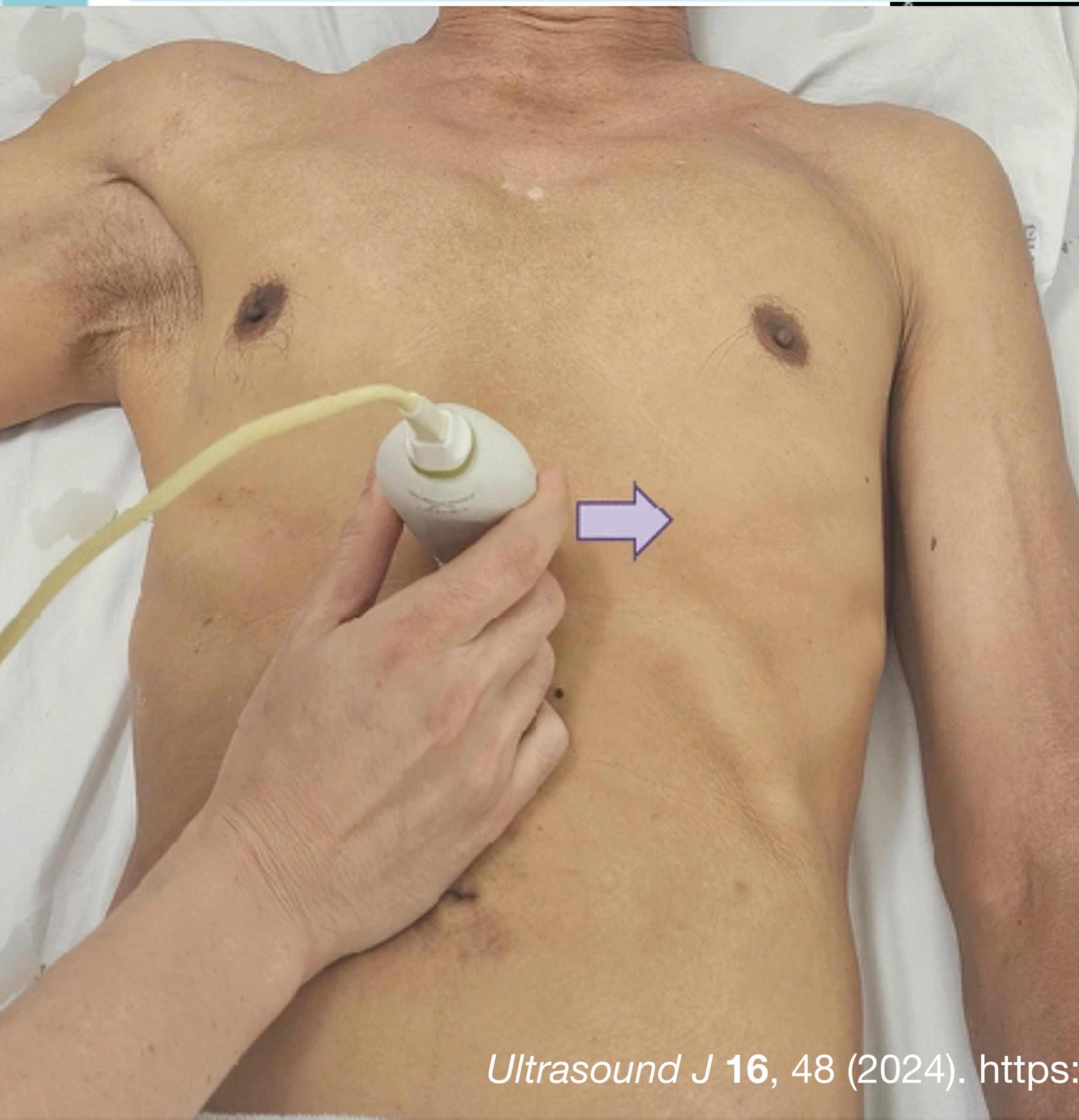
PV - Portal vein

IRV -Intrarenal vein

Indications

Volume overload
Heart failure
Hemodynamic AKI
Shock
Unexplained hypotension

IVC exam - short axis



Ultrasound J **16**, 48 (2024). https://doi.org/10.1186/s13089-024-00396-z

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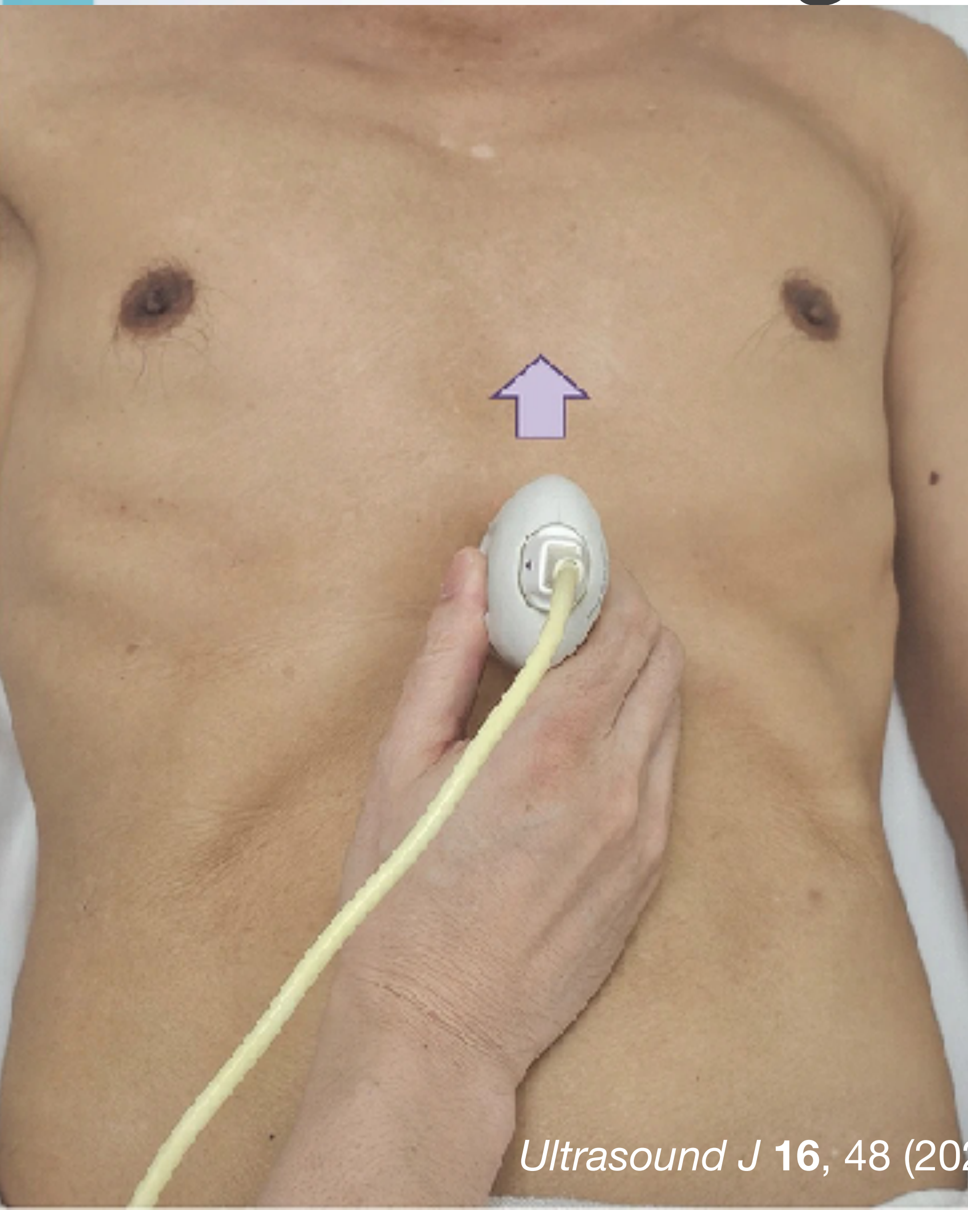
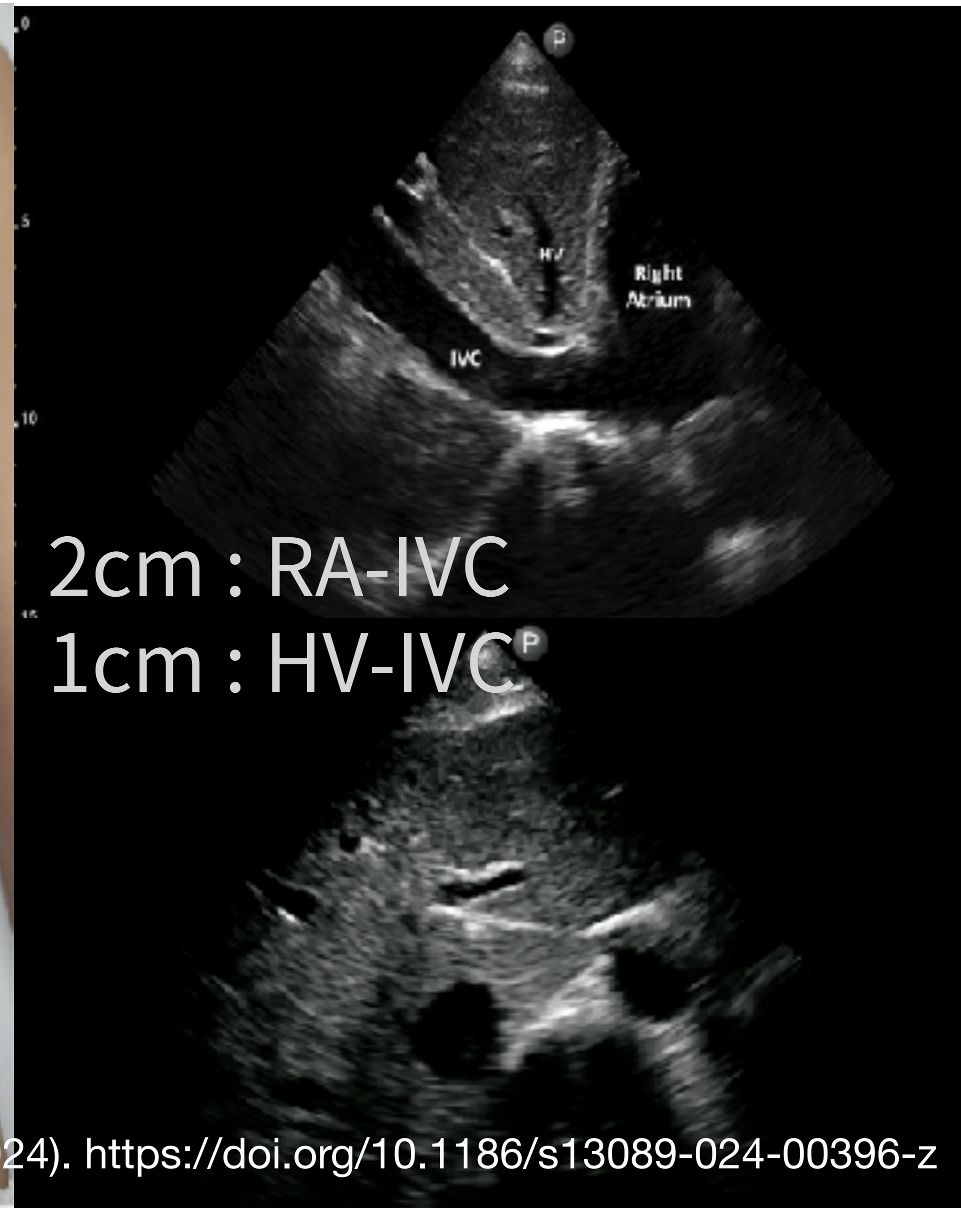
IVC exam - long axis





2cm : RA-IVC
1cm : HV-IVC

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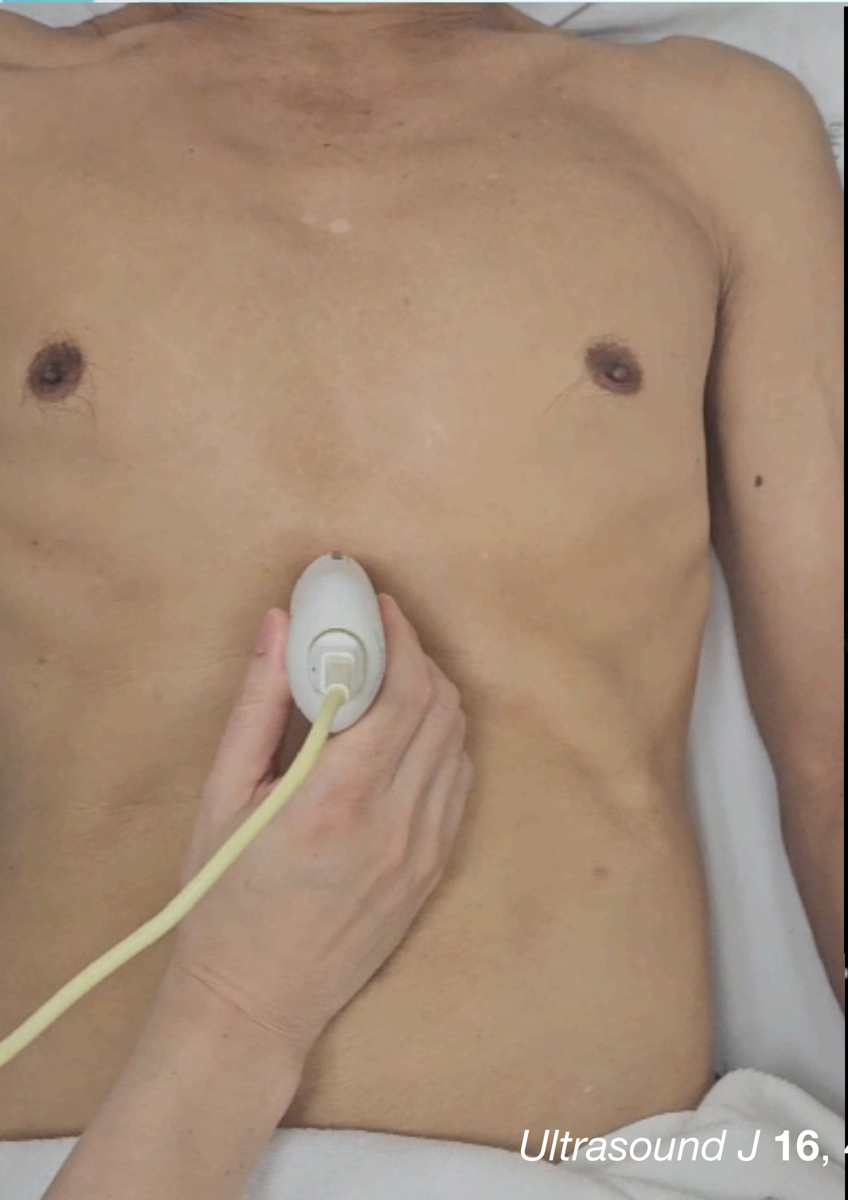
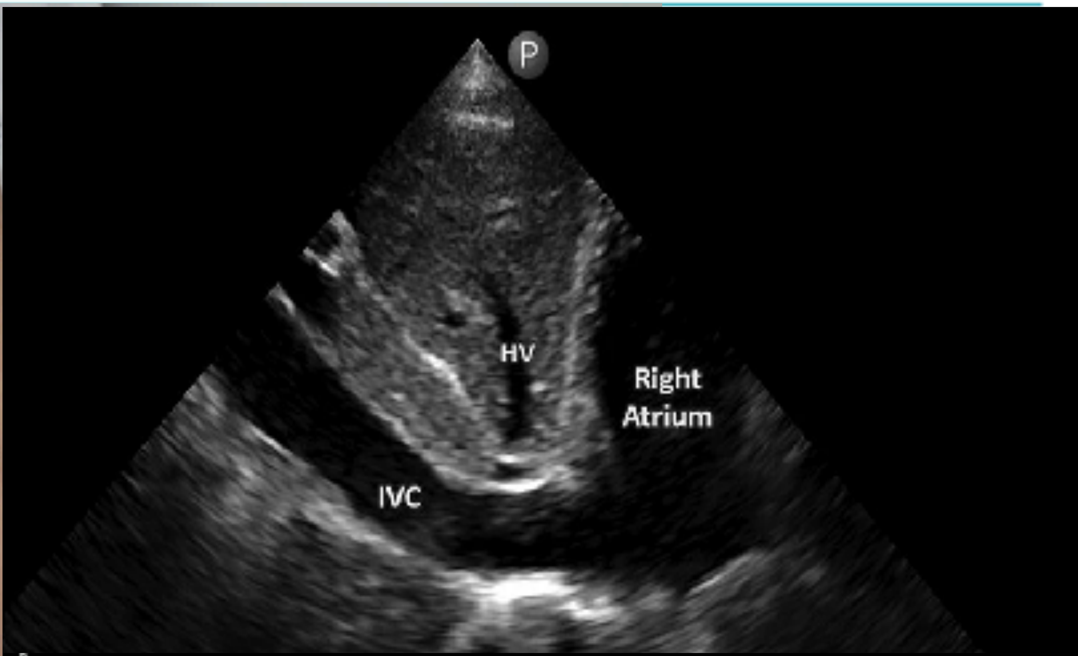
HV exam & Doppler (subxiphoid view)





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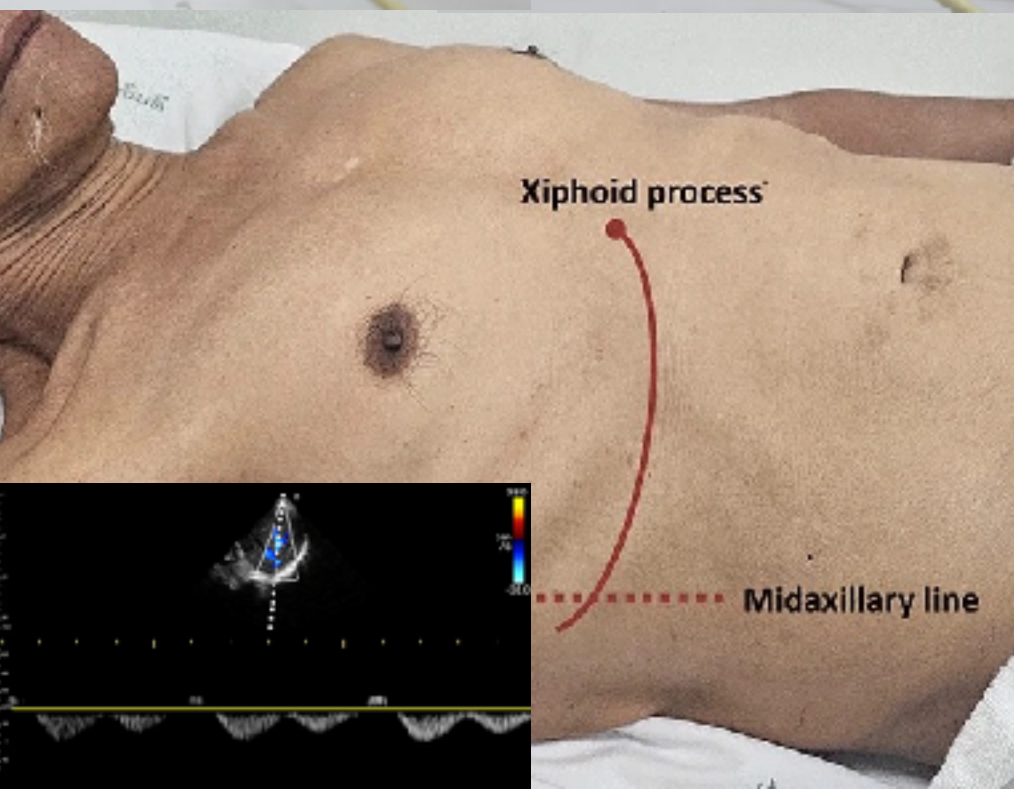
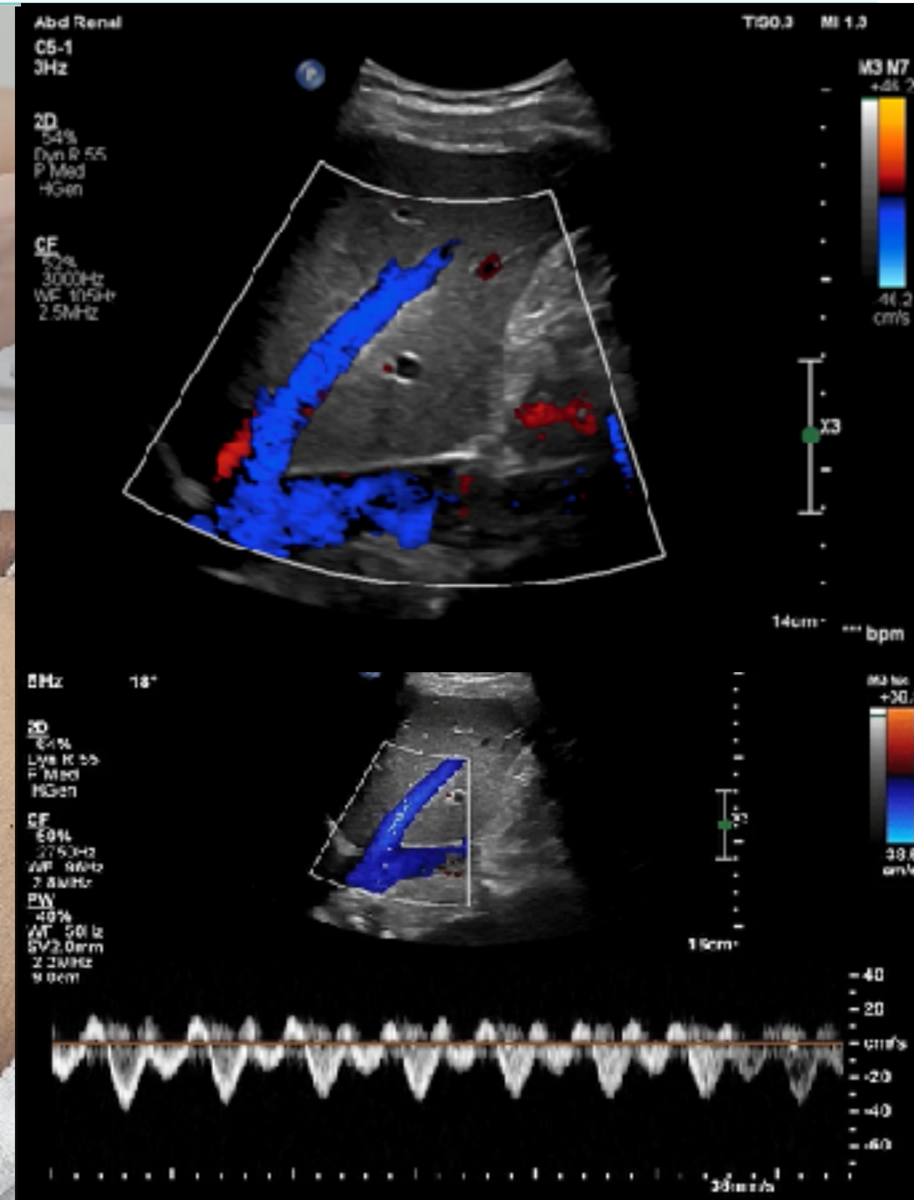
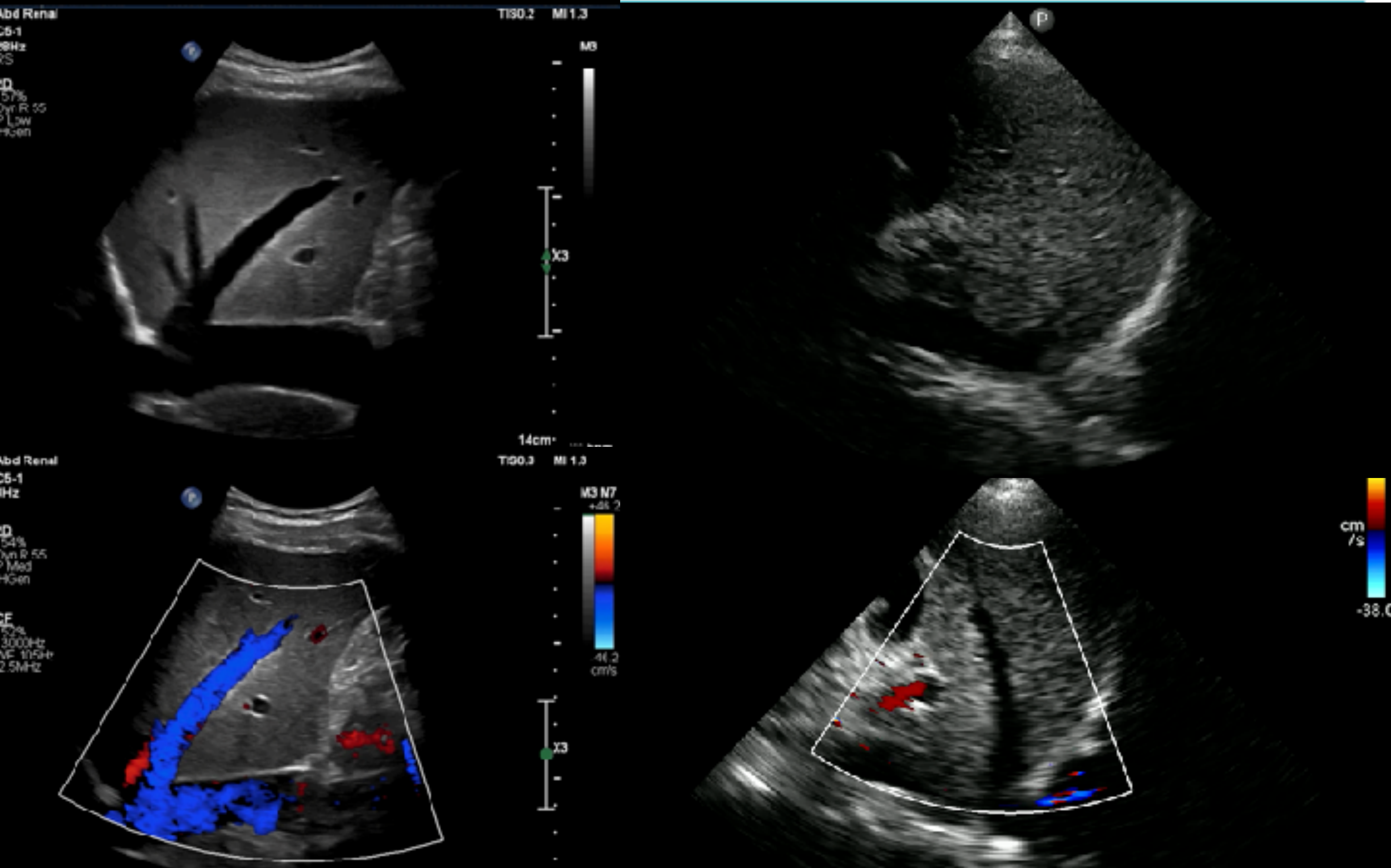
HV exam & Doppler (coronal view)

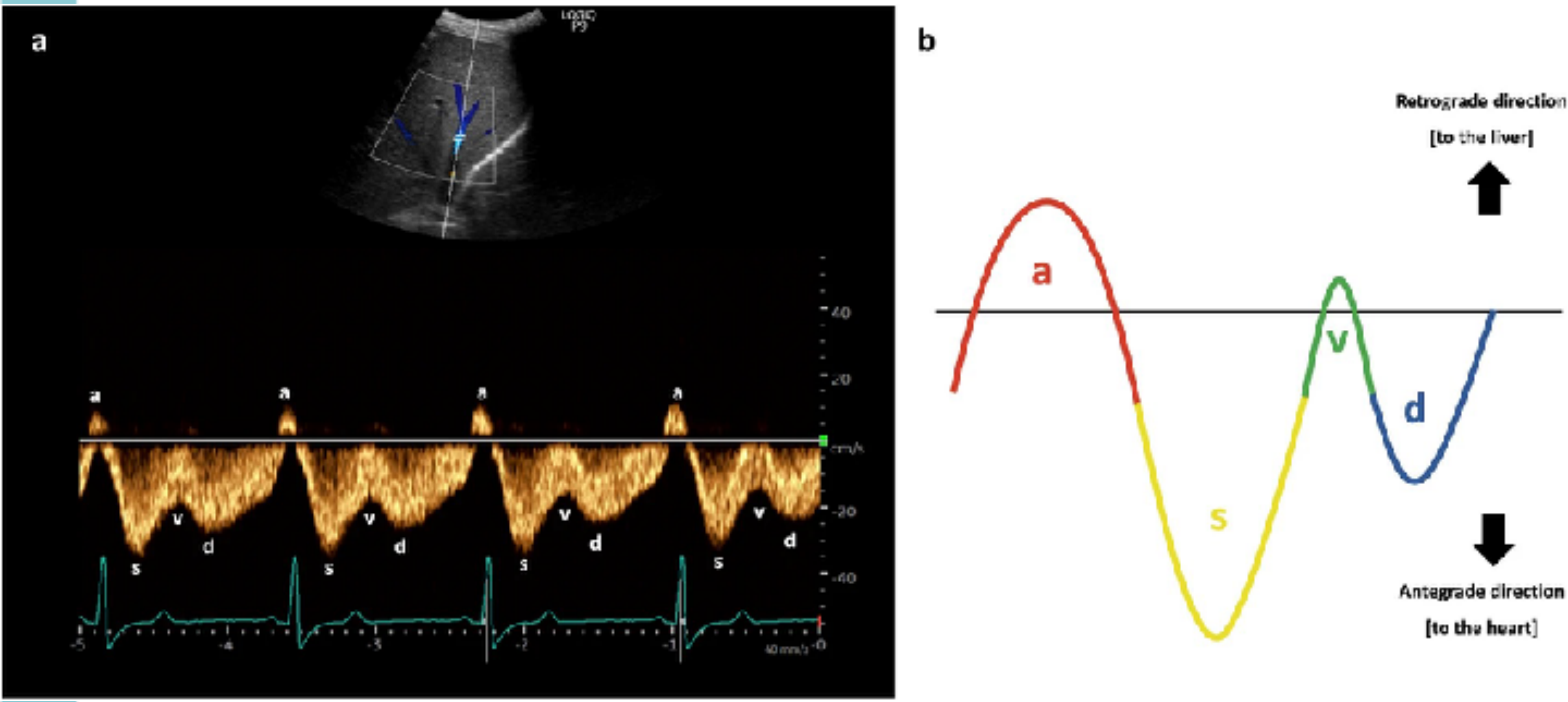




HV exam & Doppler



HV waveform with ECG tracing



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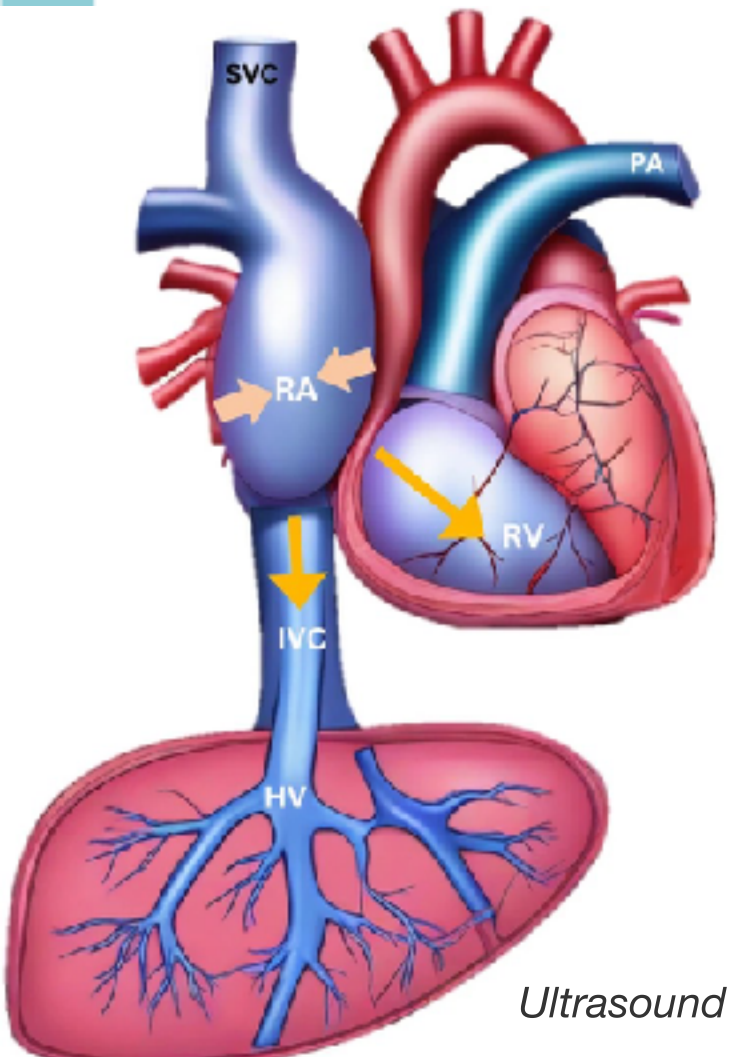
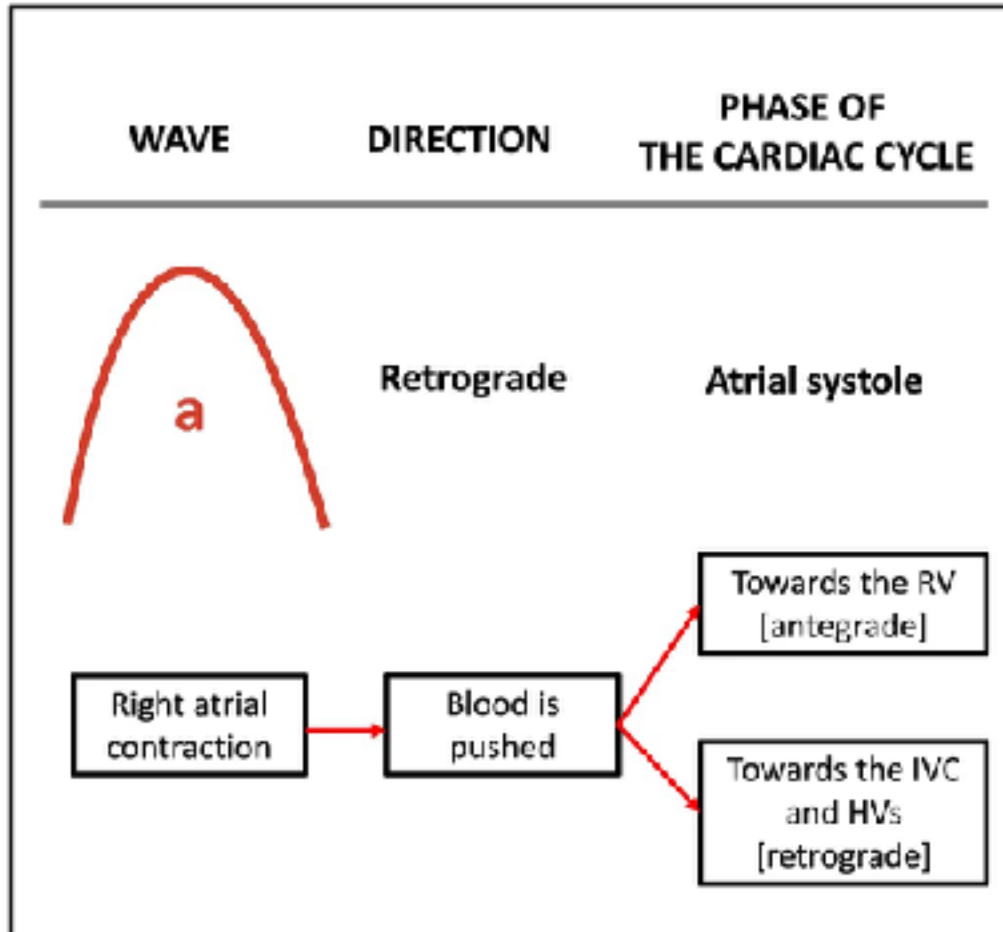
HV waveform - a wave





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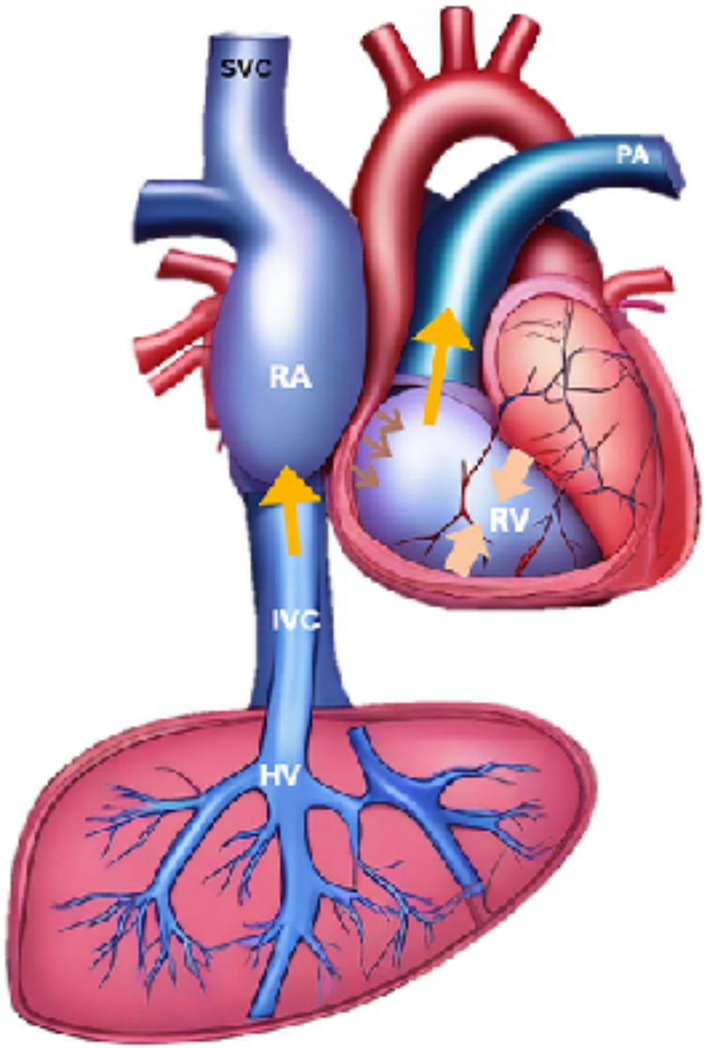
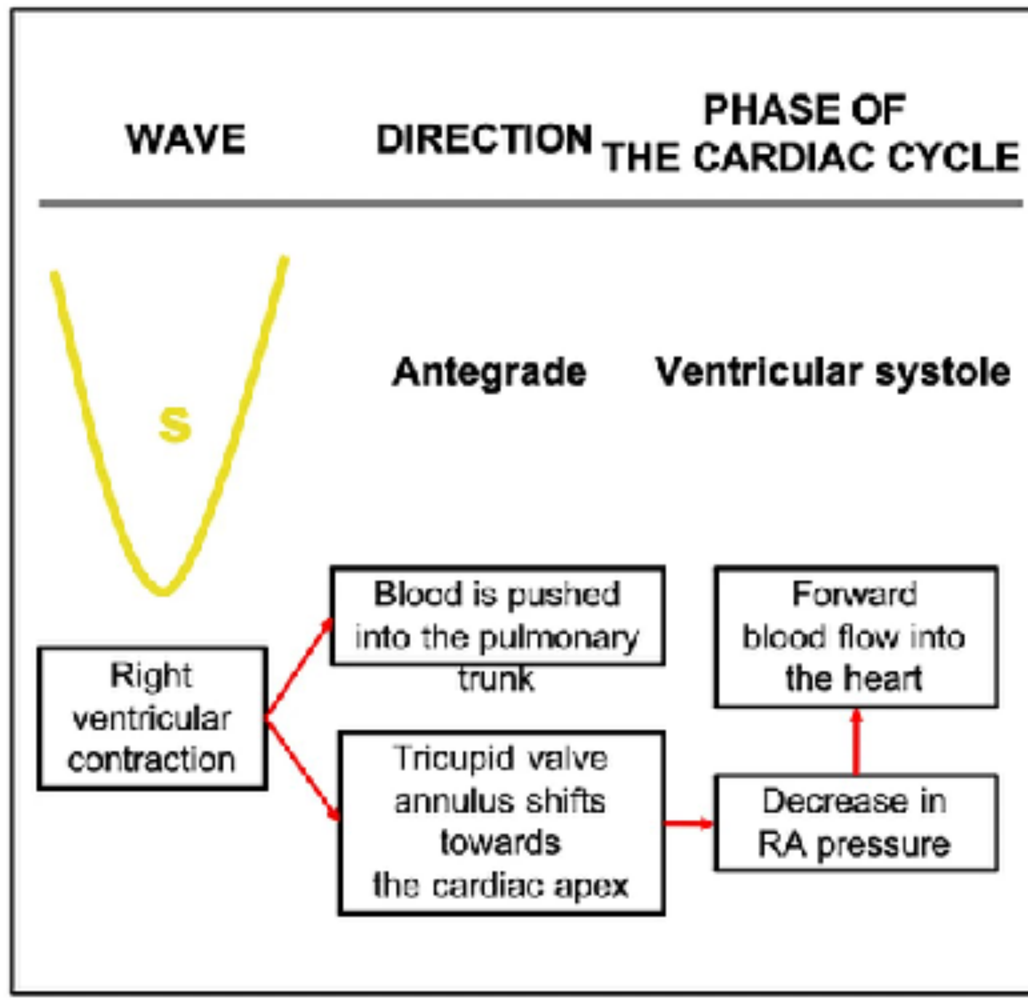
HV waveform - s wave





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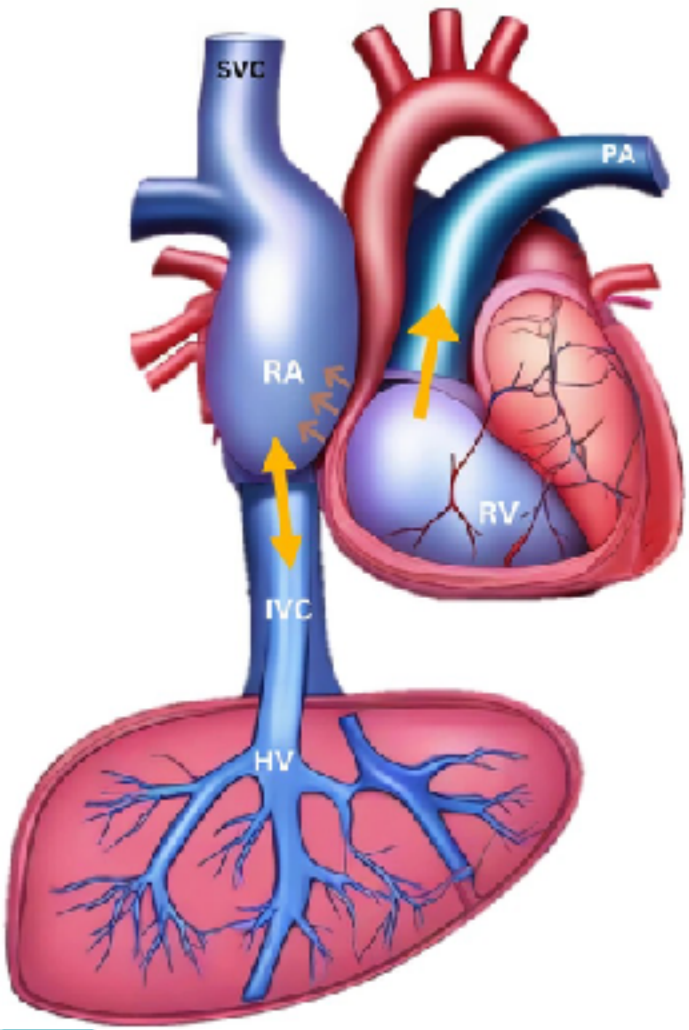
HV waveform - v wave



WAVE	DIRECTION	PHASE OF THE CARDIAC CYCLE
v	**Transitional** *antegrade, retrograde, or neutral*	**End of ventricular systole**

End of RV contraction → Tricuspid annulus shifts back to its normal position → Increase in RA pressure → Retrograde flow of blood towards the hepatic veins

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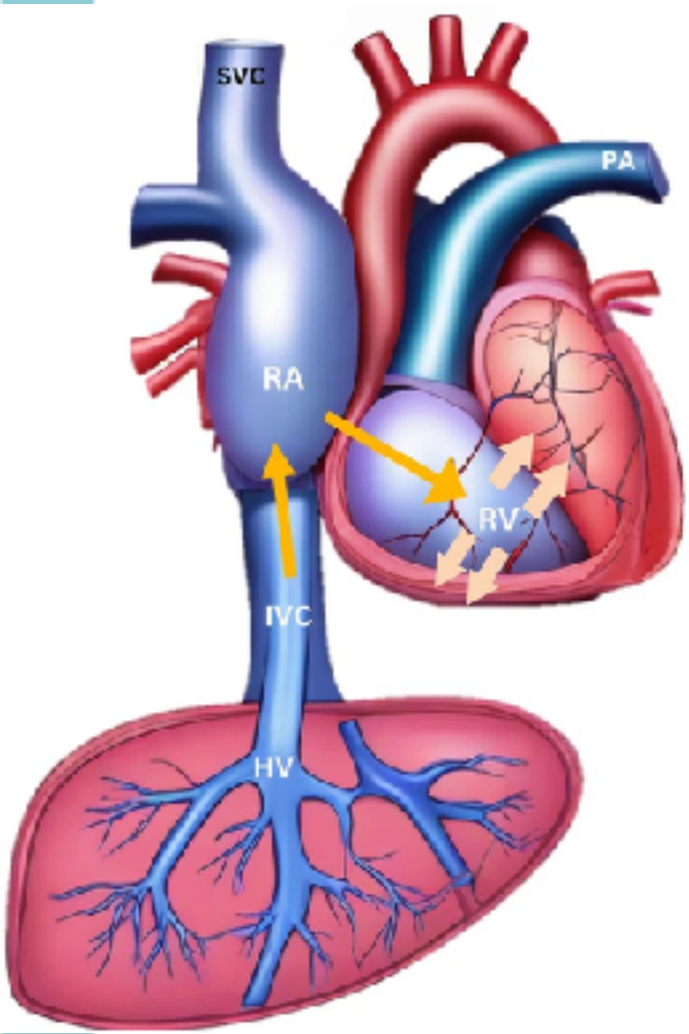
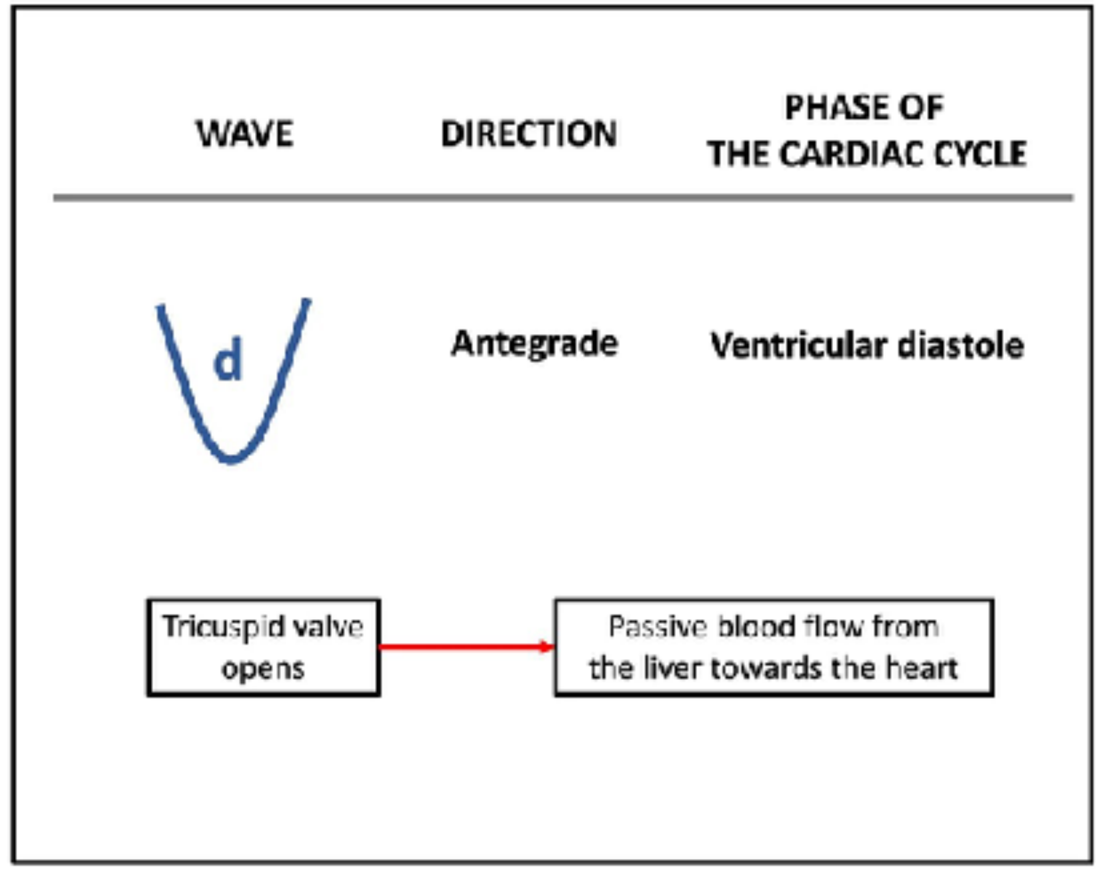
HV waveform - d wave





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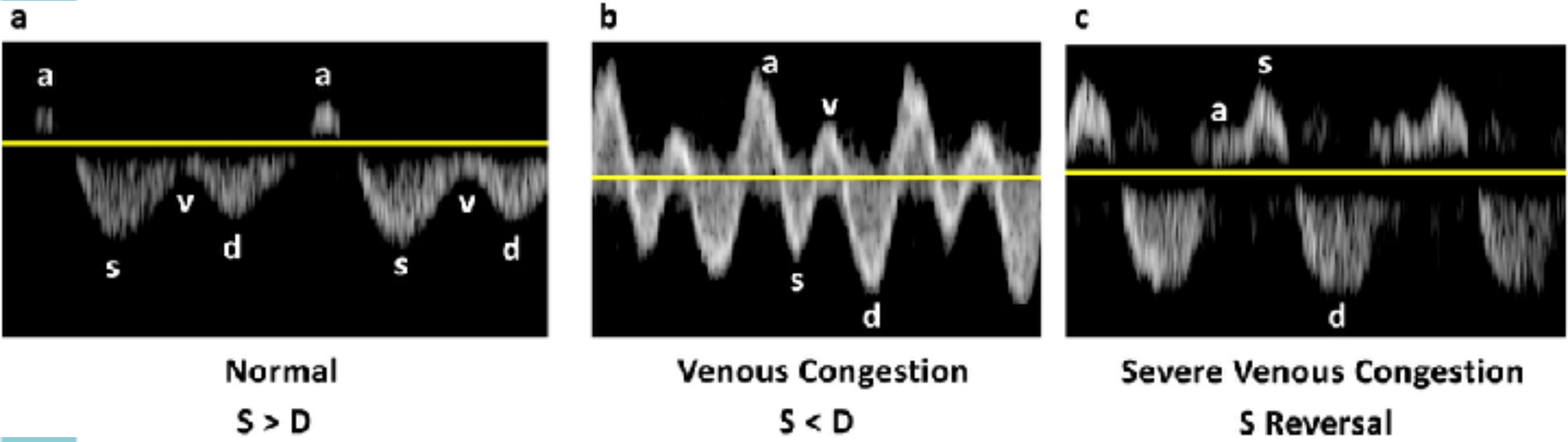
HV waveform



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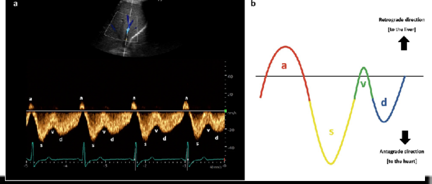
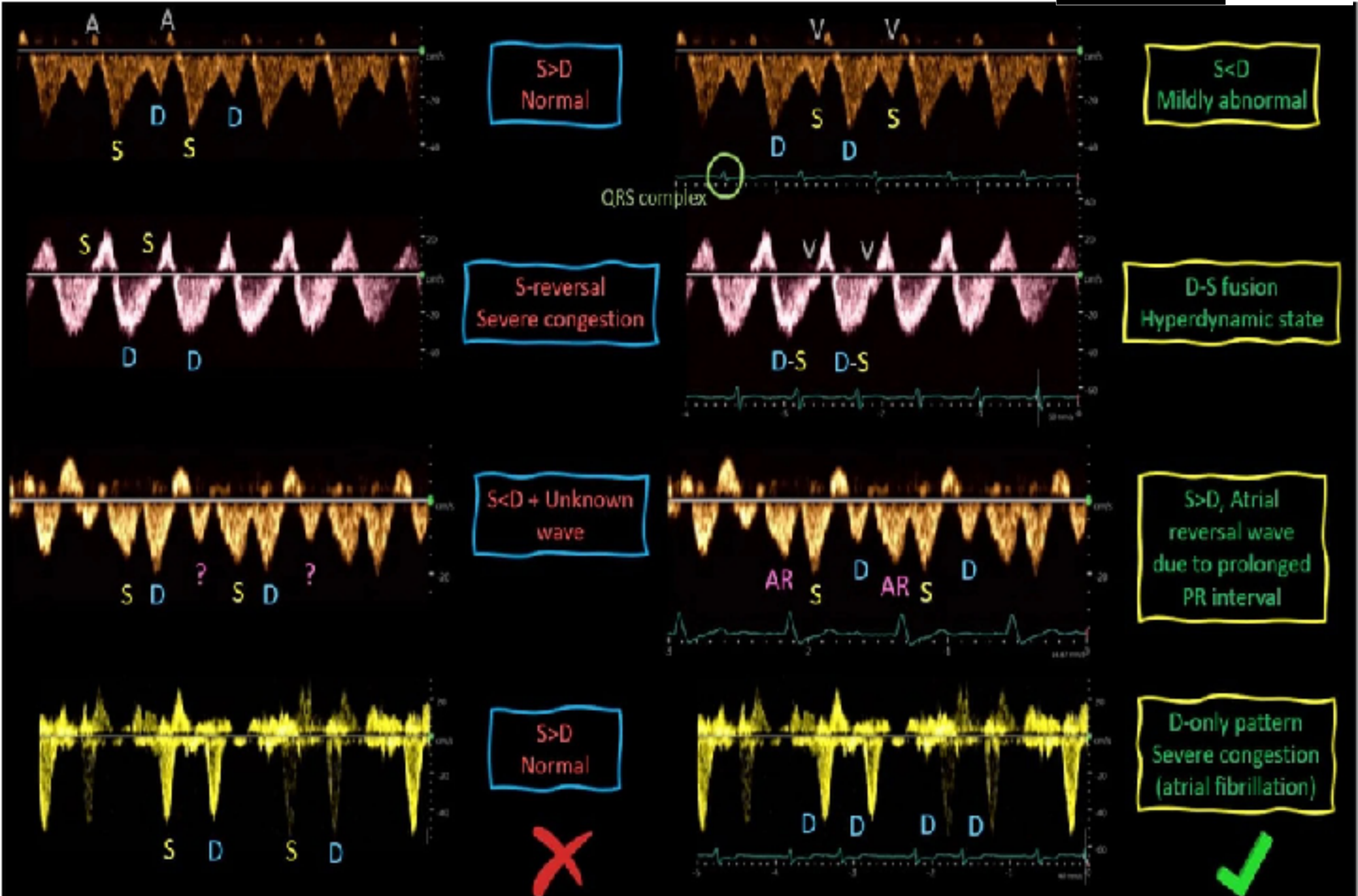
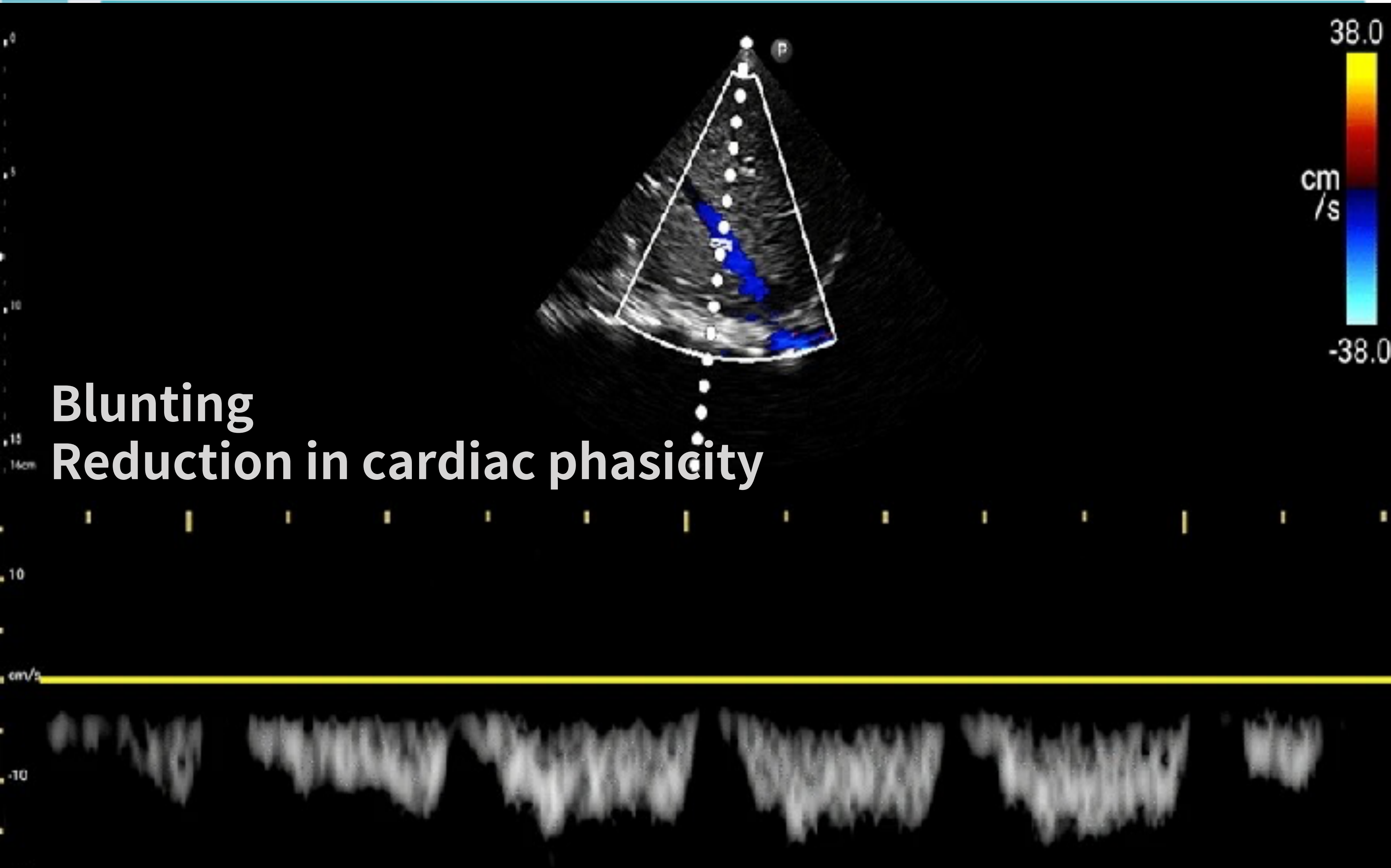
Pitfalls without ECG

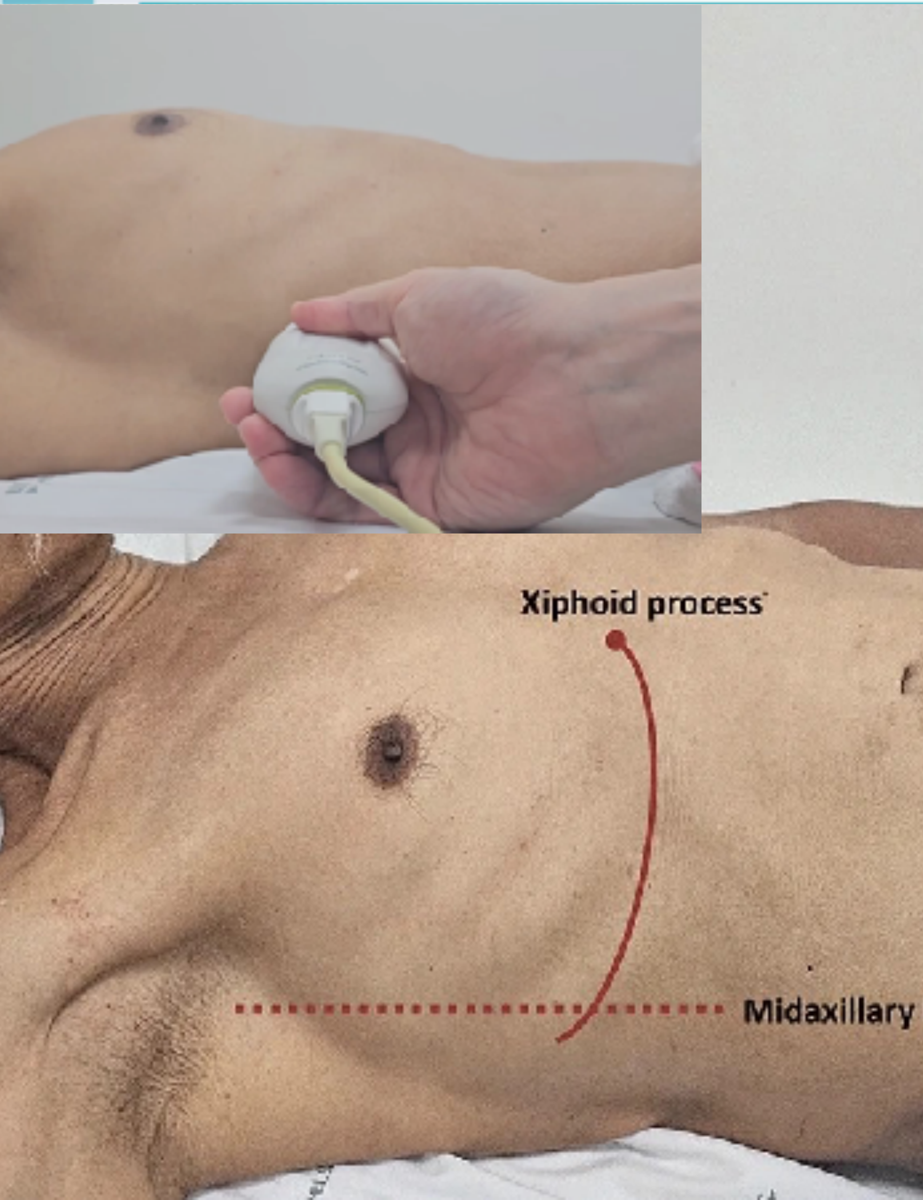


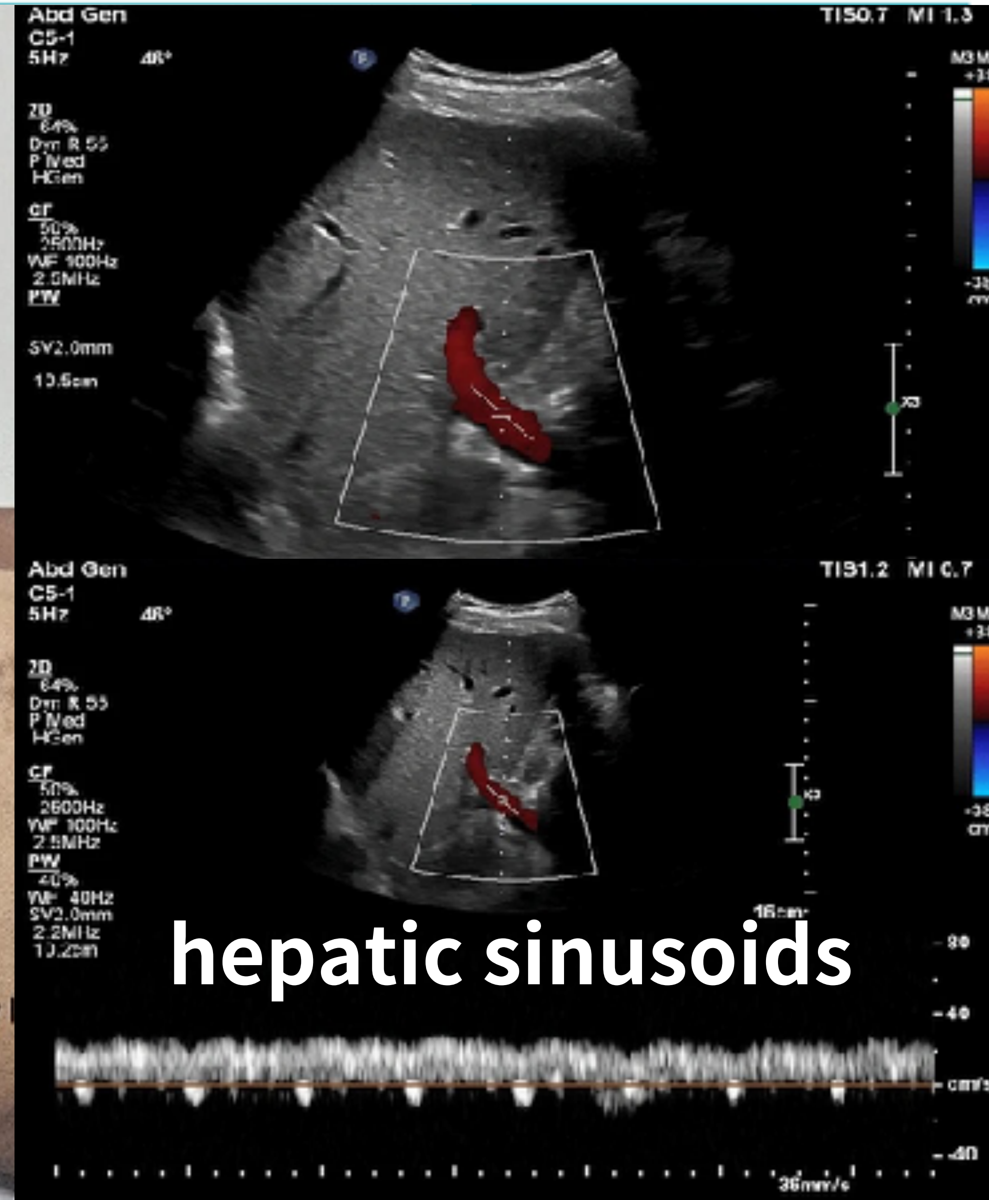


HV waveform in cirrhosis

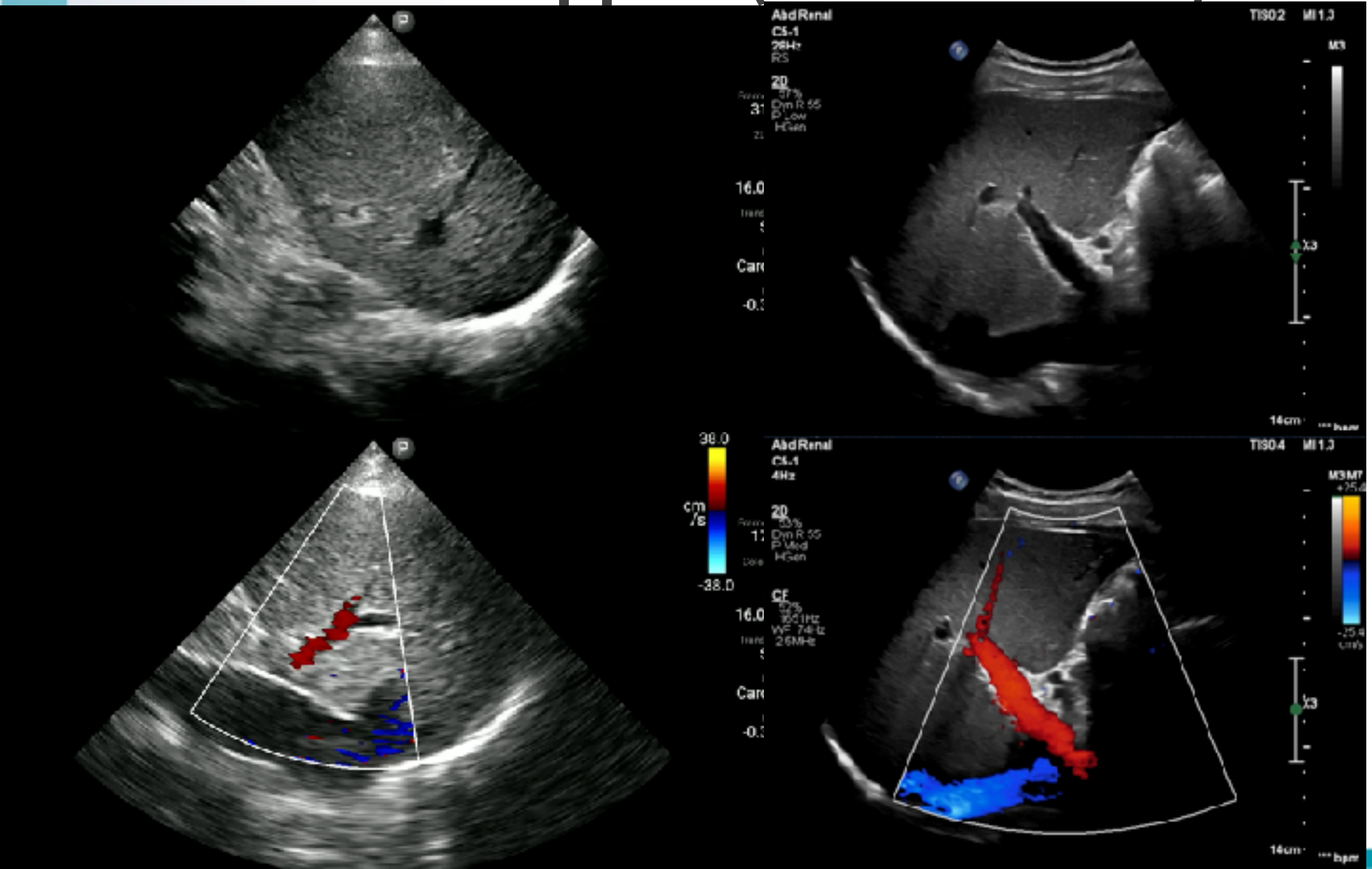


PV exam & Doppler (coronal view)

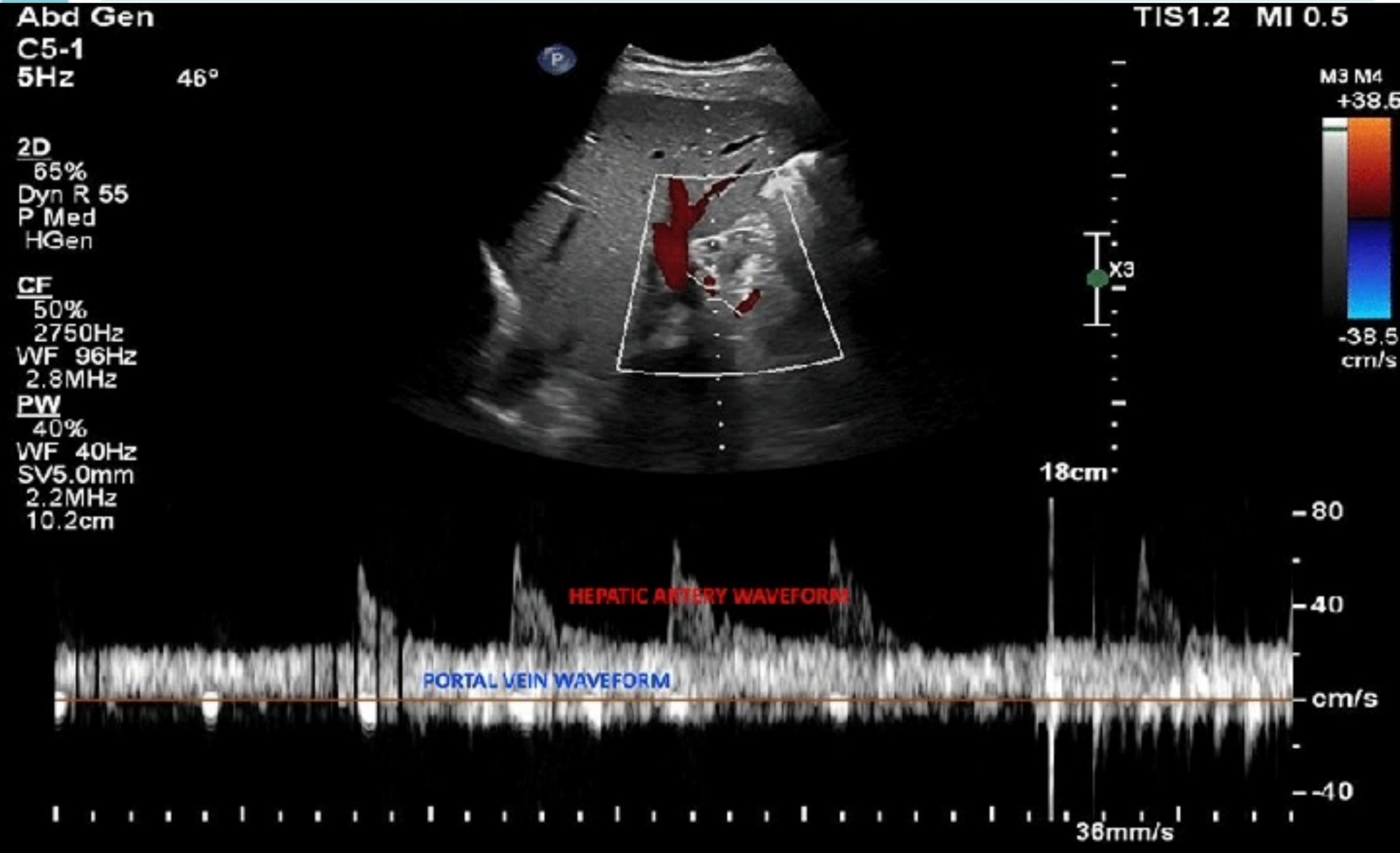




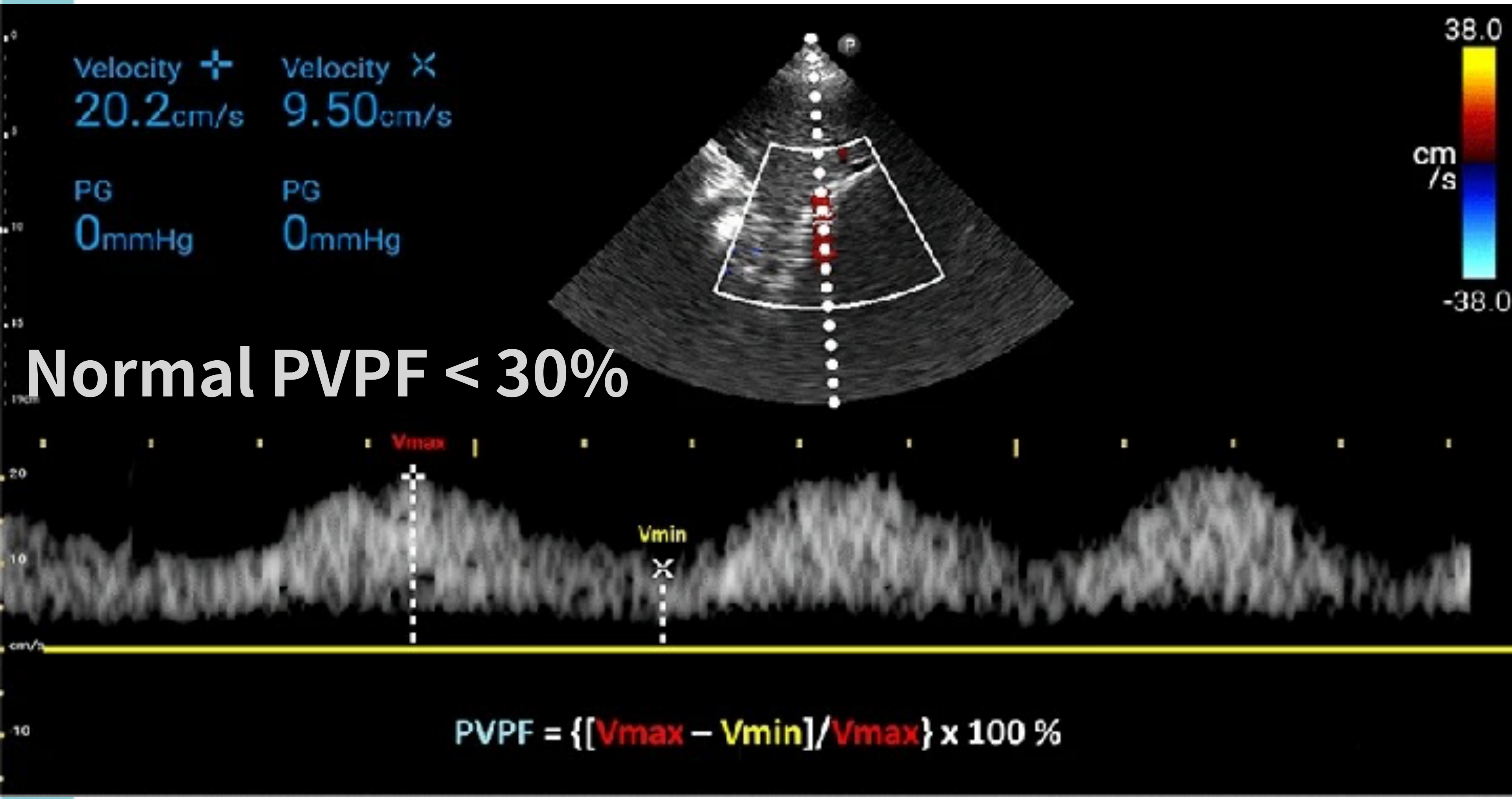
PV exam & Doppler (coronal view)



PV & hepatic artery waveform



Portal vein pulsatility fraction (PVPF)



Normal PVPF < 30%

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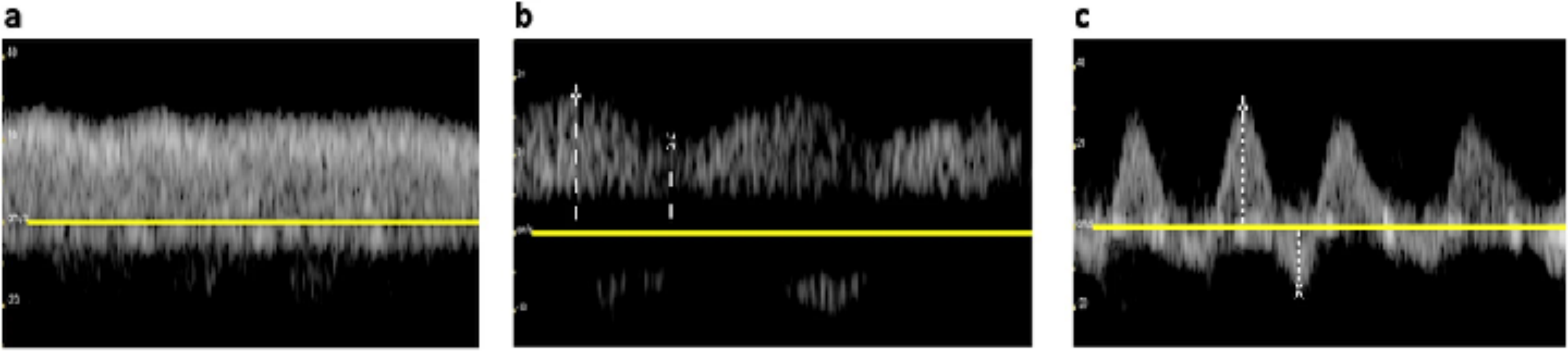


Normal

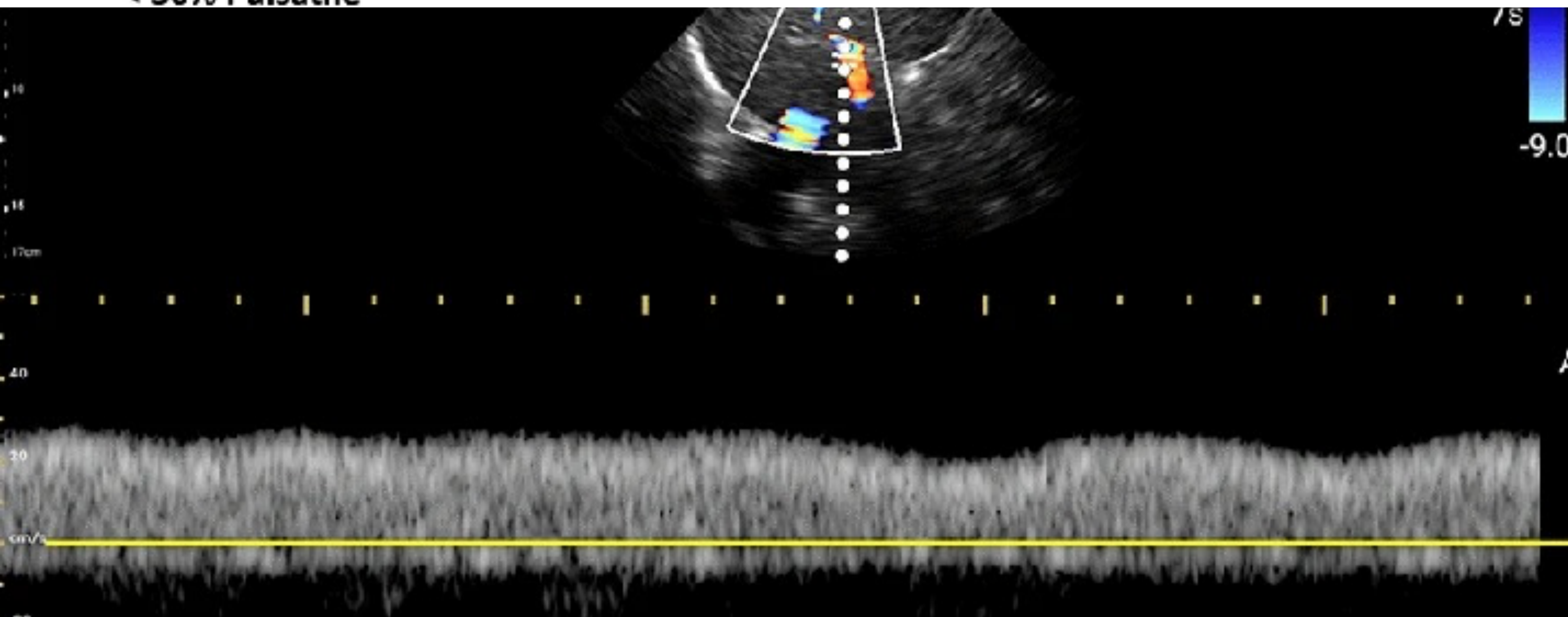
Continuous
< 30% Pulsatile

Venous Congestion

30-50% Pulsatile

Severe Venous Congestion

> 50% Pulsatile



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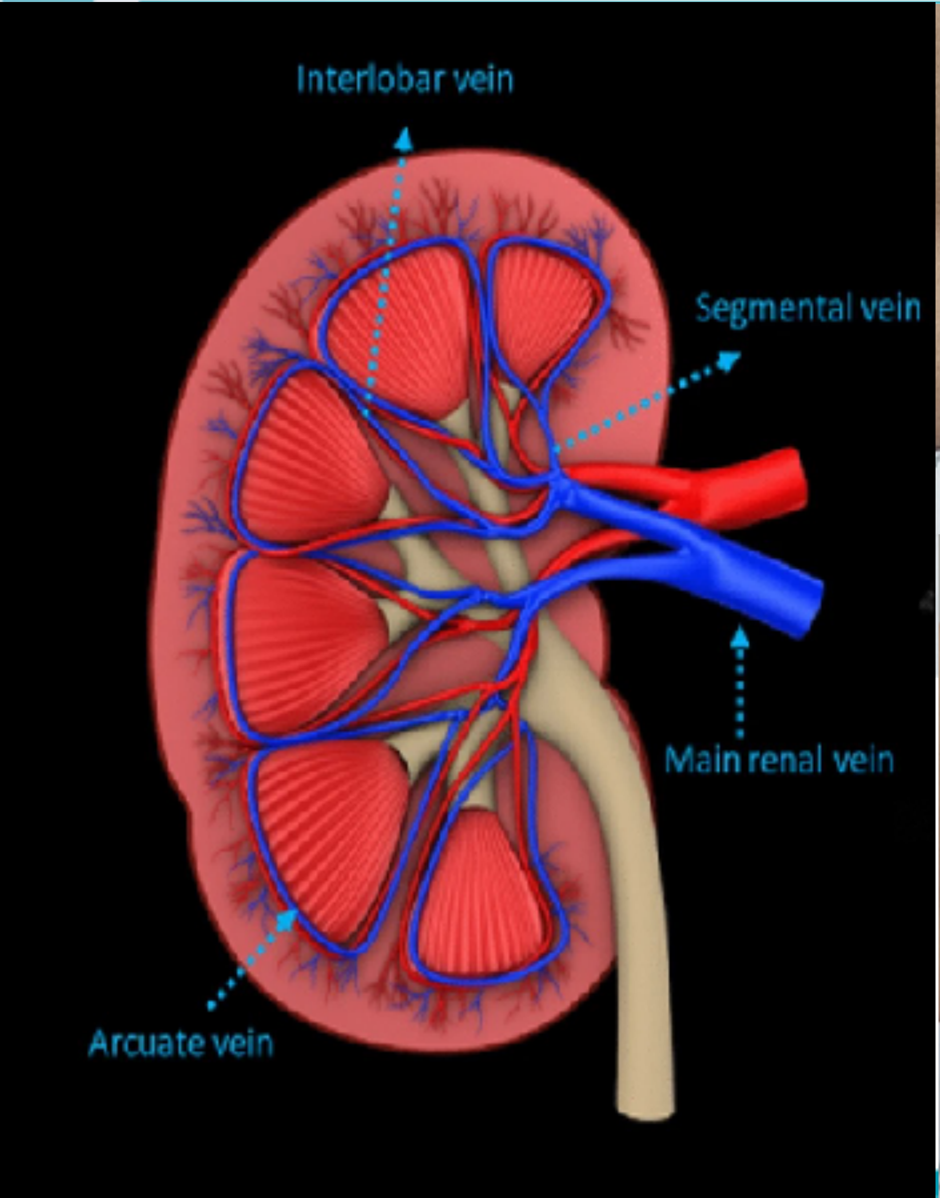
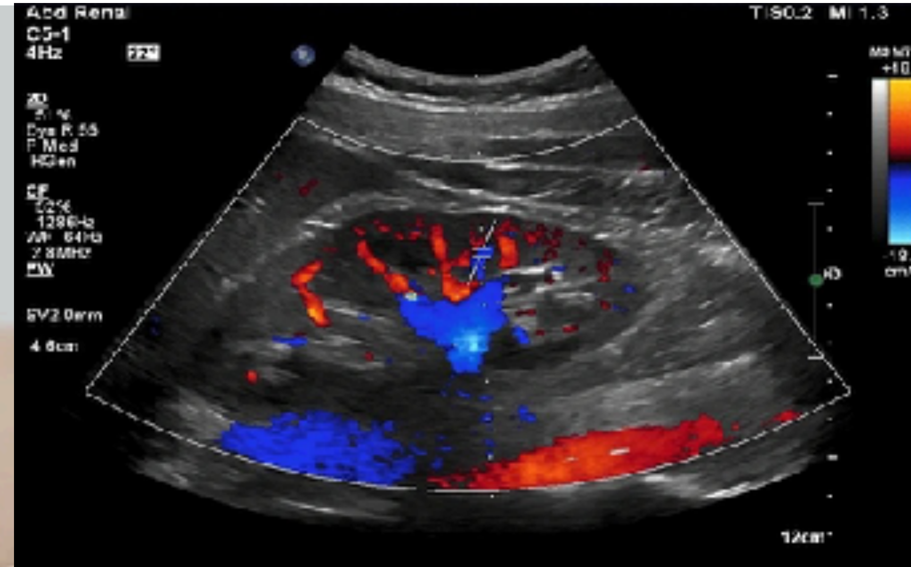
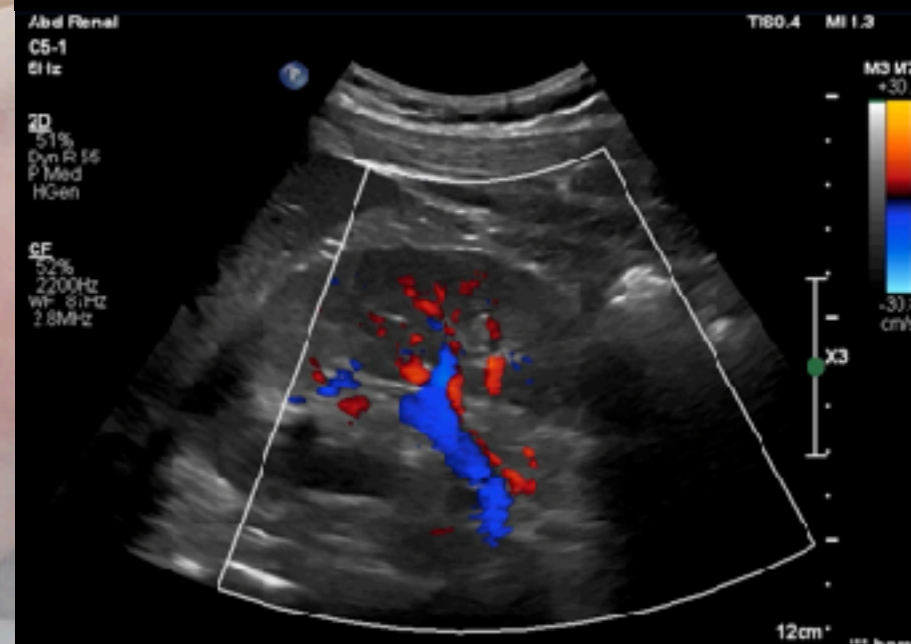
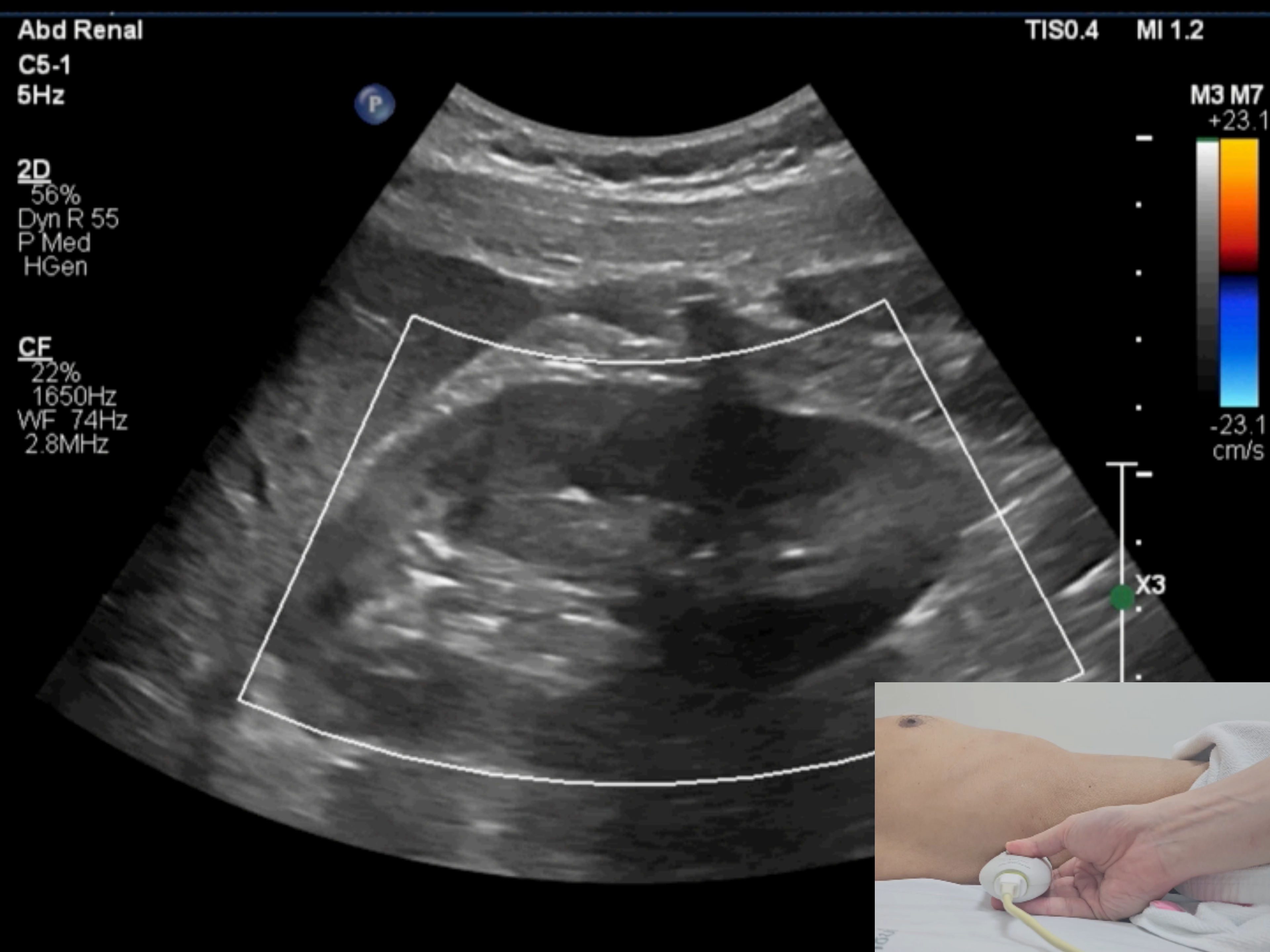
Intrarenal vein Doppler



Intrarenal vein Doppler



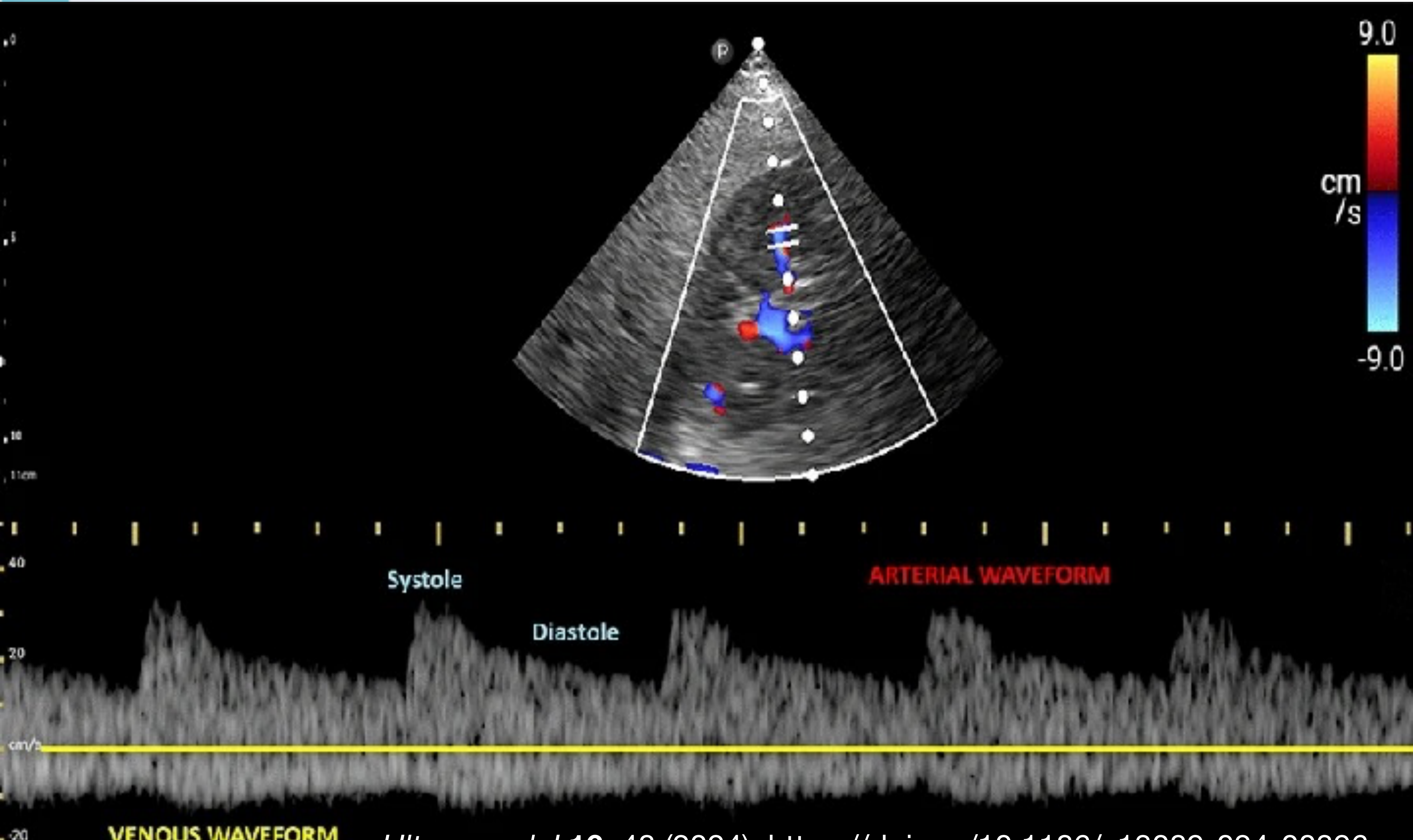




Abd Renal
C5-1
5Hz
TIS0.4
MI 1.2
2D
56%
Dyn R 55
P Med
HGen
CF
22%
1650Hz
WF 74Hz
2.8MHz
M3 M7
+23.1
-23.1
cm/s
X3

IRVD

continuous pattern with minimal pulsatility and no interruptions



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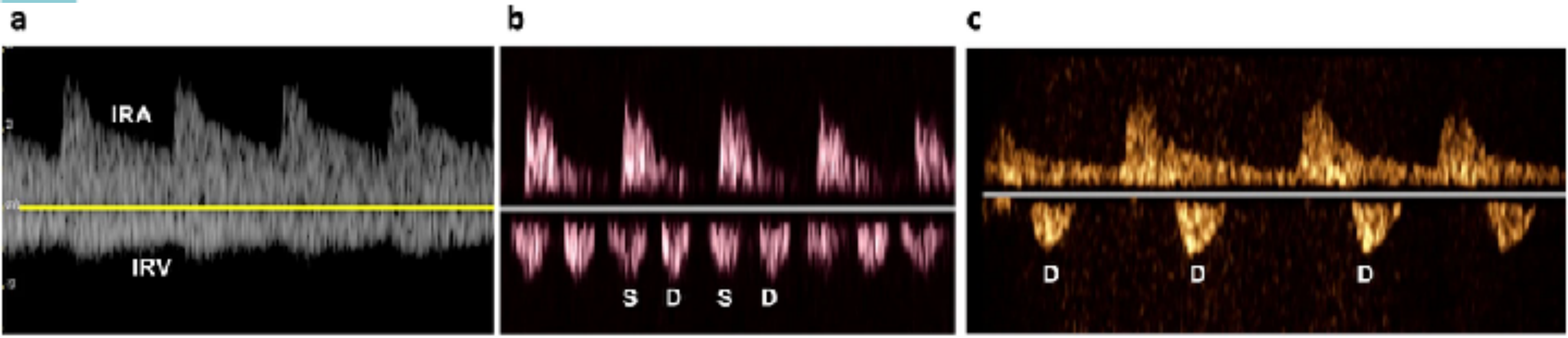
IRVD patterns



Normal	Venous Congestion	Severe Venous Congestion
Continuous	Biphasic Distinct S,D waves	Monophasic D-only below baseline

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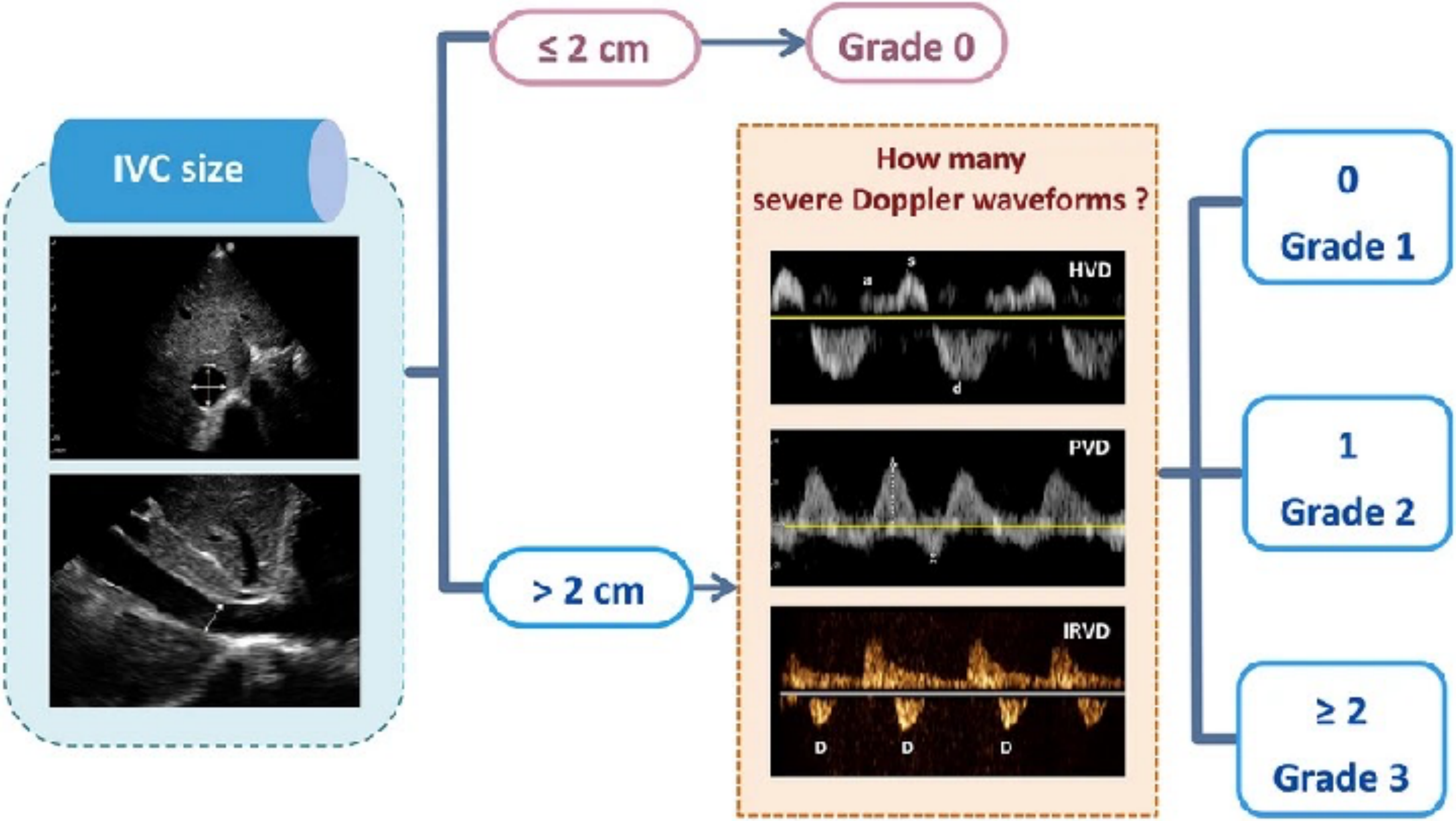
VExUS grading system



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https://doi.org/10.1186/s13089-024-00397-y

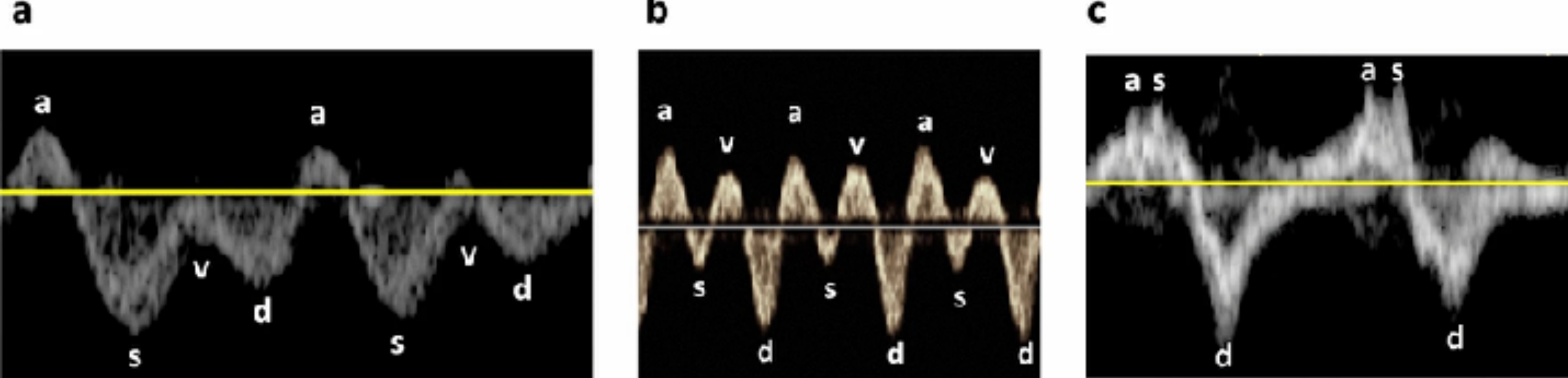
The Ultrasound Journal

ORIGINAL ARTICLE **Open Access**

Correlation between right atrial pressure measured via right heart catheterization and venous excess ultrasound, inferior vena cava diameter, and ultrasound-measured jugular venous pressure: a prospective observational study

Suppawee Klangthamneam[1], Krissada Meemook[1], Tananchai Petnak[1], Anchana Sonkaew[1] and Taweevat Assavapokee[1*]

2022/9 ~ 2023/7
73 patients with RHC


a
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c
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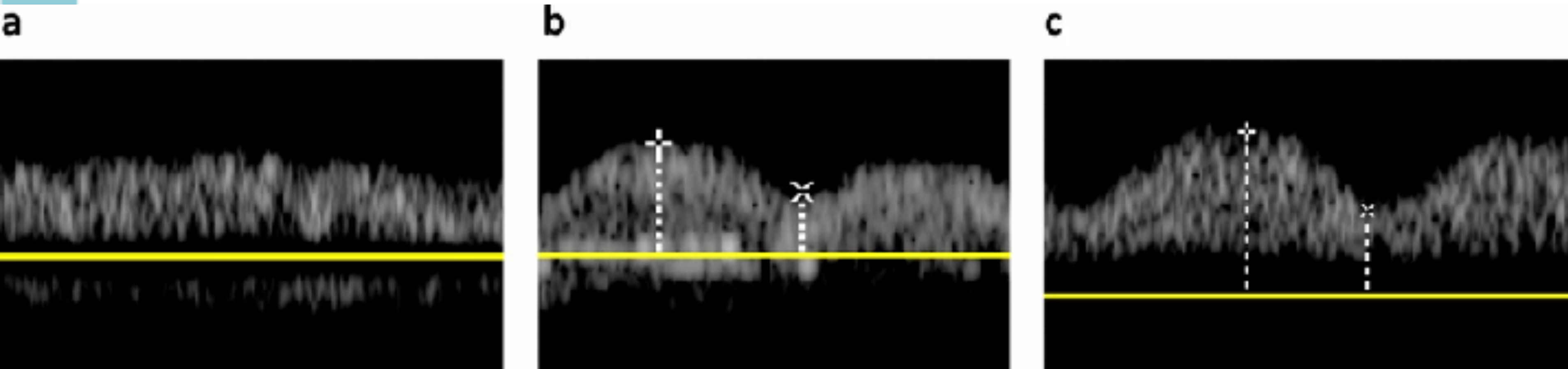
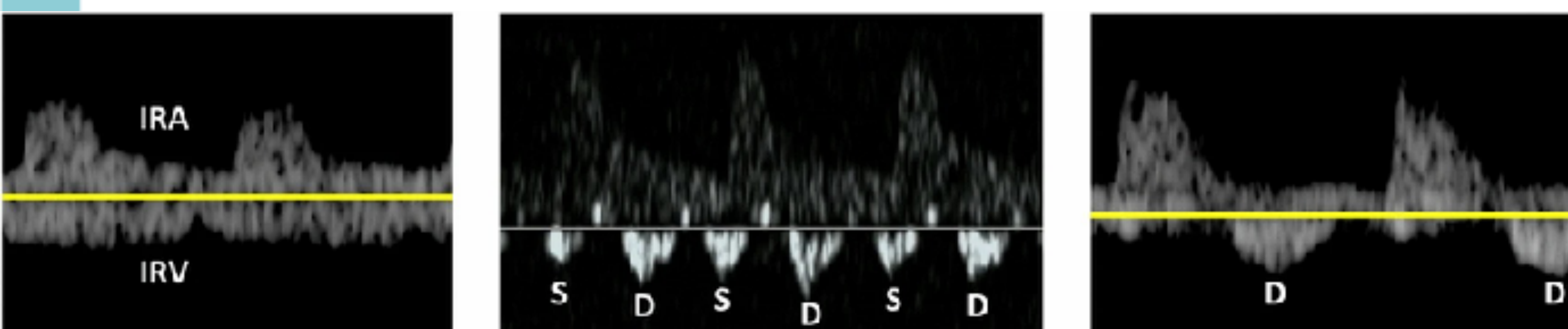
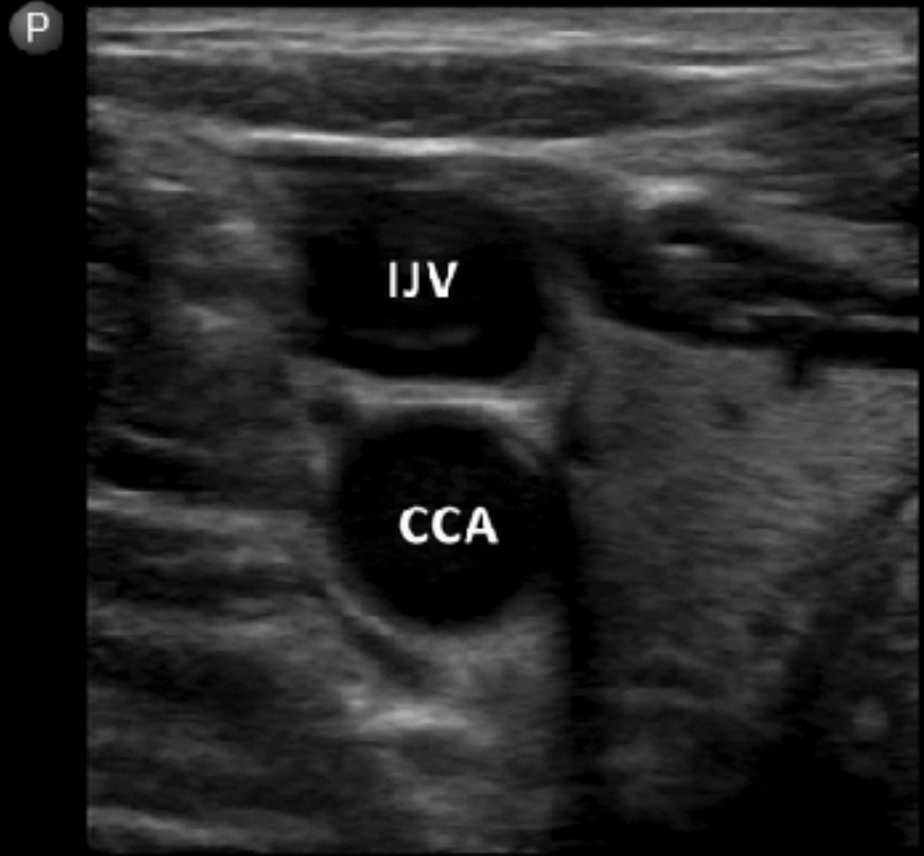
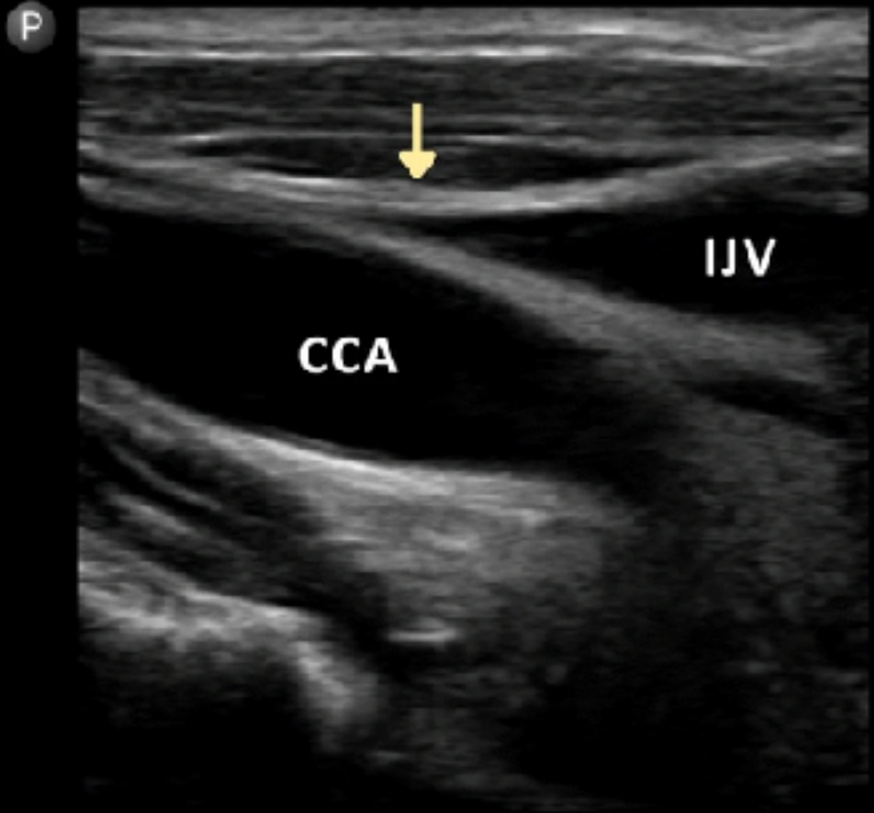

a
b
c


IRA
IRV
S
D
S
D
S
D
D
D

Neck bottle sign

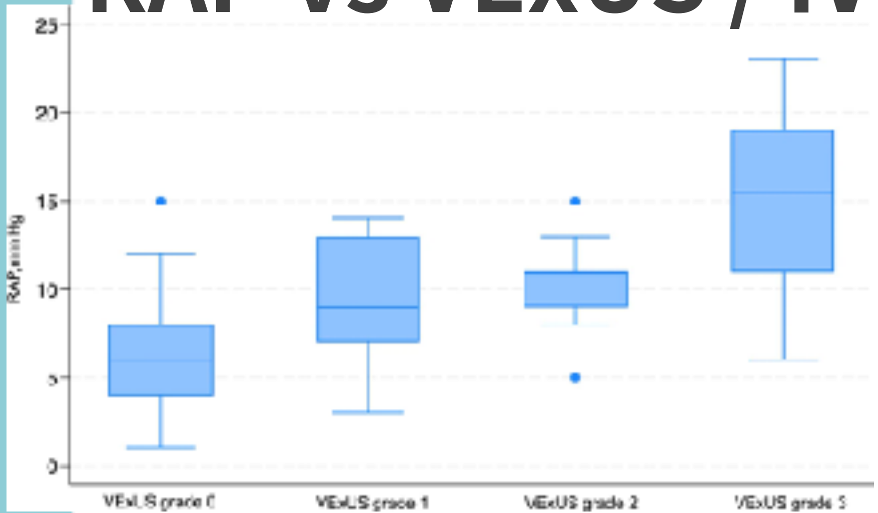
uJVP: Point of collapse in IJV - - Sternal angle (+ 5cm H2O)

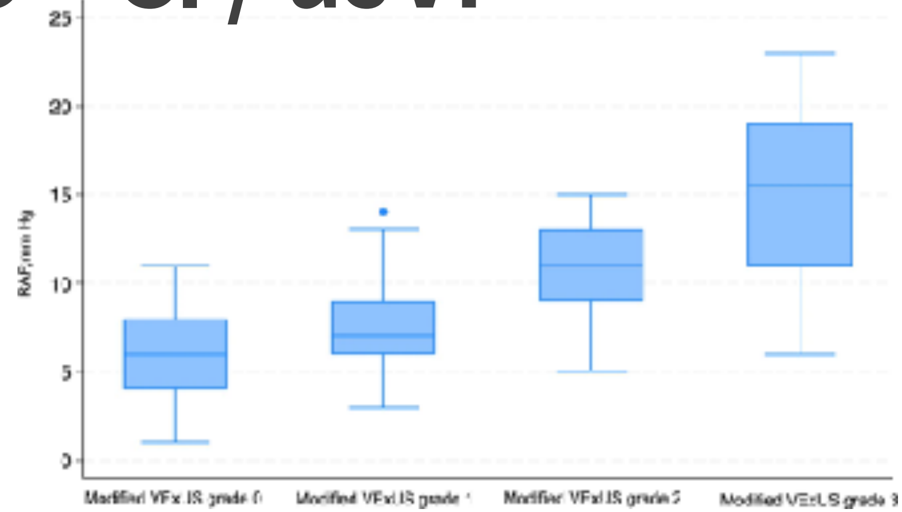


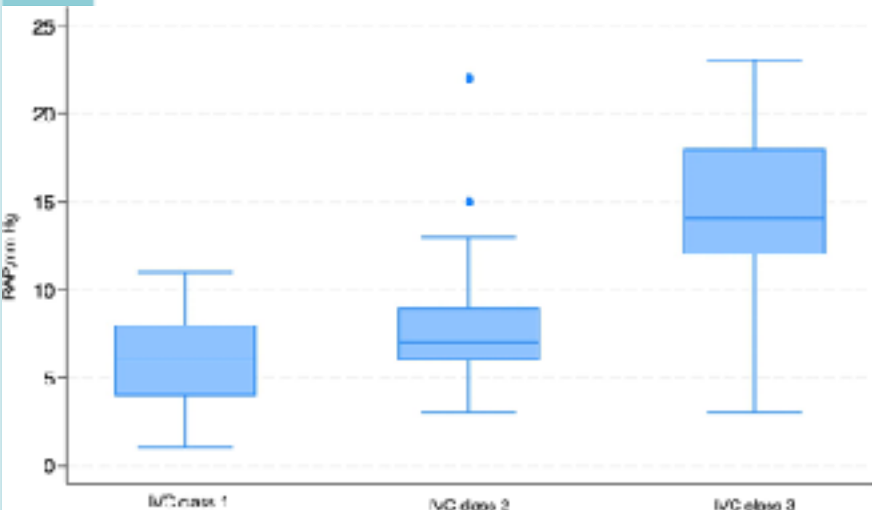


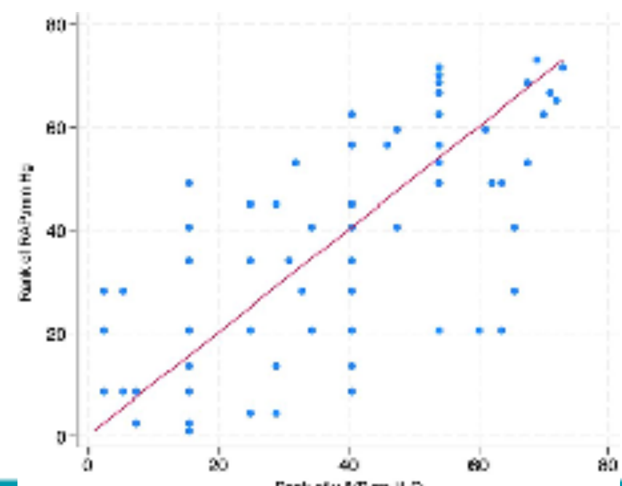
Head position: 45°

Strong correlation
RAP vs VExUS / IVC + CI / uJVP









Monnet et al. Annals of Intensive Care (2022) 12:46
https://doi.org/10.1186/s13613-022-01022-8

Annals of Intensive Care

REVIEW Open Access

Prediction of fluid responsiveness. What's new?

Xavier Monnet*, Rui Shi and Jean-Louis Teboul

Trends in Anaesthesia and Critical Care 54 (2024) 101316

Contents lists available at ScienceDirect

Trends in Anaesthesia and Critical Care

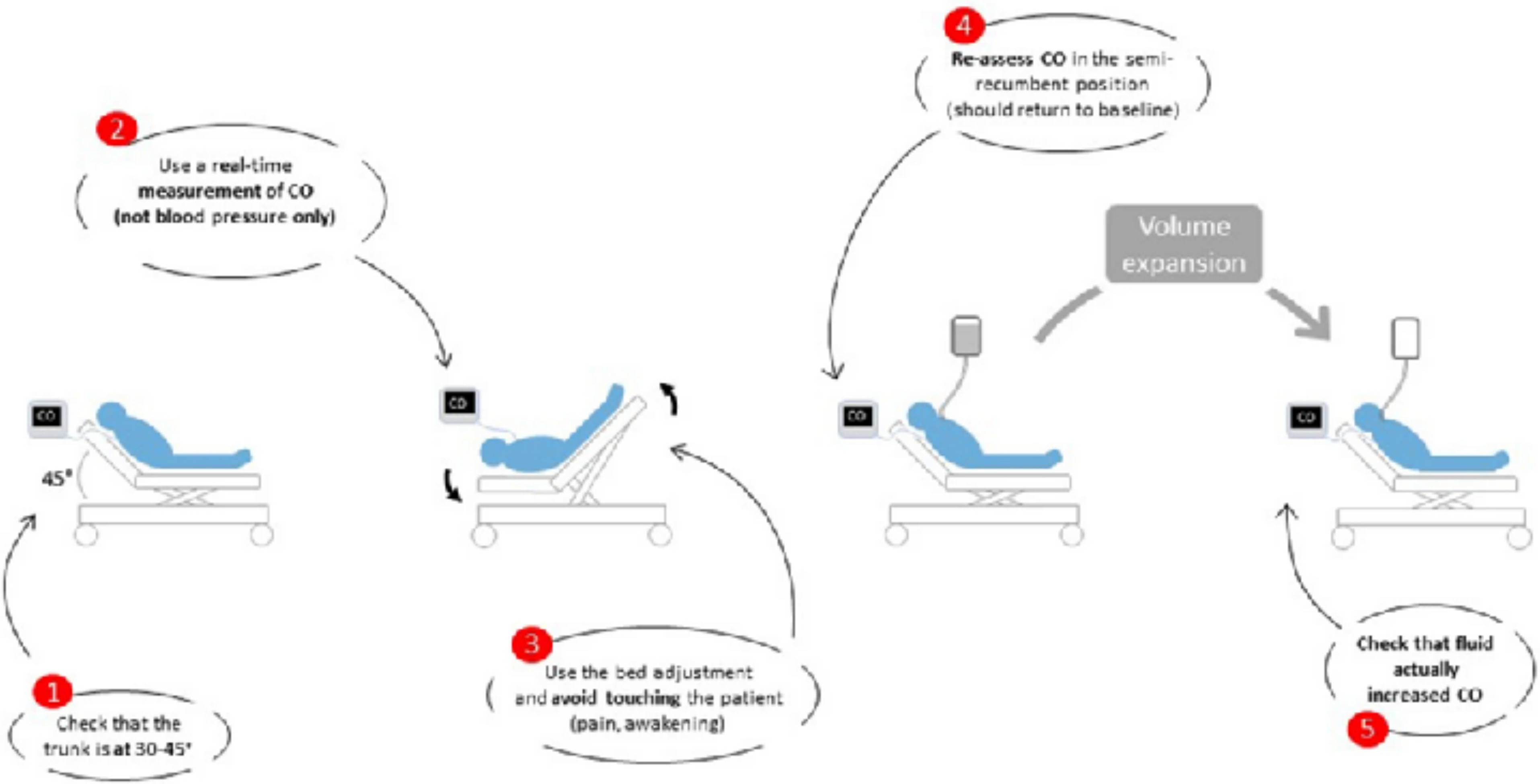
journal homepage: www.elsevier.com/locate/tacc

Prediction of fluid responsiveness in critical care: Current evidence and future perspective

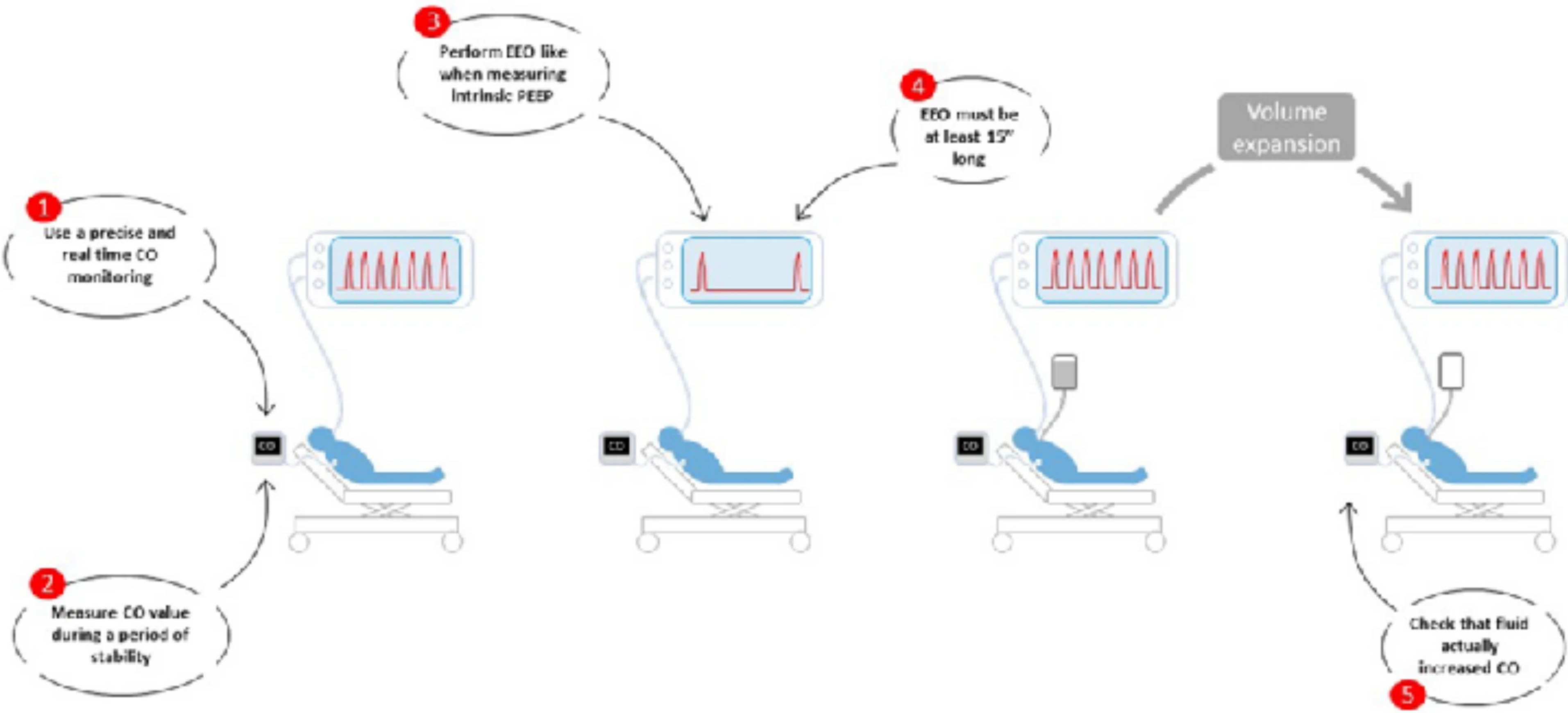
Luigi La Via [a,*], Francesco Vasile [a], Francesco Perna [a], Mateusz Zawadka [b]

[a] Department of Anesthesia and Intensive Care, Azienda Ospedaliera Universitaria Policlinico "G. Rodolico- San Marco", Via Santa Sofia, 78, 95123, Catania, Italy
[b] Second Department of Anesthesia and Intensive Care, Medical University of Warsaw, 1A Banacha Str., 02-097, Warsaw, Poland

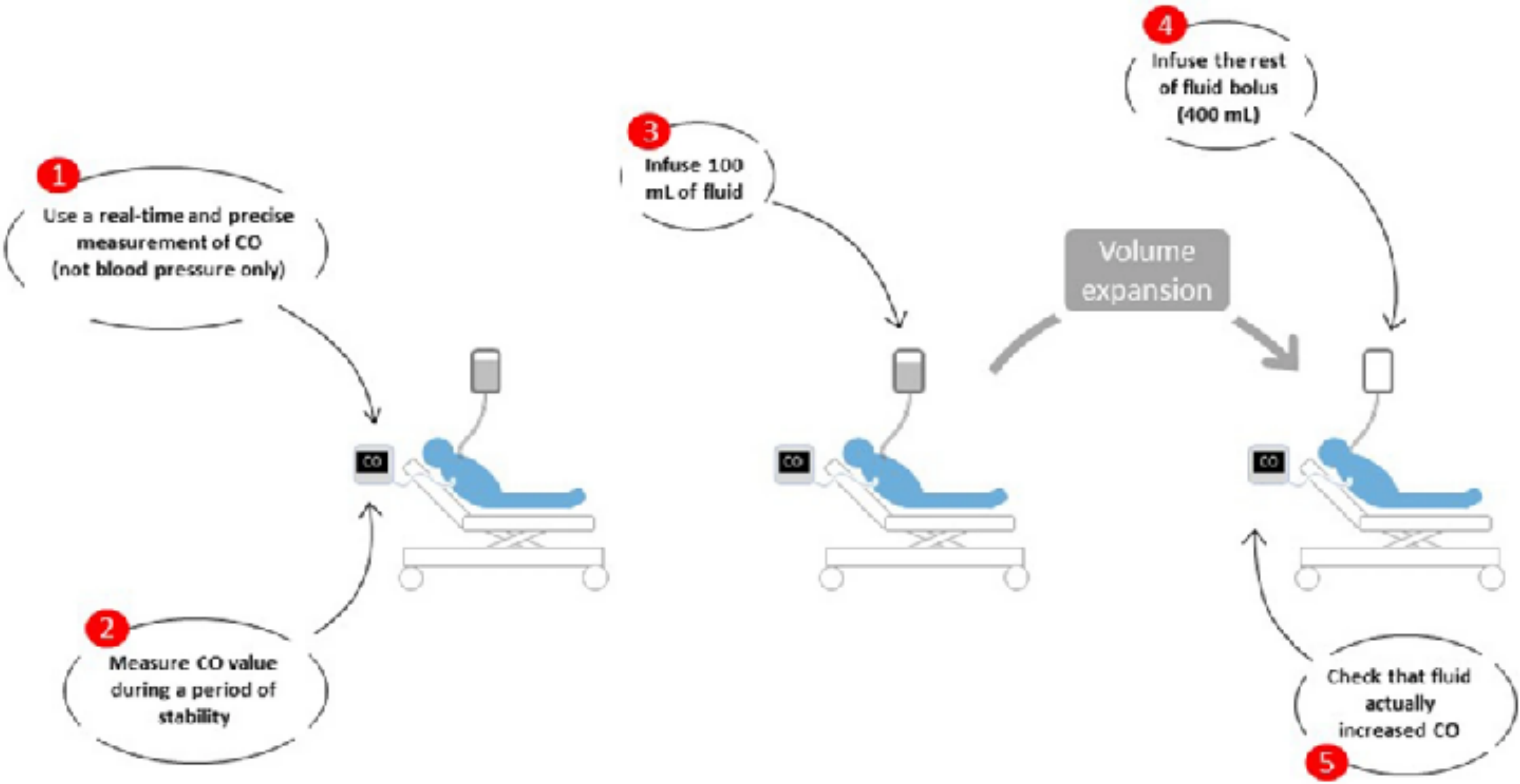
Passive leg raising test



End-expiratory occlusion test



Mini-fluid challenge



Mimicking a classic fluid challenge

Test	Advantages	Limitations	Confounding factors	Criterion of judgement	Diagnostic threshold	Level of evidence*
Passive leg raising	→Reversible, no fluid infusion	→Requires a direct estimation of CO/SV	→Possible false negatives in case of intra-abdominal hypertension →False negatives in case of venous compression stockings	↗ CO	≥ 10%	++++
	→Works regardless of breathing activity, cardiac rhythm, Vt, lung compliance	→False negatives in case of IAH		↗ VTI	≥ 10%	++++
	→Very well validated			↗ end-tidal CO_2	≥ 5% ≥ 2 mmHg	++
				↗ perfusion index	≥ 9%	+
				↘ PPV/SVV	≥ − 1 to 4 points	+
				↘ capillary refill time	≥ − 27%	+
Mini-fluid challenge	→Easy to perform	→Requires a direct estimation of CO/SV	→Poor precision of the technique measuring cardiac output →Volume of fluid infused (minimum: 100 mL)	↗ CO	≥ 5%	++
	→Works regardless of breathing activity, cardiac rhythm, Vt, lung compliance, IAP	→Requires a precise estimation of CO/SV →Still requires fluid infusion		↗ VTI	≥ 10%	+
Trendelenburg manoeuvre	→Reversible, no fluid infusion →Possible even in prone position, on the operating table or under ECMO →Works regardless of breathing activity, cardiac rhythm, Vt, lung compliance	→Possible gastric reflux →Requires more validation	→Intra-abdominal hypertension?	↗ CO	≥ 8 to 10%	+

Heart–lung interactions

Test/index	Advantages	Limitations	Confounding factors	Criterion of judgement	Diagnostic threshold	Level of evidence
PPV	→Automatically measured →Widely available (invasive or non-invasive arterial pressure curve) →Requires no manoeuvre →Very well validated	→Impossible to use in many patients because of confounding factors	→False positives in case of cardiac arrhythmias, spontaneous breathing activity and possibly right ventricular failure →False negatives in case of low Vt, low lung compliance and IAH	Absolute value itself	≥ 15%	++++
SVV	→Automatically measured →Requires no manoeuvre →Well validated	→Impossible to use in many patients because of confounding factors →Requires a device for pulse contour analysis	→Those of PPV →An arterial pressure of poor quality may provide wrong values	Absolute value itself	≥ 15%	+++
EEO test	→Easy to perform →Works regardless of breathing activity, cardiac rhythm, Vt, lung compliance →Well validated	→Requires a direct estimation of CO/SV →Requires mechanical ventilation →Cannot be used if the patient interrupts the 15-s EEO	→Interruption of the test before its end by breathing efforts of the patient	↗ CO	≥ 5%	+++
				↗ VTI (better with additional EIO)	EEO alone: ≥ 5% EEO + EIO: ≥ 13%	+
				↗ perfusion index	≥ 2.5%	+
Vt challenge	→Requires no measurement in CO/SV (just an invasive or non-invasive arterial pressure curve) →Reliable in prone position and in spontaneously breathing patients	→Requires mechanical ventilation →Different diagnostic thresholds reported →Requires more validation	→Cardiac arrhythmias? →Intra-abdominal hypertension?	↗ PPV	≥ 1 to 3.5%	++
Vena cava distensibility	→Requires no measurement in CO/SV	→False positives in case of spontaneous breathing activity and possibly right ventricular failure →False negatives in case of low Vt, low lung compliance →Quite low reliability →Not reliable in case of IAH →For SVC: requires TOE	→Those of PPV (except cardiac arrhythmia)	Absolute value itself	IVC: ≥ 12% SVC: ≥ 12 to 36%	+

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Luigi La Via [a,*], Francesco Vasile [a], Francesco Perna [a], Mateusz Zawadka [b]

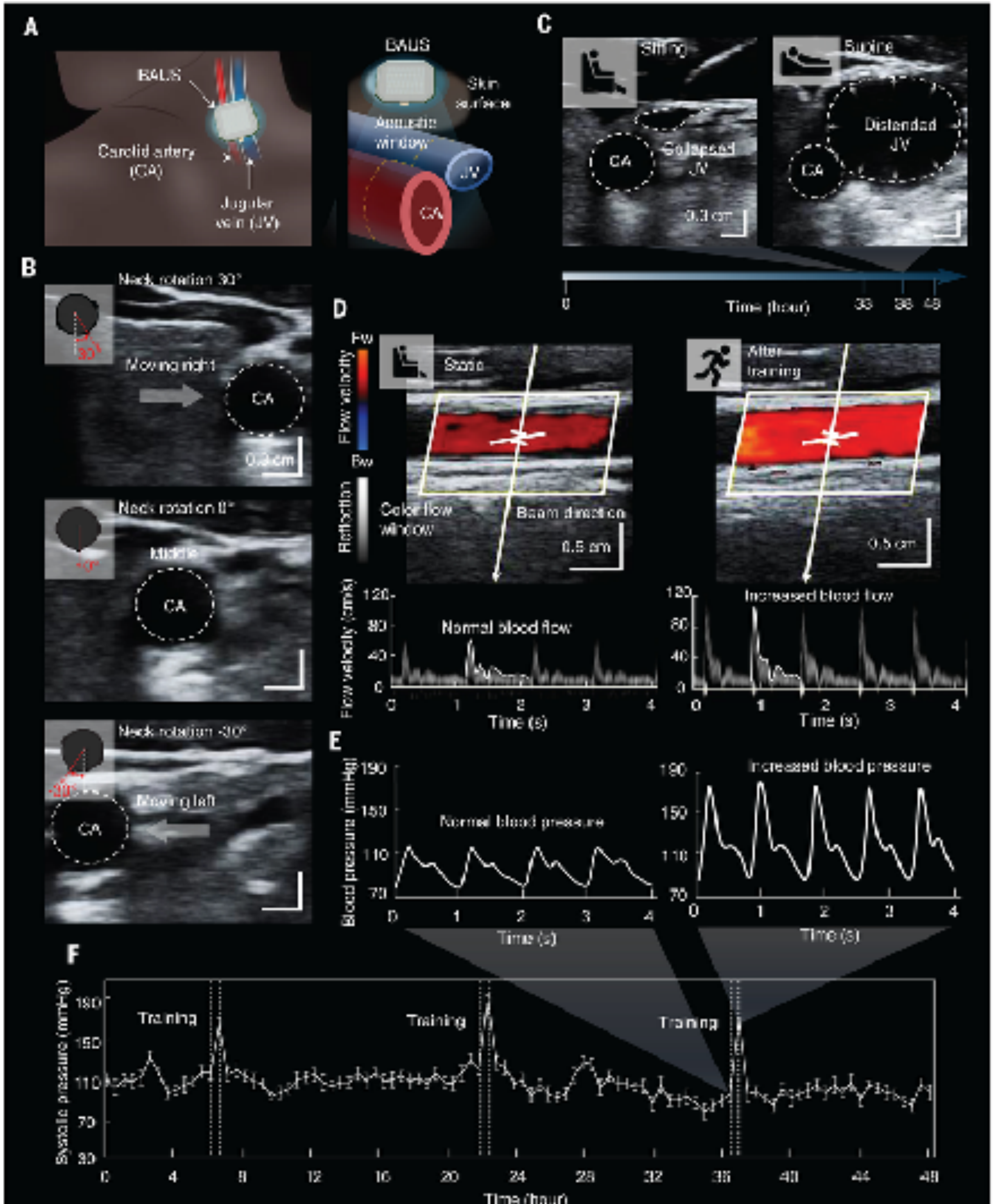
	Equipment	Advantages	Disadvantages
Static indices of preload			
- ***CVP***	o CVC, transducer	o Hemodynamic parametrs integration	o Poor fluid resposivness prediction
- ***PCWP***	o Pulmunory catheter set		o Pulmunary artery damage, infections
Dynamic indices od preload			
- ***SVV***	o Pulse contour analysis device (es. ClearSight, Hemosphere, PiCCO)	o High fluid resposivness prediction sensitivity	o ARDS, cardiac arrhythmia, spontaneous breathing, open chest surgery
- ***PPV***			
- ***SPV***	o Plethysmography	o No specific devices needed	
- ***PVI***		o Non-invasive or mini-invasive	
Echocardiographic methods			
- ***IVC index***	o Ultrasound device	o High fluid resposivness prediction sensitivity	o Operator-dependent
- ***SVC index***	o Critical care bed unit	o Non-invasive	o Low Tidal Volume, Arrhythmia, LV dysfunction, increased abdominal pressure, high ICP
Dynamic tests			
- ***PLR test***	o Hemodynamic monitoring (or Ultrasound device)	o Easy to perform	o Low diagnostic thresholds
- ***Mini-fluid Challenge***		o Repeatable	o Sensible monitoring required
- ***Tidal Volume Challenge***	o Critical care bed unit	o Reliable	o Irreversible (Mini-fluid Challenge)
Future perspective methods			
- ***EEOT***	o EtCO2 monitoring	o High fluid resposivness prediction sensitivity	o Operator-dependent
- ***CFT***	o Ultrasound doppler		o Low lung compliance, aortic valve disease, LV dysfunction
- ***Machine learning applied to echocardiography***	o Specific equipment (NICOM)	o Moderate sensitivity of fluid resposivness	o High thoracic impedance, lung disease, electrical interference, chest deformities
- ***Bioreactance***			

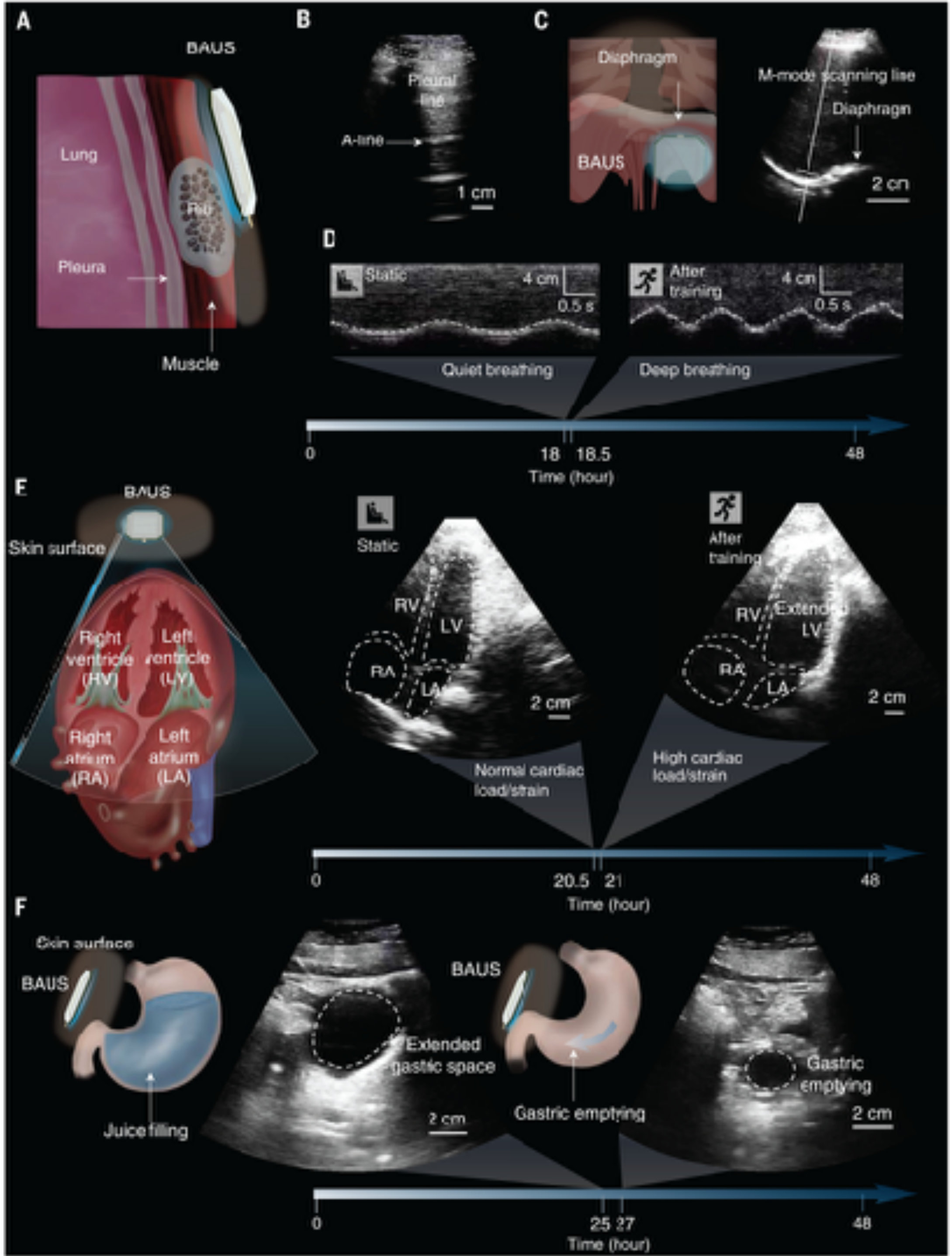
Bioadhesive ultrasound for long-term continuous imaging of diverse organs

Chonghe Wang[1]†, Xiaoyu Chen[1]†, Liu Wang[1], Mitsutoshi Makihata[2], Hsiao-Chuan Liu[3], Tao Zhou[1], Xuanhe Zhao[1,4]*

Continuous imaging of internal organs over days could provide crucial information about health and diseases and enable insights into developmental biology. We report a bioadhesive ultrasound (BAUS) device that consists of a thin and rigid ultrasound probe robustly adhered to the skin via a couplant made of a soft, tough, antidehydrating, and bioadhesive hydrogel-elastomer hybrid. The BAUS device provides 48 hours of continuous imaging of diverse internal organs, including blood vessels, muscle, heart, gastrointestinal tract, diaphragm, and lung. The BAUS device could enable diagnostic and monitoring tools for various diseases.

Science 2022. DOI: 10.1126/science.abo2542


A
BAUS
Carotid artery (CA)
Jugular vein (JV)
BAUS
Skin surface
Acoustic window
JV
CA
B
Neck rotation 30°
30°
Moving right
CA
0.3 cm
Neck rotation 0°
~0°
Middle
CA
Neck rotation -30°
-30°
Moving left
CA
C
Sitting
CA
Collapsed JV
0.3 cm
Supine
Distended JV
CA
0
Time (hour)
33
36
48
D
Fw
Flow velocity
Bw
Reflection
Static
Color flow window
Beam direction
0.5 cm
After training
0.5 cm
Flow velocity (cm/s)
Normal blood flow
Increased blood flow
Time (s)
E
Blood pressure (mmHg)
Normal blood pressure
Increased blood pressure
Time (s)
F
Systolic pressure (mmHg)
Training
Training
Training
Time (hour)


A
BAUS
Lung
Rib
Pleura
Muscle
B
Pleural line
A-line
1 cm
C
Diaphragm
BAUS
M-mode scanning line
Diaphragm
2 cm
D
Static
4 cm
0.5 s
After training
4 cm
0.5 s
Quiet breathing
Deep breathing
0
18
18.5
48
Time (hour)
E
BAUS
Skin surface
Right ventricle (RV)
Left ventricle (LV)
Right atrium (RA)
Left atrium (LA)
Static
RV
LV
RA
LA
2 cm
After training
RV
Extended LV
RA
LA
2 cm
Normal cardiac load/strain
High cardiac load/strain
0
20.5
21
48
Time (hour)
F
Skin surface
BAUS
Juice filling
Extended gastric space
2 cm
BAUS
Gastric emptying
Gastric emptying
2 cm
0
25
27
48
Time (hour)

Intensive Care Med (2024) 50:1137–1142
https://doi.org/10.1007/s00134-024-07407-6

EDITORIAL

Using echocardiography to predict fluid-responsiveness and manage the need for fluids

Antoine Vieillard-Baron[1,2*], Florence Boissier[3,4] and Michel Slama[5,6]

Do not fill Fill Optional

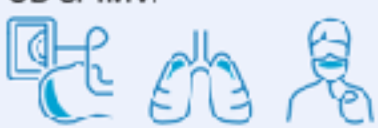
Valvulopathy	
Fluids	Do not fill when severe MR, AR or AS
Limitations	Skills of intensivists. Discussion with an echo expert can be useful. Patients with severe AS poorly tolerates hypovolemia.

Intensive Care Med (2024) 50:1137–1142
https://doi.org/10.1007/s00134-024-07407-6

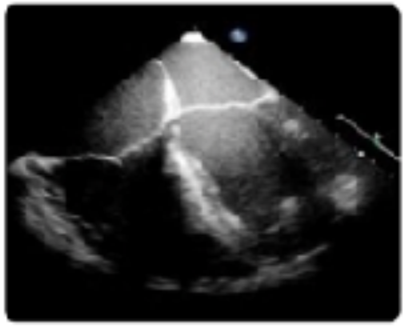
EDITORIAL

Using echocardiography to predict fluid-responsiveness and manage the need for fluids

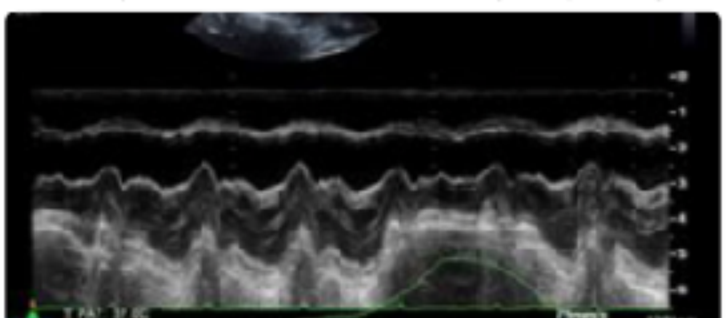
Antoine Vieillard-Baron[1,2*], Florence Boissier[3,4] and Michel Slama[5,6]

Passive Leg Raising	
Type of ventilation	SB or IMV. 
Clinical context	Validated regardless type of ventilation, cardiac rhythm, Vt, lung compliance.
Fluids	Optional when increase in aortic VTI ≥10% within 1 minute.
Limitations	False negative if venous compression stockings or intra-abdominal pressure ≥ 16 mmHg.

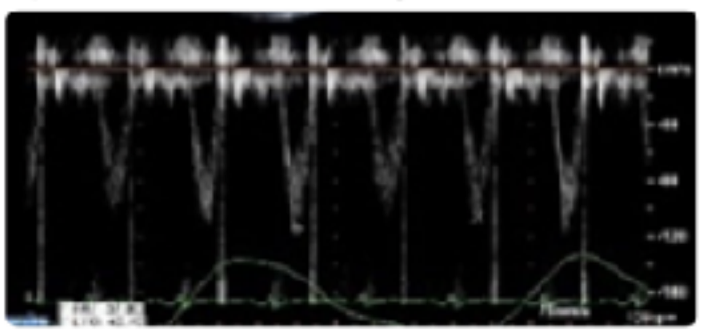
Using echocardiography to predict fluid-responsiveness and manage the need for fluids

RV size: RV/LV EDA	
Route and views	TEE transverse mid-esophageal view. TTE apical 4-chamber view.
Type of ventilation	SB and IMV. 
Clinical context	Described in ARDS and in septic shock.
Fluids	Do not fill when RV severely/markedly dilated. 
Limitations	Optimal threshold of RV/LV EDA is unknown; could be lower than 1. A non- severely dilated right ventricle do not always exclude to fill the patient according to the other parameters.

Using echocardiography to predict fluid-responsiveness and manage the need for fluids

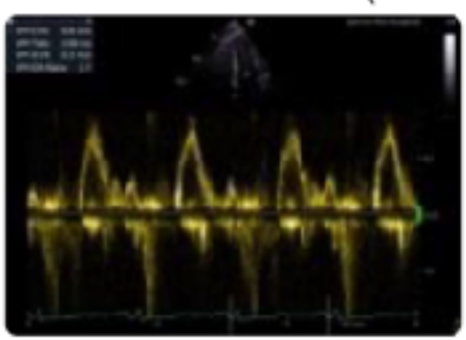
SVC respiratory variations (SVC collapsibility index): Dmax - Dmin/Dmax	
Route and views	TEE longitudinal (90°) upper esophageal view. 2D may be combined with time-motion.
Type of ventilation	IMV without spontaneous effort. 
Clinical context	Vt 6-8 mL/kg. Shock. Still usable in arrhythmia.
Fluids	Fill when collapsibility >31% or partial/complete SVC collapse. Optional when mild SVC respiratory variations. It is likely that in the absence of any respiratory variation the patient is non- responder, i.e. do not fill. 
Limitations	TEE is required. False negative in case of very low Vt?

Using echocardiography to predict fluid-responsiveness and manage the need for fluids

Respiratory variations of aortic maximal velocity: Vmax - Vmin/Vmean	
Route and views	TEE transgastric oblique view at 110°. TTE apical 5-chamber view.
Type of ventilation	IMV without spontaneous effort. 
Clinical context	Vt 6-8 mL/kg. Shock.
Fluids	Optional when > 10% during tidal ventilation. 
Limitations	Sinus rhythm is mandatory. May be present in unresponsive patient with severe RV dilatation. False negative may occur in the case of very low tidal volume.

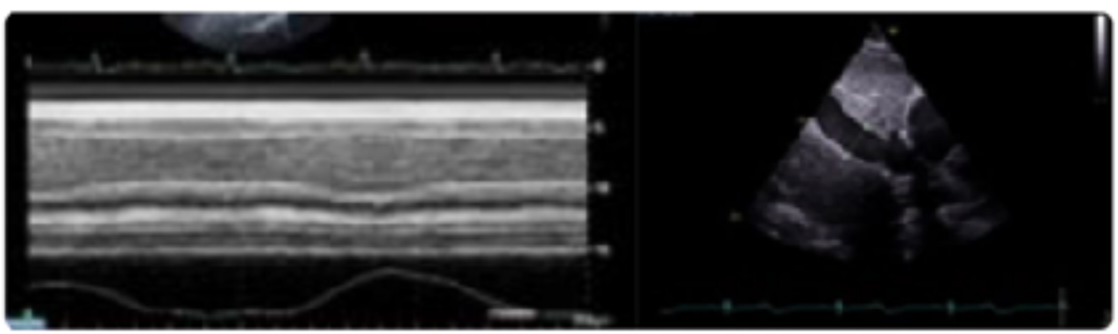
Using echocardiography to predict fluid-responsiveness and manage the need for fluids

Antoine Vieillard-Baron[1,2*], Florence Boissier[3,4] and Michel Slama[5,6]

LV filling pressure	
Route and views	TEE transverse mid-esophageal view. TTE apical 4-chamber view. Pulsed wave Doppler and tissue Doppler imaging.
Type of ventilation	SB or IMV. 
Clinical context	Most studies done in the cardiological field.
Fluids	Do not fill when elevated (restrictive mitral inflow with E/A>1.8 and/or E/E'>15). 
Limitations	A restrictive mitral inflow may be observed in young patients (low LV compliance). E/E' was mainly validated in cardiac patients.

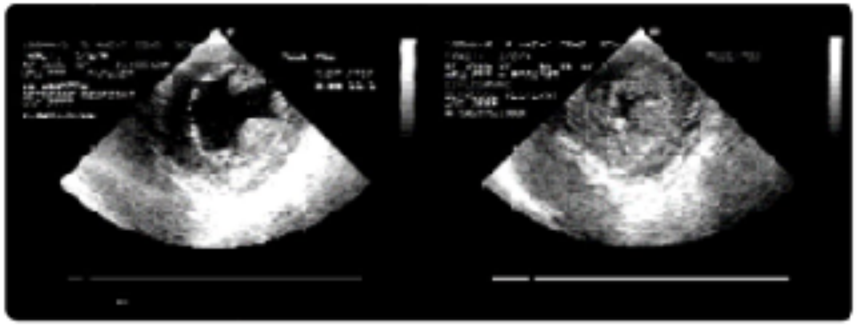
Using echocardiography to predict fluid-responsiveness and manage the need for fluids

Antoine Vieillard-Baron[1,2*], Florence Boissier[3,4] and Michel Slama[5,6]

End-expiratory IVC diameter	
Route and views	TTE sub-costal view. 2D may be combined with time motion.
Type of ventilation	SB or IMV. 
Clinical context	Vt 6- 8 mL/kg. Shock. Still usable in arrhythmia.
Fluids	Fill when diameter < 10 mm. Do not fill when diameter > 25-27 mm. 
Limitations	2/3 of patients are between 10 and 25-27mm. Place of measurement can be questionable.

Using echocardiography to predict fluid-responsiveness and manage the need for fluids

Antoine Vieillard-Baron[1,2*], Florence Boissier[3,4] and Michel Slama[5,6]

LV size and function	
Route and views	TEE transverse transgastric view. TTE parasternal short axis view. (At papillary muscle level).
Type of ventilation	SB or IMV. 
Clinical context	Septic shock. Dynamic obstruction with SAM may be associated.
Fluids	Fill when "kissing" LV with low end-diastolic area (<5 cm^2/m^2). 
Limitations	A "kissing" LV is observed in profound vasoplegia but LVEDA is preserved.

Journal of Critical Care 71 (2022) 154070

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.journals.elsevier.com/journal-of-critical-care

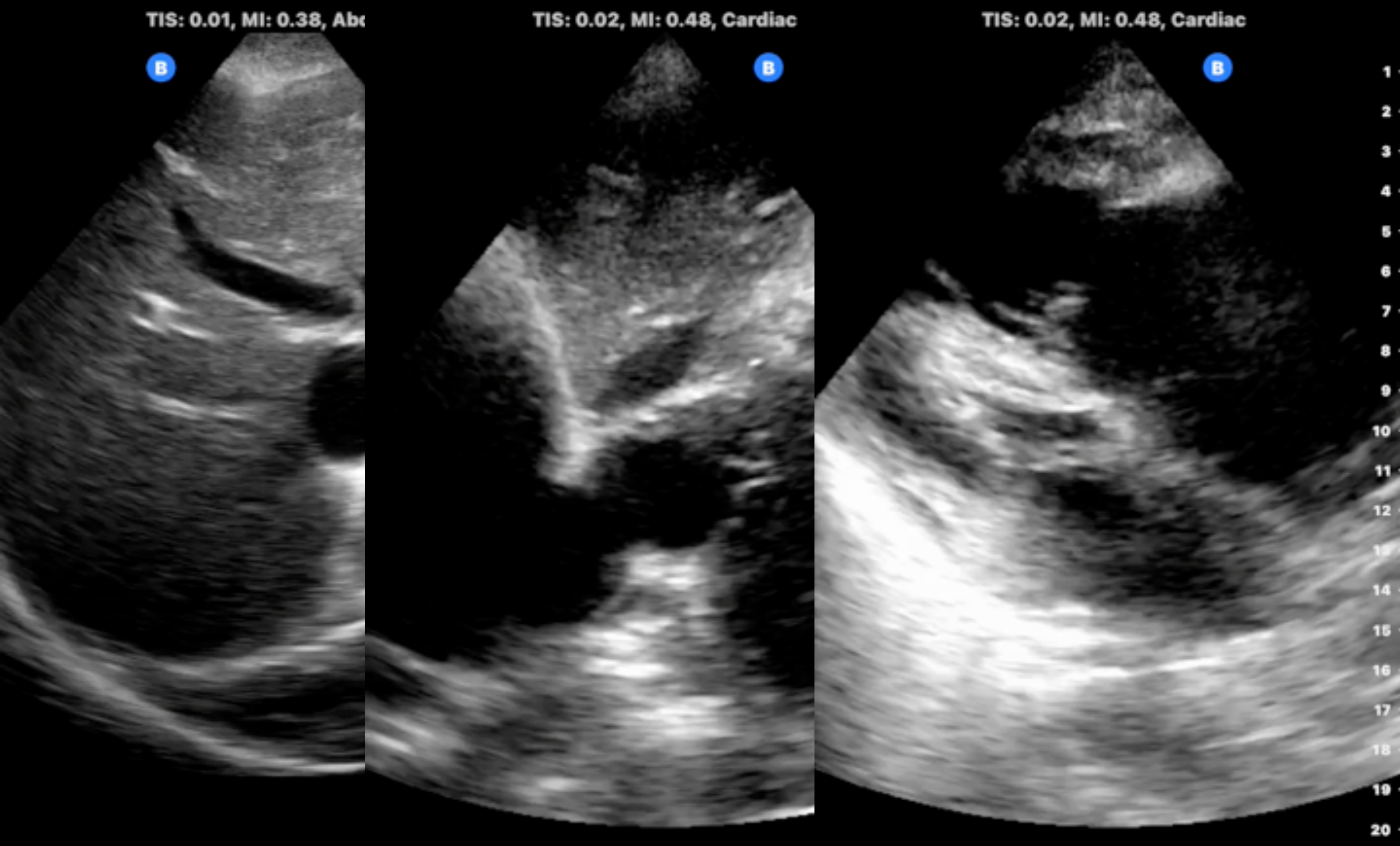
The emerging concept of fluid tolerance: A position paper

Eduardo Kattan [a], Ricardo Castro [a], Francisco Miralles-Aguiar [b], Glenn Hernández [a], Philippe Rola [c,*]

[a] Departamento de Medicina Intensiva, Facultad de Medicina, Pontificia Universidad Católica de Chile, Chile
[b] Anesthesia & Surgery Critical Care Service, Hospital Universitario Puerta del Mar, Cádiz, Spain
[c] Chief of Service, Intensive Care Unit, Hopital Santa Cabrini, CIUSSS EMTL, Montreal, Canada

Characteristic	Fluid responsiveness	Fluid tolerance	Fluid overload
Definition	Increase on cardiac output ≥10% after preload incrementation by manipulation of venous return in a dynamic test context.	Fluid tolerance is the degree to which a patient can tolerate administration of fluids without causation of organ dysfunction.	A state of global body accumulation of fluids after resuscitation with a deleterious impact on organ function.
When to use	During resuscitation	During resuscitation	After resuscitation
Adequate use	Increase CO through a fluid challenge in FR+ patients to resolve hypoperfusion	Modify resuscitation strategy (vasopressors, other types of fluids, etc.)	Prompt de-resuscitation
Inadequate use	Consider fluid responsiveness as a mandatory trigger for fluid administration, irrespective of tissue perfusion status	Assume that fluid intolerance only occurs in fluid unresponsive patients	Inadequate timing or intensity of de-resuscitation
Limitations	Not assessable in all patients and technical challenges	Theoretical construct, not clinically validated yet	Retrospective diagnosis; still lack of evidence on how to best de-resuscitate

Fill or not to fill ?



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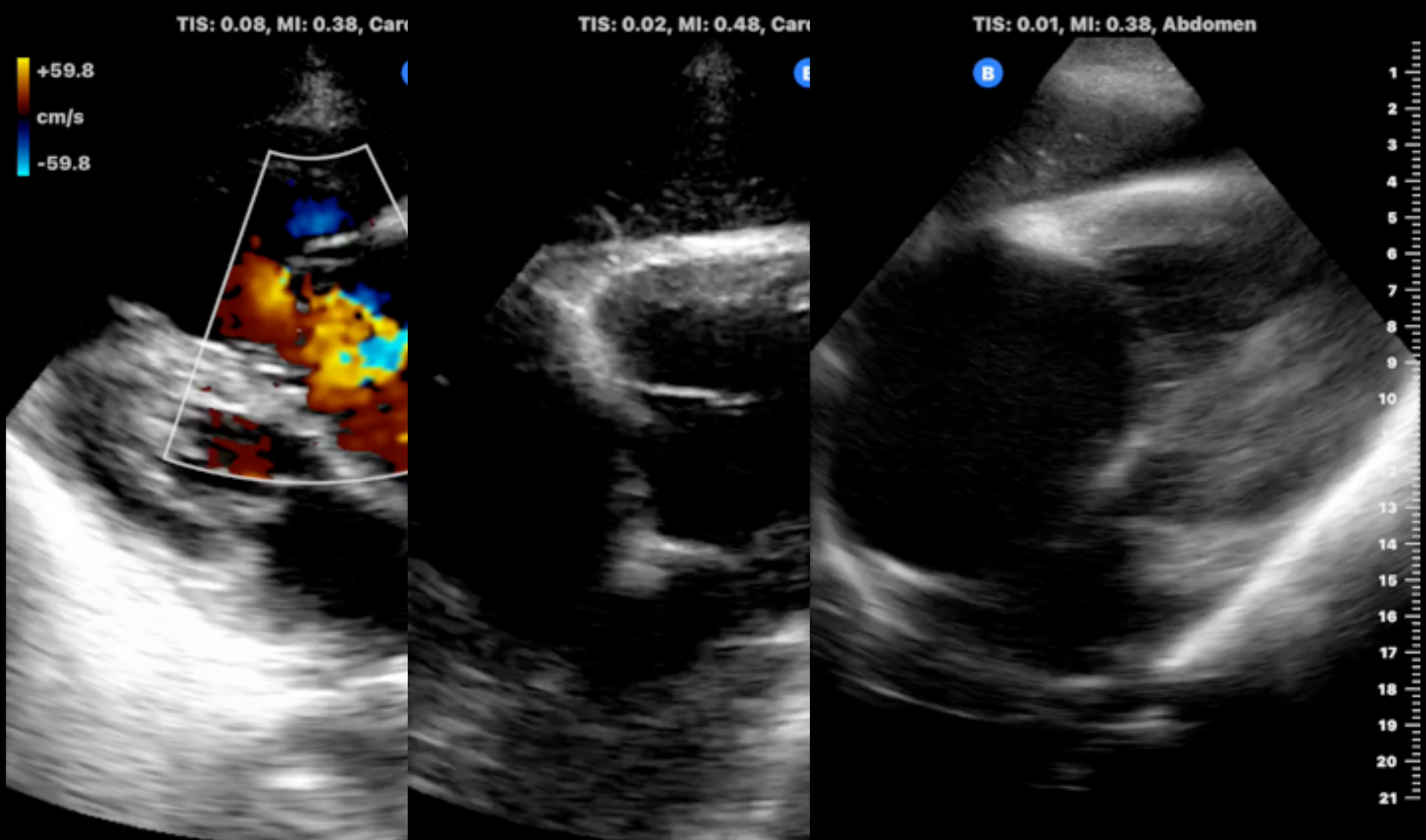

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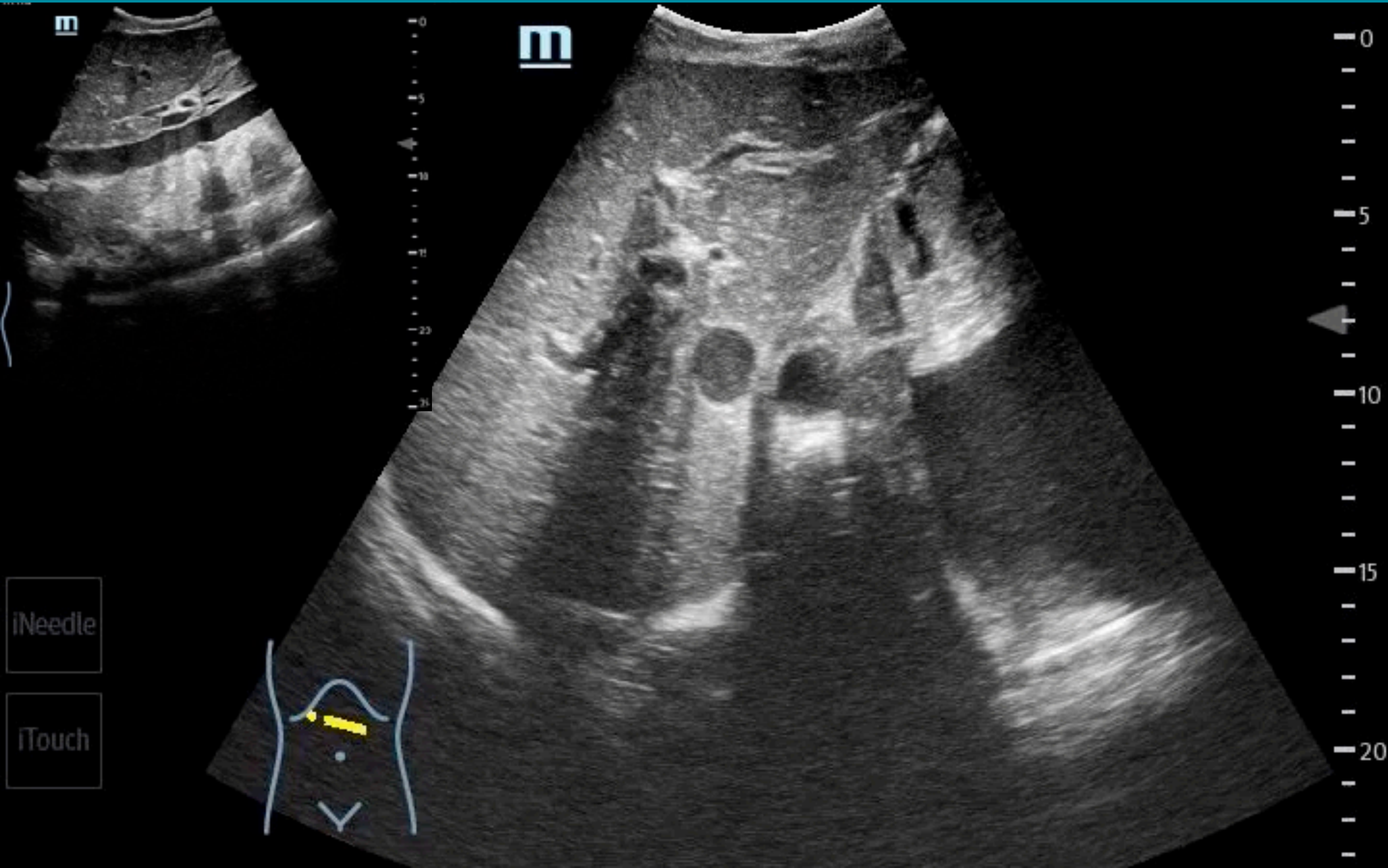
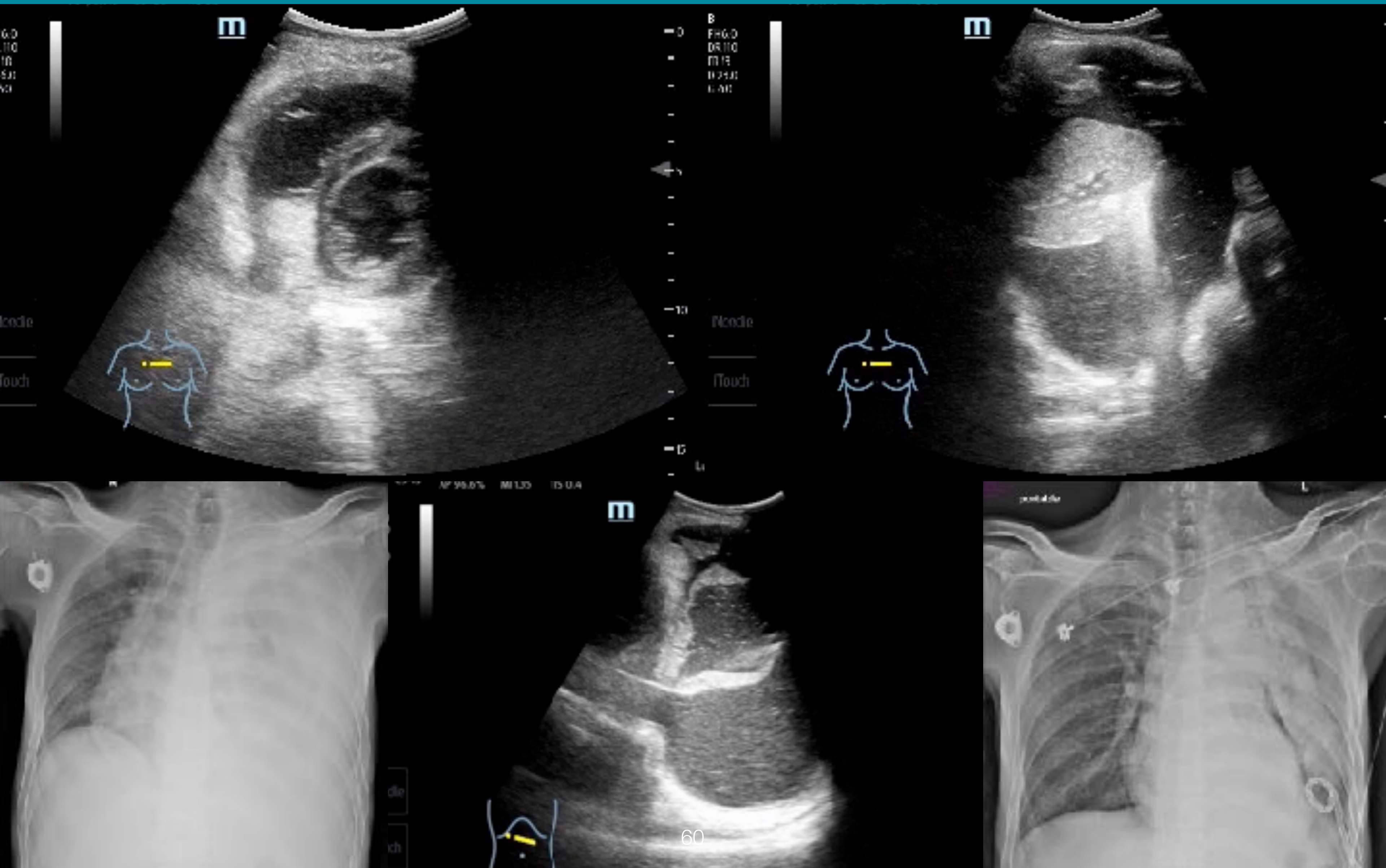


Pyopneumothorax



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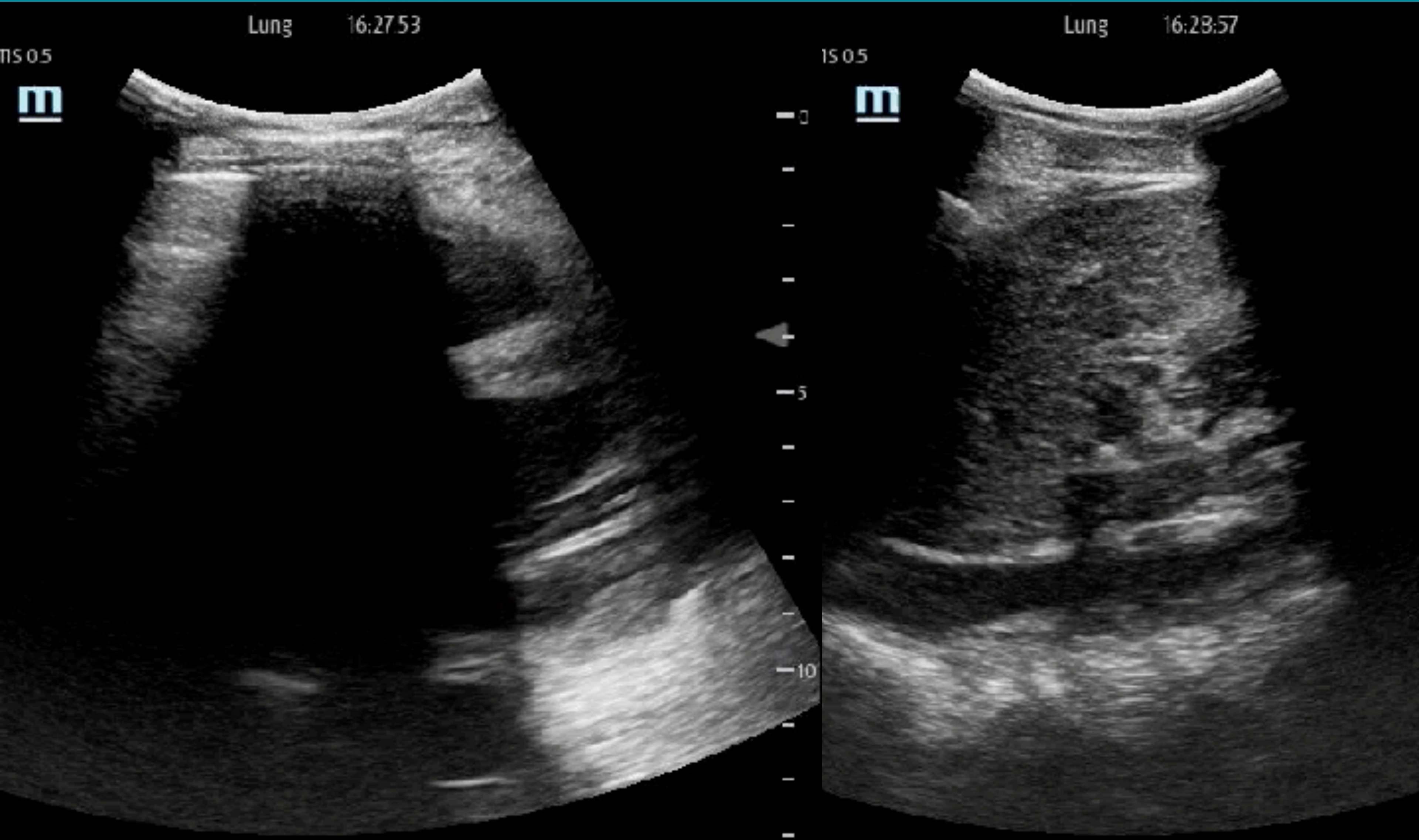
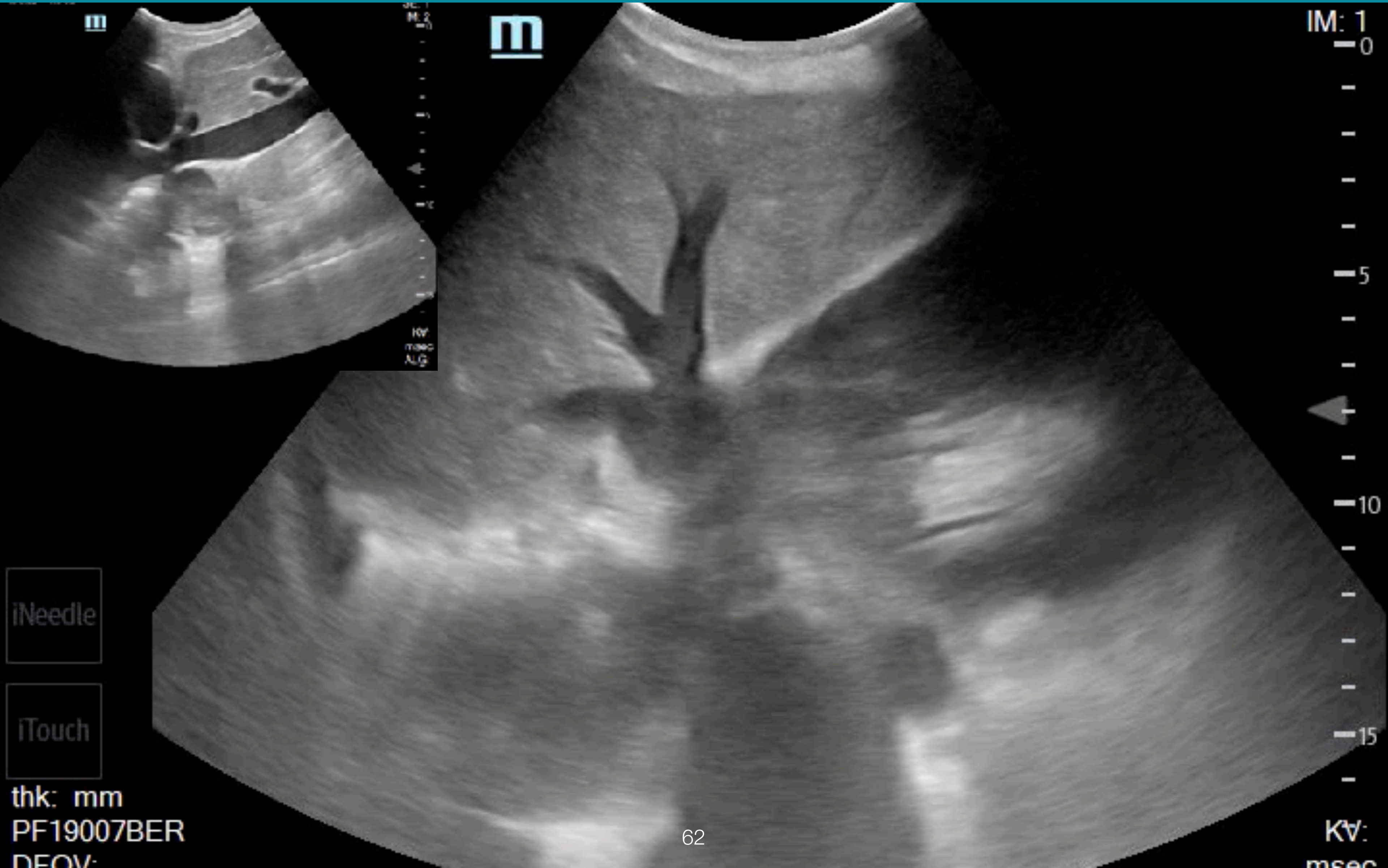
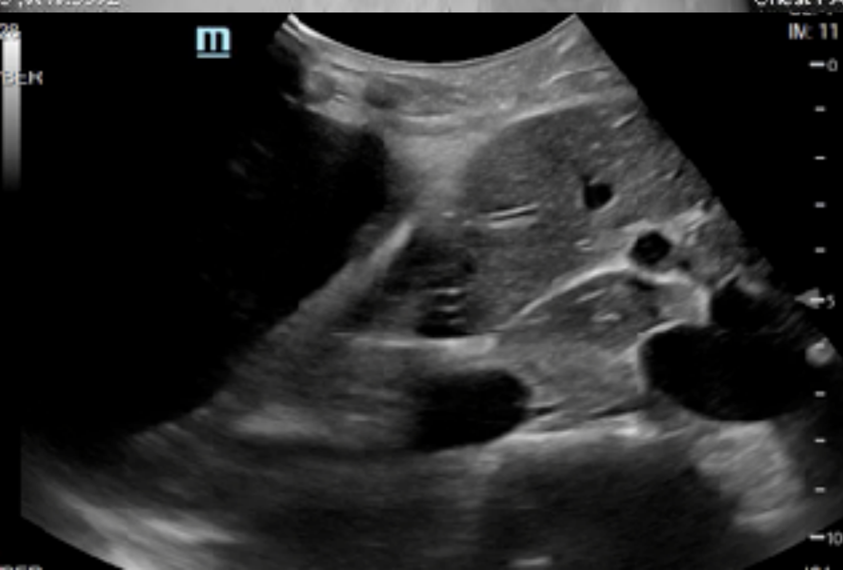


Fill or not to fill ?




Chest PA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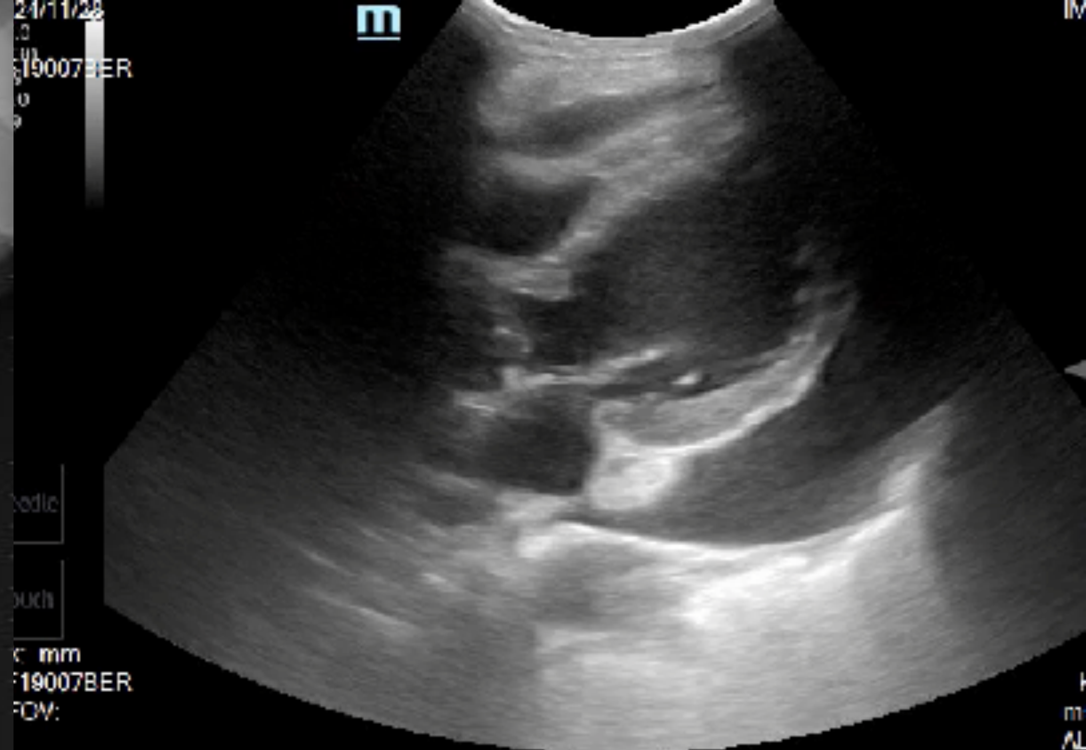
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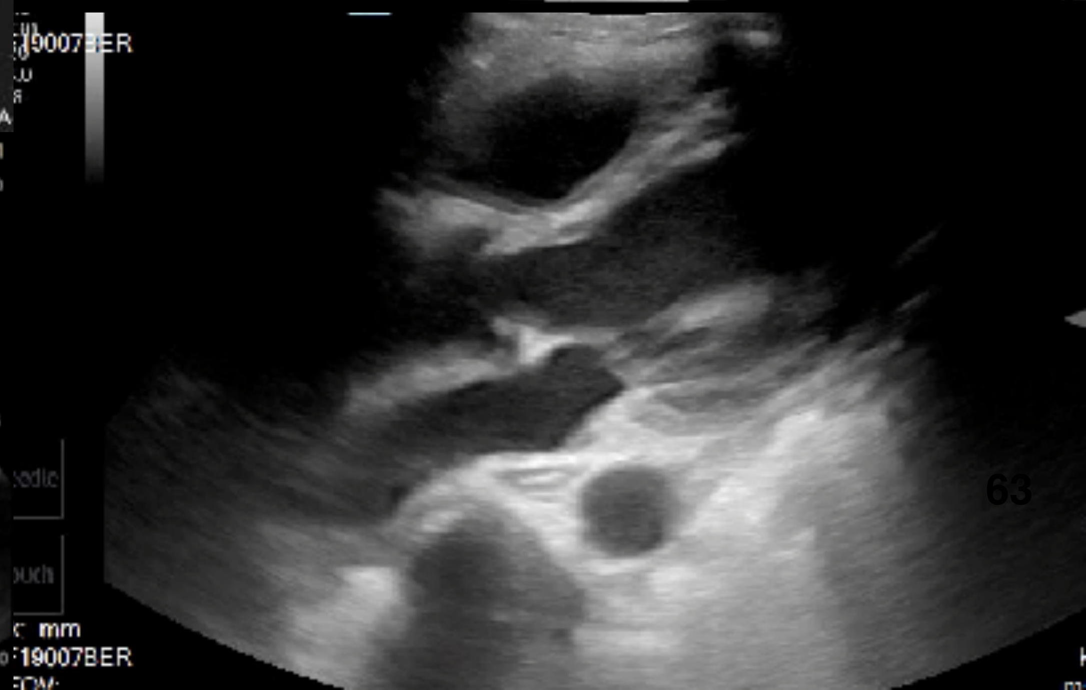
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mm
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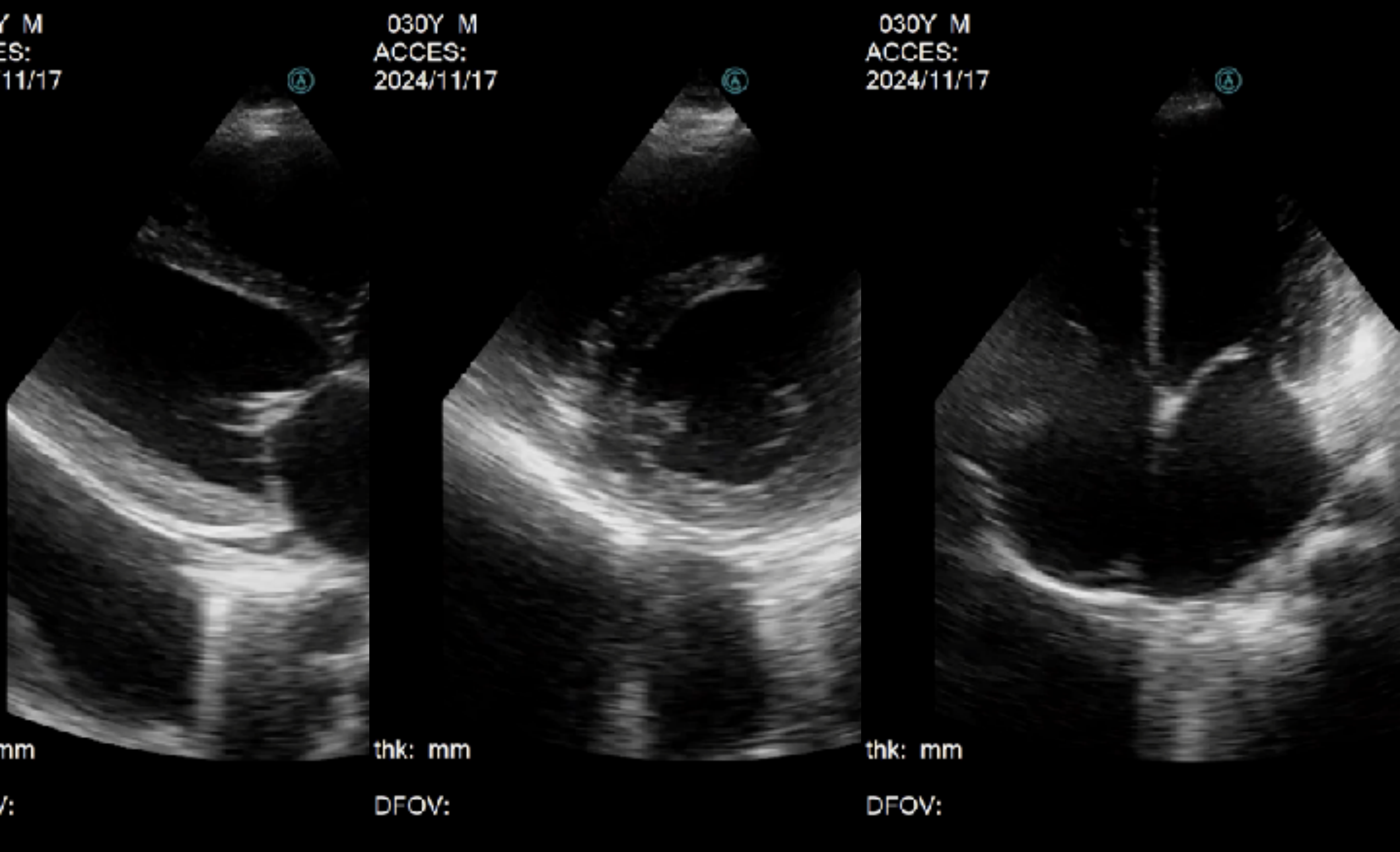
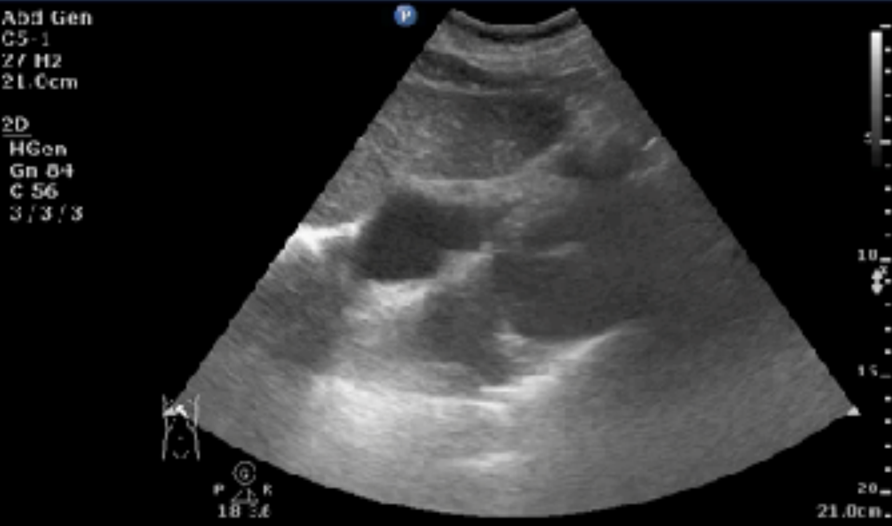
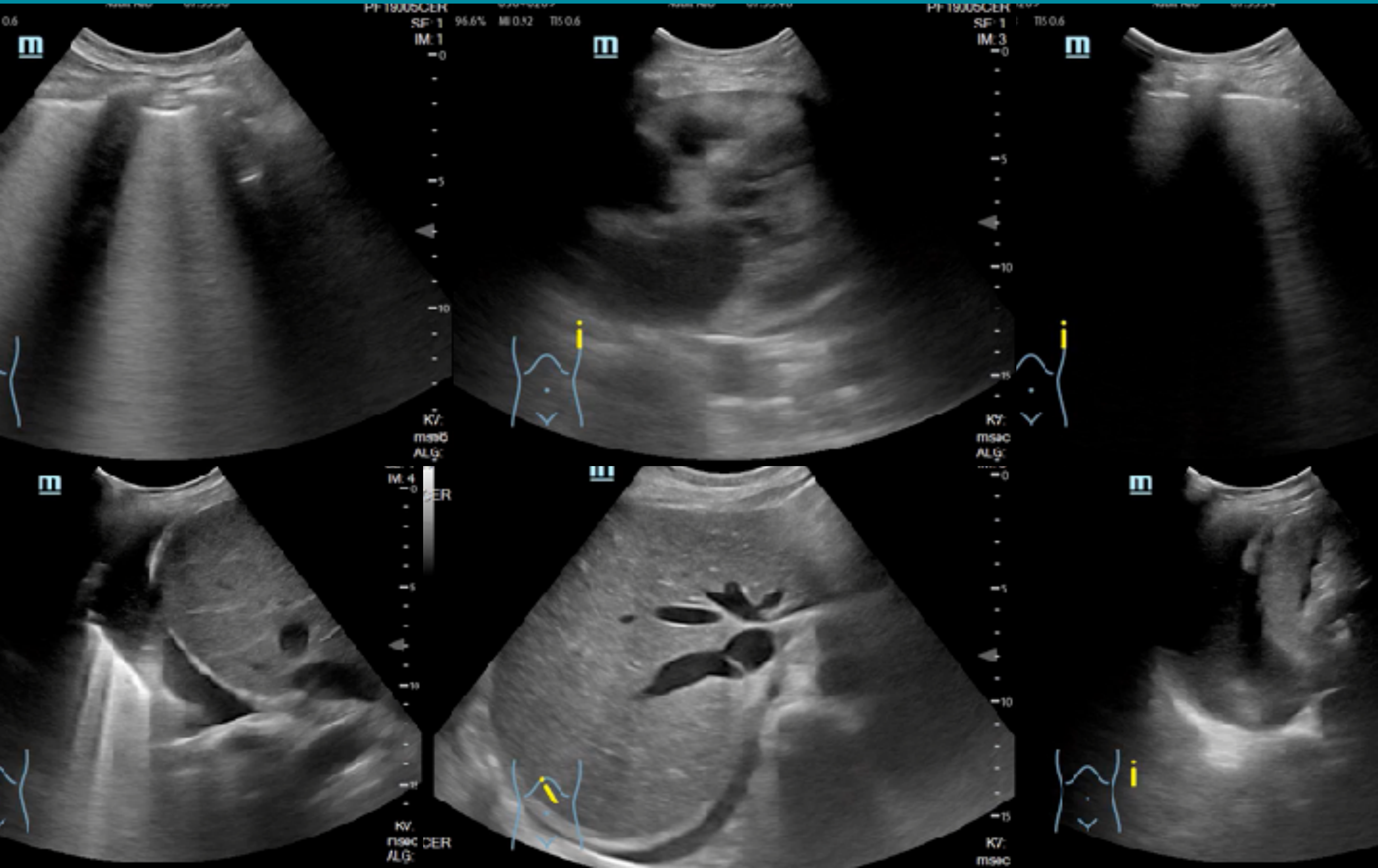
Heart - Lung - IVC



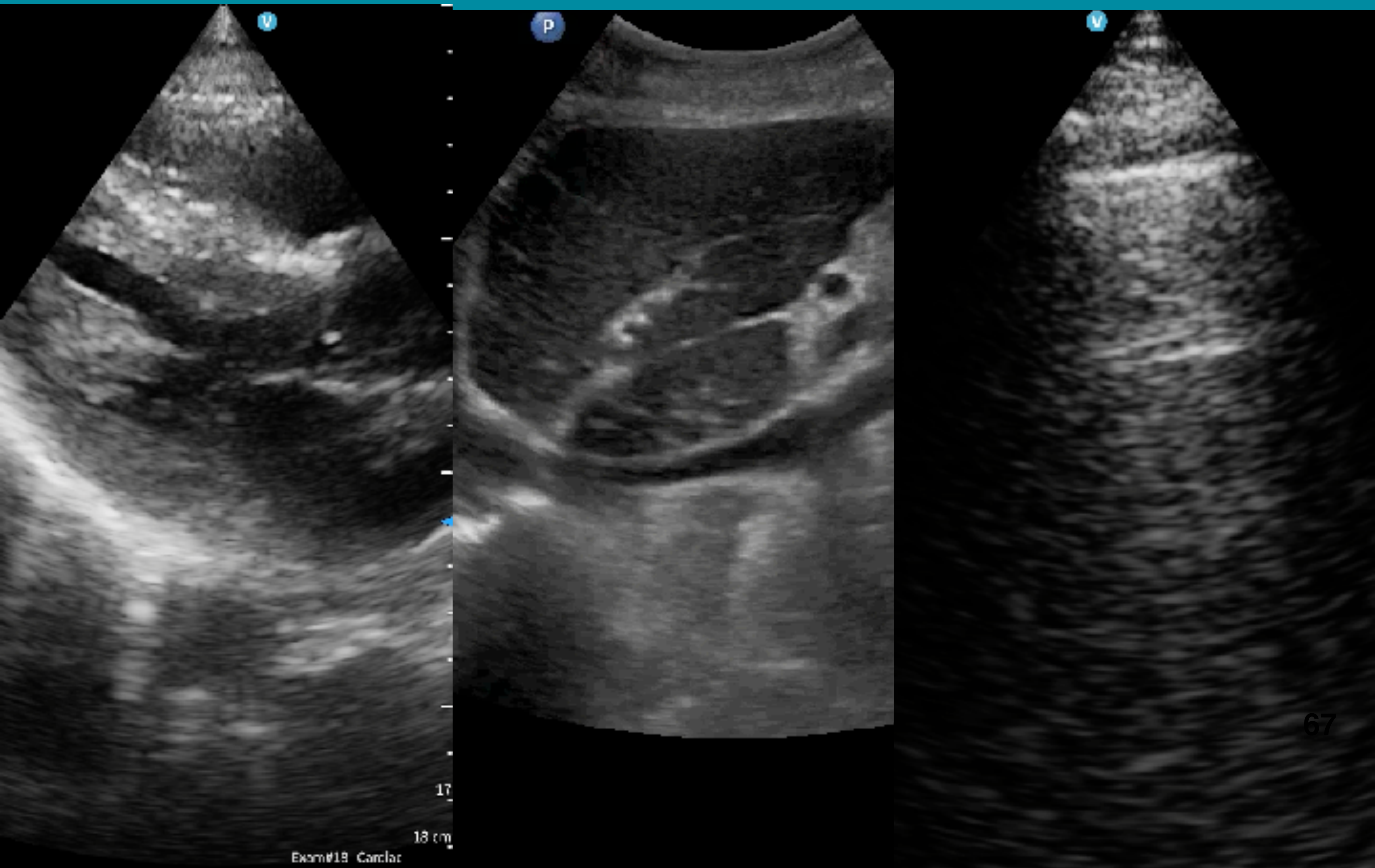
Heart - Lung - IVC



Heart - Lung - IVC



Fill



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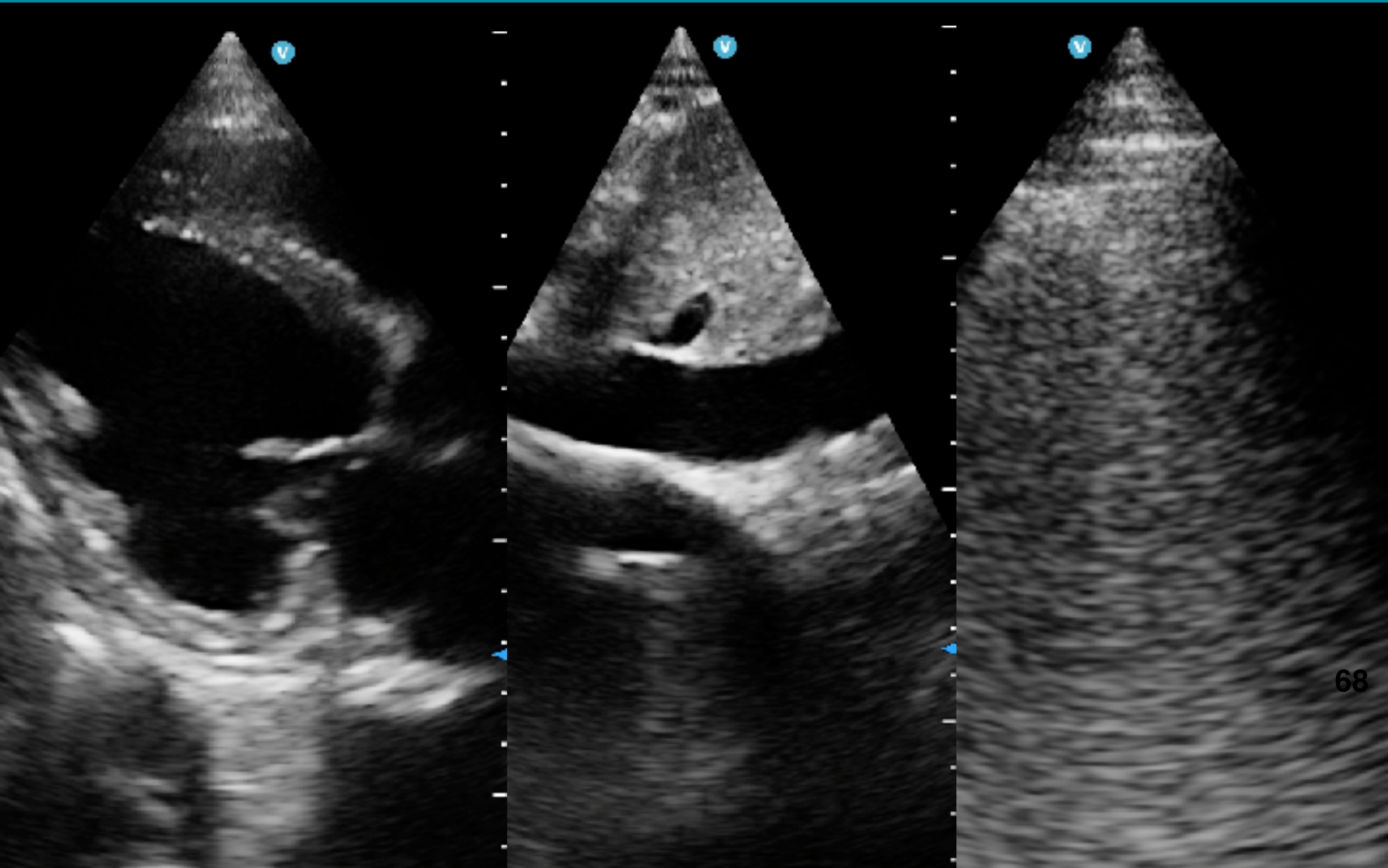

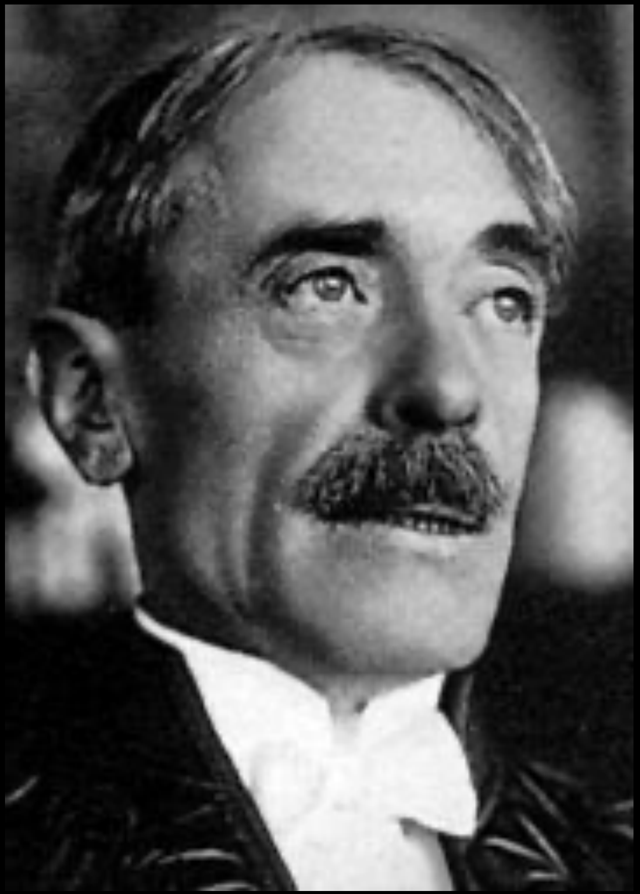

Paul Valéry

~ French poet, essayist, philosopher

"Everything simple is false.
Everything complex is unusable."