Σύγχρονες εφαρμογές των υπερήχων στη Μονάδα Εντατικής Θεραπείας

Χριστίνα Ι. Ρούτση

Α΄ Κλινική Εντατικής Θεραπείας

Ιατρική Σχολή ΕΚΠΑ

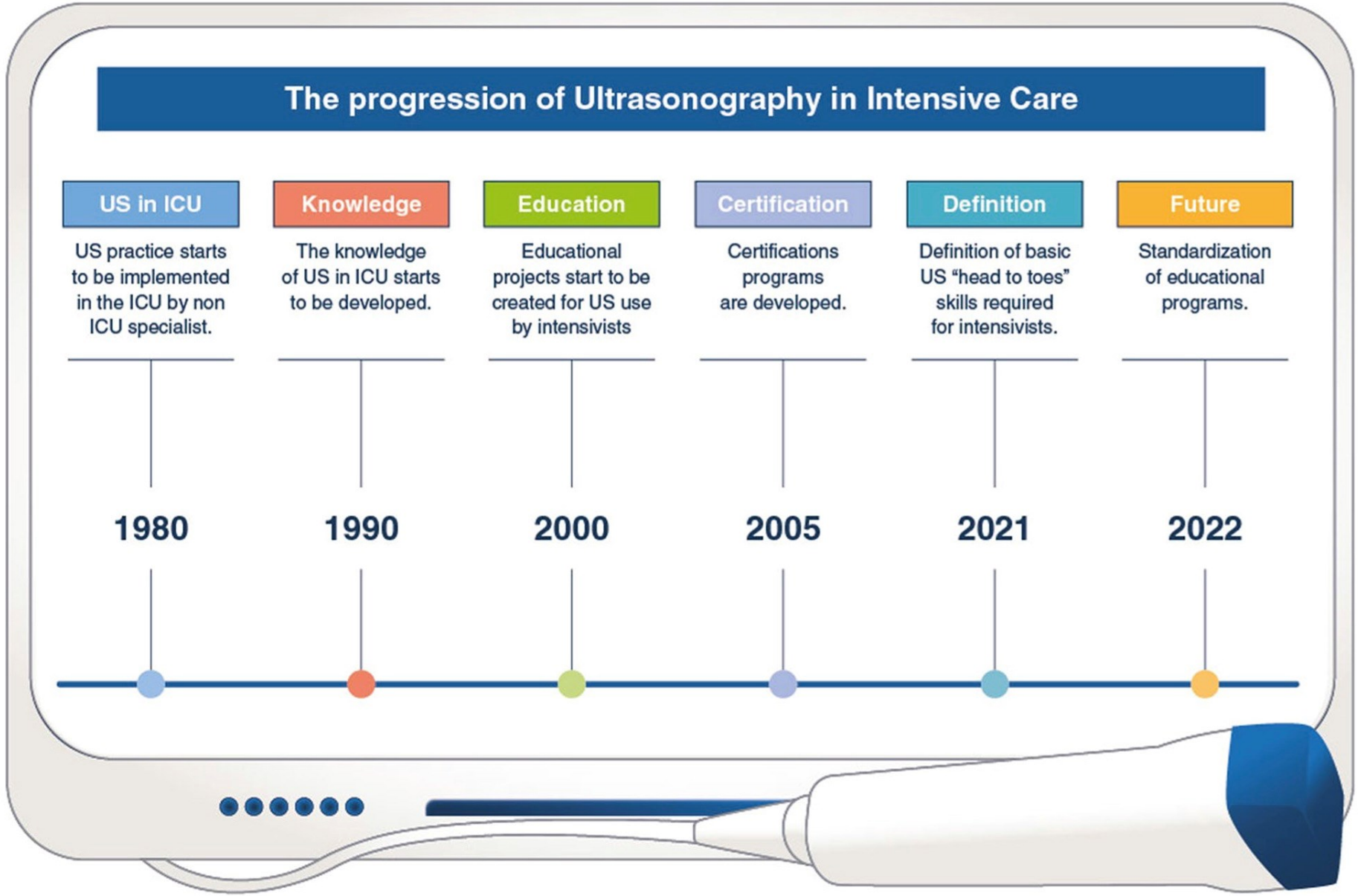
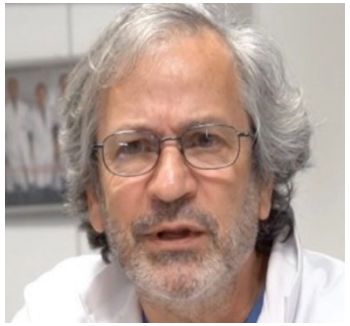


Fig. 1 Main steps over the last decades which led to the progression of Ultrasonography in Intensive Care. Abbreviations: *US* Ultrasound, *ICU* Intensive Care Unit



In the 1990s, Dr. Daniel Lichtenstein demonstrated the utility of lung ultrasonography in the management of critically ill patients

The Comet-tail Artifact
An Ultrasound Sign of Alveolar-Interstitial Syndrome

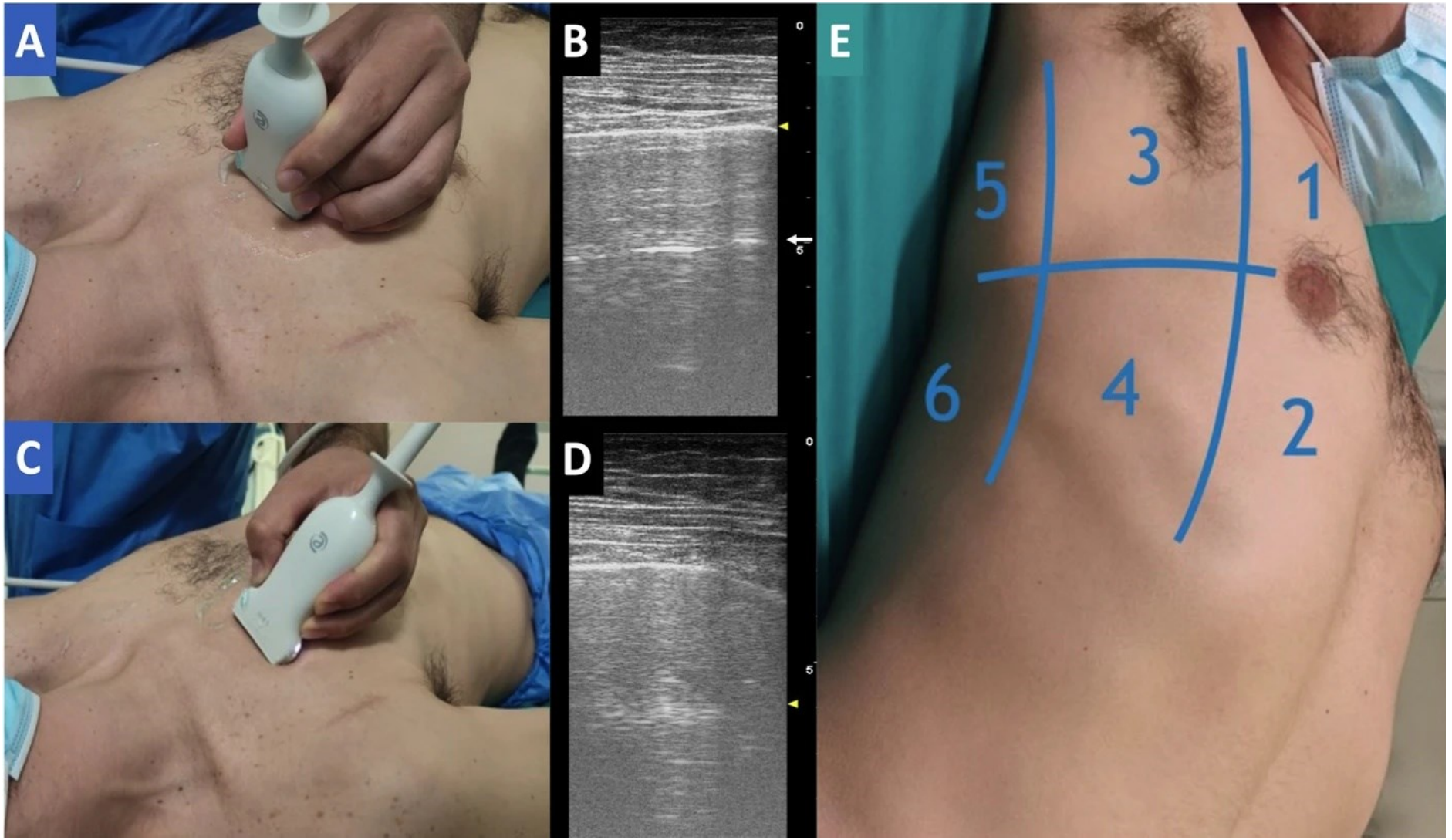
DANIEL LICHTENSTEIN, GILBERT MÉZIÈRE, PHILIPPE BIDERMAN, AGNÈS GEPNER, and OLIVIER BARRÉ

Service de Réanimation Médicale and Service de Radiologie, Hôpital Ambroise-Paré, Boulogne (Paris), and Service de Réanimation Polyvalente, Centre Hospitalier Général, Saint-Cloud (Paris), France

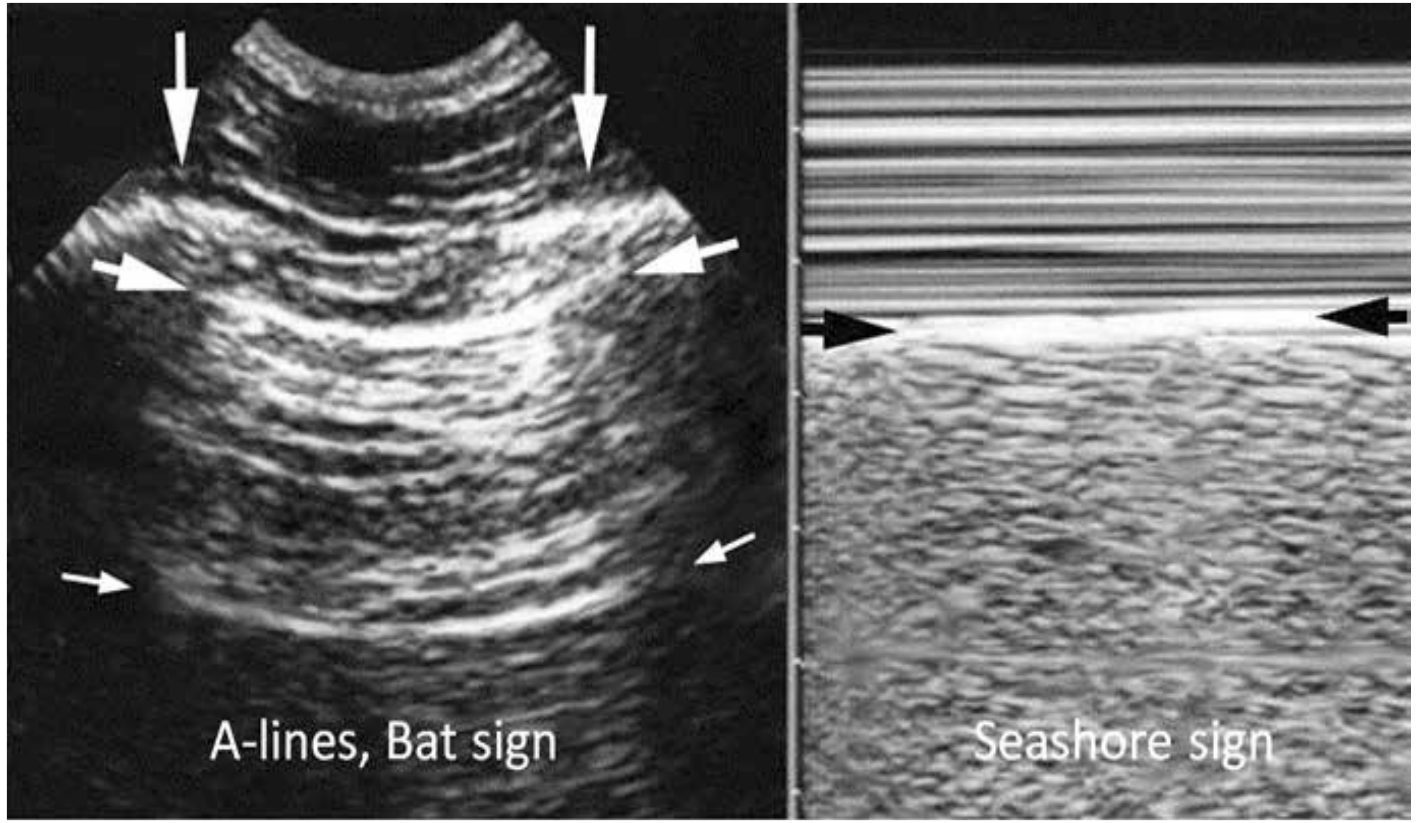
A Bedside Ultrasound Sign Ruling Out Pneumothorax in the Critically Ill*
Lung Sliding

Daniel A. Lichtenstein, MD, and Yves Menu, MD

Lung ultrasound



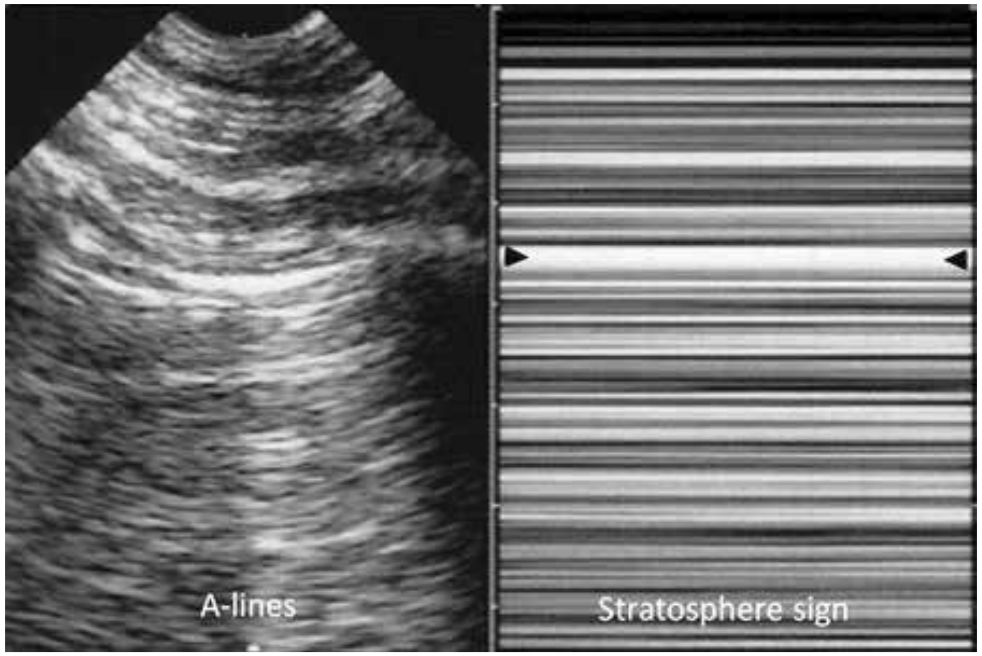
Ultrasound scan of the anterior intercostal space: bat and seashore sign



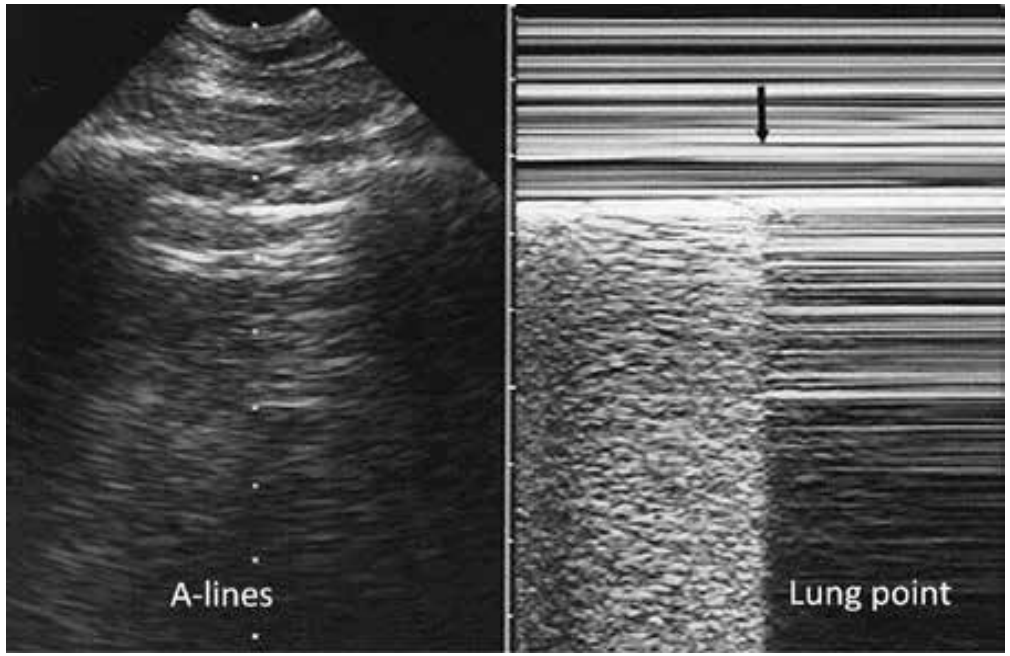
PNEUMOTHORAX

1. absence of lung sliding
2. presence of A-lines
3. stratosphere sigh in M-mode
4. the presence of lung point

Pleural line with A-lines, indicating gas below the pleural line. on M-mode, the abolition of lung sliding is visible through the stratosphere sign (which replaces the seashore sign) and indicates total absence of motion.



M-mode. The left-hand side of the image shows lung patterns(lung sliding) before the visceral pleura disappears. The arrow shows the exact moment the visceral pleura is no longer in contact with the pleura line.



D. Lichtenstein

Bedside **L**ung **U**ltrasound in **E**mergency (**BLUE**)-protocol

- **The BLUE-protocol is a fast protocol (<3 minutes), which allows rapid diagnosis of acute respiratory failure.**
- **The BLUE-protocol can distinguish cardiogenic pulmonary edema from ARDS, COPD, and rule out pneumothorax as confirmed**

CHEST Original Research
CRITICAL CARE MEDICINE

Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure*

The BLUE Protocol

Daniel A. Lichtenstein, MD, FCCP; and Gilbert A. Mezière, MD

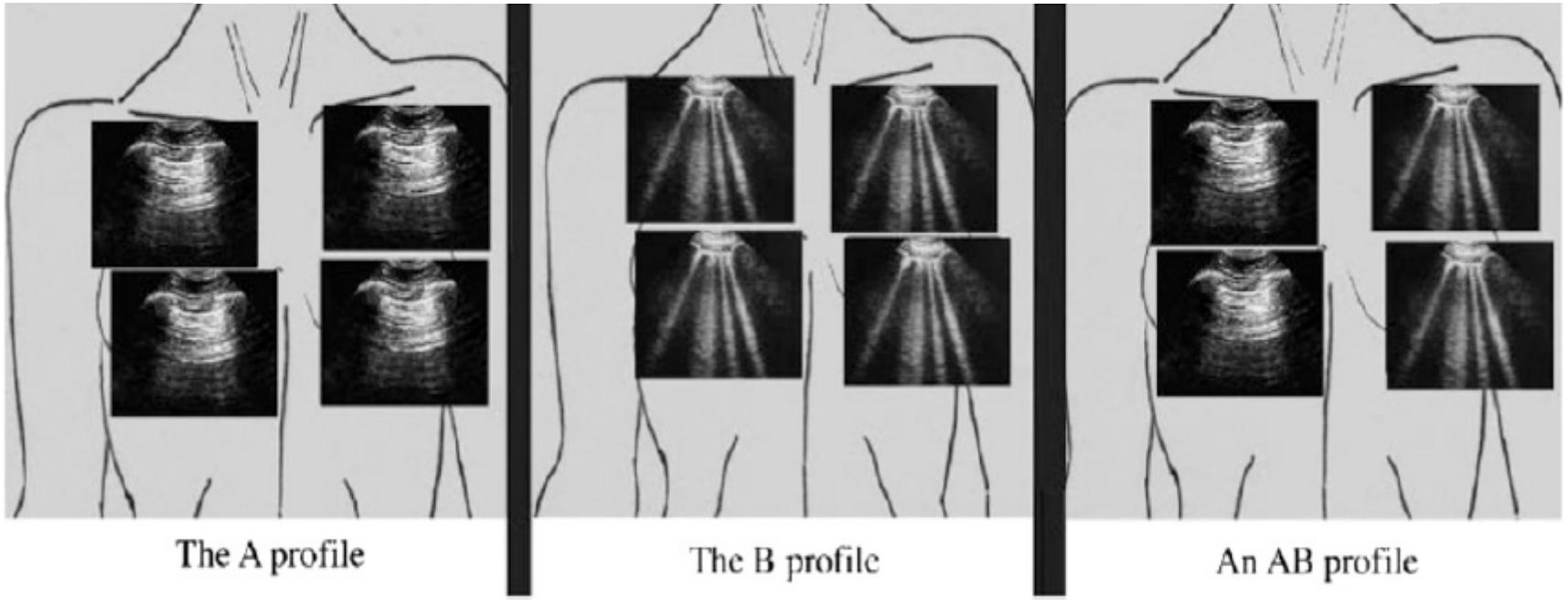
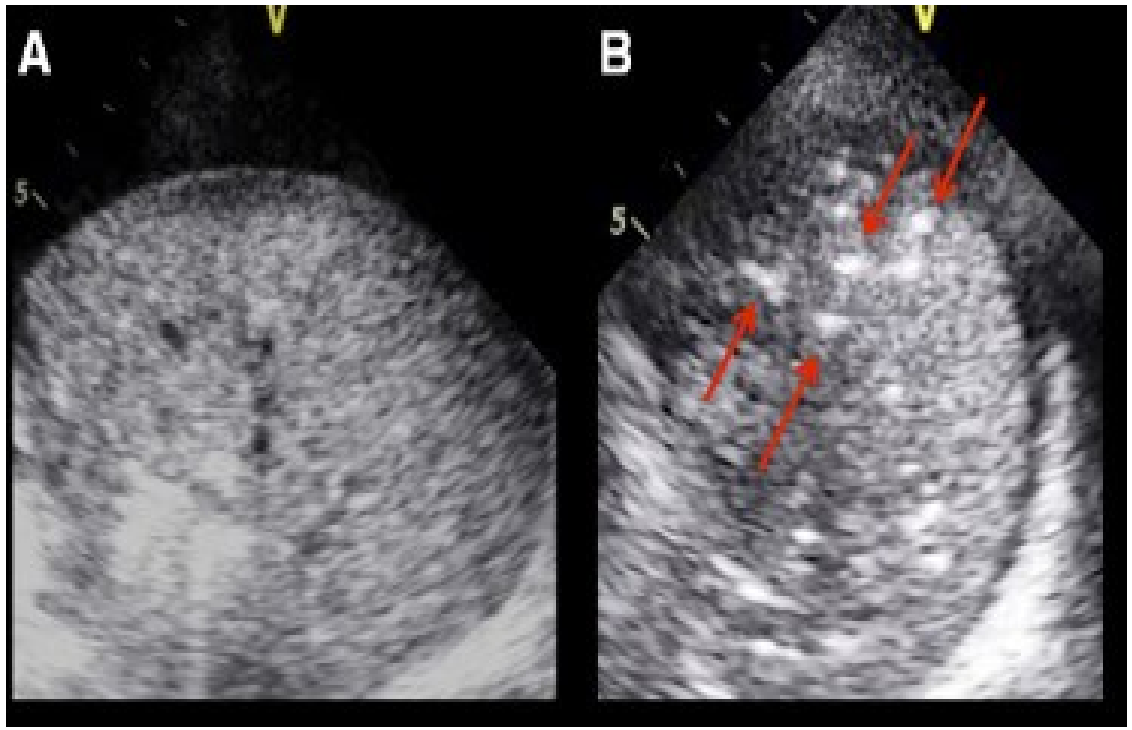


FIGURE 6. Ultrasound profiles. *Left panel*: The A profile is defined as predominant A lines plus lung sliding at the anterior surface in supine or half-sitting patients (stage 1/1'). This profile suggests COPD, embolism, and some posterior pneumonia. Pulmonary edema is nearly ruled out. Middle: The B profile is defined as predominant B + lines in stage 1. This profile suggests cardiogenic pulmonary edema, and nearly rules out COPD, pulmonary embolism, and pneumothorax. *Right panel*: an A/B + profile, massive B lines at the left lung, A lines at the right lung. This profile is usually associated with pneumonia.


A
B

CHEST
Original Research
CRITICAL CARE MEDICINE

Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure*

The BLUE Protocol

Daniel A. Lichtenstein, MD, FCCP; and Gilbert A. Mezière, MD

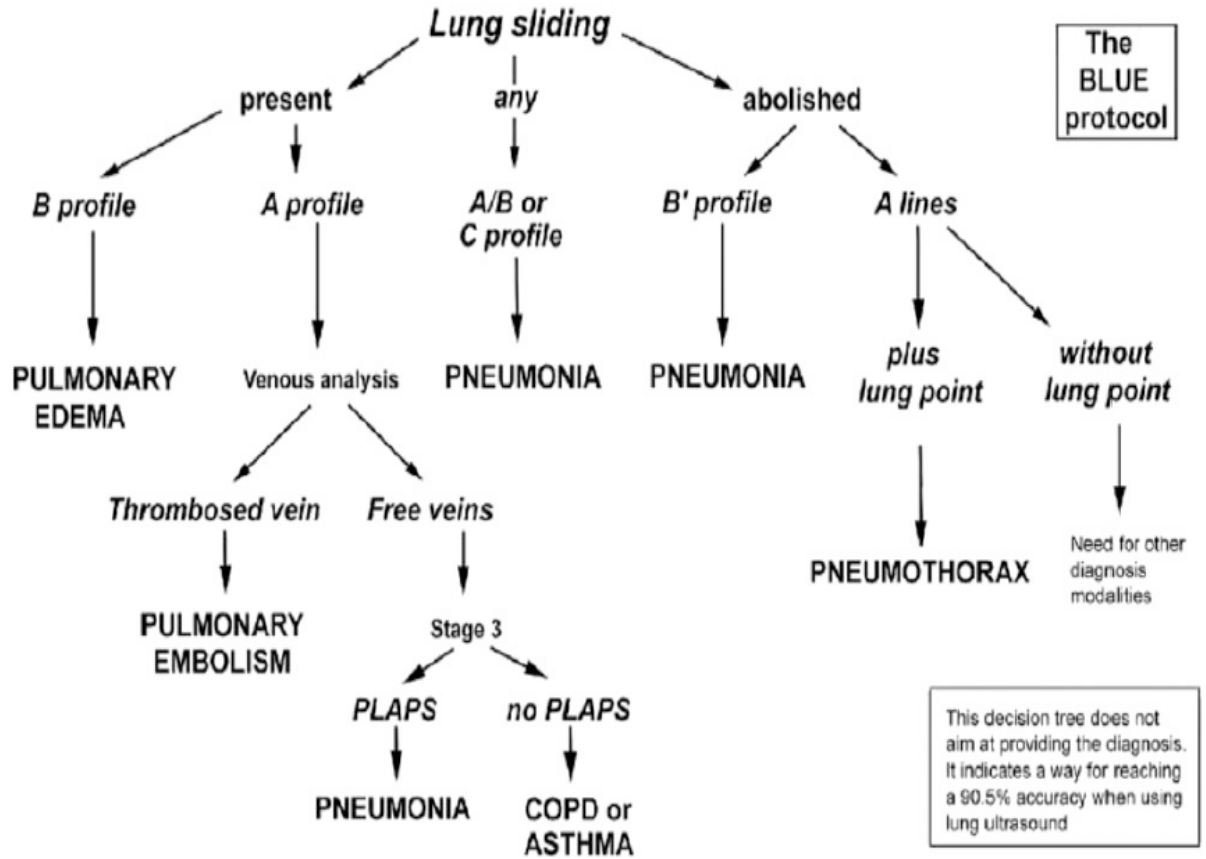


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lung Ultrasonography Compared to Chest Radiography

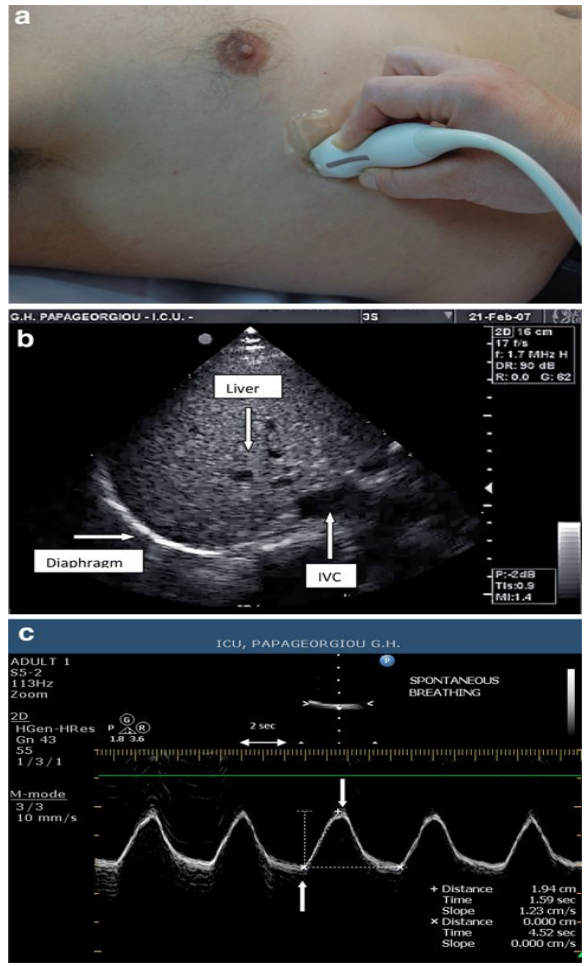
- Lung ultrasonography is superior to portable chest radiographs for detection of
  - Pneumothorax
  - Alveolar-interstitial pattern
  - Consolidation
  - Pleural effusion

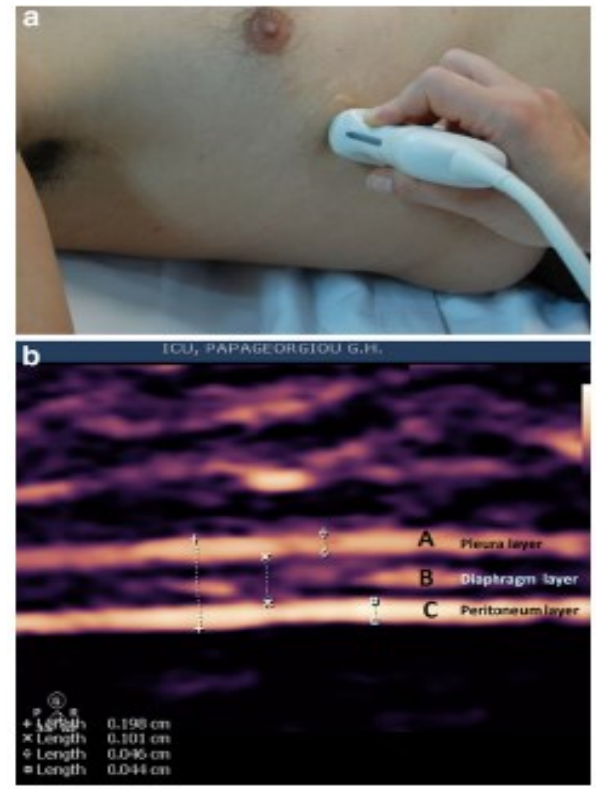
Intensive Care Med
DOI 10.1007/s00134-013-2823-1

REVIEW

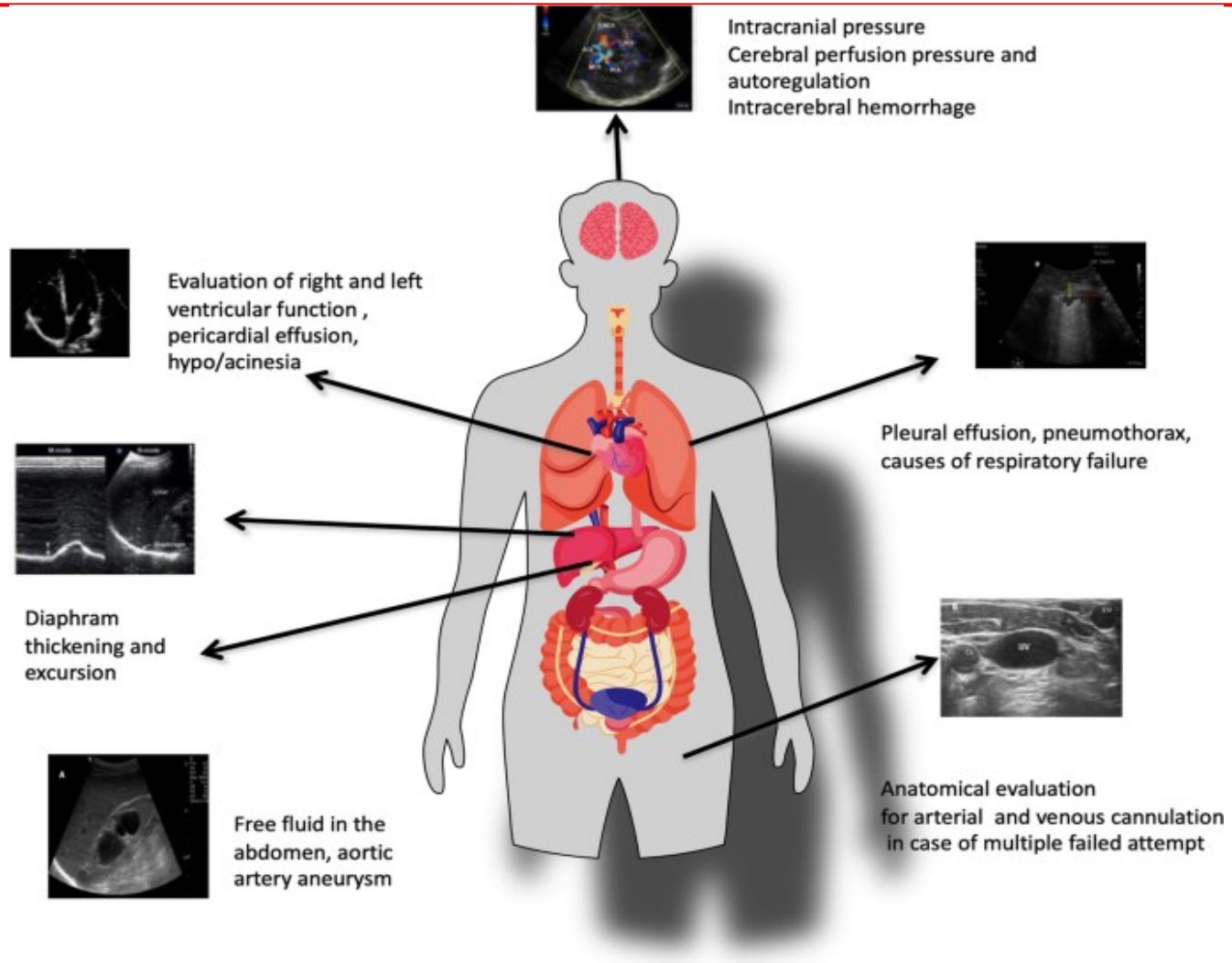
Dimitrios Matamis
Eleni Soilemezi
Matthew Tsagourias
Evangelia Akoumianaki
Saoussen Dimassi
Filippo Boroli
Jean-Christophe M. Richard
Laurent Brochard

Sonographic evaluation of the diaphragm in critically ill patients. Technique and clinical applications





Η υπερηχογραφία σήμερα θεωρείται θεμελιώδης δεξιότητα για την παρα κλίνη εκτίμηση των ασθενών στη ΜΕΘ



Head to toe ultrasound assessment in critically ill patients for brain, lung, heart, diaphragm, abdomen, and vessels with the main clinical applications

Critical Care Ultrasound

General Critical Care Ultrasound

- brain
- lung
- abdominal
- vascular
  - procedural
  - diagnostic

Critical Care Echocardiography

Intensive Care Med (2021) 47:1347

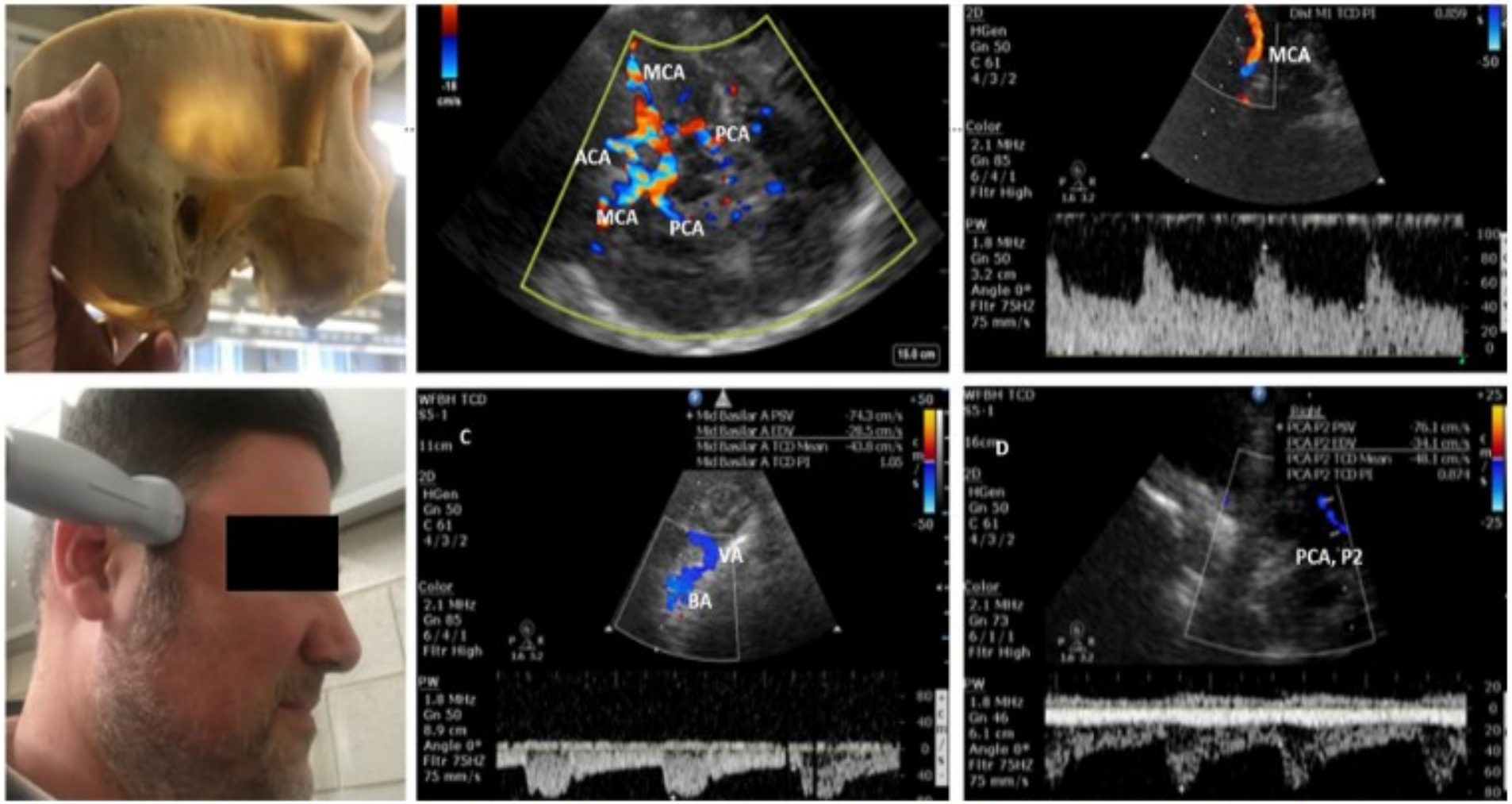
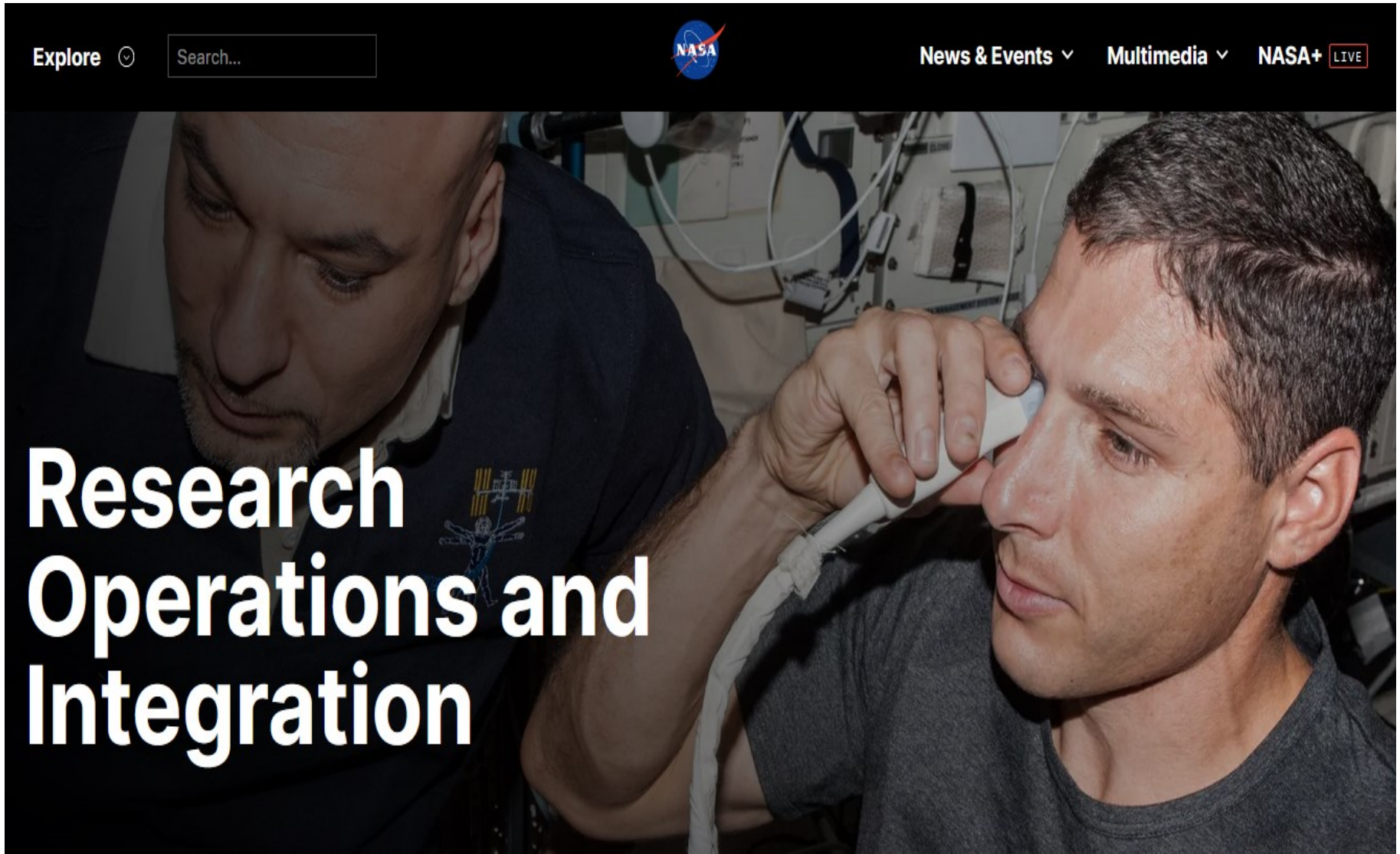


Fig. 1 Brain ultrasound. **A**, **B**, **D** Images obtained using phased-array probe placed over the temporal window. Temporal windows are used for insonation of middle cerebral artery (MCA) anterior (ACA) and posterior cerebral artery (PCA). **C** Sub occipital windows can be performed for insonation of basilar (BA) and vertebral arteries (VA)

optic nerve sheath diameter



- At present, however, the skills and competencies required for intensivists have not yet been established.

- Practical ultrasound training opportunities are still relatively scarce

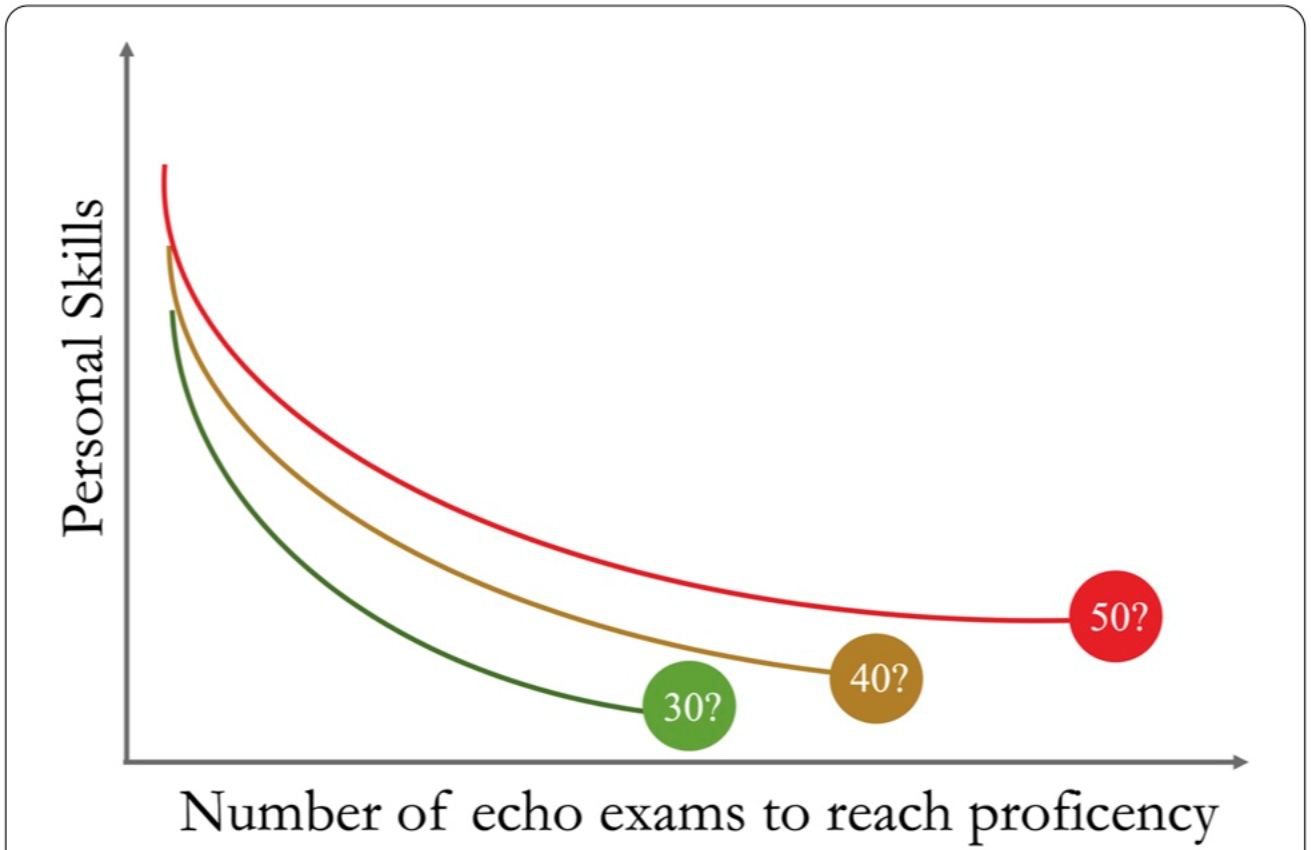


Fig. 3 Learning curves required for the achievement of critical care echocardiography skills. Thresholds of 30, 40, and 50 examinations have been proposed

The European Respiratory Society led training programme improves self-reported competency and increases the use of thoracic ultrasound

Pia Iben Pietersen[1], Lars Konge[2], Rahul Bhatnagar[3], Marek Slavicky[4], Najib M. Rahman[5], Nick Maskell[6], Laurence Crombag[7], Nathalie Tabin[4], Christian B. Laursen[8,9] and Anders Bo Nielsen[10,11]

81.8% των συμμετεχόντων ήταν ειδικευόμενοι Πνευμονολογίας

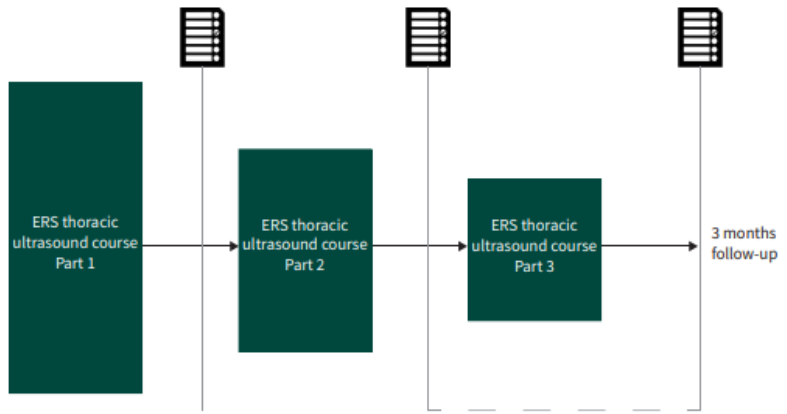


FIGURE 1 Overview of the components of the European Respiratory Society thoracic ultrasound training programme and time of surveys.

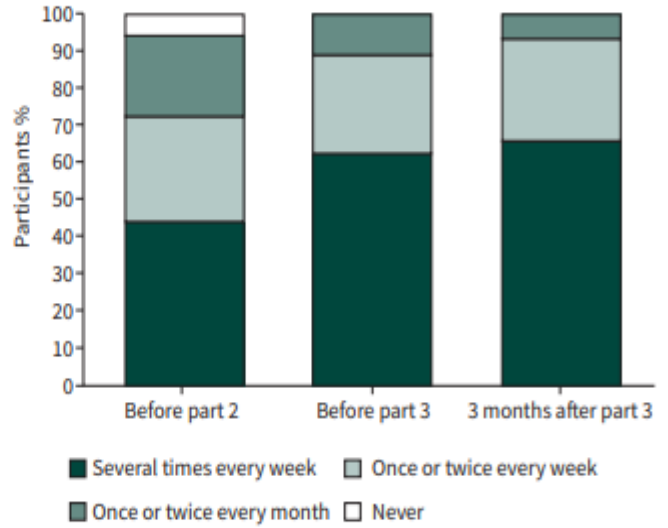


FIGURE 2 Frequency of how often the participants used thoracic ultrasound. All participants use thoracic ultrasound and more than 90% use thoracic ultrasound weekly 3 months after the course.

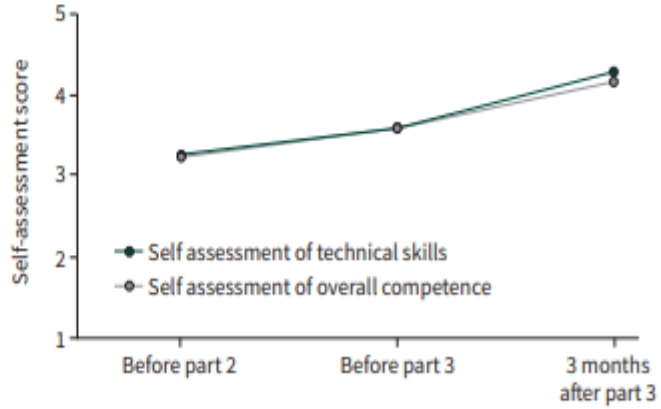


FIGURE 3 Mean self-assessment score in each survey. Participants rated their own performance on a scale from 1–5 in each survey sent out. A slight increase in mean self-assessment score was seen during the course. The technical skill mean±SD scores were 3.25±0.98, 3.6±0.63, and 4.3±0.47, respectively (green line). The mean ±SD overall competence self-assessment scores were 3.25±0.88, 3.6±0.62, and 4.17±0.54, respectively (grey line).

Training for Lung Ultrasound Score Measurement in Critically Ill Patients

JJ Rouby, Am J Respir Crit Care Med 198:398, 2018

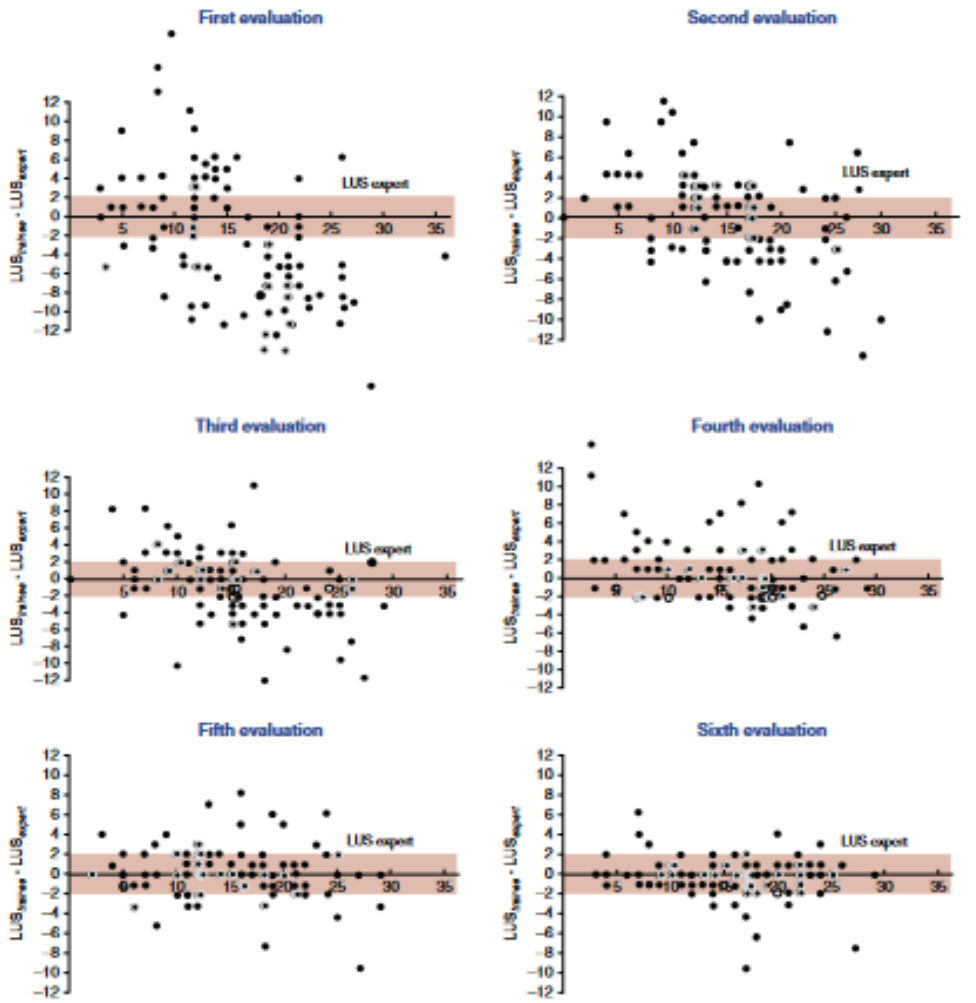


Figure 2. Difference between lung ultrasound scores (LUSs) measured by trainees and experts over six successive evaluations. The first evaluation was performed 2 hours after a lecture describing the method for measuring the LUS. Further evaluations were each separated by five ultrasound examinations performed by the trainee and supervised by the expert. The pink zone indicates the limit of agreement between trainees and experts.

Intensive Care Med (2021) 47:1347–1367
https://doi.org/10.1007/s00134-021-06486-z

CONSENSUS AND EXPERT RECOMMENDATION

Basic ultrasound head-to-toe skills for intensivists in the general and neuro intensive care unit population: consensus and expert recommendations of the European Society of Intensive Care Medicine

Chiara Robba[1,2*], Adrian Wong[3], Daniele Poole[4], Ashraf Al Tayar[5], Robert T. Arntfield[6], Michelle S. Chew[7], Francesco Corradi[8,9], Ghislaine Douflé[10], Alberto Goffi[11], Massimo Lamperti[12], Paul Mayo[13], Antonio Messina[14], Silvia Mongodi[15], Mangala Narasimhan[16], Corina Puppo[17], Aarti Sarwal[18], Michel Slama[19], Fabio S. Taccone[20], Philippe Vignon[21], Antoine Vieillard-Baron[22,23] and The European Society of Intensive Care Medicine task force for critical care ultrasonography*[24*]

1. BRAIN

1. Triage or clinical suspicion for intracranial hypertension

• We ***recommend*** B-mode **Transcranial Doppler (TCD)** of the middle cerebral artery *as basic skill* to rule out intracranial hypertension impairing cerebral perfusion (***weak recommendation*****).**

• We are ***unable to provide recommendation*** regarding the use of **optic nerve sheath** diameter (ONSD) *as a basic skill* for intensivists to rule out intracranial hypertension.

2. Clinical suspicion of brain death

- We are ***unable to provide recommendation*** regarding the use of **TCD** to recognize patterns suggesting impending cerebral circulatory arrest.

3. Detection of cerebral vasospasm after subarachnoid hemorrhage

- We are ***unable to provide recommendation*** through **TCD** for the detection of vasospasm in patients with aneurysmal subarachnoid hemorrhage *as basic skill* for intensivists.

CONSENSUS AND EXPERT RECOMMENDATION

Intensive Care Med (2021) 47:1347

2. THORAX

- *1.* ***Pneumothorax***
- We ***recommend*** (***strong recommendation***) that the identification of either one of the following findings ***to rule out the presence of pneumothorax*** : lung sliding, lung pulse, and/or B-lines should be considered as basic skill as well as the *"lung point"* to confirm a suspected pneumothorax.
- *2.* ***Pleural effusion***
- We ***recommend*** (***strong recommendation*****)**that the evaluation of the presence of an anechoic region above the diaphragm as primary sonographic finding of pleural effusion should be considered as basic skill (as well as other issues on pleural effusion).
- *3.* ***Respiratory failure***
- We ***recommend*** **(*strong recommendation*)** the integration of lung US within the clinical context as *basic skill* for:
- the evaluation of respiratory failure
- the appearance of interstitial syndrome (B pattern)
- identifying etiology of respiratory failure (i.e., lung injury versus cardiogenic pulmonary edema)

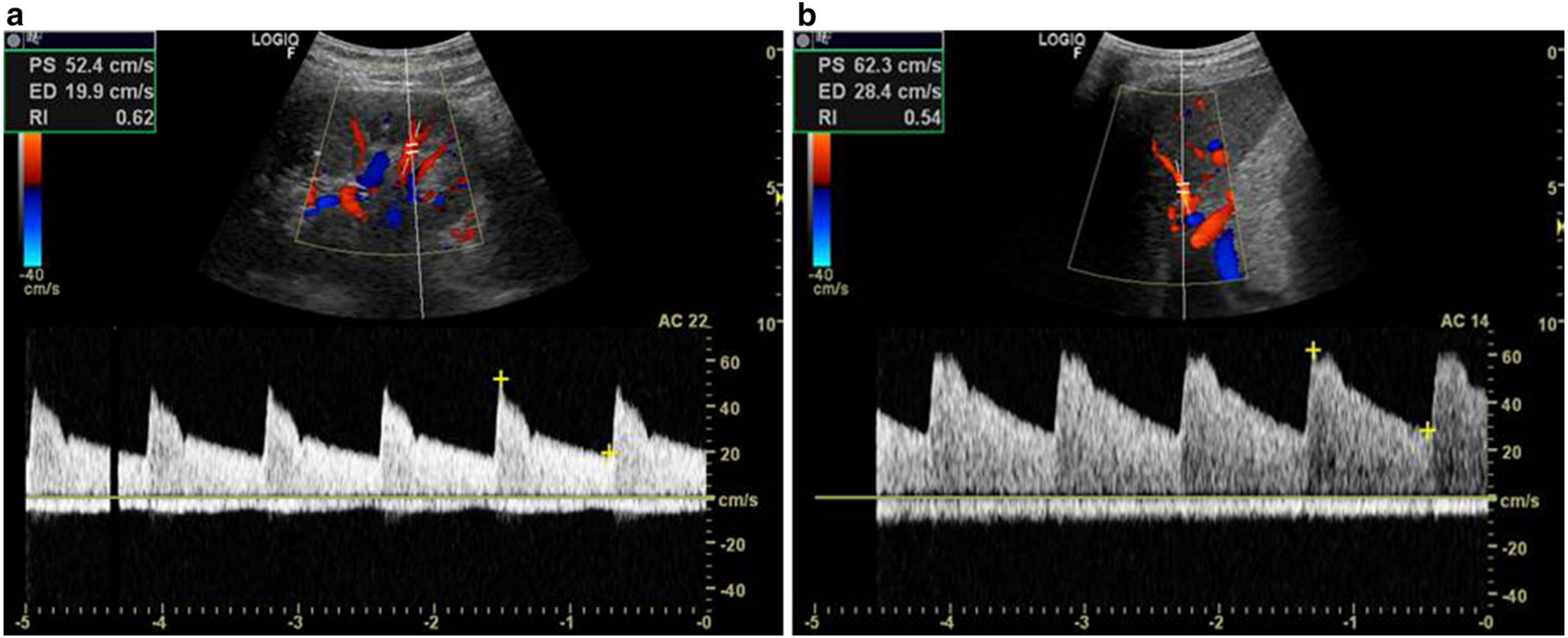
- *4.* ***Diaphragm ultrasound***
- We ***recommend*** **(*strong recommendation*)** the estimation of diaphragmatic excursion for diaphragmatic function assessment
- We are ***unable to provide recommendation*** on the evaluation of diaphragmatic thickening fraction as basic skill (***no recommendation*****).**

Vascular

- ***1. Vascular cannulation*** **(*strong recommendation*).**

Renal Resistive Index: not only kidney

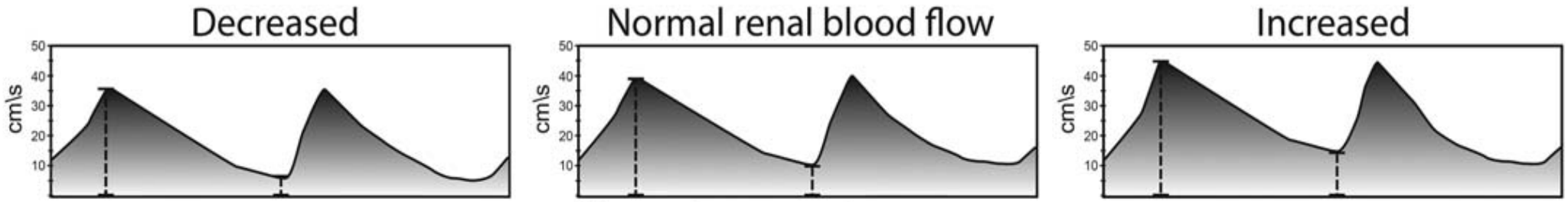
Di Nicolo et al. Clin Exp Nephrol DOI 10.1007/s10157-016-1323-3



Renal and splenic Doppler ultrasonography in a 43-year-old healthy female volunteer. a Renal Resistive Index (RRI) sampled at the level of an interlobar artery. For a more accurate measure multiple Doppler sampling in upper, mid and lower pole of the kidney is performed and a mean RRI value is obtained.

Doppler Renal Resistance Index for the Prediction of Response to Passive Leg-Raising Following Cardiac Surgery

Beaubien-Souligny et al. J Clin Ultrasound 2018



Numeric example:

$V_{Systole}$ = 36 cm/s

$V_{Diastole}$ = 4 cm/s

RI = 0.89

$V_{Systole}$ = 40 cm/s

$V_{Diastole}$ = 10 cm/s

$$\frac{V_{Systole} - V_{Diastole}}{V_{Systole}} = RI$$

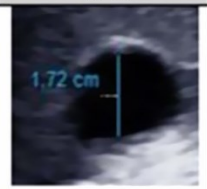
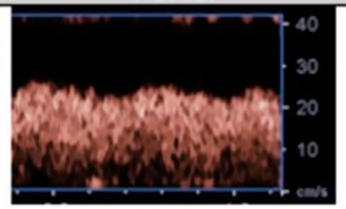
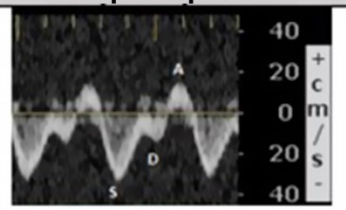
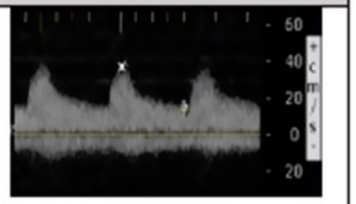
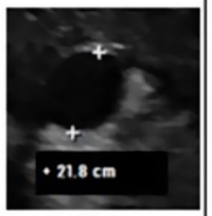
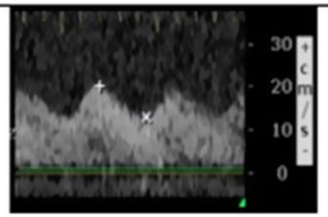
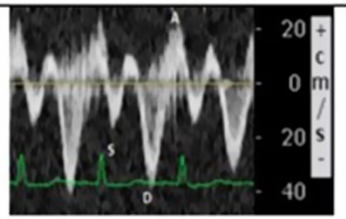
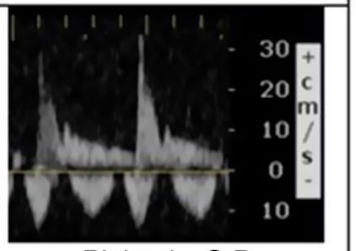
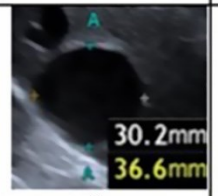
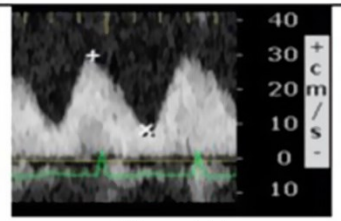
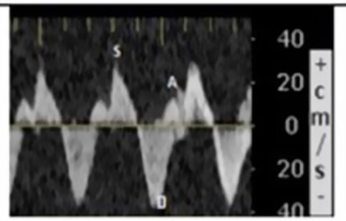
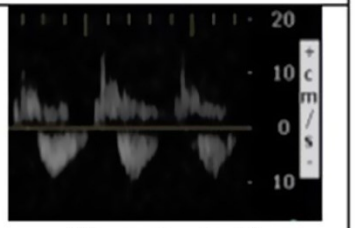
RI = 0.75

$V_{Systole}$ = 44 cm/s

$V_{Diastole}$ = 14 cm/s

RI = 0.68

Venous excess ultrasound score (VExUS) for the classification of venous congestion.

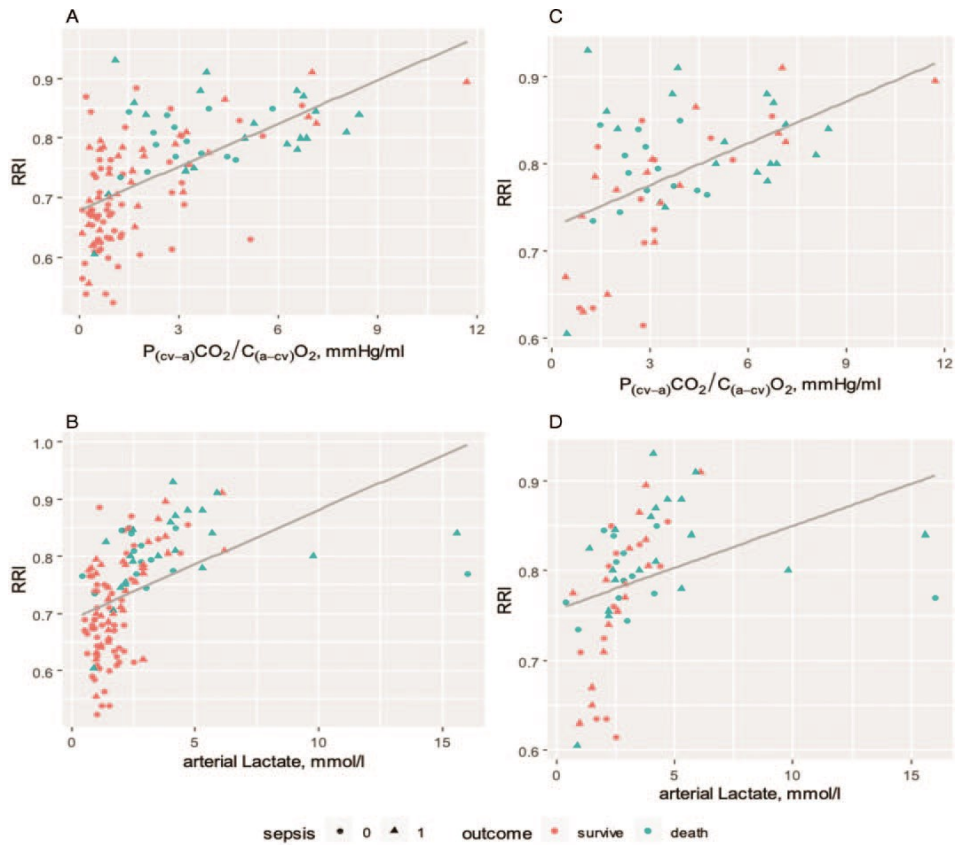
Congestion	Diameter IVC	Flows		
		Portal	Suprahepatic	Renal
Normal	 < 2 cm	 PI < 30%	 S>D	 Continuous
Mild	 > 2 cm	 PI 30-50%	 S<D	 Biphasic, S-D
Severe	 > 2 cm	 PI > 50%	 Systolic inversion	 Monophasic, D

Grade 0: IVC < 2 cm, normal patterns; Grade 1: IVC > 2 cm and mild congestion pattern;
Grade 2: IVC > 2 cm and one organ with severe congestion pattern; Grade 3: at least two organs with severe congestion pattern.

SHOCK, Vol. 57, No. 4, pp. 501–507, 2022

RENAL RESISTIVE INDEX ON INTENSIVE CARE UNIT ADMISSION CORRELATES WITH TISSUE HYPOPERFUSION INDICES AND PREDICTS CLINICAL OUTCOME

Georgia Fotopoulou,* Ioannis Poularas,* Stelios Kokkoris,* Efstratia Charitidou,* Ioannis Boletis,† Elias Brountzos,‡ Athanasios Benetos,§ Spyros Zakynthinos,* and Christina Routsi*



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Journal of Intensive Medicine

journal homepage: www.elsevier.com

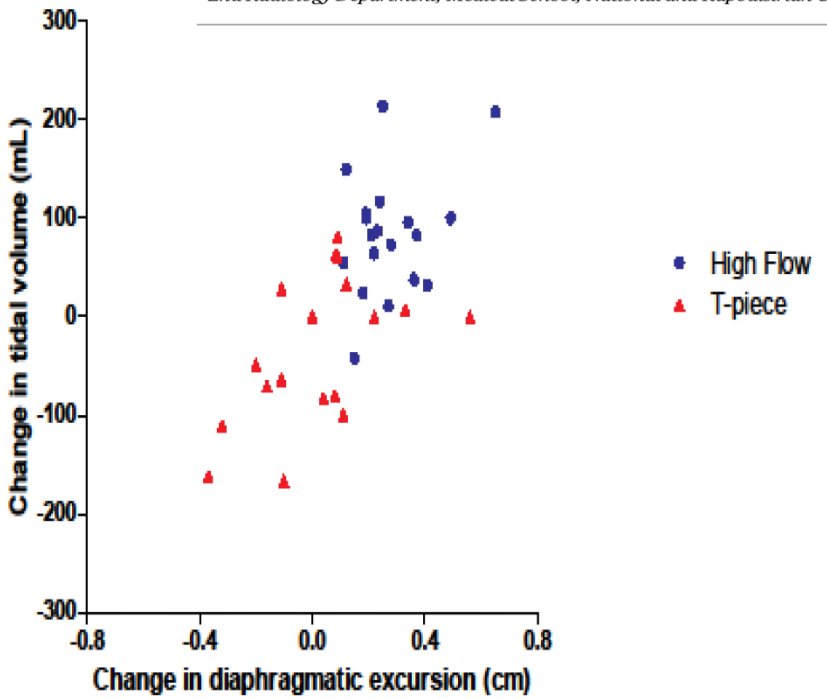
Journal Cover Image

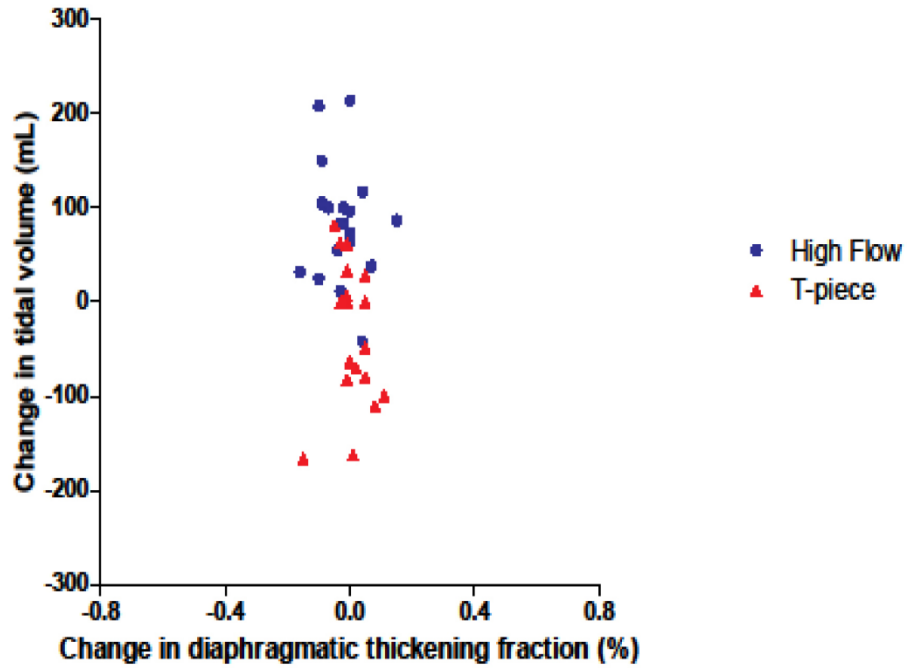
Original Article

The effect of high-flow oxygen via tracheostomy on respiratory pattern and diaphragmatic function in patients with prolonged mechanical ventilation: A randomized, physiological, crossover study

Elena Lytra [a, b], Stelios Kokkoris [a], Ioannis Poularas [a], Dimitrios Filippiadis [c], Demosthenes Cokkinos [b], Dimitrios Exarhos [b], Spyros Zakynthinos [a], Christina Routsi [a, *]

[a] 1st Department of Intensive Care, Medical School, National and Kapodistrian University of Athens, Evangelismos Hospital. Athens. Greece
[b] Radiology Department, Evangelismos Hospital, Athens, Greece
[c] 2nd Radiology Department, Medical School, National and Kapodistrian University of Athens, Attikon Ho





Ten good reasons to practice ultrasound in critical care

Daniel Lichtenstein[1], Simon van Hooland[2], Paul Elbers[3], Manu L.N.G. Malbrain[4]

Anaesthesiology Intensive Therapy 2014;46: 323

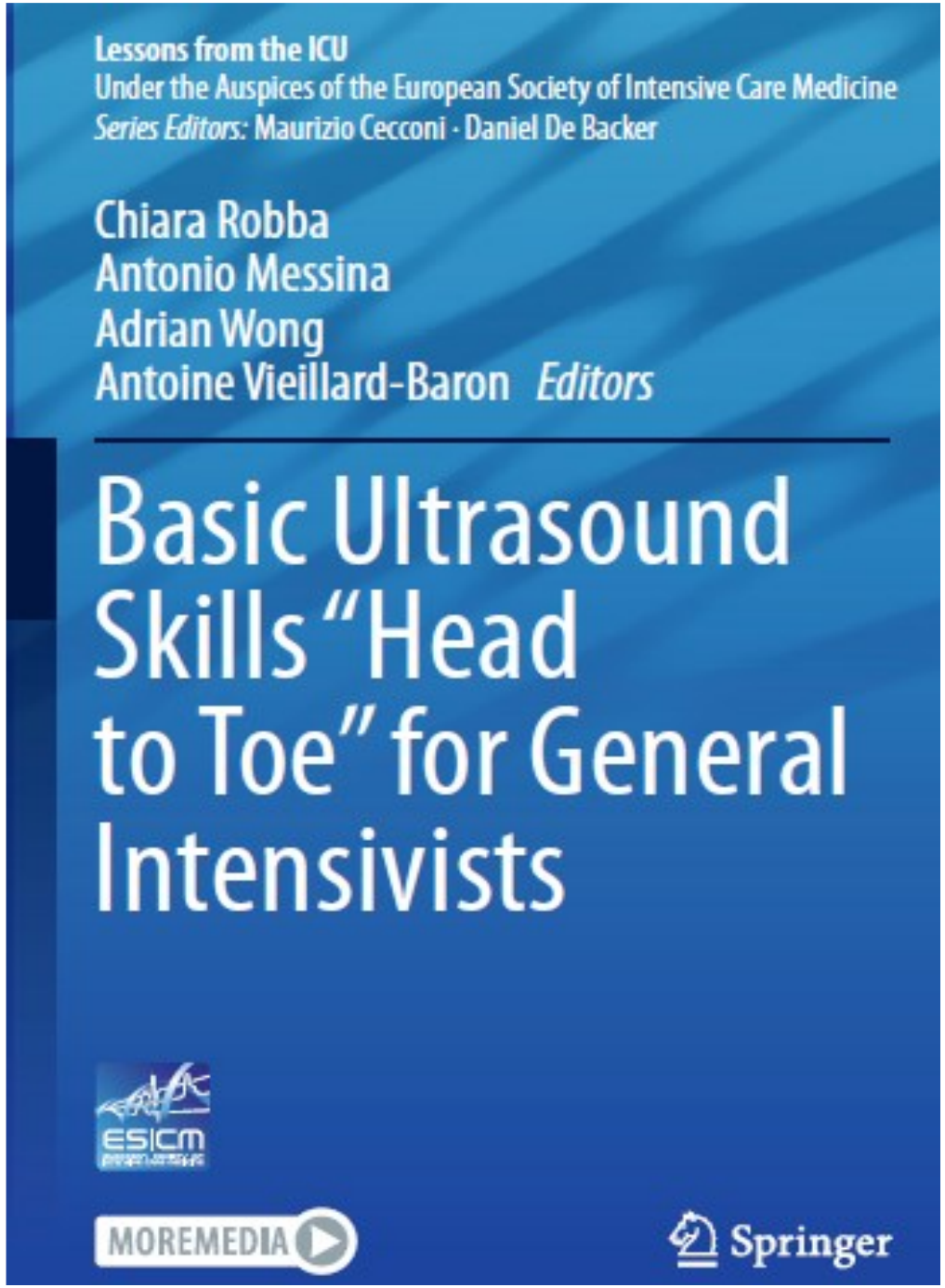
1. ***Ultrasound is helpful in differential diagnosis of acute respiratory failure***
2. ***Acute circulatory failure***
3. ***Cardiac arrest***
4. ***Assistance during venous cannulation***
5. ***Assessing ARDS (or any critically ill lung under mechanical ventilation)***
6. ***Finding the cause of a fever in an ICU patient***
7. ***Decreasing radiation doses while improving patient management (and contributing to huge cost savings)***
8. ***Practicing a holistic approach to the heart***
9. ***Practicing medicine in a new way, a visualising modern tool for all***
10. ***Let the readers choose their own final 'custom-made' reason***

ΣΥΜΠΕΡΑΣΜΑΤΑ

- **Σήμερα η υπερηχογραφία αποτελεί μέρος της φυσικής εξέτασης και αξιολόγησης του βαρέως πάσχοντος**

- **Σε συνδυασμό με το υπερηχογράφημα καρδίας και πνευμόνων παρέχει έγκαιρη διάγνωση, επομένως και έγκαιρη θεραπεία, και καλύτερη χρήση των πιο εξειδικευμένων απεικονιστικών εξετάσεων ακολουθως.**

- **Η αλληλεπίδραση και η ερευνητική συνεργασία με την επιστήμη φυσικής και μαθηματικών και την καθ΄ύλη αρμόδια ειδικότητα της Ακτινολογίας θα μπορούσε να προσφέρει πρόσθετα, σημαντικά ευρήματα π.χ. ως προς την ανάλυση των κυματομορφών**.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