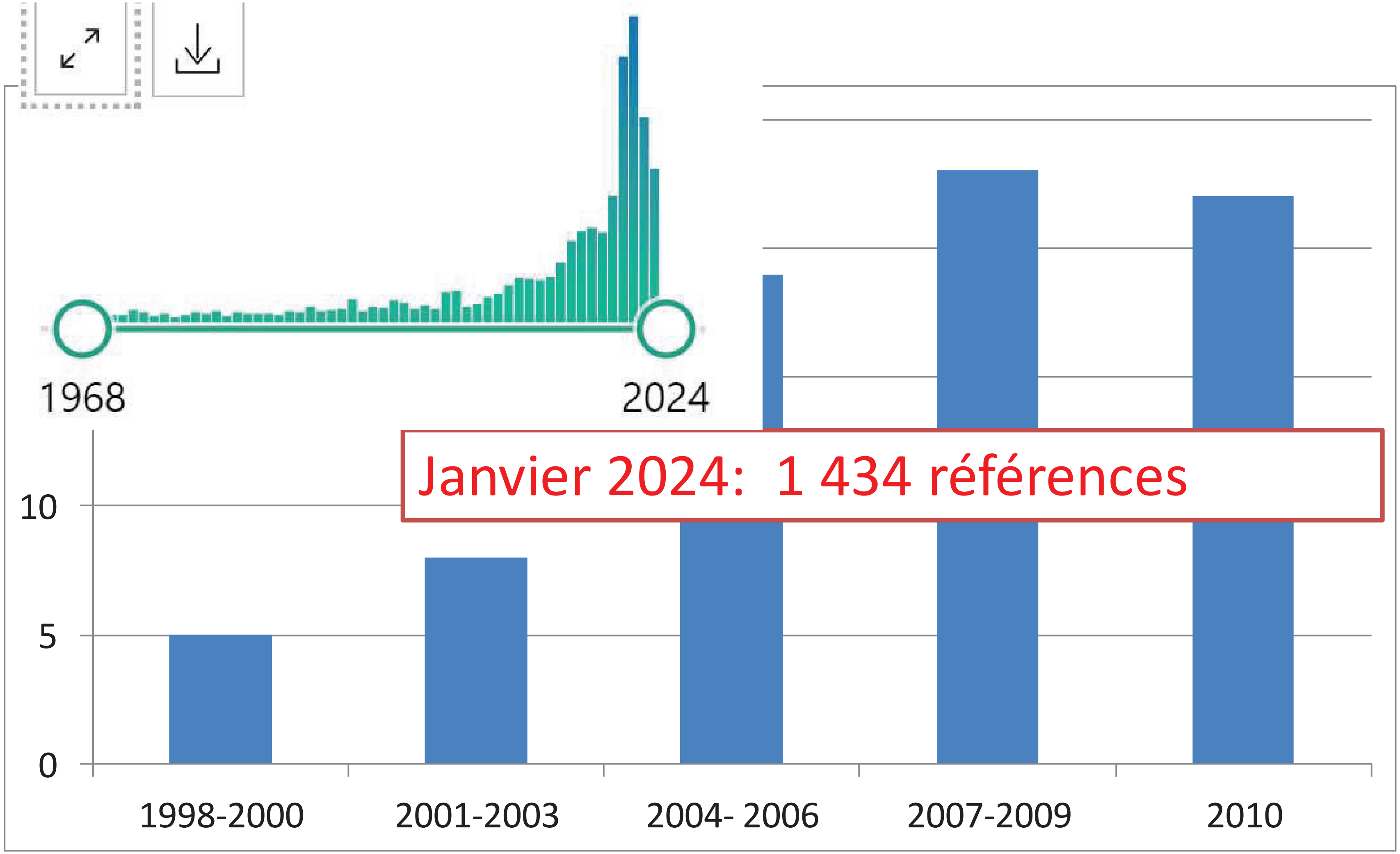
échographie pleuro pulmonaire et diaphragmatique

Dr Riu Poulenc
Réanimation Purpan- CHU Toulouse
TUSAR 2024

Lus and bedside



D lichtenstein and lung ultrason >30 références

Réani

ELSEVIER MASSON

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

Réanimation

MISE AU POINT

Échographie pulmonaire en réanimation et aux urgences

Lung ultrasound in the critically ill

D. Lichtenstein

Service de réanimation médicale, faculté Paris-Ouest, hôpital Ambroise-Paré, 9, rue Charles-de-Gaulle, 92100 Boulogne, France

Disponible sur Internet le 26 septembre 2008

Intensive Care Med (2012) 38:577–591
DOI 10.1007/s00134-012-2513-4

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International evidence-based recommendations for point-of-care lung ultrasound

US dans le poumon

- Semblait peu accessible, faible pénétration US ds l'air
- Outil diagnostic: pneumopathie, atélectasie, syndrome interstitiel, pneumothorax, épanchement pleural
- Faible sensibilité RT
- Risque TDM

Intensive Care Med (2011) 37:1488–1493
DOI 10.1007/s00134-011-2317-y

ORIGINAL

Nektaria Xirouchaki
Eleftherios Magkanas
Katerina Vaporidi

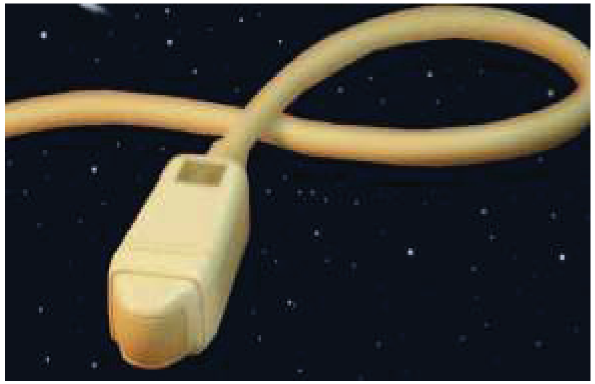
Lung ultrasound in critically ill patients: comparison with bedside chest radiography

	consolidation	Sd interstitiel	pneumothorax	Épanchement pleural
RT	Se : 38 % Sp :89 % Δc : 49 %	Se : 46 % Sp : 80 % Δc : 58 %	Se : 0 % Sp : 99 % Δc : 89 %	Se : 65 % Sp : 81 % Δc : 69 %
EPP	Se : 100 % Sp : 78 % Δc : 95 %	Se : 94 % Sp : 93 % Δc : 94 %	Se : 75 % Sp : 93 % Δc : 92 %	Se : 100 % Sp : 100 % Δc : 100 %

Un appareil simple

- Compact
- Facilement décontaminable, tactile
- Ni filtre, ni doppler, ni harmonique
- Sonde
- Allumage rapide

L'appareil et la sonde



Techniques échographiques

Capteurs

- Fréquence et résolution

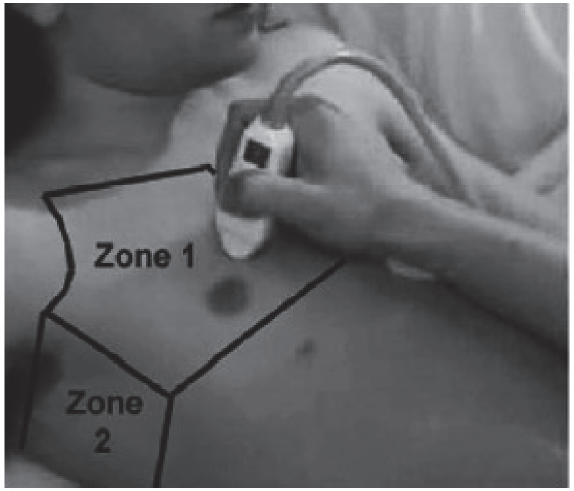
Fréquence	Profondeur	Réso axiale	Réso latérale
2,5 MHz	24 cm	2,2 mm	3 mm
3,5 MHz	16 cm	1,6 mm	2,2 mm
5,0 MHz	12 cm	1,0 mm	1,3 mm
7,5 MHz	8 cm	0,7 mm	0,9 mm

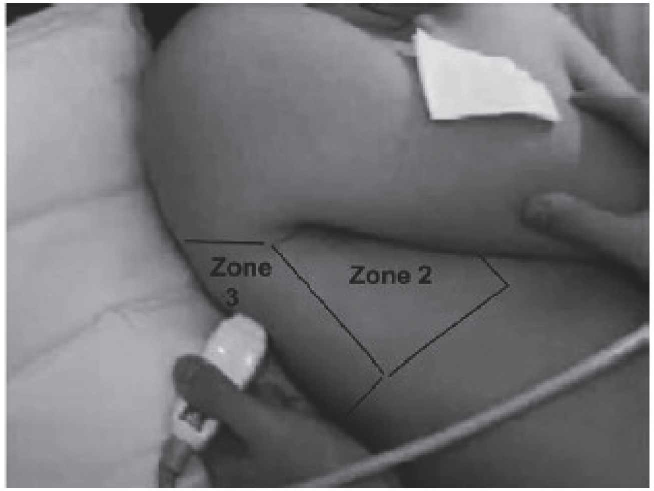
Lieu mélange air eau

- Désordre **riche en eau** (pleurésie, pneumonie) dans les zones post

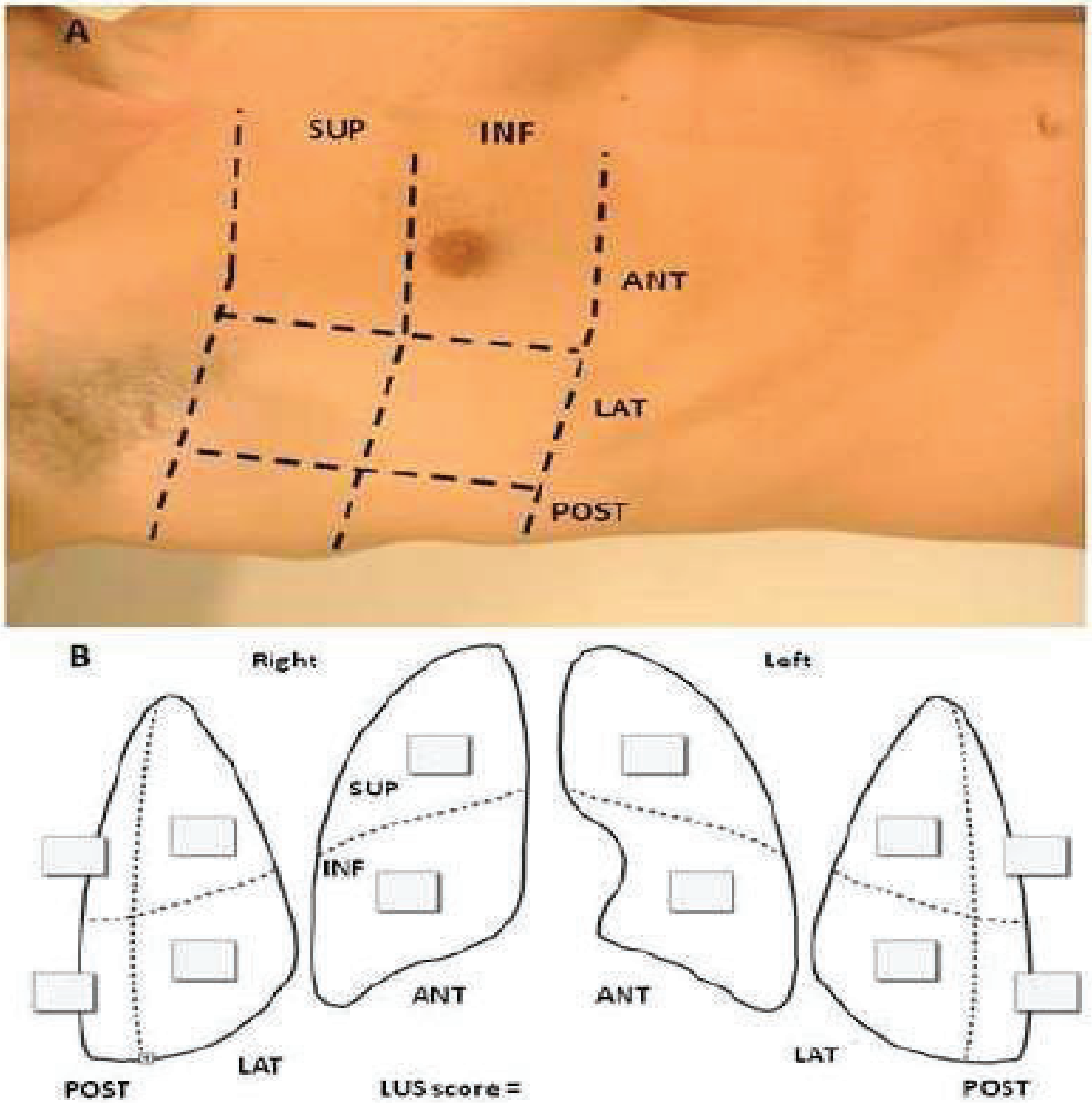
- Désordres **riches en air** (pneumo, syndrome interstitiel) en antérieur ou latéral

Aires thoraciques
6 incidences





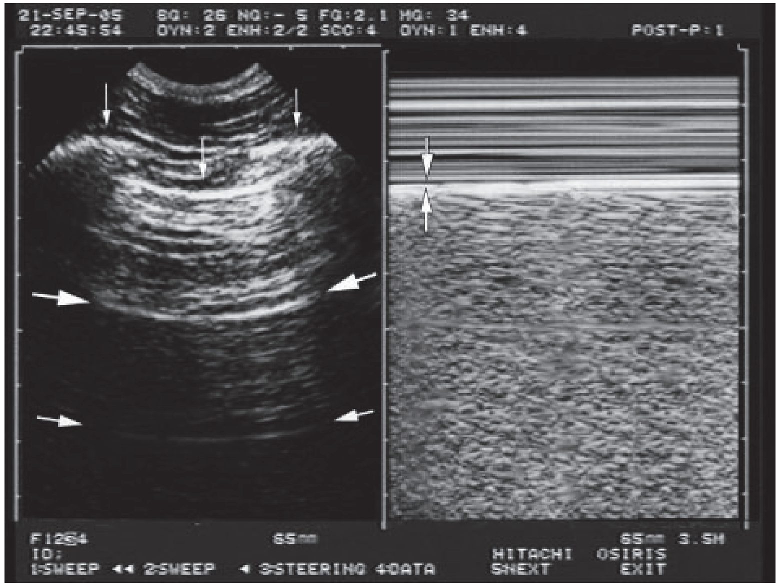
- Zone 1 :Antérieure
- Zone 2: Zone latérale
- Zone :3 zone postérolatérale

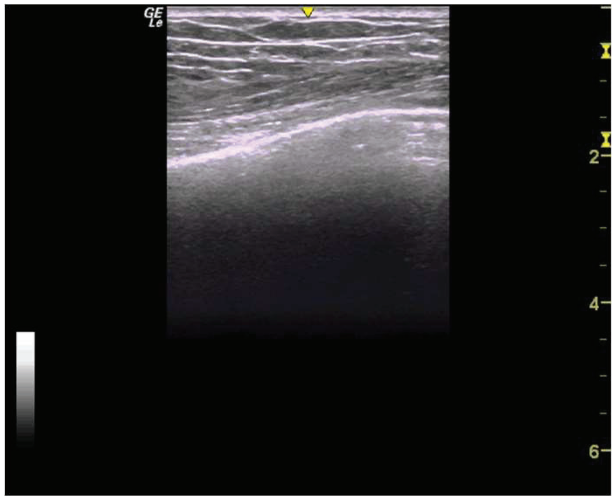


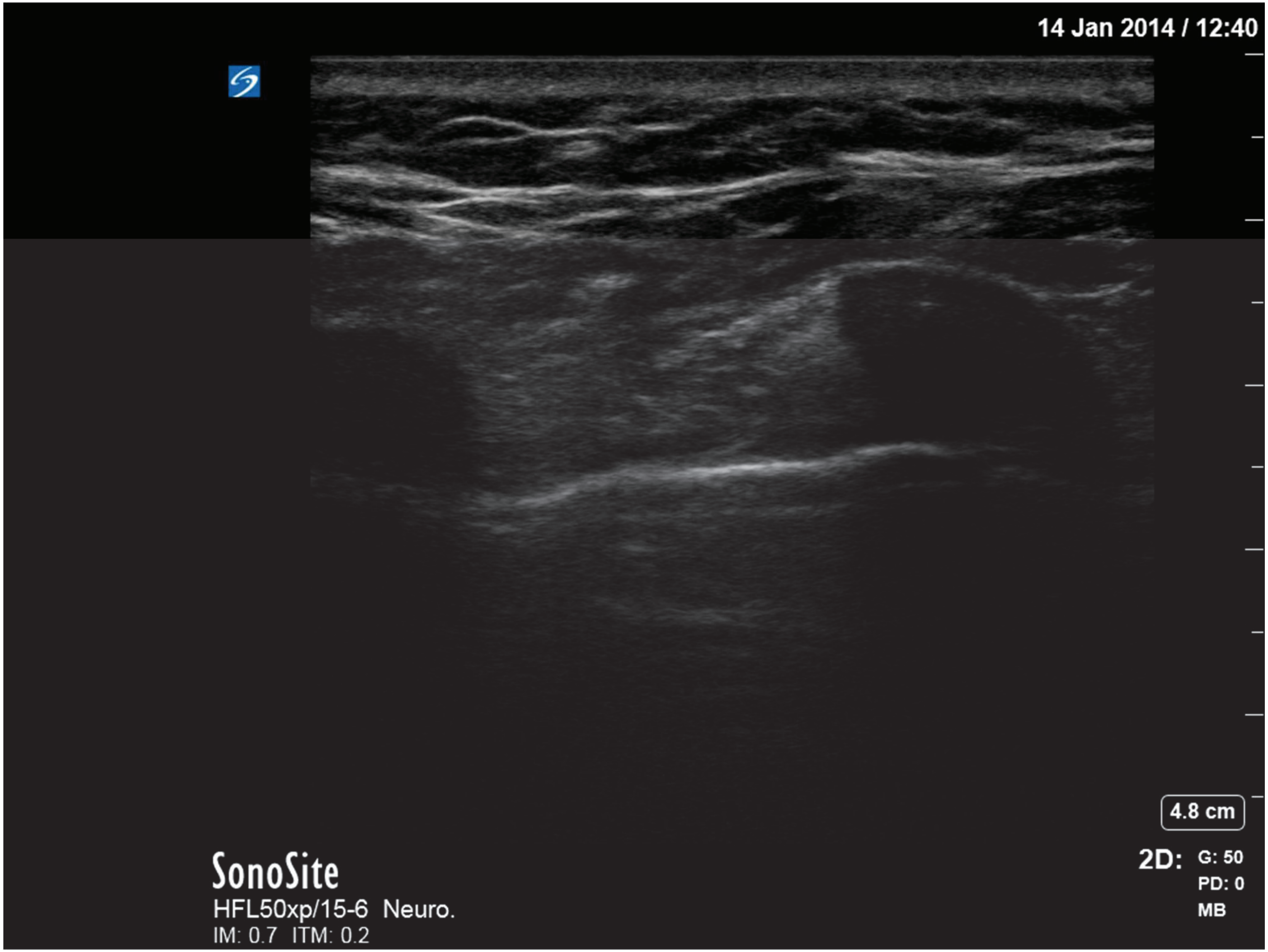
LUS
0=normal
1=syndrome interstitiel
2=Syndrome alvéolo interstitiel
3=condensation

Bouhemad B, rouby JJ, Arbelot C, AJRCCM 2011

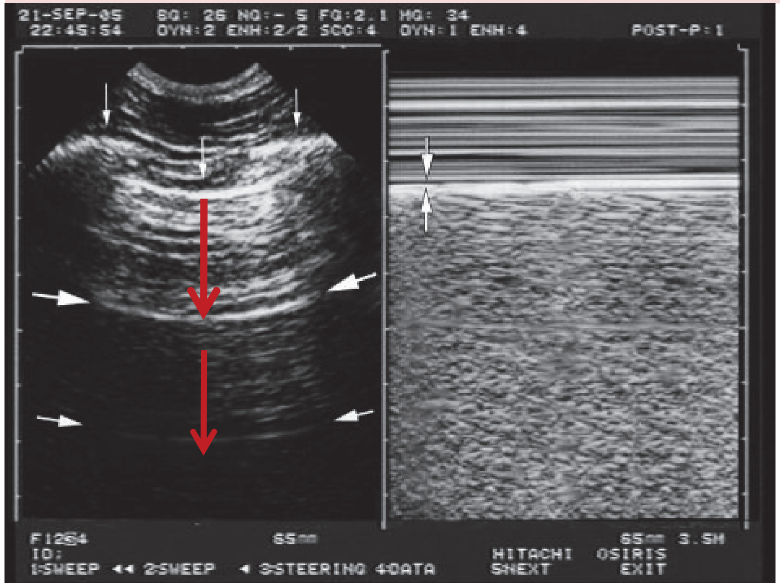
La ligne pleurale





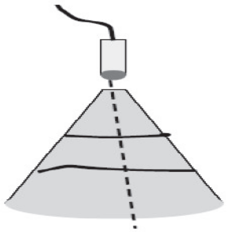

14 Jan 2014 / 12:40
4.8 cm
2D:
G: 50
PD: 0
MB
SonoSite
HFL50xp/15-6 Neuro.
IM: 0.7 ITM: 0.2

Echo pleurale normale

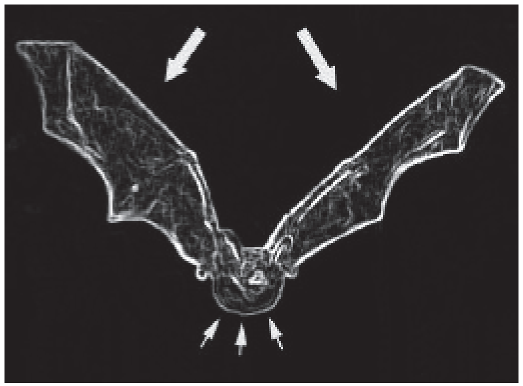


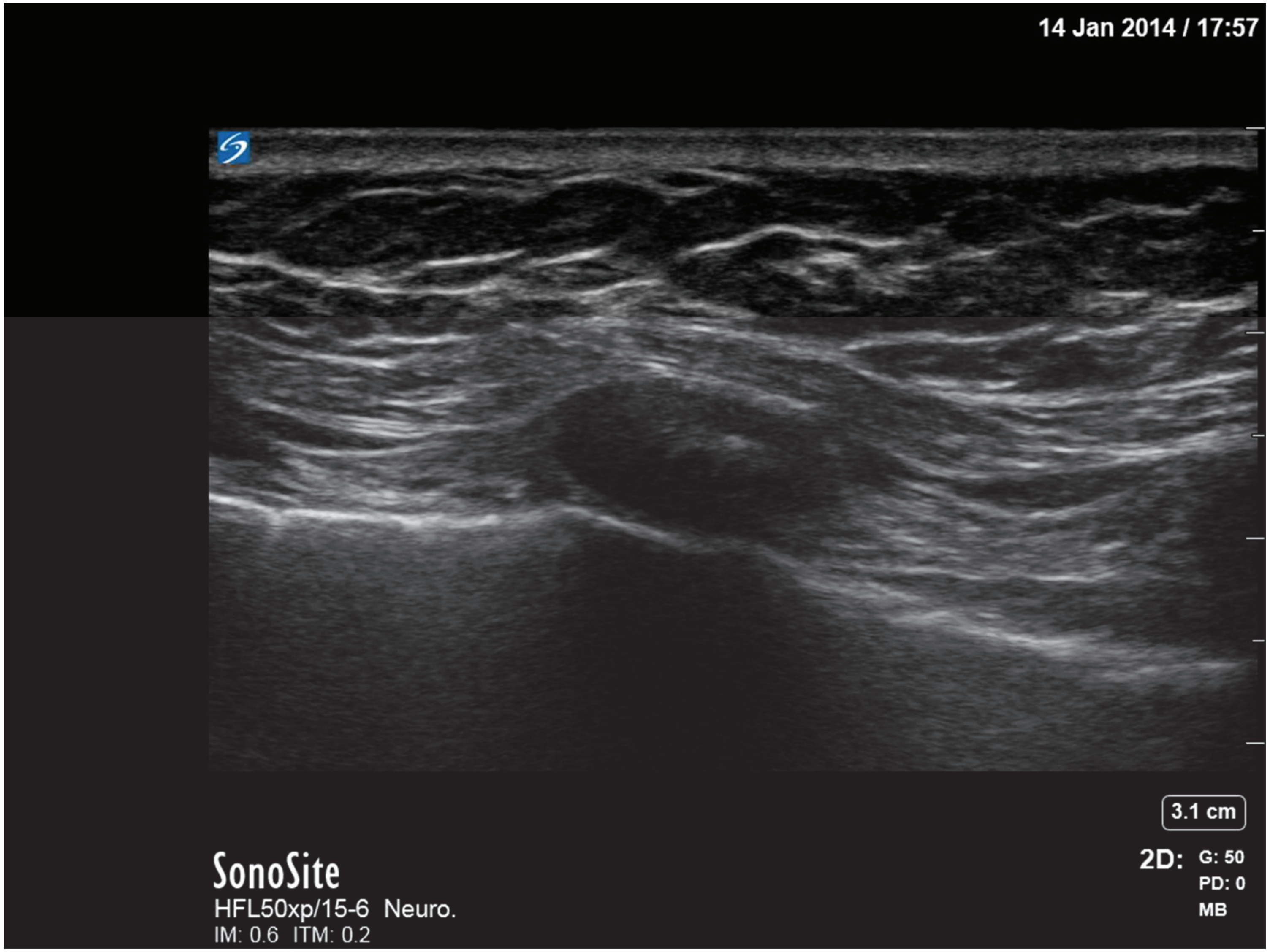
- Localisation ligne pleurale, hyperéchogène
- Signe de la chauve souris
- Ligne A:Artefact basic poumon normalement aérè

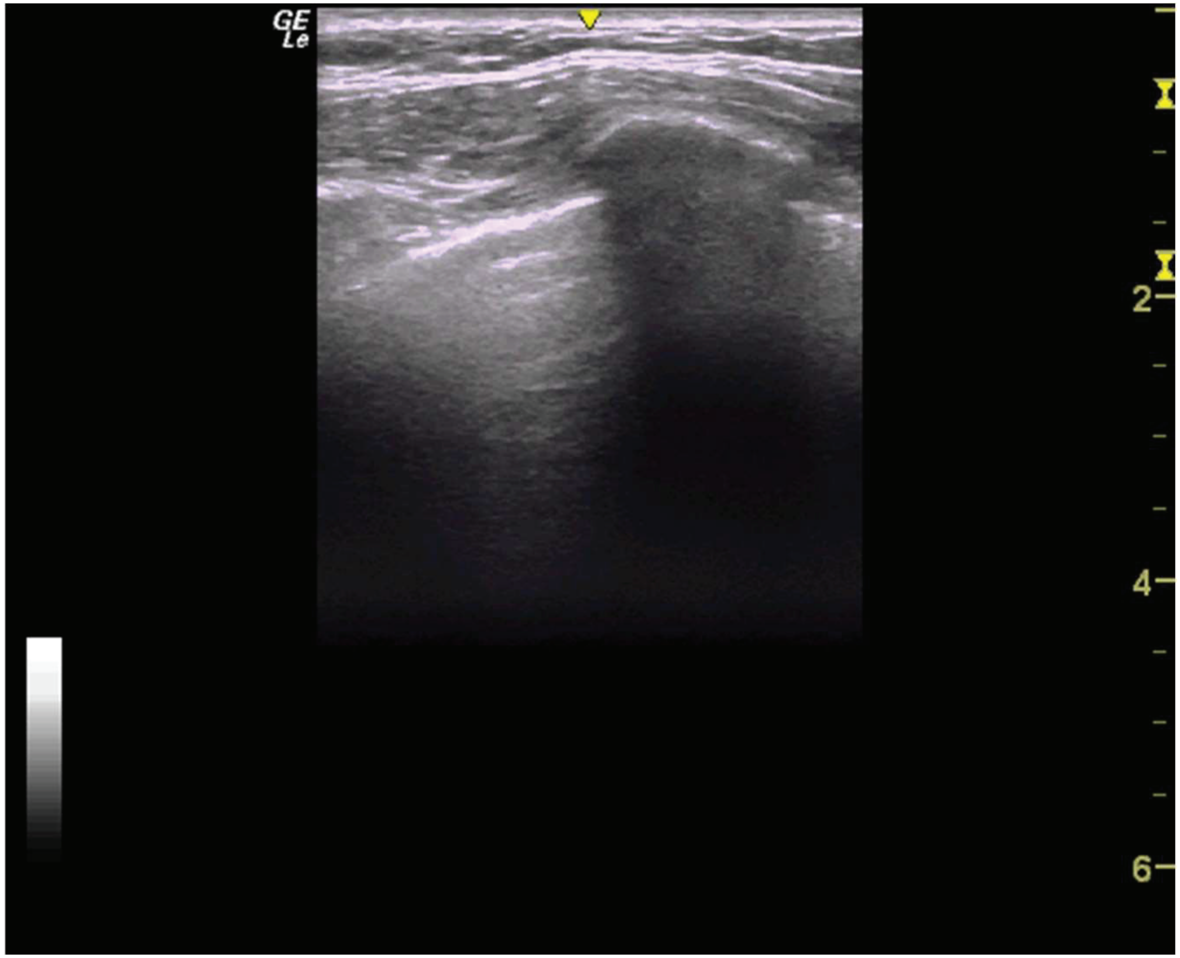
2 D



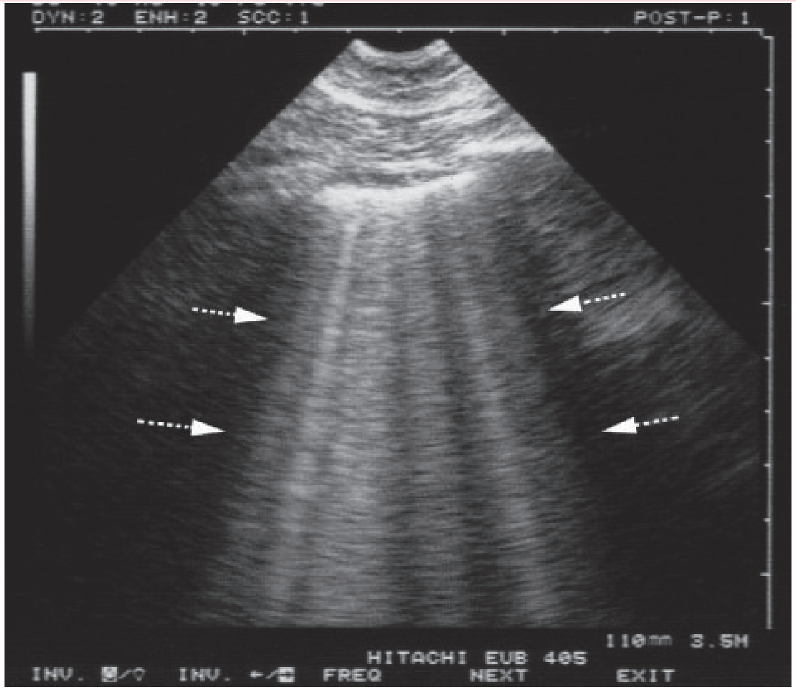
TM



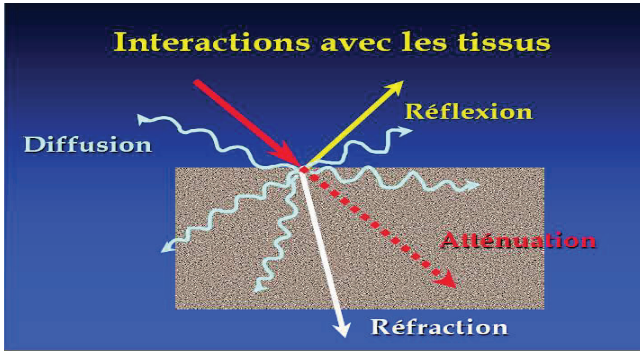

14 Jan 2014 / 17:57
3.1 cm
2D:
G: 50
PD: 0
MB
SonoSite
HFL50xp/15-6 Neuro.
IM: 0.6 ITM: 0.2

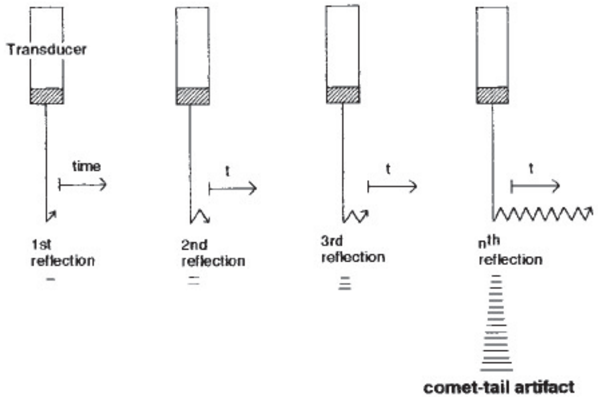

GE
Le
2
4
6

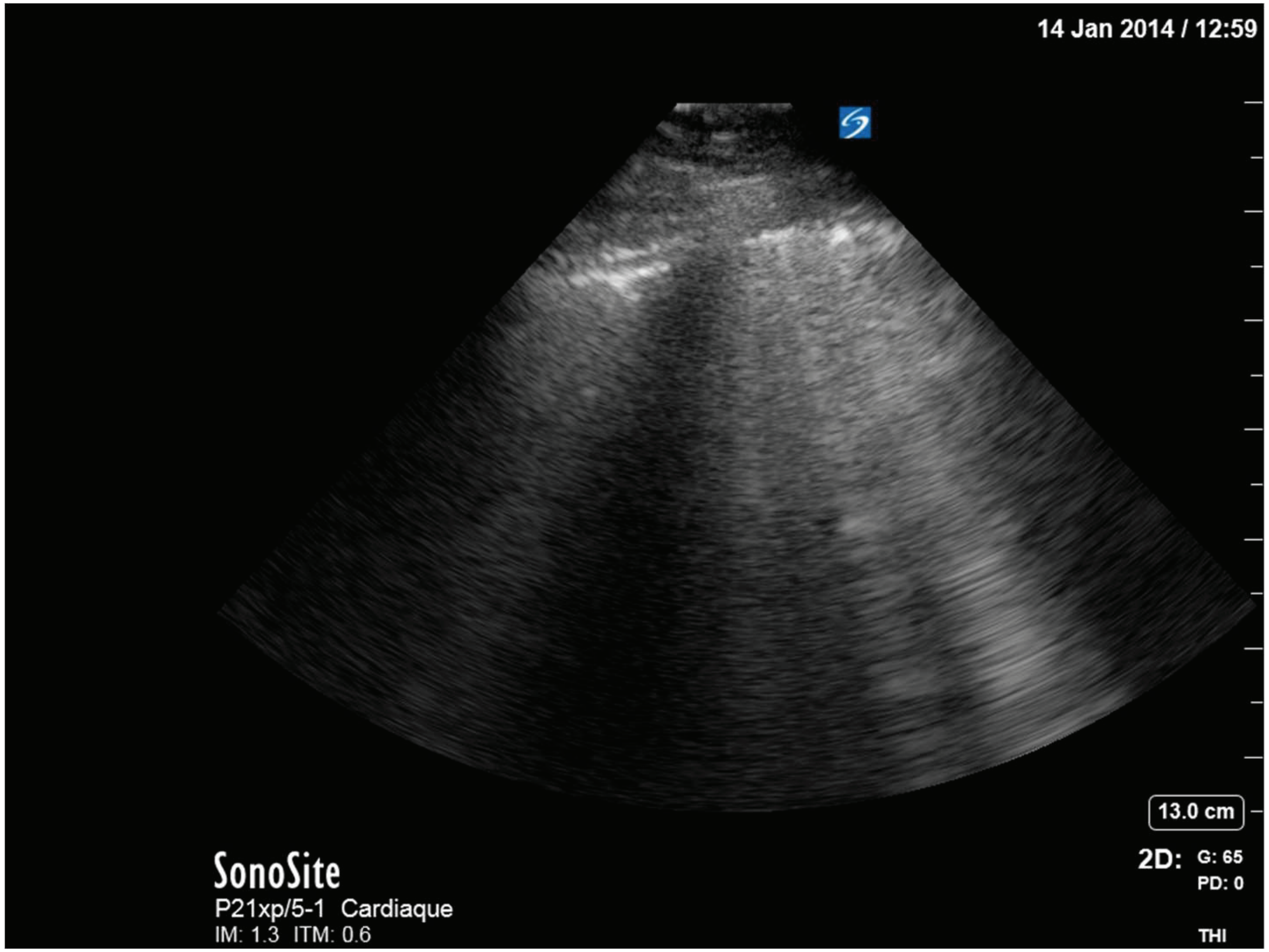
Syndrome interstitiel



- Artéfact en queue de comète (ligne B)
- Naissent de la ligne pleurale
- En rayon laser
- Hyperéchogènes
- Descendant sans épuisements
- Effacent les lignes A
- mobiles



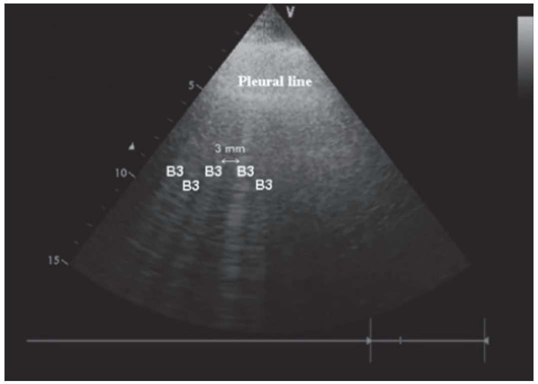


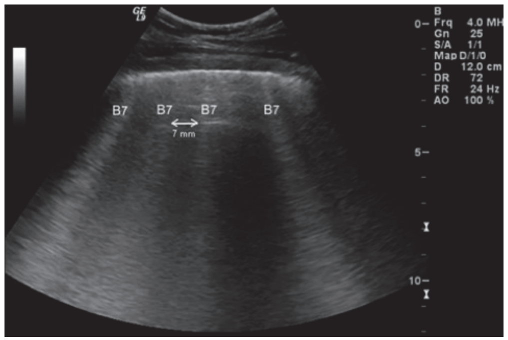

14 Jan 2014 / 12:59
13.0 cm
2D:
G: 65
PD: 0
THI
SonoSite
P21xp/5-1 Cardiaque
IM: 1.3 ITM: 0.6

Syndrome interstitiel
Se:93%, Sp: 93%

Ligne B3, espacement de 3 mm signe image en verre dépoli au TDM
Actuellement B2

Ligne B7, espacement de 7mm, signe épaississement des septas
Actuellement B1



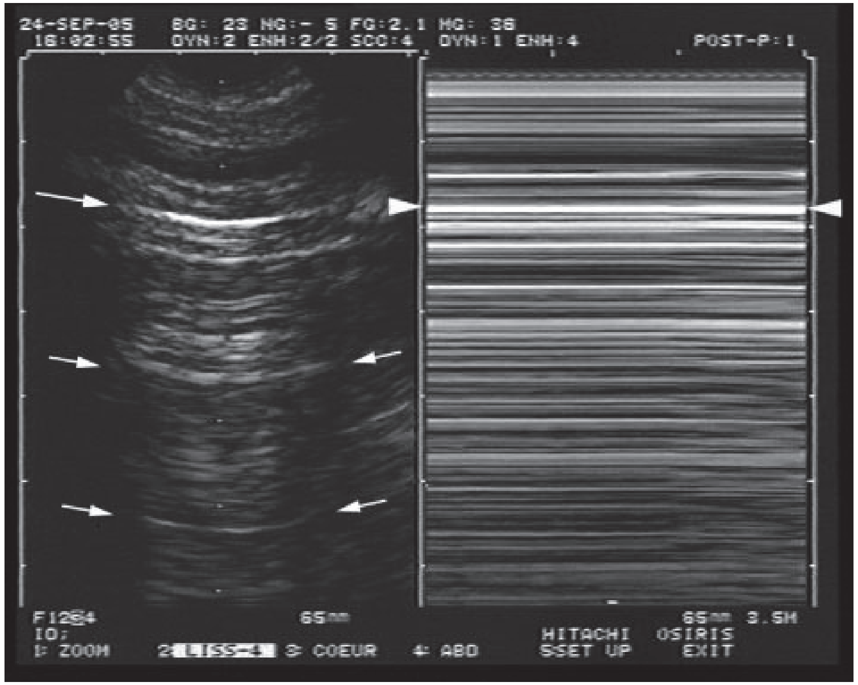


Lichtenstein D,. AM J RESPIR CRIT CARE MED 1997;156:1640–1646.

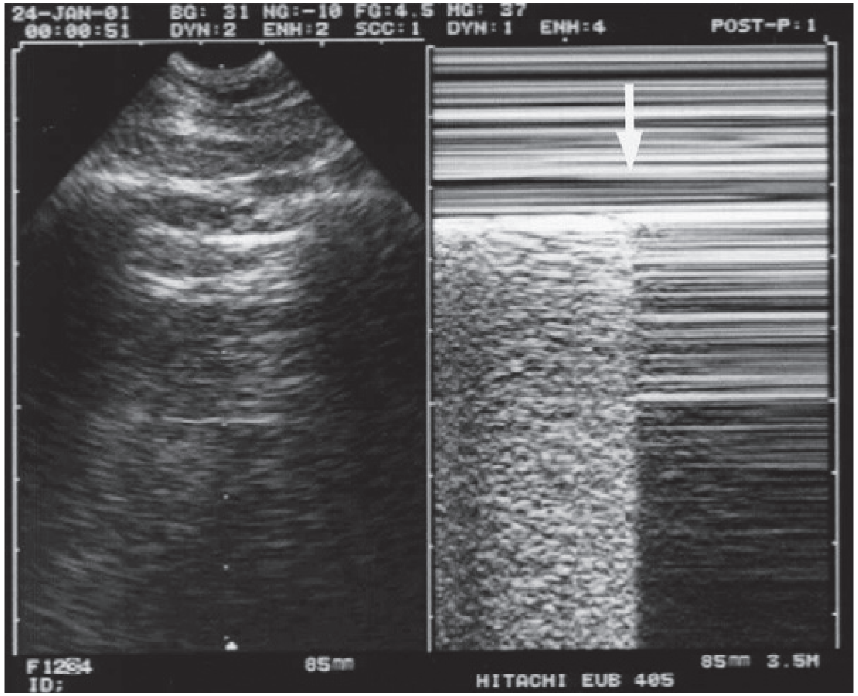
Pneumothorax

Se: 94%, Sp: 95%

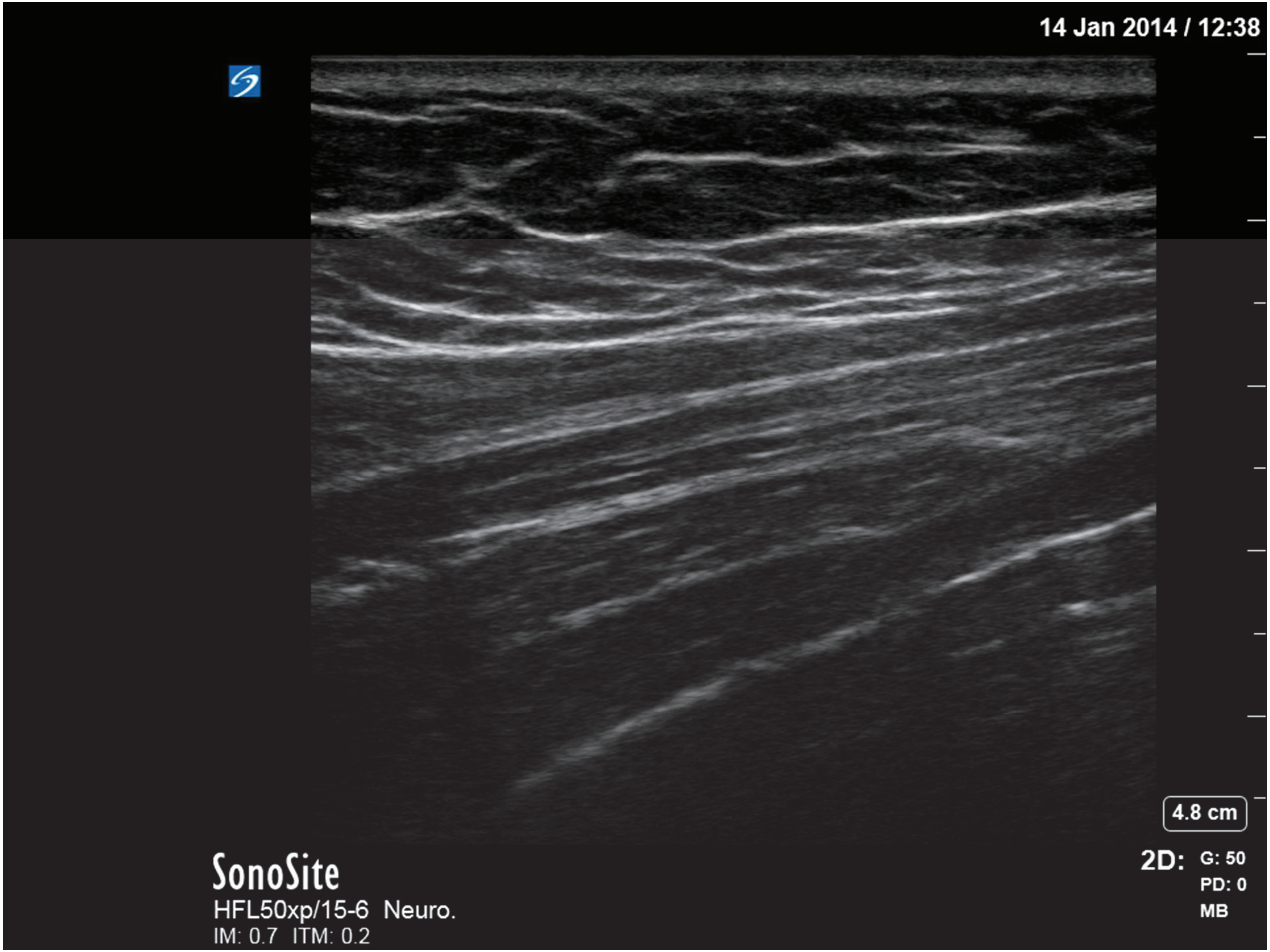
Abolition du glissement pleural
VPP 100%

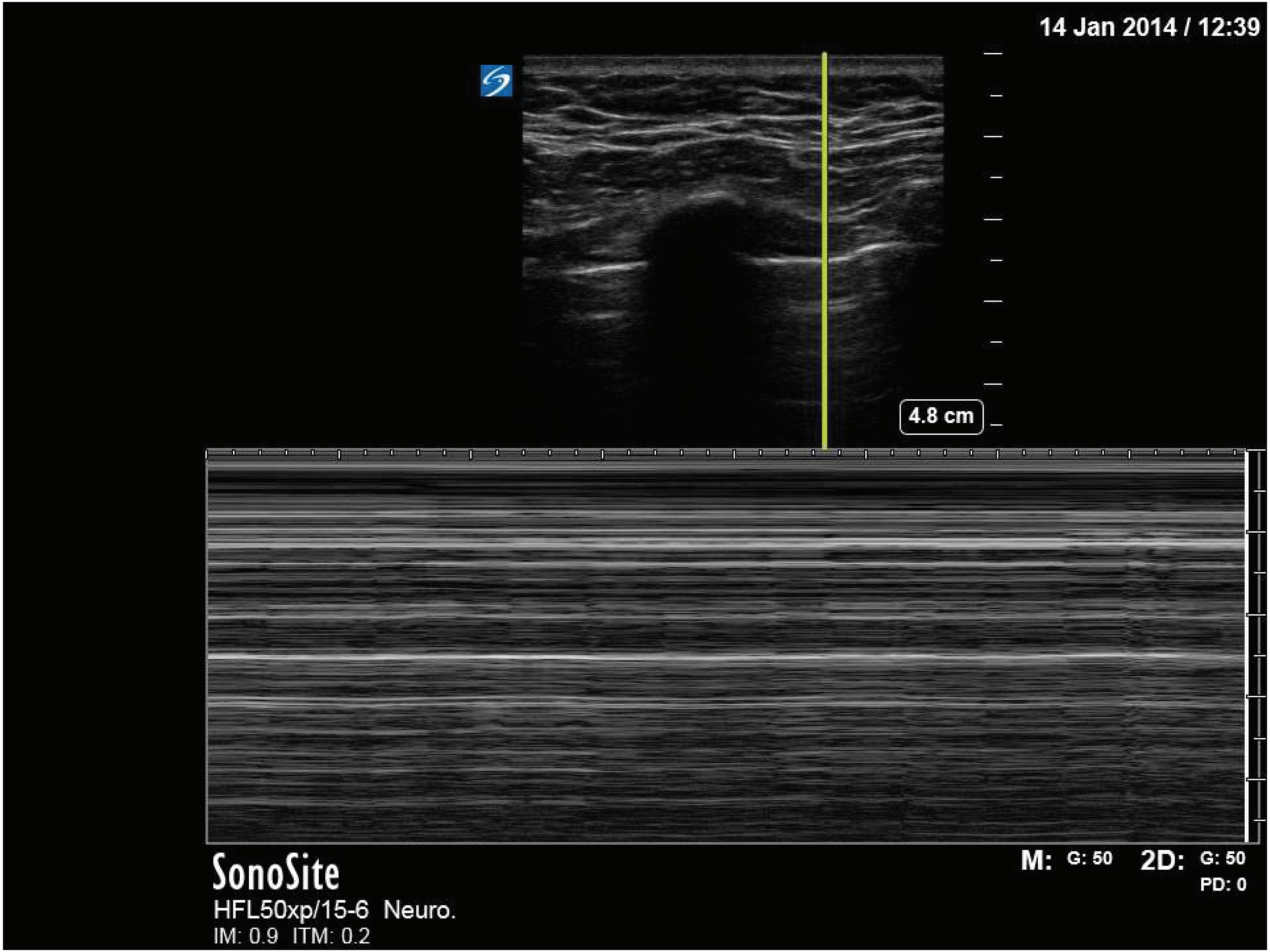


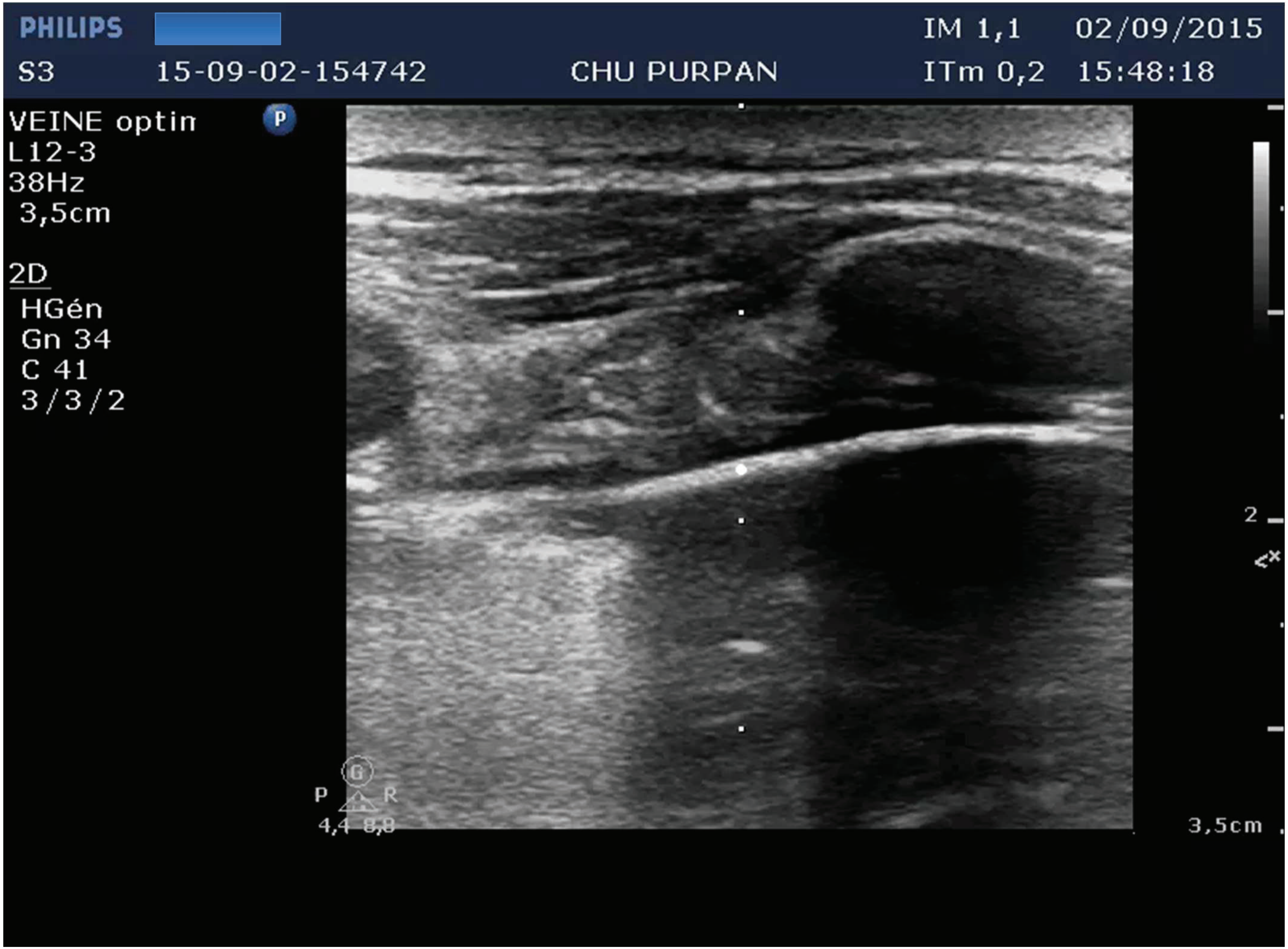
Point poumon
Spécifique à 100%

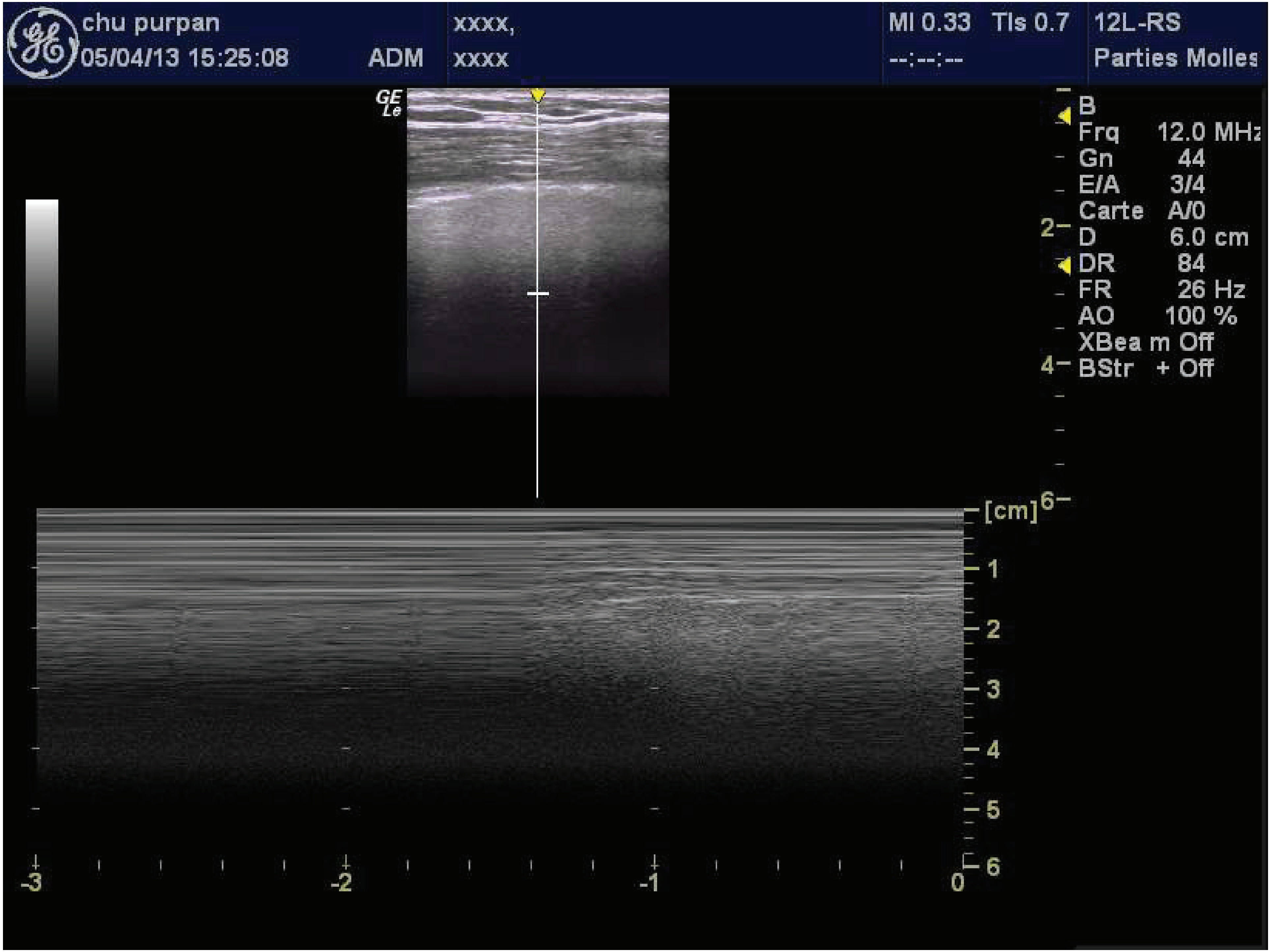


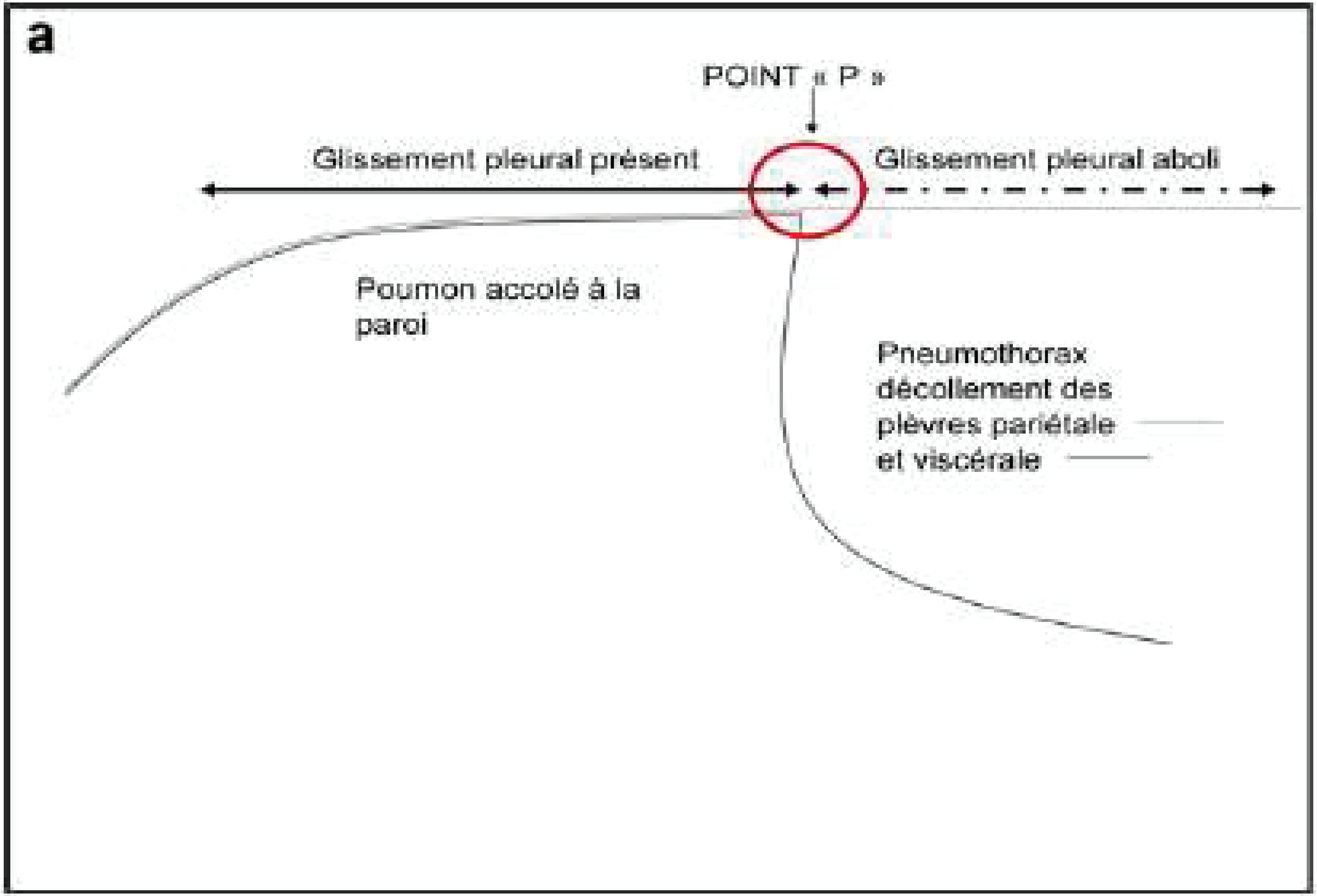
Lichtenstein D, Mezière G, Lascols N, Biderman P, Courret JP, Gepner A, et al.
Ultrasound diagnosis of occult pneumothorax.
Critical Care Med 2005;33:1231—8.

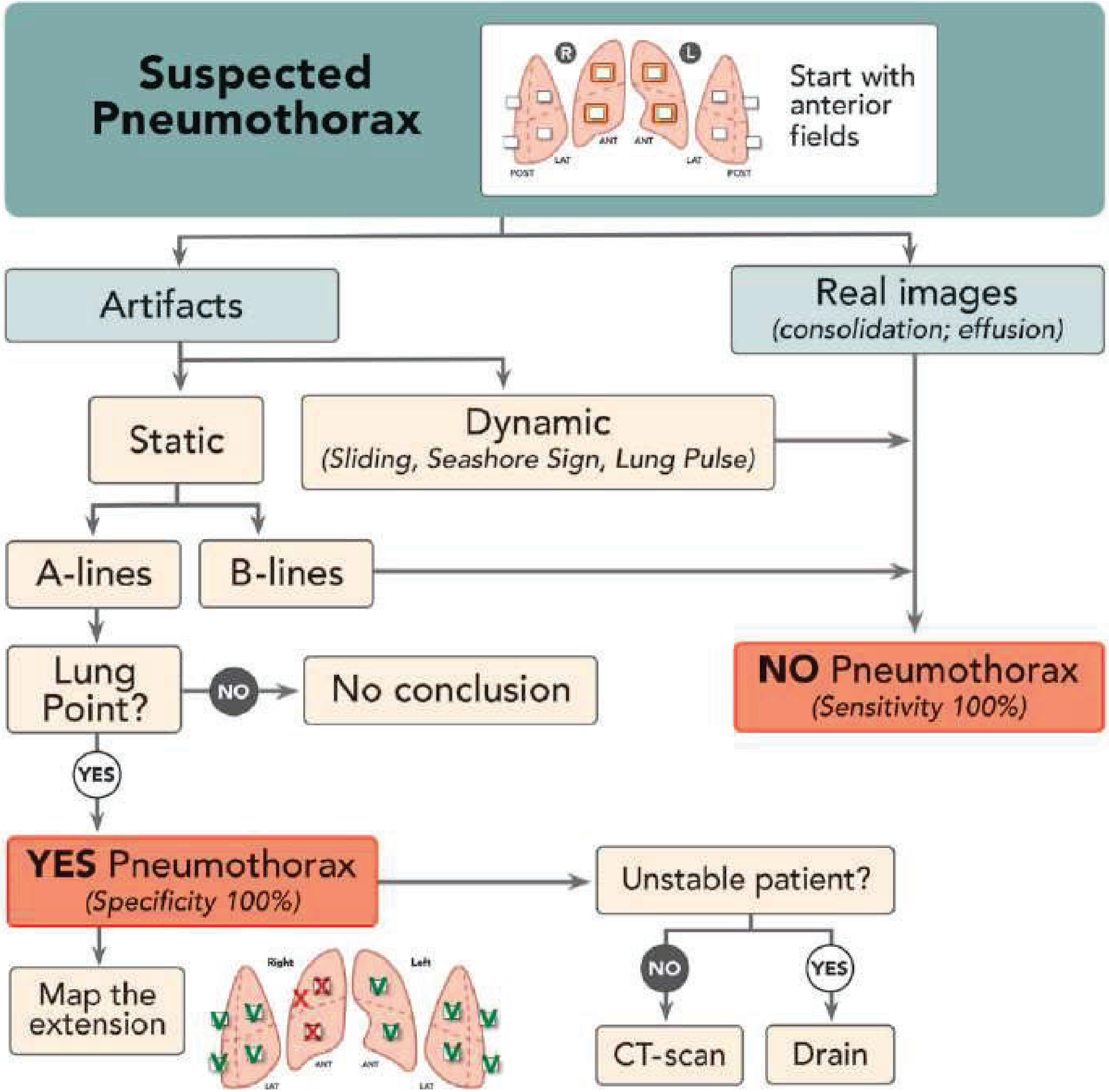

14 Jan 2014 / 12:38
4.8 cm
2D:
G: 50
PD: 0
MB
SonoSite
HFL50xp/15-6 Neuro.
IM: 0.7 ITM: 0.2


14 Jan 2014 / 12:39
4.8 cm
M: G: 50
2D: G: 50
PD: 0
SonoSite
HFL50xp/15-6 Neuro.
IM: 0.9 ITM: 0.2

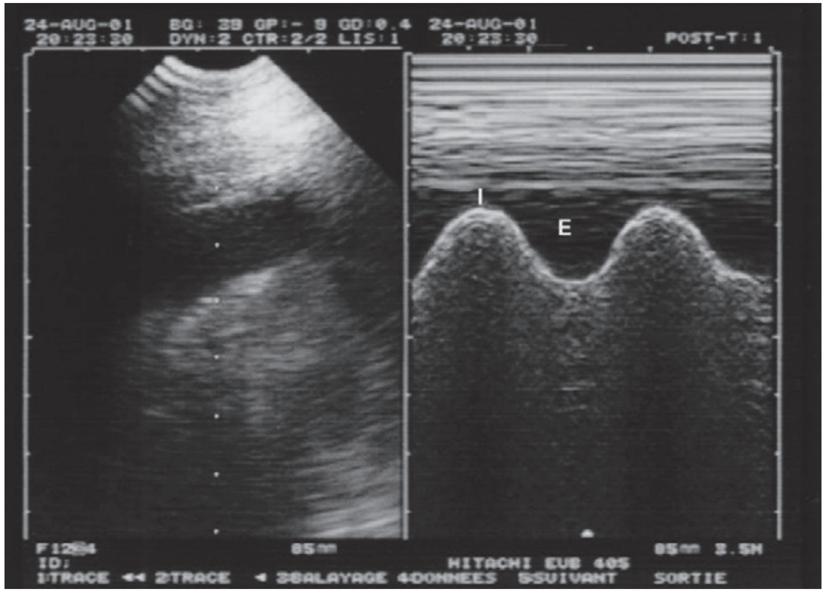

PHILIPS
IM 1,1
02/09/2015
S3
15-09-02-154742
CHU PURPAN
ITm 0,2
15:48:18
VEINE optin
L12-3
38Hz
3,5cm
2D
HGén
Gn 34
C 41
3/3/2
P
R
4,4 8,0
2
3,5cm


chu purpan
05/04/13 15:25:08
ADM
xxxx,
xxxx
MI 0.33
TIs 0.7
--:--:--
12L-RS
Parties Molles
GE
Le
B
Frq 12.0 MHz
Gn 44
E/A 3/4
Carte A/0
D 6.0 cm
DR 84
FR 26 Hz
AO 100 %
XBea m Off
BStr + Off
[cm]
-3
-2
-1
0


a
POINT « P »
Glissement pleural présent
Glissement pleural aboli
Poumon accolé à la paroi
Pneumothorax décollement des plèvres pariétale et viscérale


Suspected Pneumothorax
R
L
POST
LAT
ANT
ANT
LAT
POST
Start with anterior fields
Artifacts
Real images
(consolidation; effusion)
Static
Dynamic
(Sliding, Seashore Sign, Lung Pulse)
A-lines
B-lines
Lung Point?
NO
No conclusion
NO Pneumothorax
(Sensitivity 100%)
YES
YES Pneumothorax
(Specificity 100%)
Unstable patient?
Map the extension
Right
Left
NO
YES
CT-scan
Drain

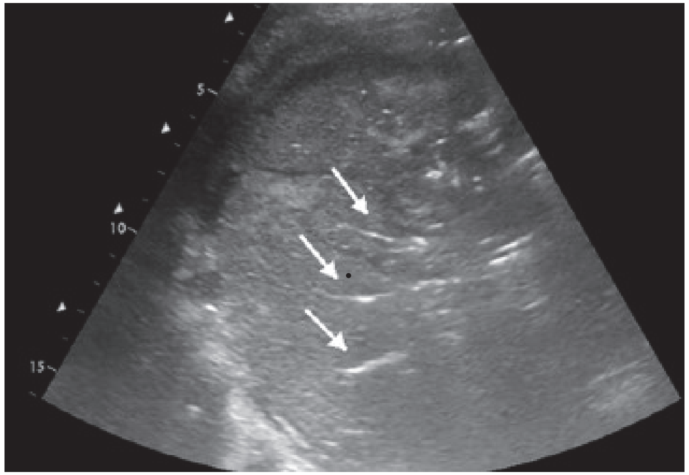
Épanchement pleural
Se:94%, Sp:97%

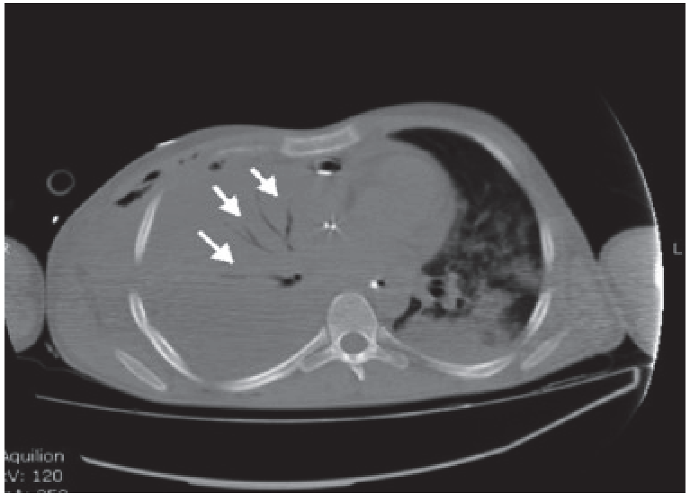


Lichtenstein D, Mezière
. Feasibility and safety of ultrasound-aided thoracentesis in mechanically ventilated patients.
Intensive Care Med 1999;25:955—8.

Consolidation alvéolaire

Se:90%, Sp:98%



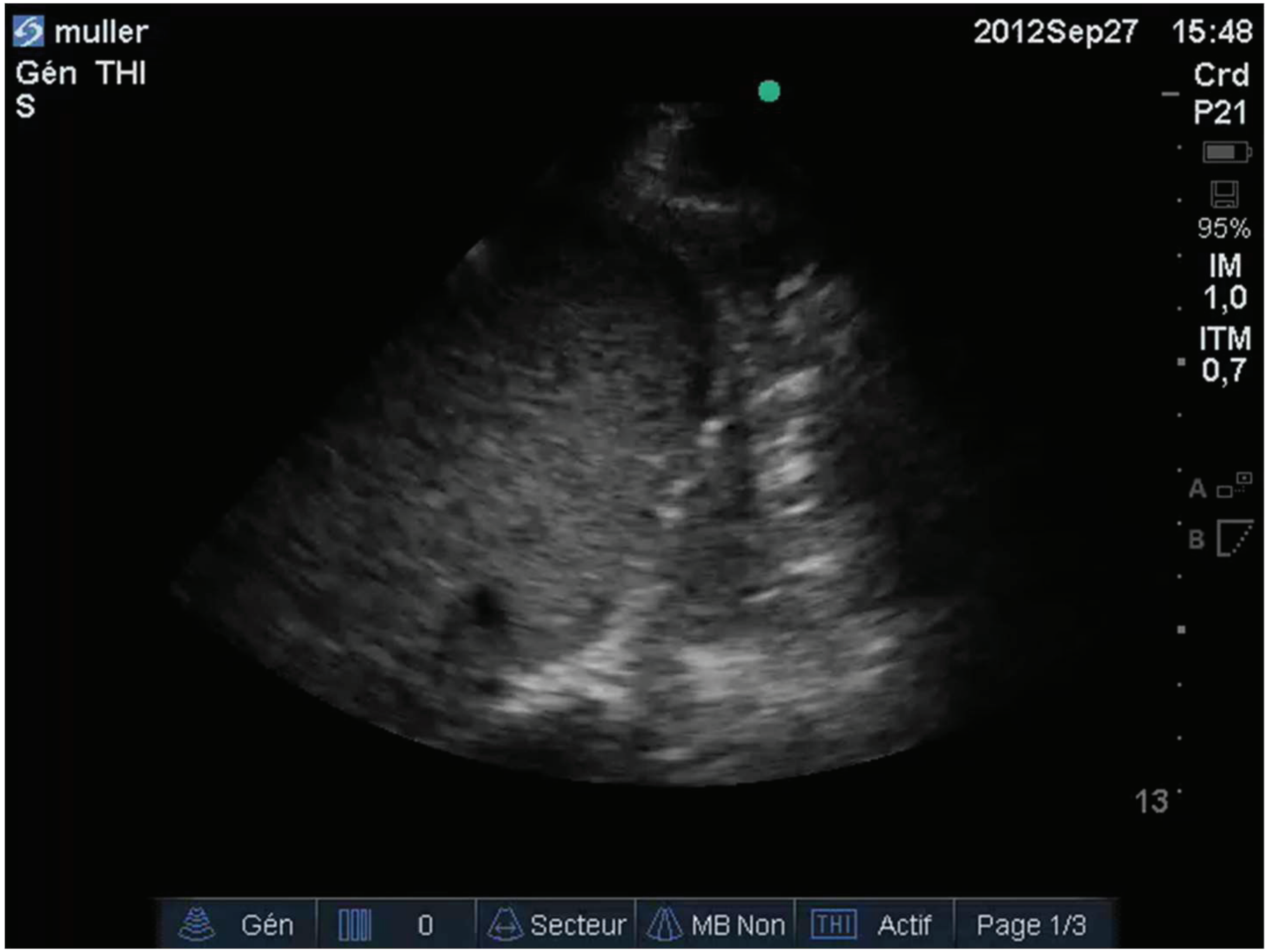


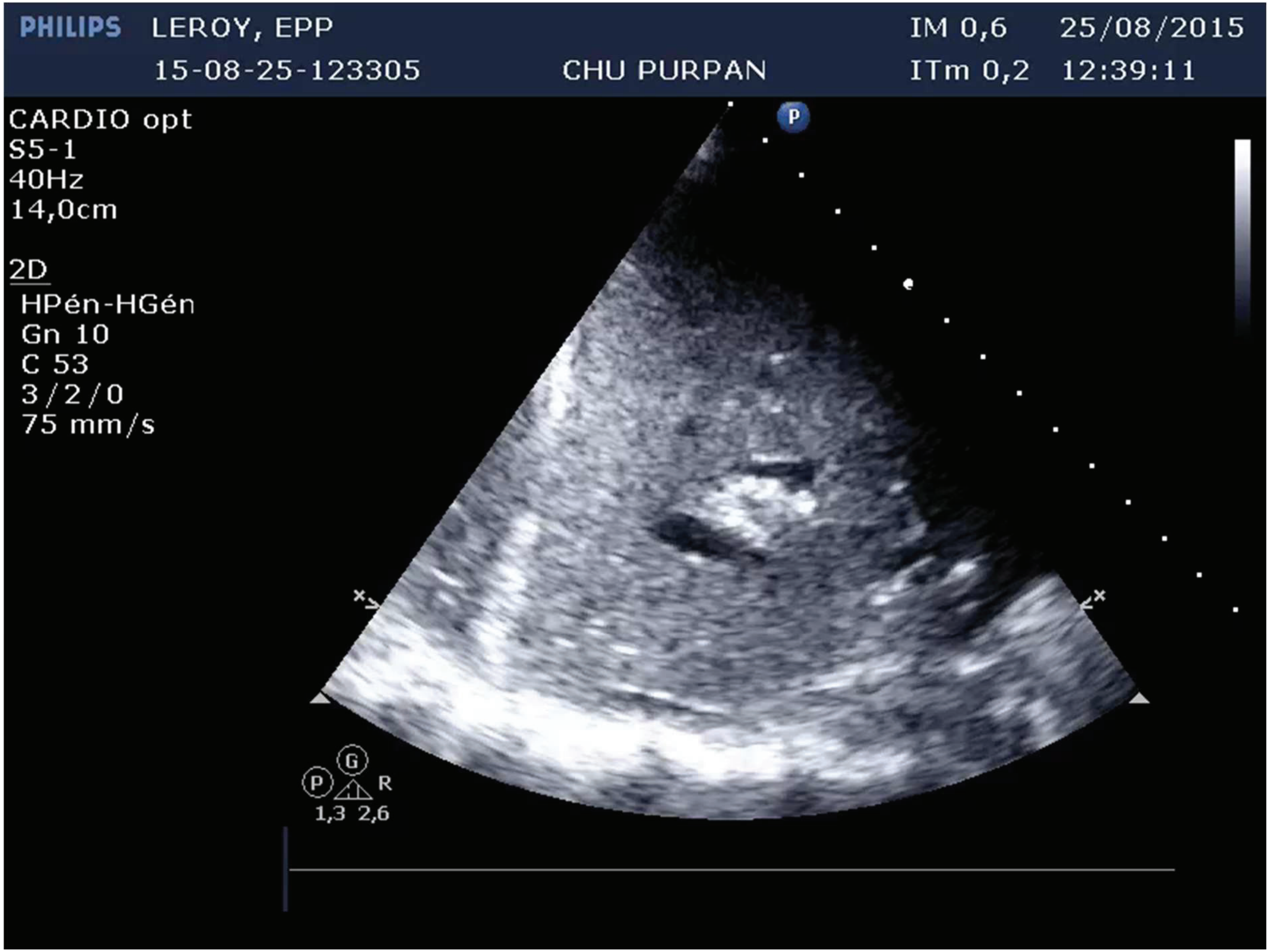
- signe du poumon tissulaire:
  tissu solide avec échogénicité tissulaire (hépatisation)

- + spécifique que la RT

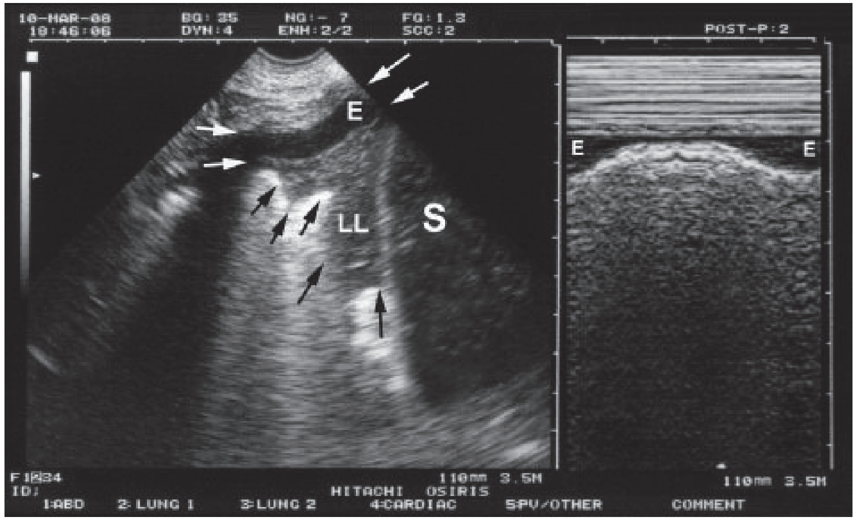
- Lignes hyperéchogène bronchogramme aèrique

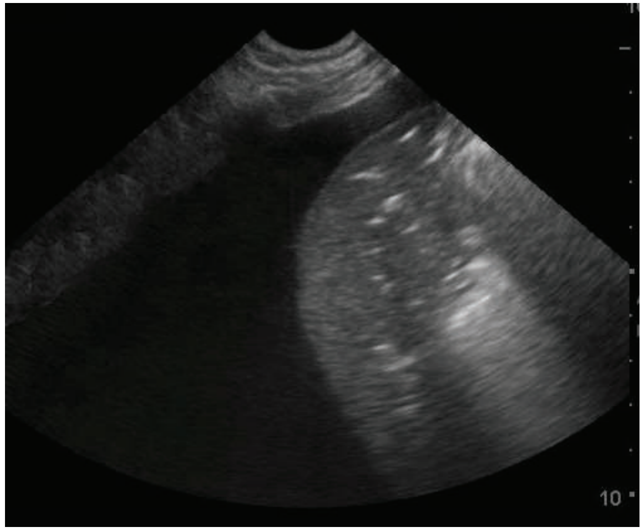
Lichtenstein D, .
Ultrasound diagnosis of alveolar consolidation in the critically ill.
Intensive Care Med 2004;30:276—81.


muller
2012Sep27 15:48
Gén THI
S
Crd
P21
95%
IM
1,0
ITM
0,7
A
B
13
Gén
0
Secteur
MB Non
THI
Actif
Page 1/3

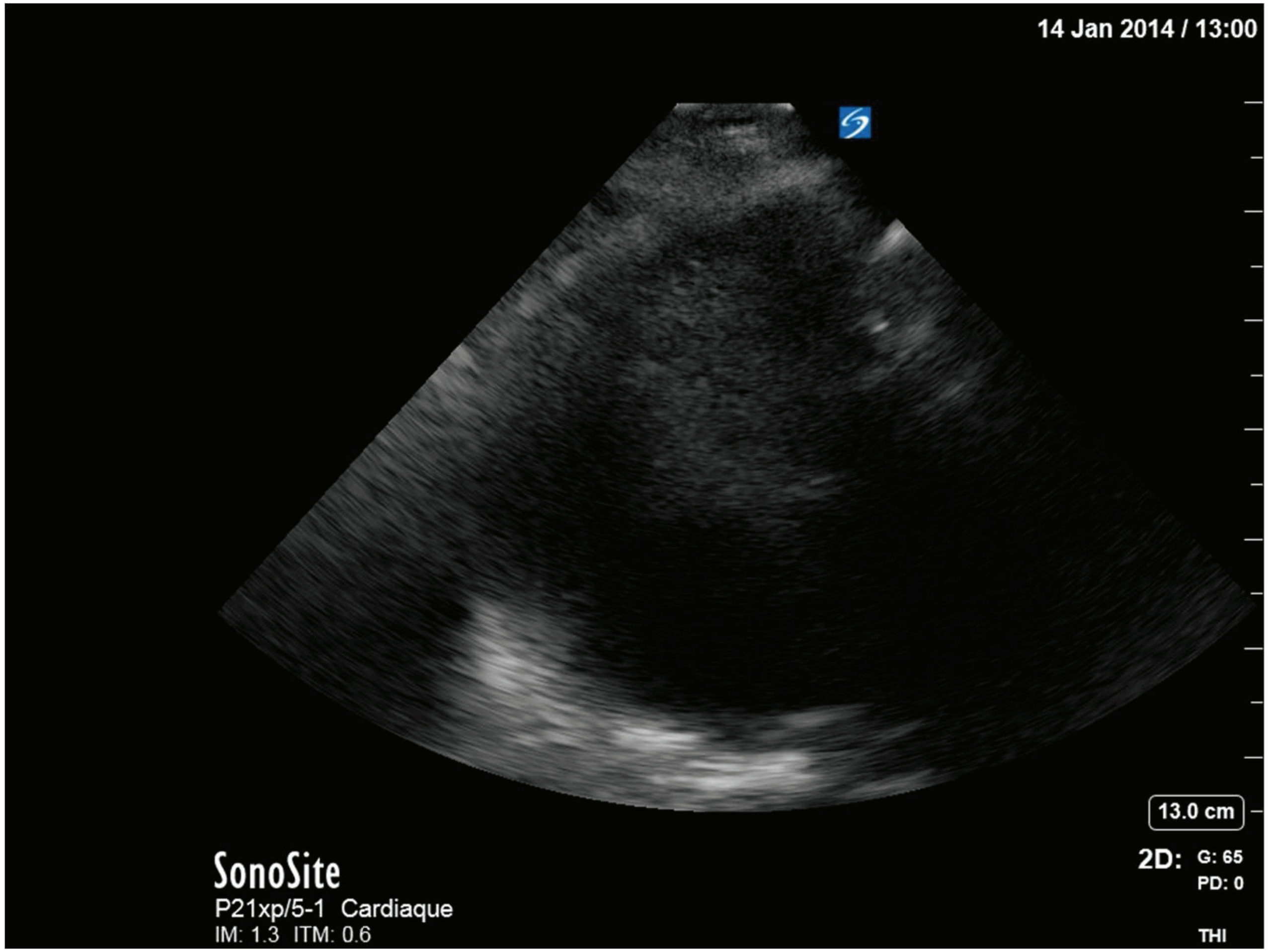

PHILIPS
LEROY, EPP
15-08-25-123305
CHU PURPAN
IM 0,6
ITm 0,2
25/08/2015
12:39:11
CARDIO opt
S5-1
40Hz
14,0cm
2D
HPén-HGén
Gn 10
C 53
3/2/0
75 mm/s
P
G
P
R
1,3 2,6

PLAPS
postero lateral alveolar and pleural syndrome

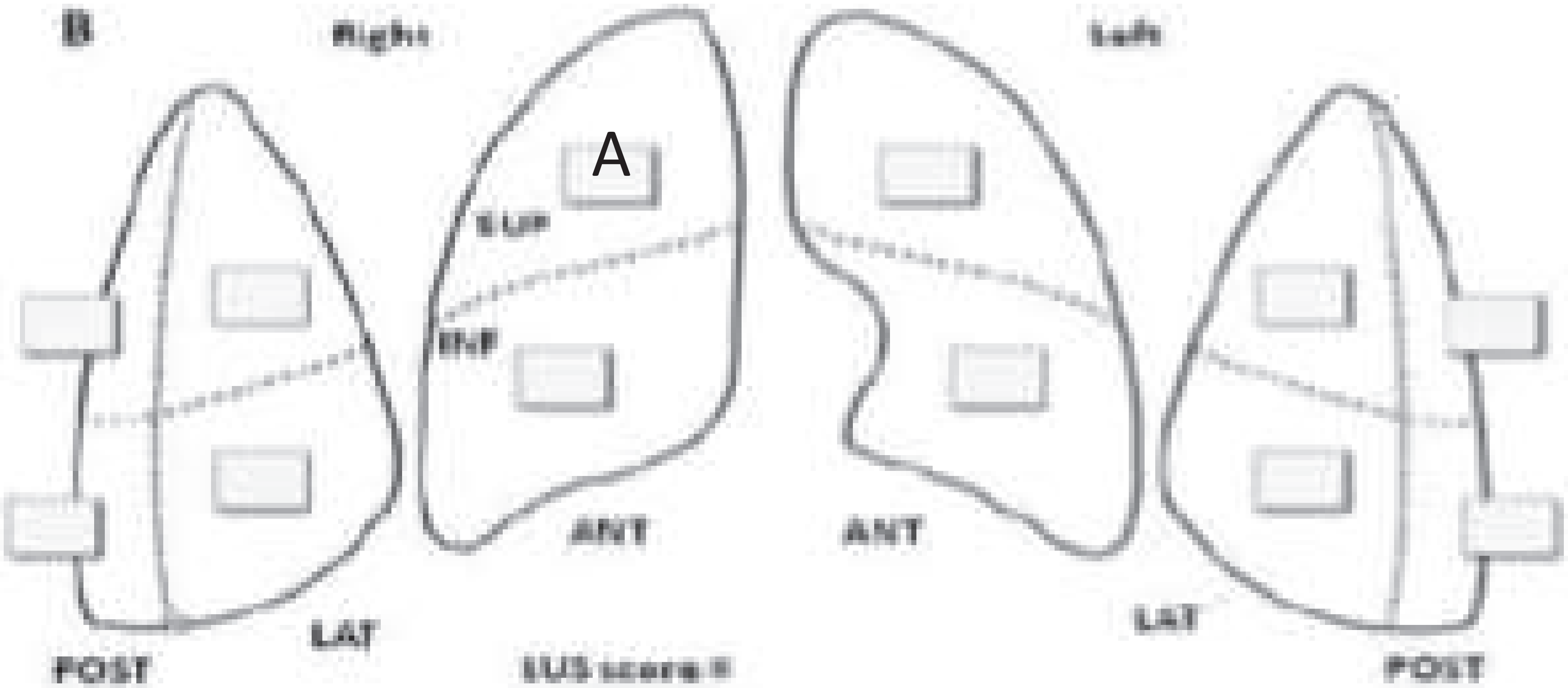




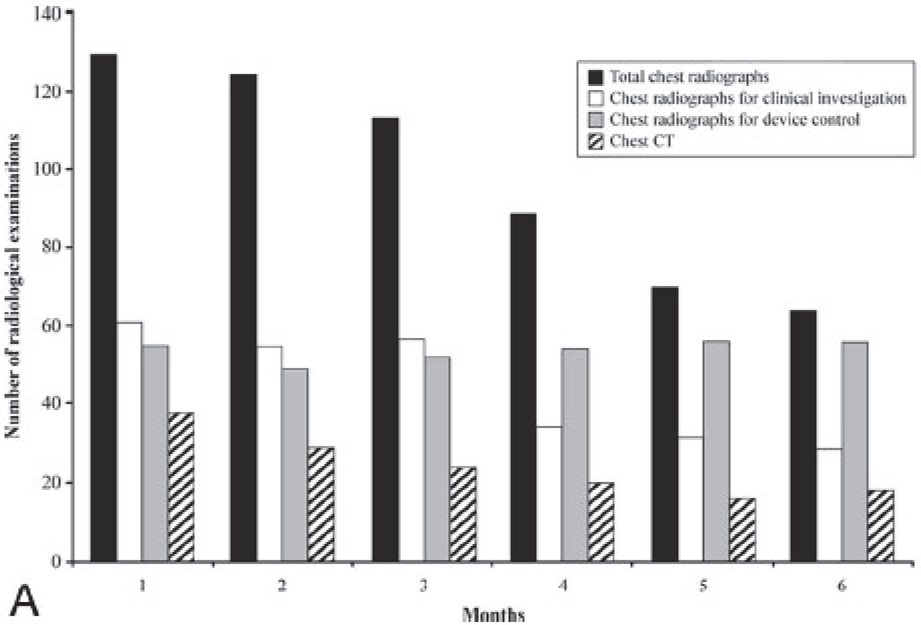
Zone 3, condensation pulmonaire et épanchement pleural
Flèches noires = bronchogramme aèrique

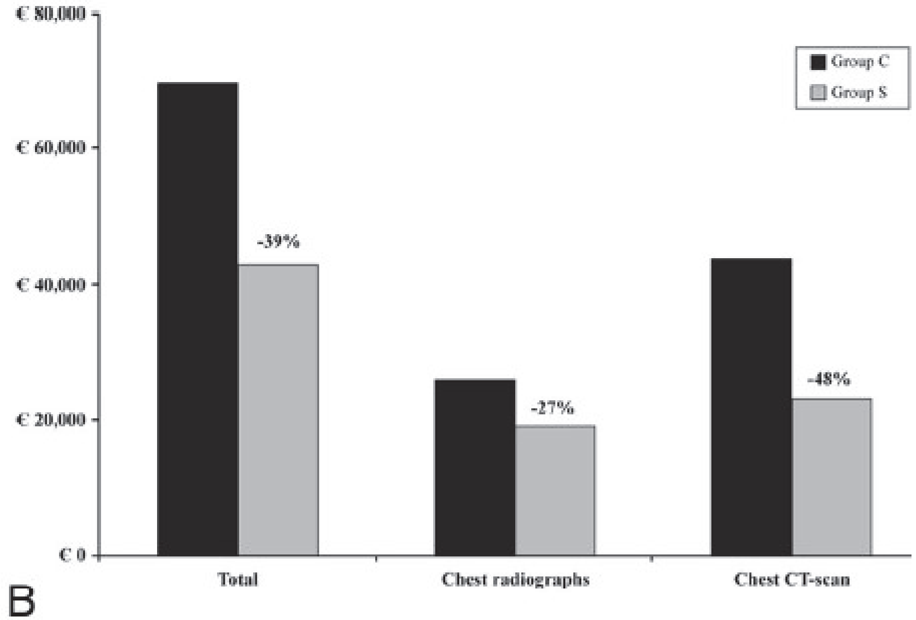

14 Jan 2014 / 13:00
13.0 cm
2D:
G: 65
PD: 0
THI
SonoSite
P21xp/5-1 Cardiaque
IM: 1.3 ITM: 0.6


muller
Gén THI
S
2012Sep27 15:46
Crd
P21
95%
IM
1,0
ITM
0,7
A
B
13
Gén
0
Secteur
MB Non
THI
Actif
Page 1/3


B
A
Sup
Inf
ANT
ANT
LAT
LAT
POST
POST

Étude médico économique





6mois,376 patients

Conclusion: Routine use of LUS in the ICU setting can be associated with a reduction of the number of chest radiographs and CT scans performed.

(Balik M,Anesth Analg 2010;111:687–92)

Applications cliniques

- Diagnostique d'une détresse respiratoire
- Atélectasie ou pneumopathie ?
- Évaluation quantitative d'un épanchement pleural
- Recrutement alvéolaire dans sdra
- Recrutement alvéolaire et DV
- Efficacité d'un traitement ATB PAVM
- Diagnostic précoce PAVM

Diagnostic d’une DRA

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

Daniel A. Lichtenstein and Gilbert A. Mezière

Chest 2008;134;117-125; Prepublished online April 10, 2008;
DOI 10.1378/chest.07-2800

- Étude observationnelle
- Patients consécutifs hospitalisés pour DRA, 1 centre, 304 patients, 4 ans
- Comparaison entre écho pulm initial et diagnostique final retenu (CR de sortie)
- 3 items:
  - Artefacts (ligne A, ligne B)
  - Glissement pleural
  - Condensation pulm +/- épanchement pleural

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

Daniel A. Lichtenstein and Gilbert A. Mezière

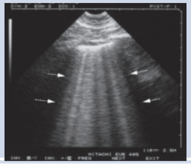
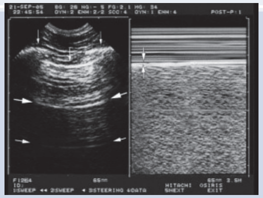
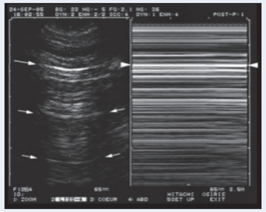
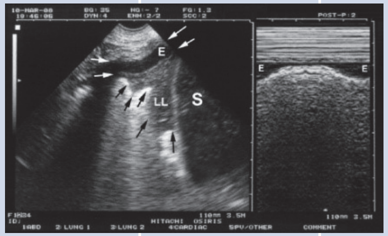
Chest 2008;134;117-125; Prepublished online April 10, 2008;
DOI 10.1378/chest.07-2800

- Objectif principal: pertinence de l'écho pulmonaire pour le diagnostique DRA

- BLUE PROTOCOL: Bedside Lung US in Emergency

Table 1—*Final Diagnoses and Methods of Diagnosis*

Diagnoses	Methods
For all patients	History, clinical examination, radiography read by radiologists, CT when available (n = 38), favorable clinical progression under treatment, and:
Cardiogenic pulmonary edema (referred to as *pulmonary edema*) [n = 64]	Evaluation of cardiac function using echocardiography, functional tests, and American Heart Association recommendations
Pneumonia (n = 83)	Infectious profile, radiologic asymmetry, microorganism isolated (blood, invasive tests), recovery with antibiotics. Included were infectious, aspiration, community, or hospital-acquired pneumonia. Pneumonia complicating chronic respiratory disease was classified as pneumonia. Beginning ARDS (n = 7) and massive atelectasis (n = 1) were included in this group
Decompensated chronic respiratory disease (referred to as *COPD*) [n = 49]	Condition defined as exacerbation of chronic respiratory disease without pneumonia, pneumothorax, pulmonary edema, pleurisy, or pulmonary embolism. COPD was confirmed by functional tests. Patients with simple bronchial superinfection were classified in this case. COPD patients with pneumonia, pneumothorax, etc, were first considered as pneumonia, pneumothorax, etc
Acute asthma (n = 34)	History, responds to bronchodilator treatment
Pulmonary embolism (n = 21)	Helical CT
Pneumothorax (n = 9)	Radiography (CT if necessary)
Excluded patients	
Rare (< 2%) causes (n = 9)	Chronic diffuse interstitial disease (n = 4), massive pleural effusion (n = 3), fat embolism (n = 1), tracheal stenosis (n = 1). Note: no dyspnea due to pericardial effusion in this consecutive series
No final diagnosis (n = 16)	Unknown diagnosis at the end of hospitalization, progression preventing conclusions
Several final diagnoses (n = 16)	Pulmonary edema plus pneumonia (n = 10), pulmonary edema plus COPD (n = 3), others (n = 3)

pathologies	artefact	glissement	PLAPS	Se	Sp
OEDEME N=64	B+/B+ 	100%	56%	97%	95%
BPCO N=49	A B (3 cas)	77%	O	89%	97%
ASTME N=34	A 	100%	1	89%	97%
PNO N=9	A 	0%	55%	81%	100%
PNEUMOPATHIE N=83	B/B (7%) B/B (11%) B/A (14%) Condensation (21%) A (40%) Normal 3%	Oui Non oui	90% 		

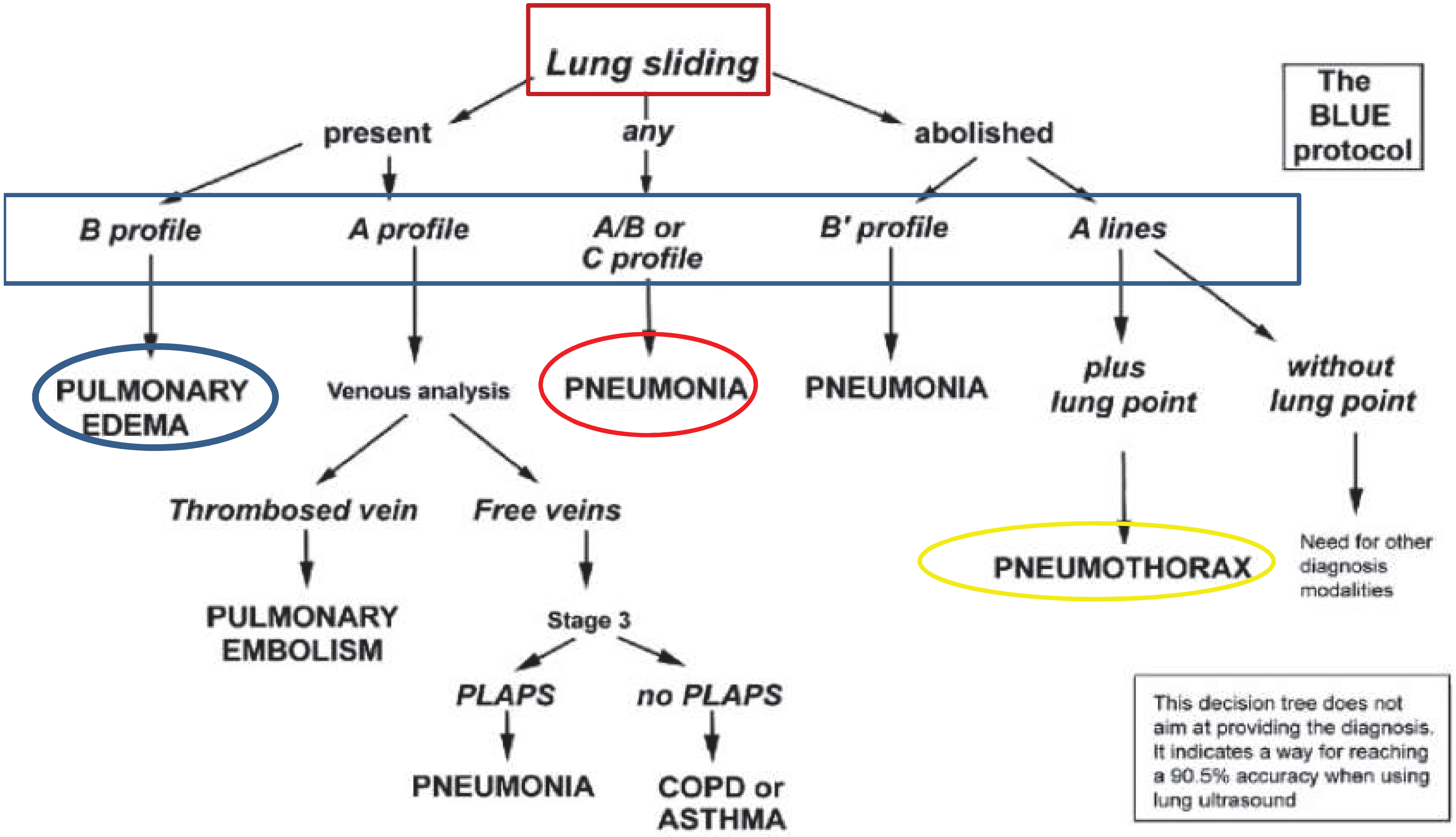
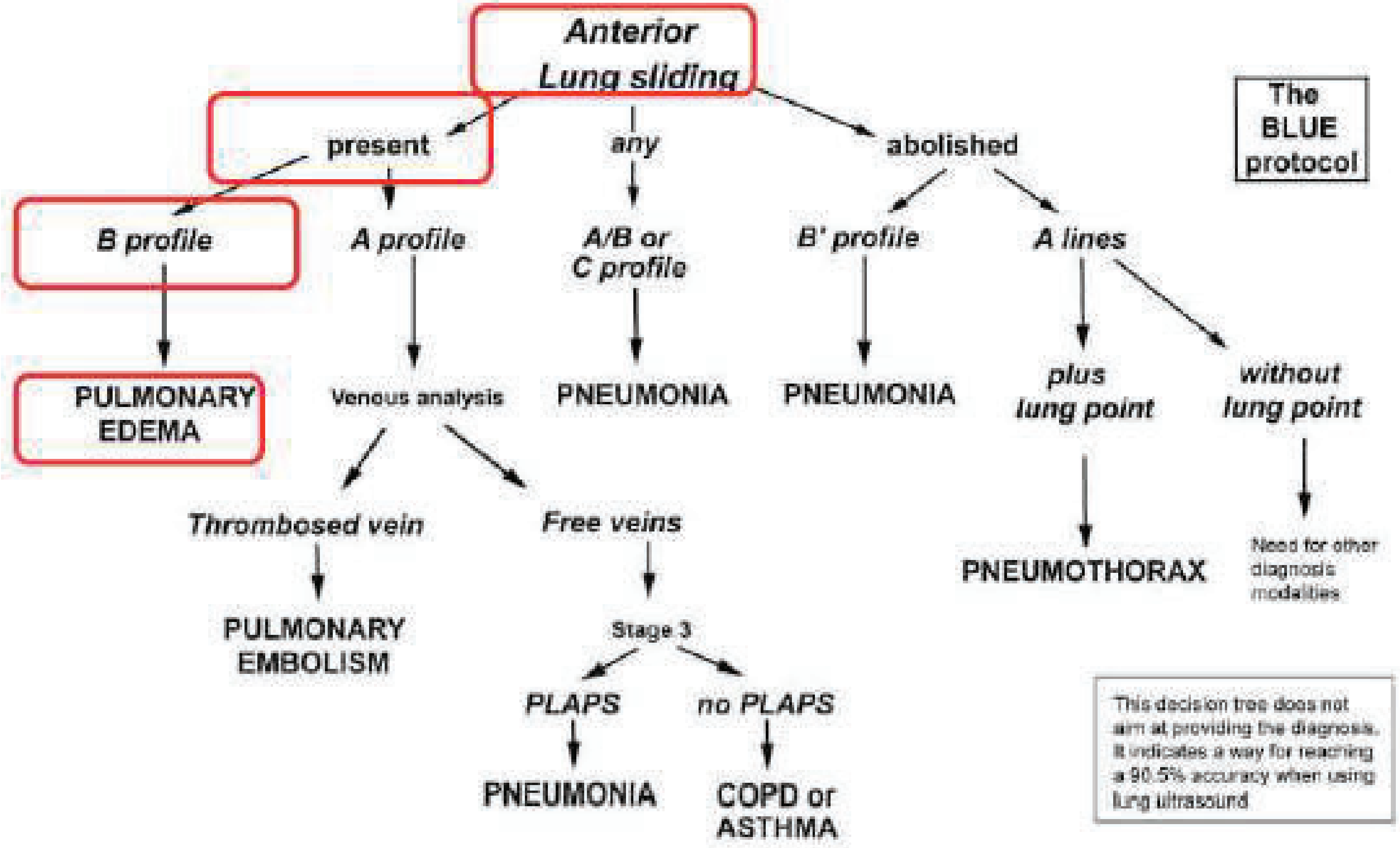


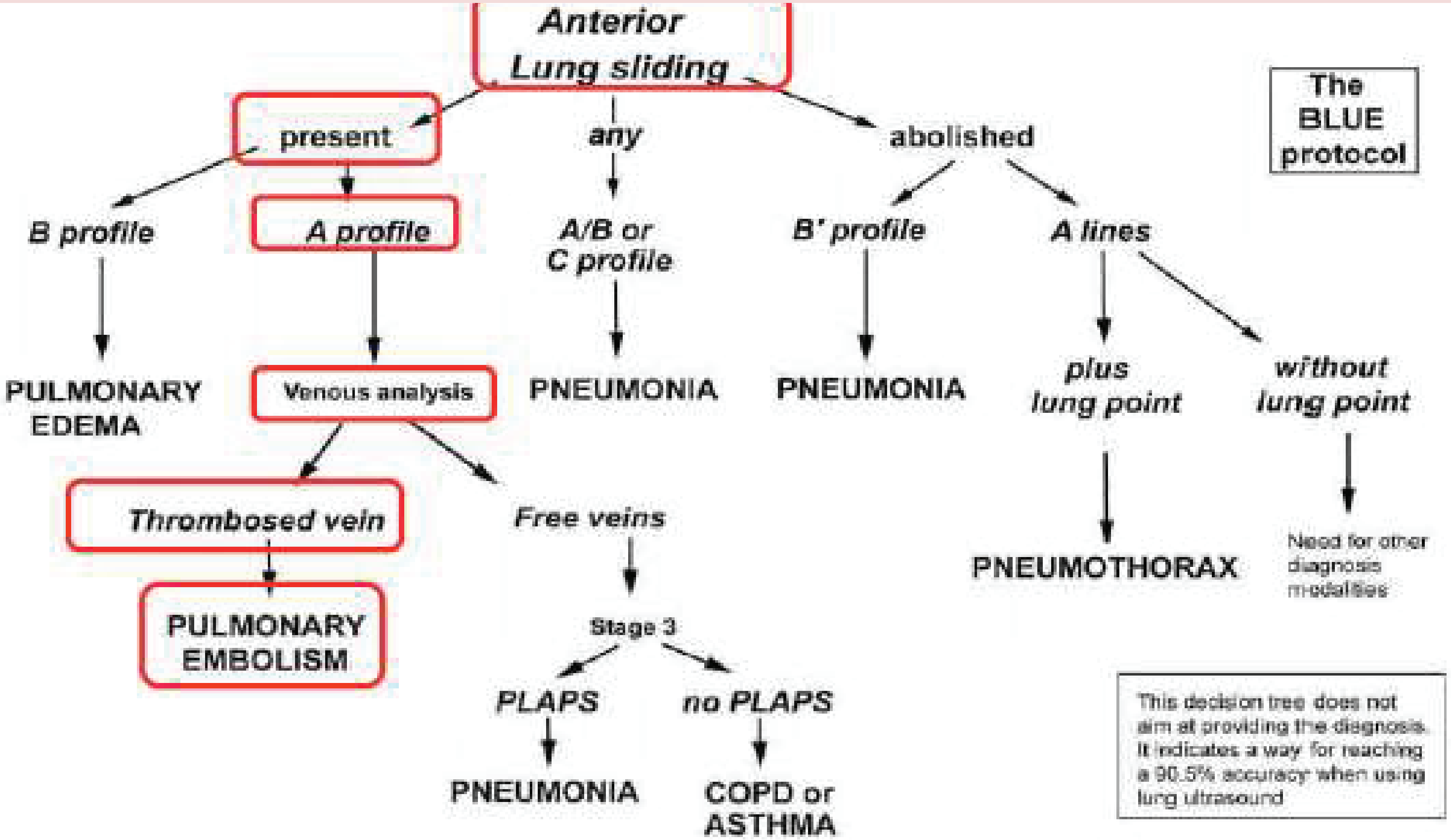
FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Diagnostic d'un OAP



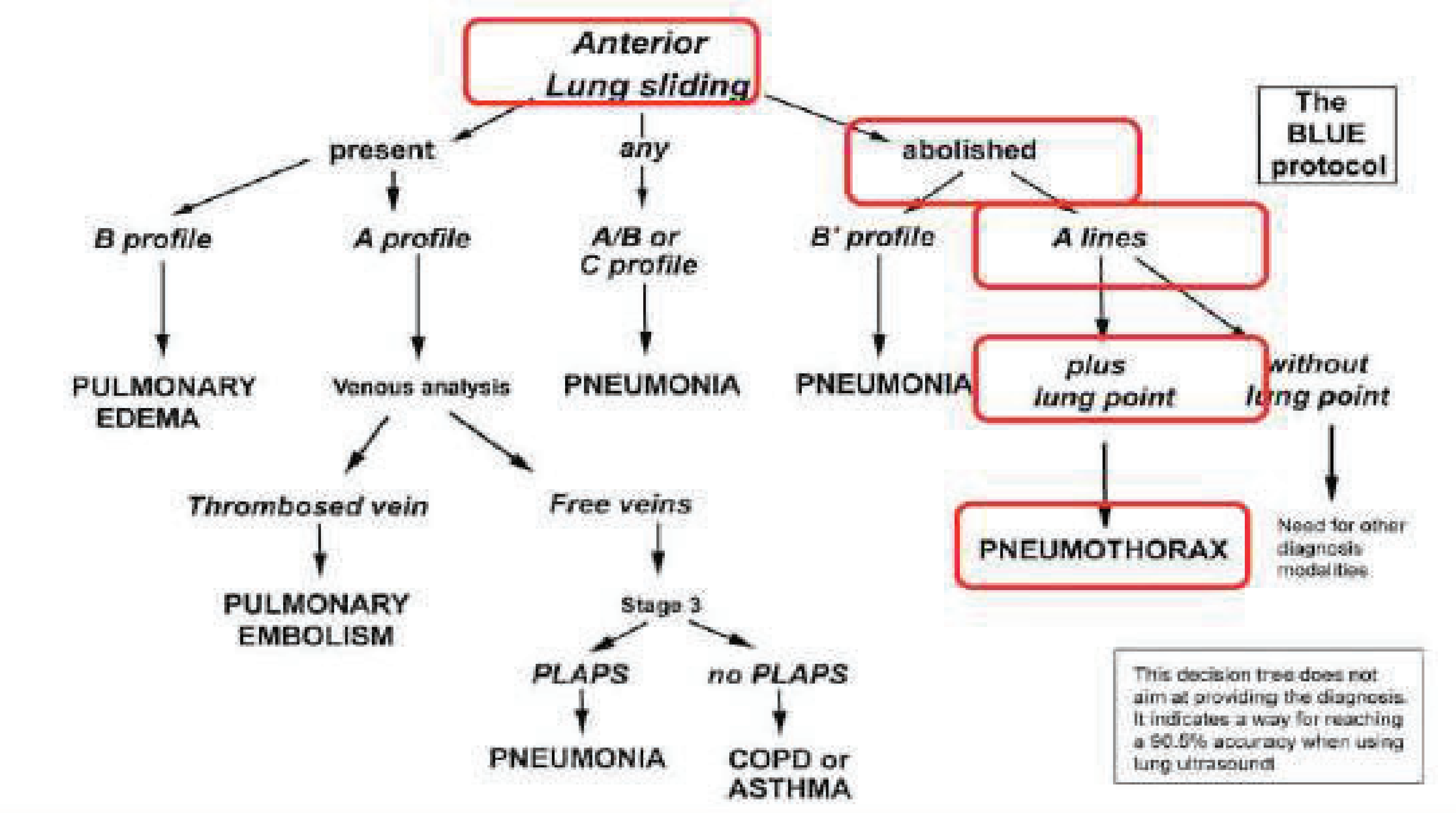
Sensibilité 97% Spécificité 95% VPN 99% VPP 87

Diagnostic d'une EP



Sensibilité 81% Spécificité 99%

Diagnostic d'un pneumothorax



88% Spécificité 100% Valeur prédictive négative 100% VP

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

Daniel A. Lichtenstein and Gilbert A. Mezière

Chest 2008;134;117-125; Prepublished online April 10, 2008;
DOI 10.1378/chest.07-2800

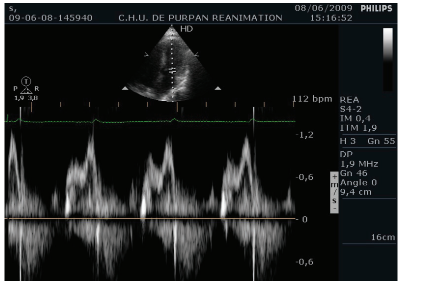
- Implications cliniques
  - Gain de temps
  - ↓ nombre de TDM
  - $\frac{1}{4}$ diagnostic erroné dans les 2 h, avec thérapeutique inappropriée
- Limites
  - Opérateurs très confirmés

Conclusion :Diagnostic immédiat d’une DRA dans 90,5% des cas

QUID des pressions de remplissage??

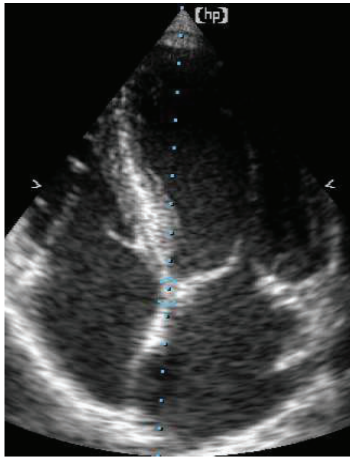
E/A>2 est prédictif d'une PAPO>18mmHg avec une VPP de 100%.

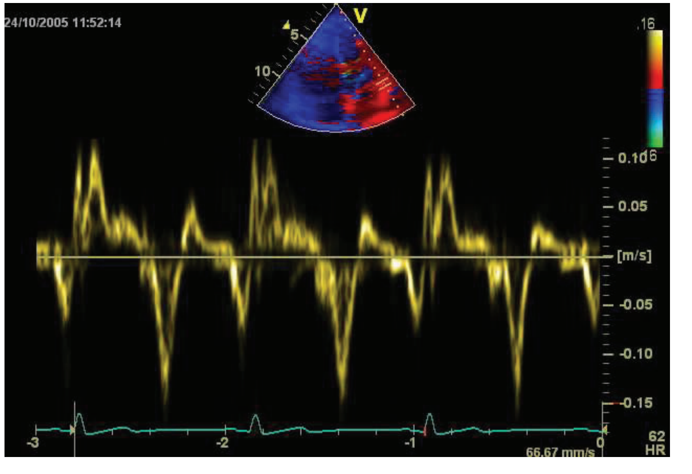
Evaluation of left ventricular filling pressure by TTE in the intensive care unit.
Boussuges.
Crit Care Med 2002 vol30 n° 2 (VM)
Giannuzzi et al. J Am Coll Cardiol 1994; 23:1630 (VS)



E/E' > 15 est prédictif d'une PAPO > 15 mmHg avec Se à 86%, Sp 88%.

Optimal noninvasive assessment of left ventricular filling pressures.
A comparison of tissue echocardiography and B-type natriuretic peptid in patients with pulmonary artery catheters. Dokainich. Circulation 2004. 109: 2432-9.





CHEST

Original Research

CRITICAL CARE

Usefulness of Cardiothoracic Chest Ultrasound in the Management of Acute Respiratory Failure in Critical Care Practice

Stein Silva, MD, PhD; Caroline Biendel, MD; Jean Ruiz, MD; Michel Olivier, MD; Benoit Bataille, MD; Thomas Geeraerts, MD, PhD; Arnaud Mari, MD; Beatrice Riu, MD; Olivier Fourcade, MD, PhD; and Michele Genestal, MD

Chest. 2013;144(3):859-865. doi:10.1378/chest.13-0167

Méthodes : protocole d' étude

Patient en DRA; inclusion

↓

ET

Protocole « STANDARD »
1er médecin

En aveugle

Protocole « US »
2ème médecin

Ensemble

Diagnostic proposé par les 2 médecins

1 : décompensation BPCO
2 : OAP
3 : pneumonie
4 : pneumothorax
5 : crise d' asthme
6 : 1 + 2
7 : 2 + 3
8 : 1 + 3
9 : EP
10 : autre

Traitement administré au patient

1: Diurétiques
2: Antibiotiques
3: Aérosols β2-mimétique
4: Aérosols anticholinergique
5: Oxygénothérapie
6: VNI ou CPAP
7: corticothérapie
8: Remplissage
9:autre

⇩

Diagnostic final par un panel d'experts

⇩

Analyse des diagnostics

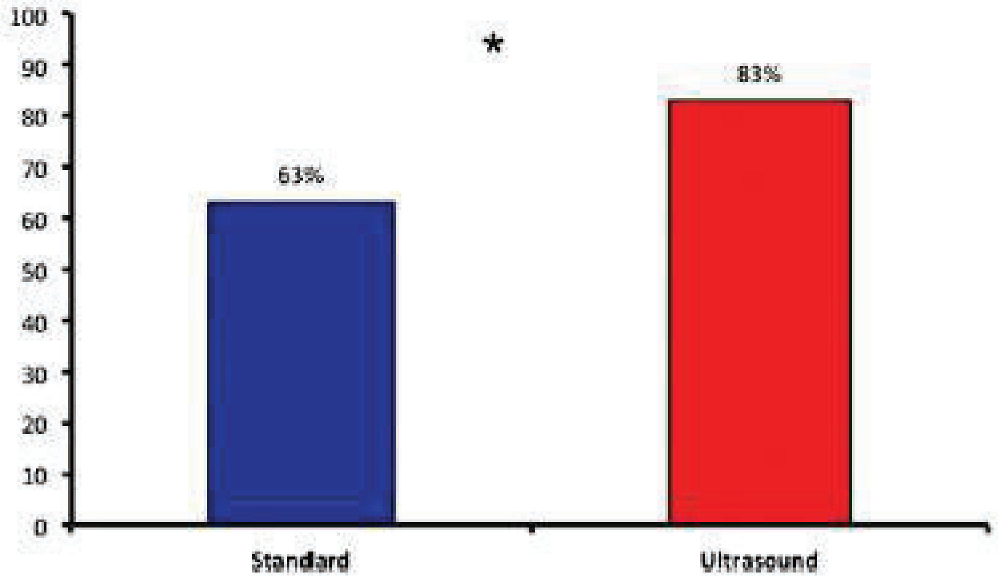
CHEST

Original Research

CRITICAL CARE

Usefulness of Cardiothoracic Chest Ultrasound in the Management of Acute Respiratory Failure in Critical Care Practice

Stein Silva, MD, PhD; Caroline Biendel, MD; Jean Ruiz, MD; Michel Olivier, MD; Benoit Bataille, MD; Thomas Geeraerts, MD, PhD; Arnaud Mari, MD; Beatrice Riu, MD; Olivier Fourcade, MD, PhD; and Michele Genestal, MD



15] 16] FIGURE 1. Comparative diagnostic accuracy. Each diagnostic approach (standard and ultrasound) was compared against the final diagnosis determined by a panel of experts ($P < .05$).

CHEST

Original Research

CRITICAL CARE

Usefulness of Cardiothoracic Chest Ultrasound in the Management of Acute Respiratory Failure in Critical Care Practice

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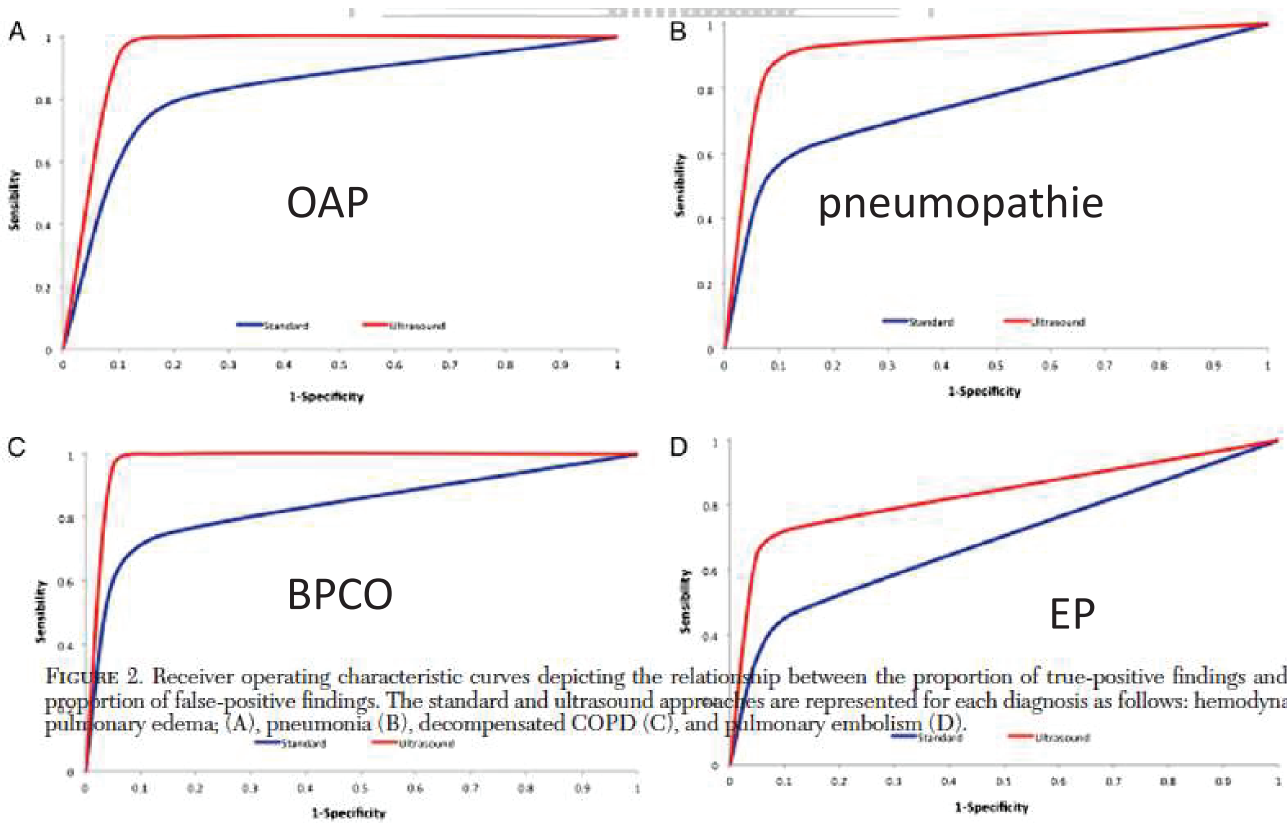

FIGURE 2. Receiver operating characteristic curves depicting the relationship between the proportion of true-positive findings and the proportion of false-positive findings. The standard and ultrasound approaches are represented for each diagnosis as follows: hemodynamic pulmonary edema; (A), pneumonia (B), decompensated COPD (C), and pulmonary embolism (D). [A(

CHEST

Original Research

CRITICAL CARE

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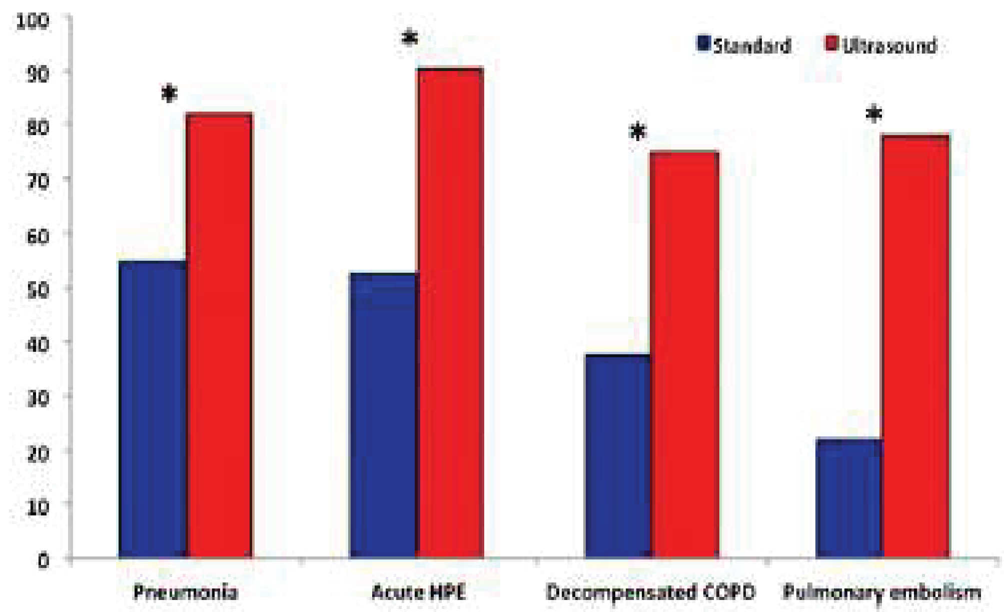


[Original Research]

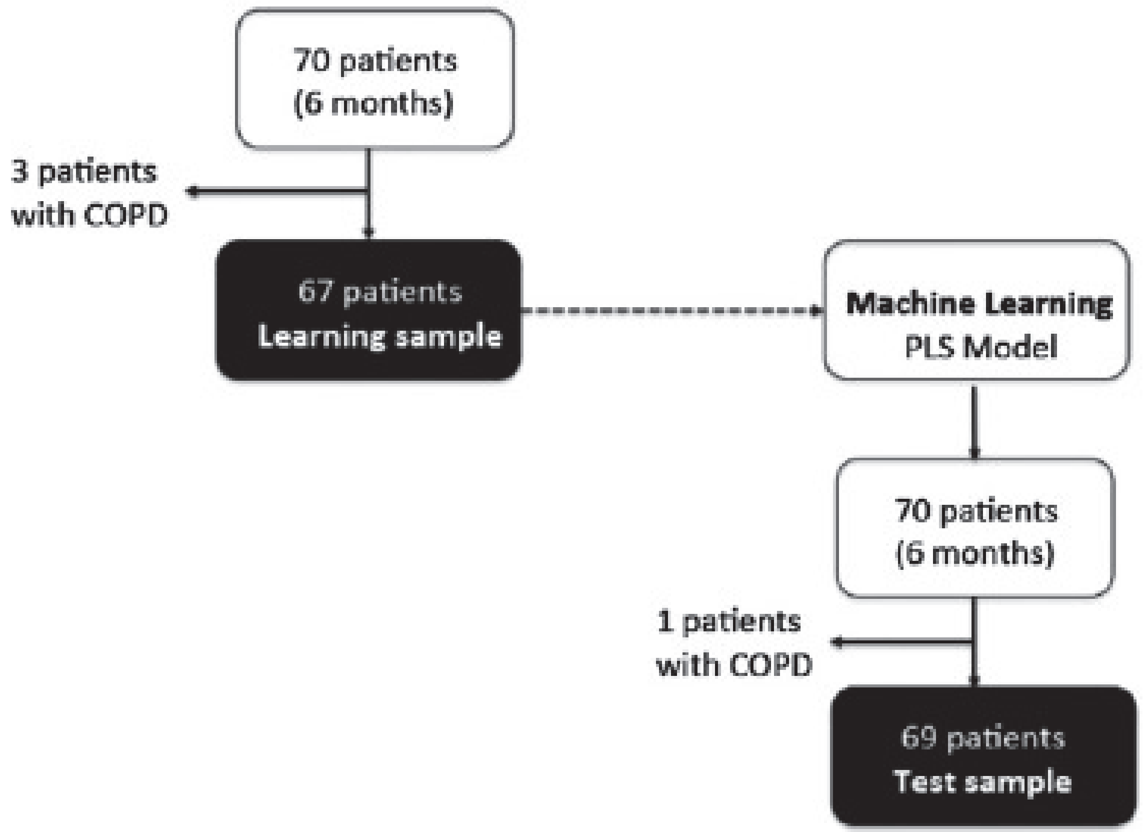
CHEST

Integrated Use of Bedside Lung Ultrasound and Echocardiography in Acute Respiratory Failure

A Prospective Observational Study in ICU

Benoit Bataille, MD; Beatrice Riu, MD; Fabrice Ferre, MD; Pierre Etienne Moussot, MD; Arnaud Mari, MD; Elodie Brunel, MD; Jean Ruiz, MD; Michel Mora, MD; Olivier Fourcade, MD, PhD; Michele Genestal, MD; and Stein Silva, MD, PhD

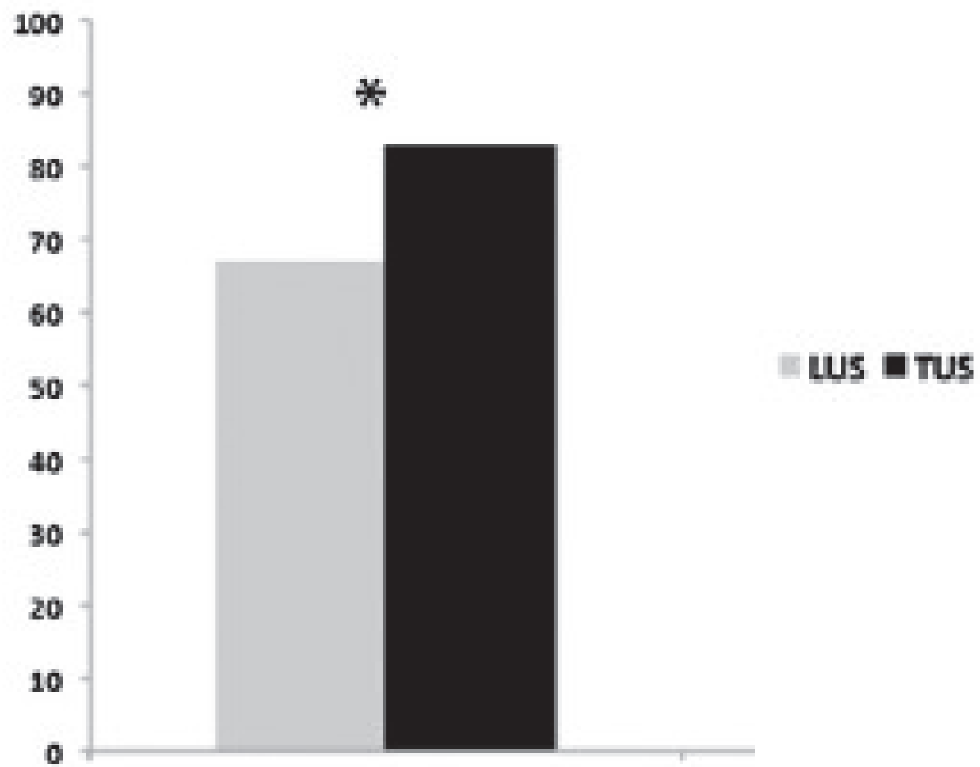
Chest. 2014. doi:10.1378/chest.14-0681



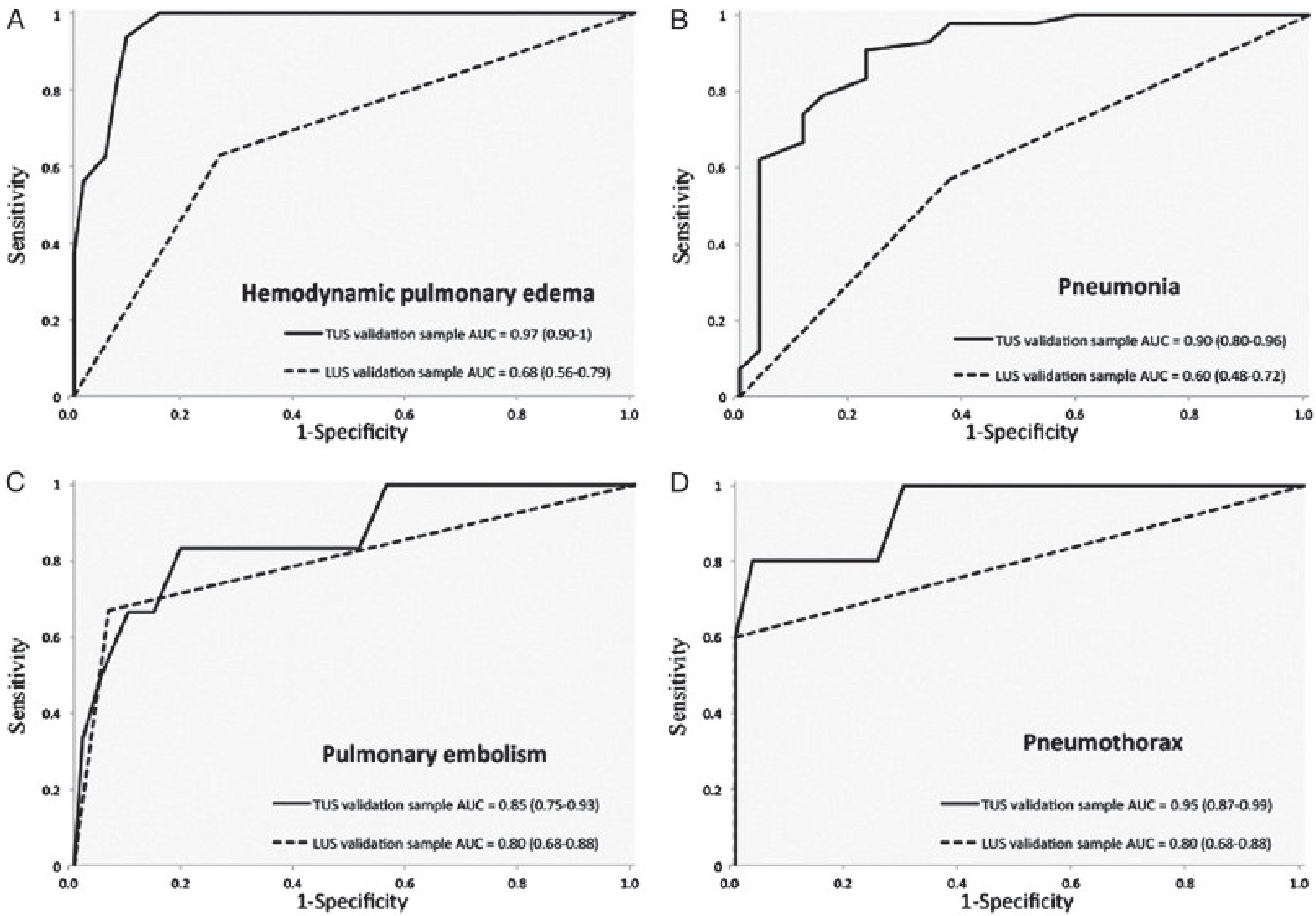
Bataille et al., Chest 2014

Demographic	Value
No. patients	136
Age, y	68 ± 15
Sex	
Female	57 (42)
Male	79 (58)
Weight, kg	76 ± 18
Height, cm	167 ± 9
Pa_{O_2}/F_{IO_2}	156 ± 82
Tracheal intubation	19 (14)
Use of catecholamine	13 (10)
SAPS II	34 ± 10
Diagnosis	
Cardiogenic edema	34 (25)
Pneumonia	77 (57)
Pulmonary embolism	13 (10)
Pneumothorax	12 (9)

Bataille et al., Chest 2014



Bataille et al., Chest 2014



Bataille et al., Chest 2014

Critical Care Ultrasonography Differentiates ARDS, Pulmonary Edema, and Other Causes in the Early Course of Acute Hypoxemic Respiratory Failure

Hiroshi Sekiguchi, MD; Louis A. Schenck, MS; Ryohei Horie, MD; Jun Suzuki, MD; Edwin H. Lee, MD; Brendan P. McMenomy, MD; Tien-En Chen, MD; Alexander Lekah, MD; Sunil V. Mankad, MD, FCCP; and Ognjen Gajic, MD, FCCP

- CHEST 2015; 148 (4): 912 - 918

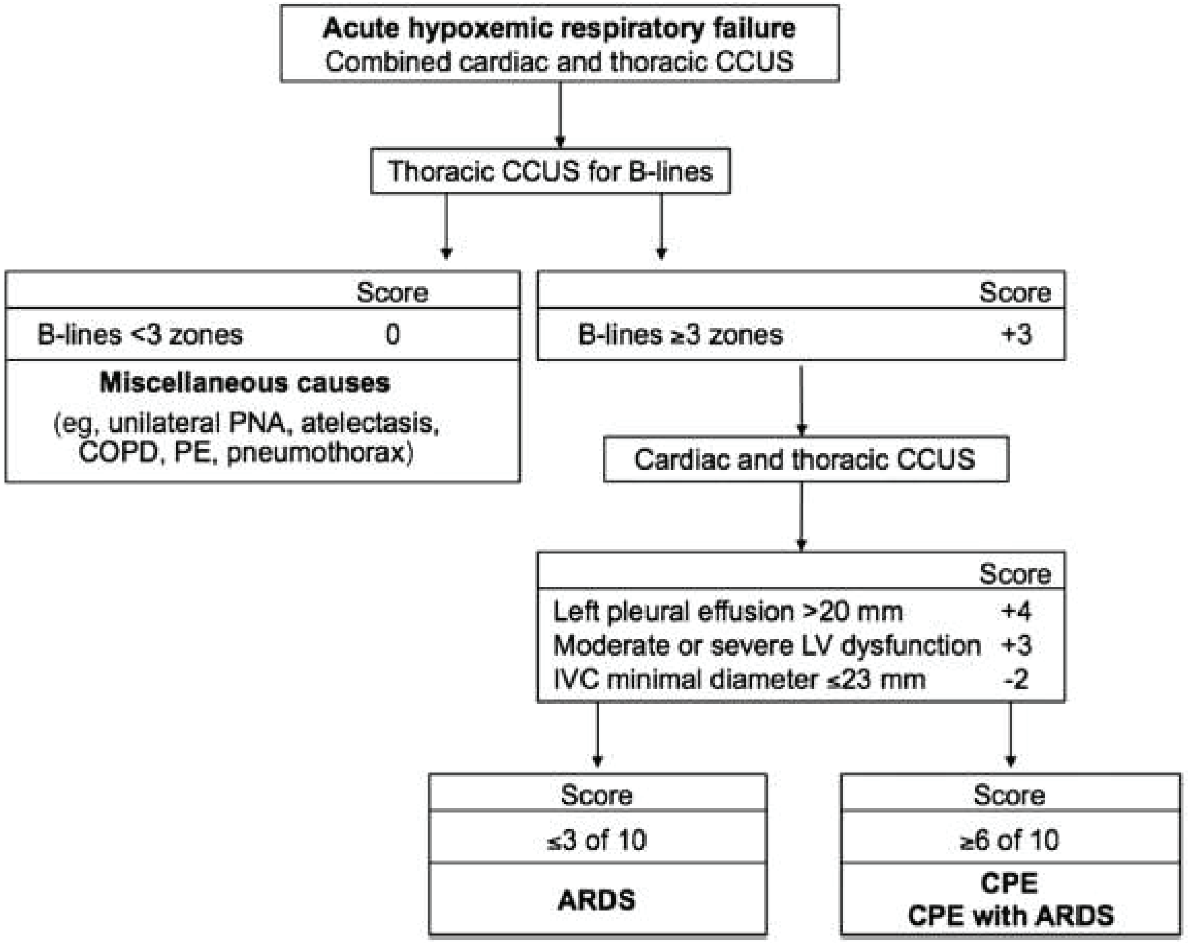


Figure 4 – *Cardiac and thoracic CCUS algorithm with a simplified scoring system. IVC = inferior vena cava; LV = left ventricular; PE = pulmonary embolism; PNA = pneumonia. See Figure 1 and 3 legends for expansion of other abbreviations.*

évaluation quantitative d'un épanchement pleural

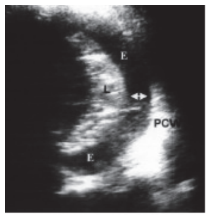
- **Vignon P**, Chastagner C, Berkane V, et al. Quantitative assessment of pleural effusion in critically ill patients by means of ultrasonography.
  Crit Care Med 2005; **33: 1757**-1763.

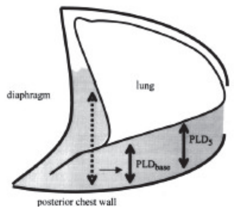
Vol>800ml si d>45mm, Se=94%, Sp=100%

- **Balik M**, Plasil P, Waldauf P, et al. Ultrasound estimation of volume of pleural fluid in mechanically ventilated patients.
  Intensive Care Med 2006; **32: 318-321**.

V (ml) = 20 x Sep (mm),

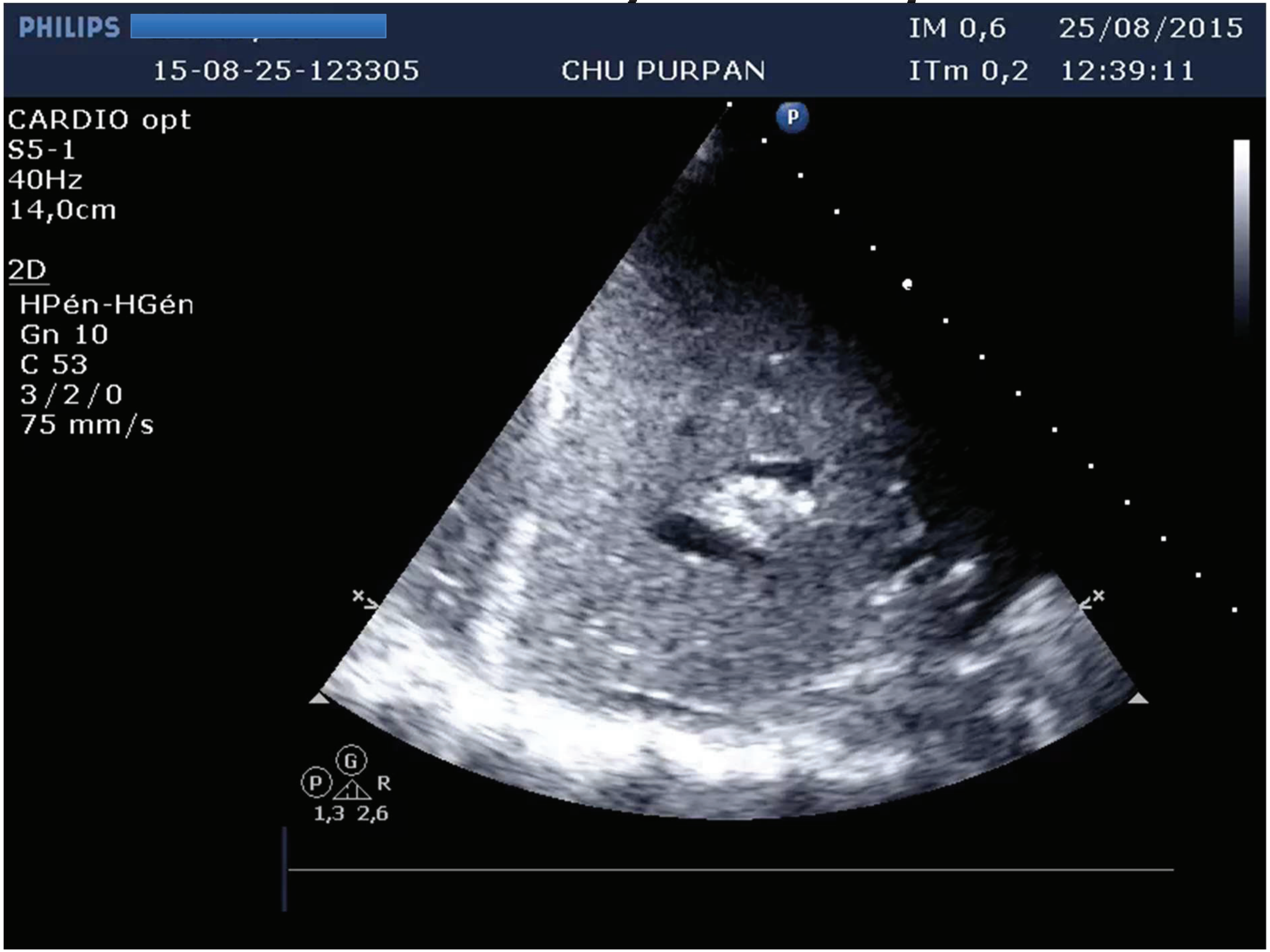
- **Roch A**, Bojan M, Michelet P, et al. Usefulness of Ultrasonography in predicting pleural effusions > 500 mL in patients receiving Mechanical Ventilation.
  Chest 2005;**127: 224-232**.





Atélectasie ou pneumopathie ?

Atélectasie ou pneumopathie ?



Atélectasie ou pneumopathie ?

Échographie thoracique combinée

Sevrage ventilatoire

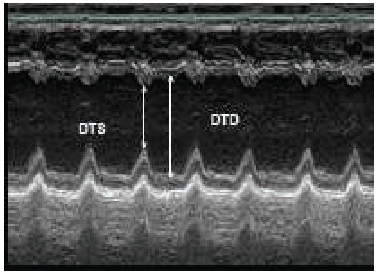
Stein SILVA

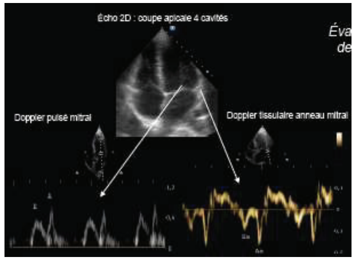
Hôpitaux de Toulouse

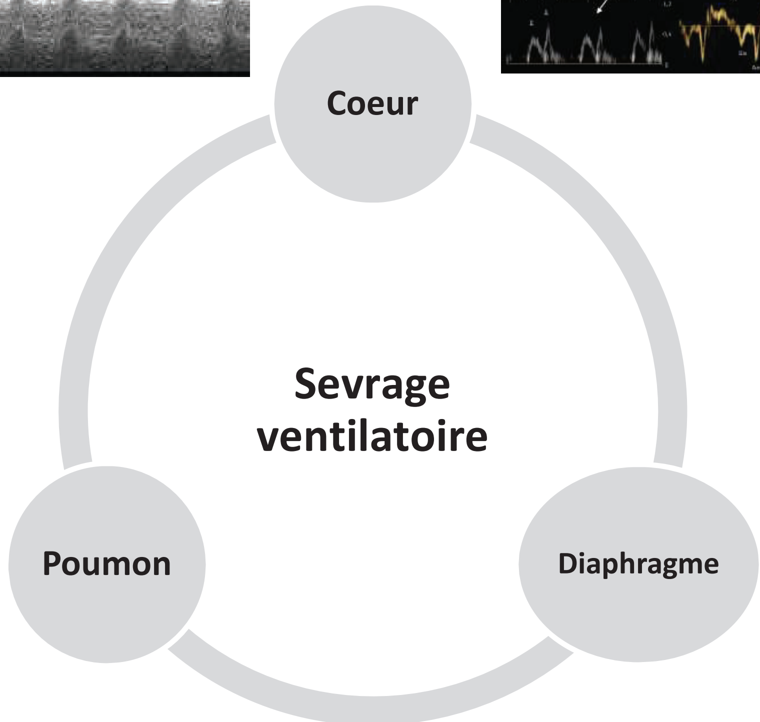
Université Paul Sabatier TOULOUSE III

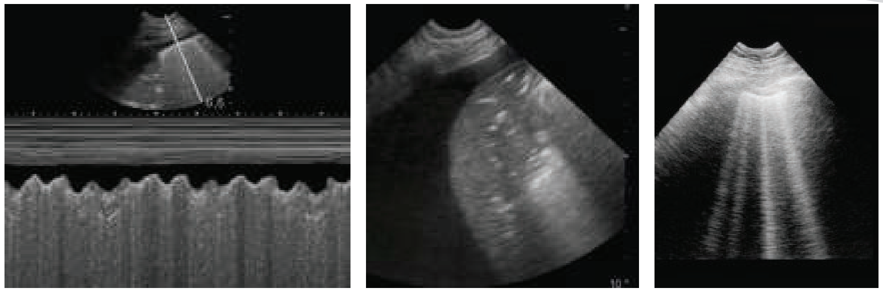
Inserm

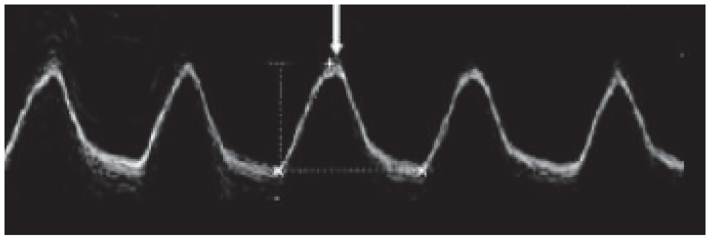
Institut national de la santé et de la recherche médicale


DTS
DTD


Écho 2D : coupe apicale 4 cavités
Doppler pulsé mitral
Doppler tissulaire anneau mitral

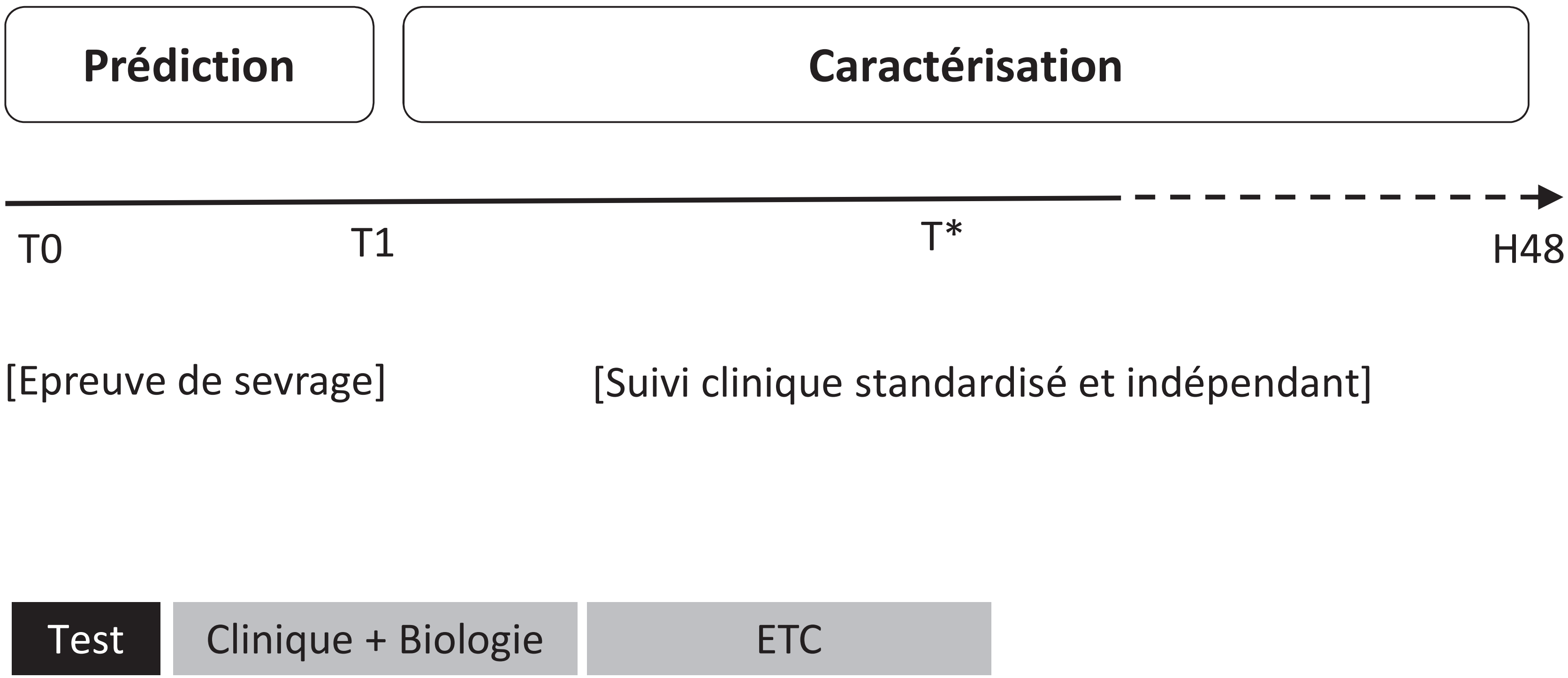

Coeur
Sevrage ventilatoire
Poumon
Diaphragme





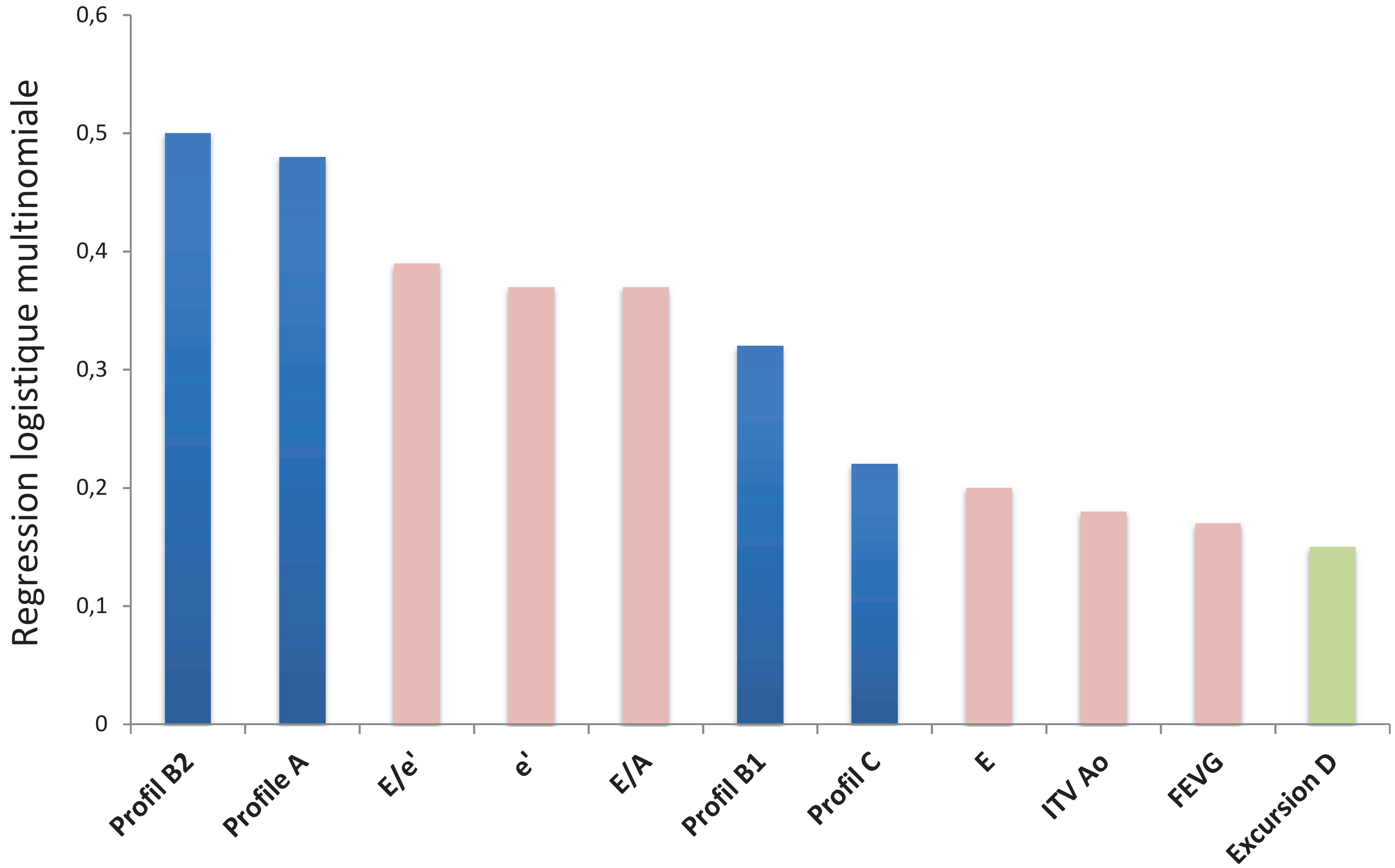
Hypothèse:

L’échographie thoracique combinée (ETC) permet de *prédire* l’échec au sevrage ventilatoire et améliore le diagnostic *étiologique* de ces échecs.


Prédiction
Caractérisation
T0
T1
T*
H48
[Epreuve de sevrage]
[Suivi clinique standardisé et indépendant]
Test
Clinique + Biologie
ETC

Données démographiques	Patients (N=70)
Patient	
Age (années)	60 ± 15
Sex Ratio (H/F)	31 (44%)/ 39(55%)
Poids (kg)	79 ± 11
Taille (cm)	177 ± 9
PaO_2/FiO_2	156 +/-82
Intubation trachéale (>48H)	70 (100%)
Catecholamines	35(50%)
Simplified Acute Physiology Score (SAPS2)	34 ± 10
Motif d'admission	
Sepsis	24 (34%)
Hemorragie	12 (17%)
Detresse respiratoire aigue.	10 (14%)
Polytraumatisme	9 (13%)
Post-operatoire	15(22%)

Modèle d'apprentissage automatique: *échographie thoracique*



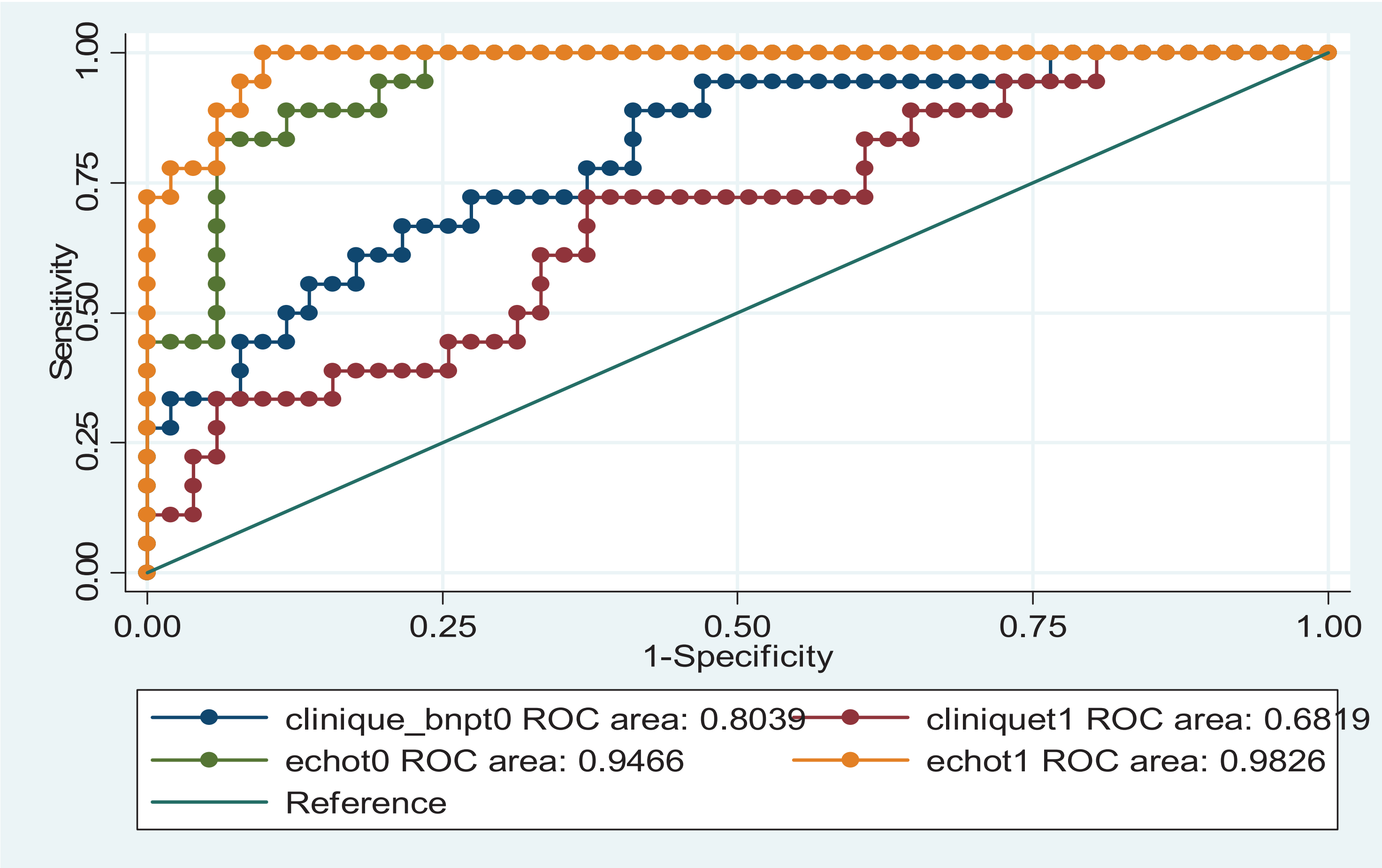

1.00
0.75
0.50
0.25
0.00
Sensitivity
0.00
0.25
0.50
0.75
1.00
1-Specificity
clinique_bnpt0 ROC area: 0.8039
cliniquet1 ROC area: 0.6819
echot0 ROC area: 0.9466
echot1 ROC area: 0.9826
Reference

Figure 5: Précision diagnostique des causes de l'échec du sevrage ventilatoire

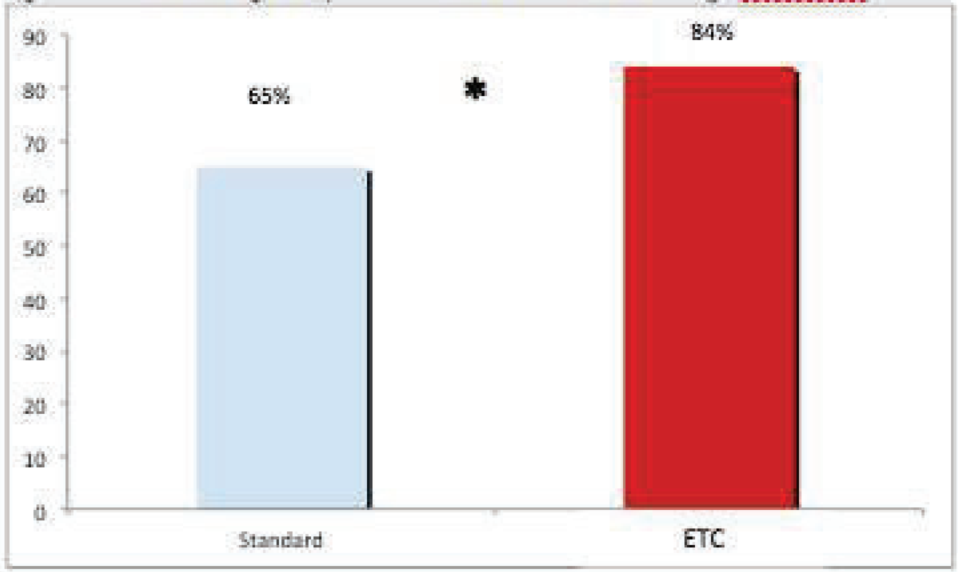
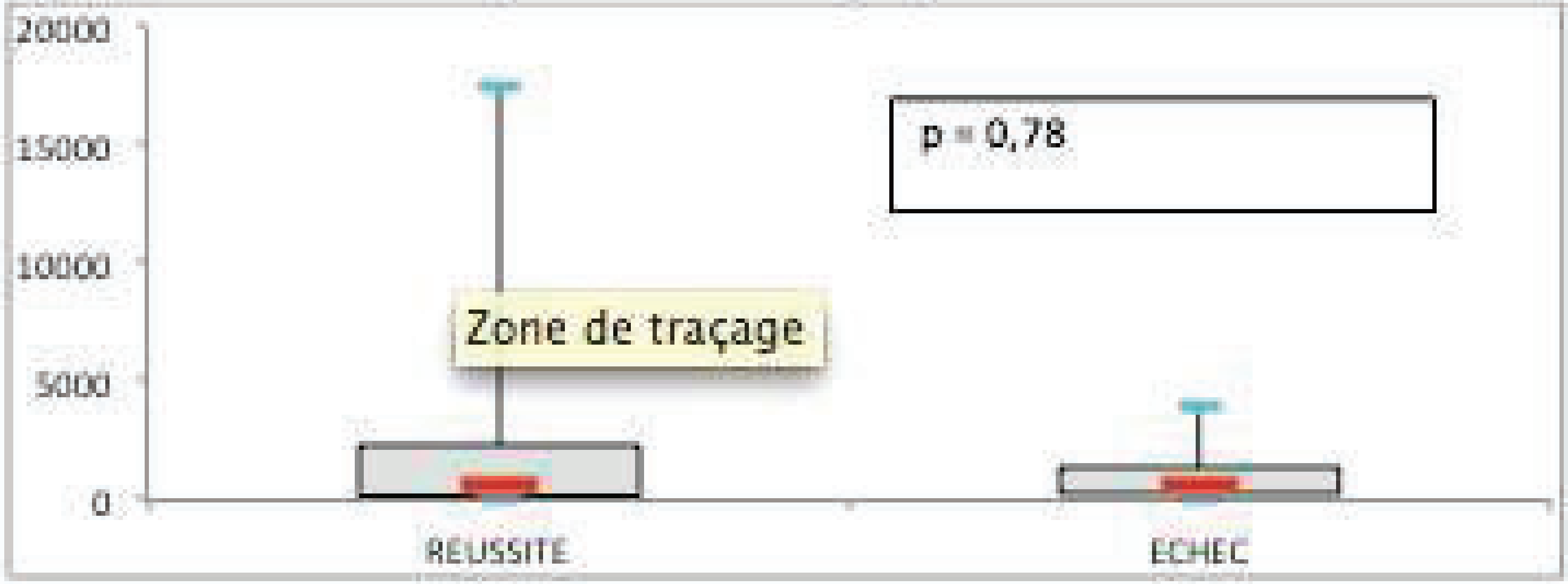


Figure 6 : Différence de NT pro-BNP entre les groupes « réussite » et « échec »



Moyenne : 695 pg/mL dans le groupe « réussite », 588 pg/mL dans le groupe « échec » (NS).

Ultrasound findings of lung ultrasonography in COVID-19: A systematic review

Jaime Gil-Rodríguez [a,*], Javier Pérez de Rojas [b], Pablo Aranda-Laserna [a], Alberto Benavente-Fernández [a], Michel Martos-Ruiz [a], José-Antonio Peregrina-Rivas [c], Emilio Guirao-Arrabal [c]

[a] *Internal Medicine Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain*

[b] *Preventive Medicine and Public Health Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain*

[c] *Infectious Diseases Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain*

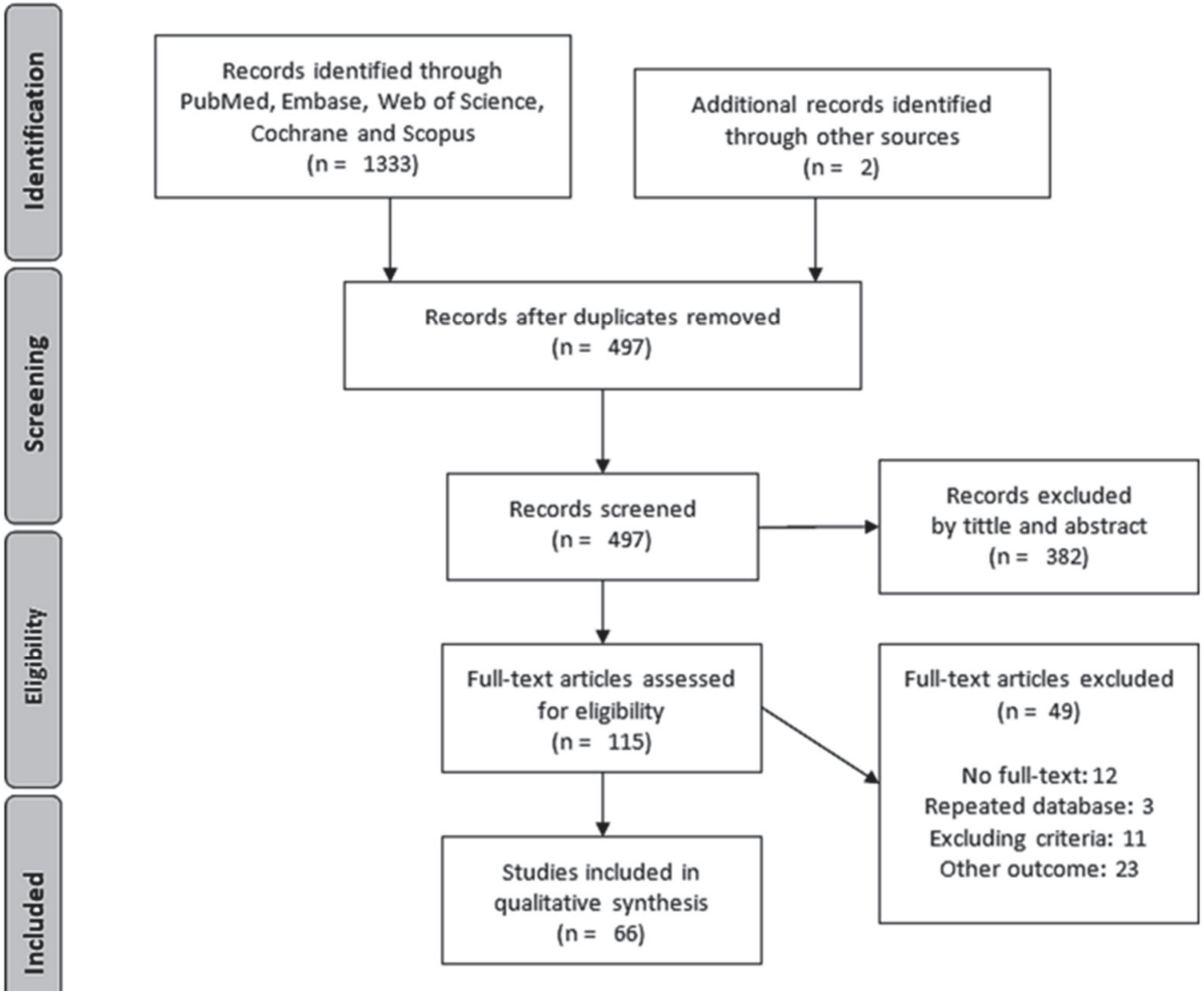

Identification
Screening
Eligibility
Included
Records identified through PubMed, Embase, Web of Science, Cochrane and Scopus (n = 1333)
Additional records identified through other sources (n = 2)
Records after duplicates removed (n = 497)
Records screened (n = 497)
Records excluded by tittle and abstract (n = 382)
Full-text articles assessed for eligibility (n = 115)
Full-text articles excluded (n = 49)
No full-text: 12
Repeated database: 3
Excluding criteria: 11
Other outcome: 23
Studies included in qualitative synthesis (n = 66)

Table 3
LUS findings and diagnostic performance.

	All studied patients* (n = 2543)	Emergency department (n = 580)	Wards (n = 342)	Intensive care unit (n = 179)
LUS score (mean)	11.27	15.10	13.98	22.52
	All studied patients* (n = 2894)	**Emergency Department** (n = 2169)	**Wards** (n = 49)	**Intensive care unit** (n = 109)
Sensitivity % (95% CI)	89.48 (87.80–91.00)	90.83 (89.05–92.41)	90.91 (58.72–99.77)	97.40 (90.93–99.68)
Specificity % (95% CI)	70.16 (67.71–72.53)	62.55 (59.44–65.59)	76.32 (59.76–88.56)	90.62 (74.98–98.02)
Positive Predictive Value % (95% CI)	75.66 (74.13–77.13)	74.64 (73.04–76.17)	52.63 (37.87–66.95)	96.15 (89.48–98.66)
Negative Predictive Value % (95% CI)	86.55 (84.67–88.23)	84.90 (82.37–87.13)	96.67 (81.61–99.48)	93.55 (78.61–98.28)

* Including pregnancy wards, nursing homes, rehabilitation units and patients followed at home.

Remerciements

Réanimation (CHU Toulouse)

S Silva

J Ruiz

A Mari

E Brunel

F Ferre

D Ait Aissa

J Etcheverry

E Hourcastagnou

D Rousset

Cardiologie (CHU Toulouse)

C Biendel

Méthodologie

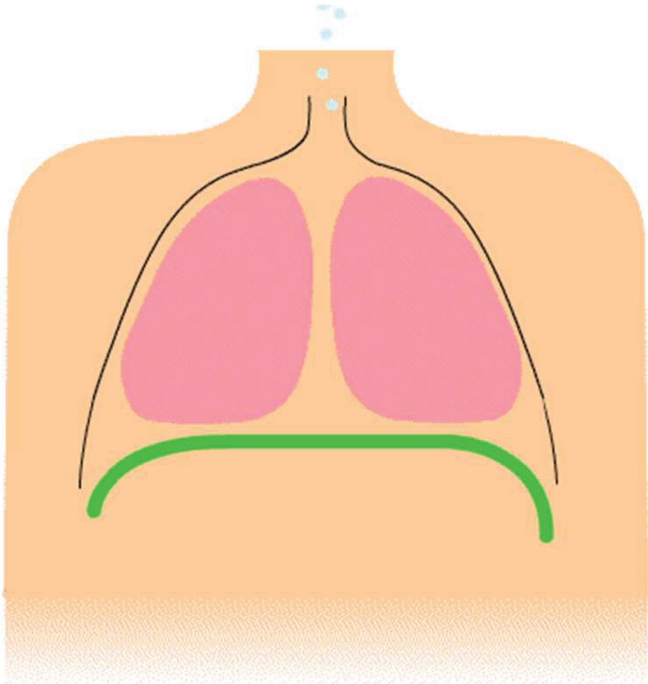
B Bataille (CHR Narbonne)

K Boulanour (Inserm)

I loubinoux (Inserm)

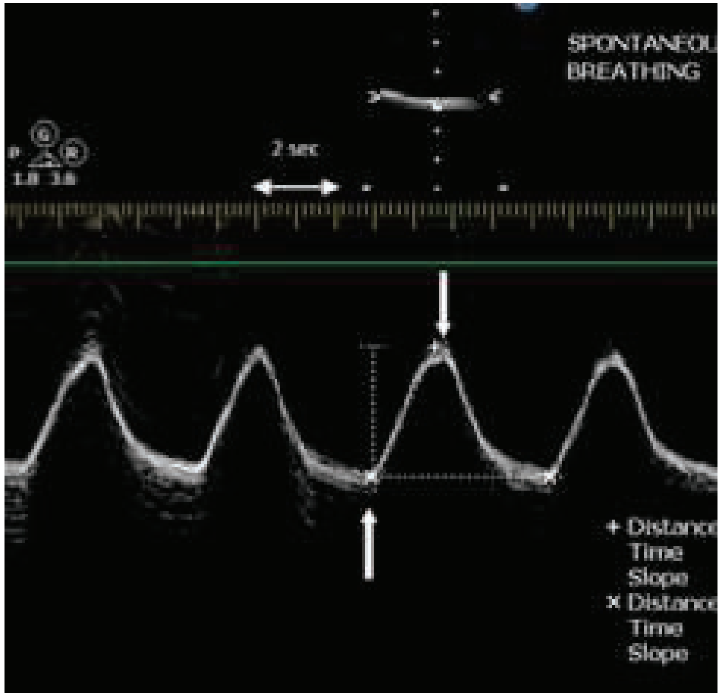
F Aubry (IMT)

Le diaphragme

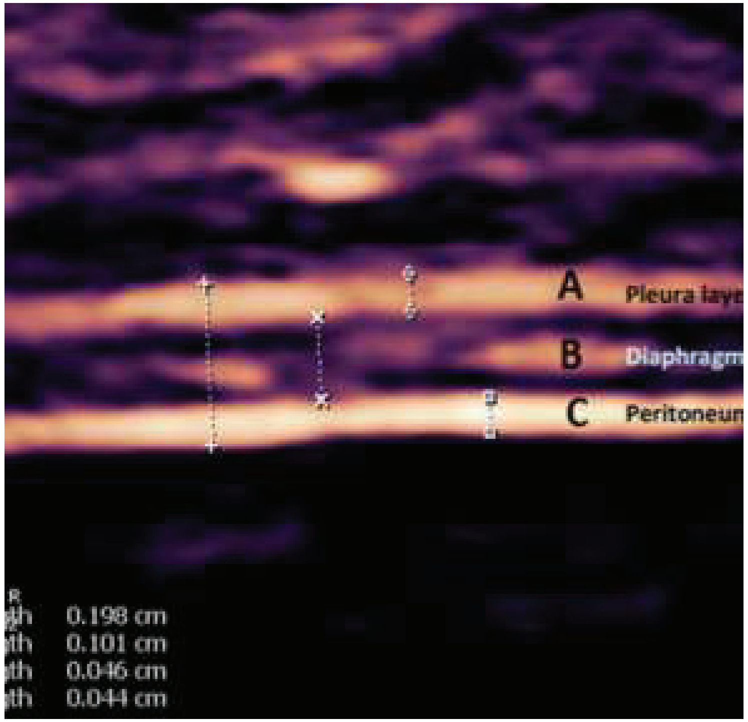


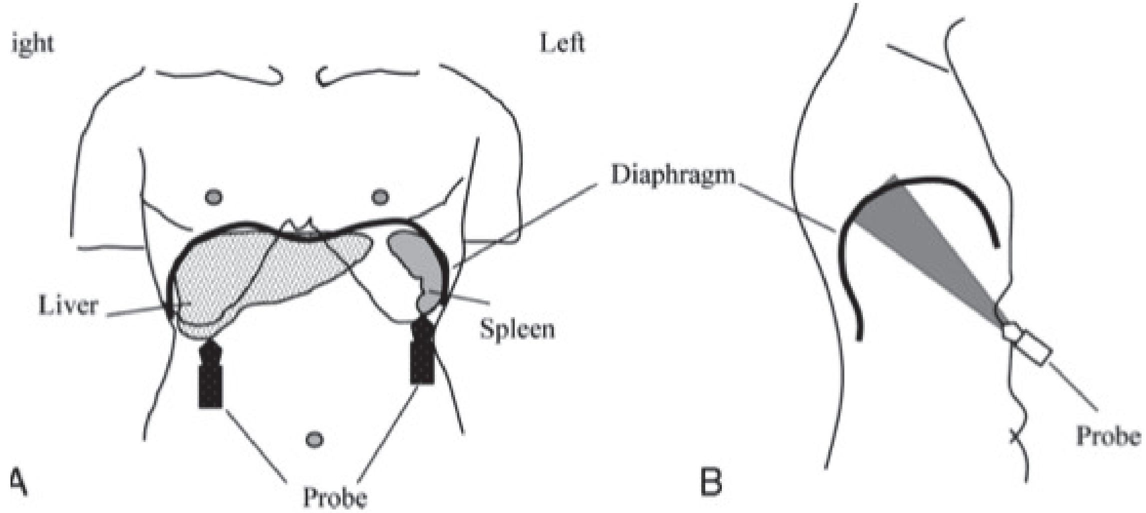
2 techniques US

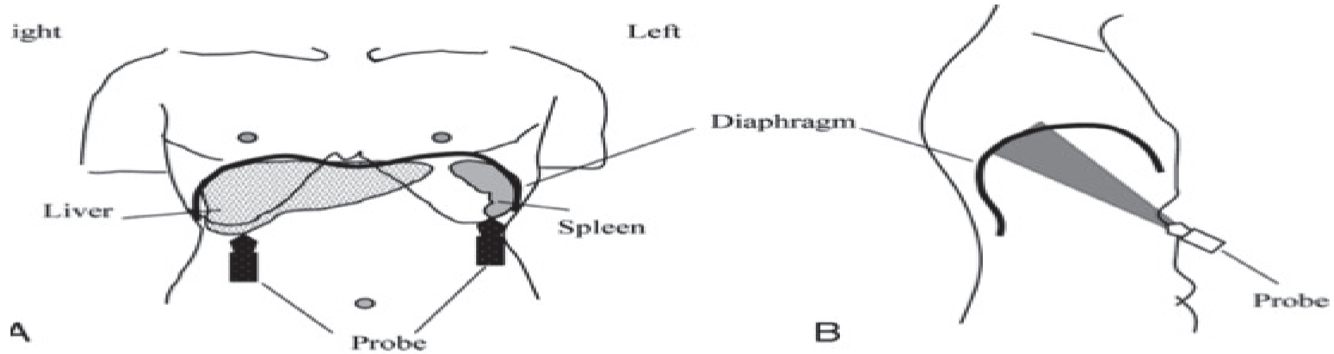
Excursion diaphragmatique



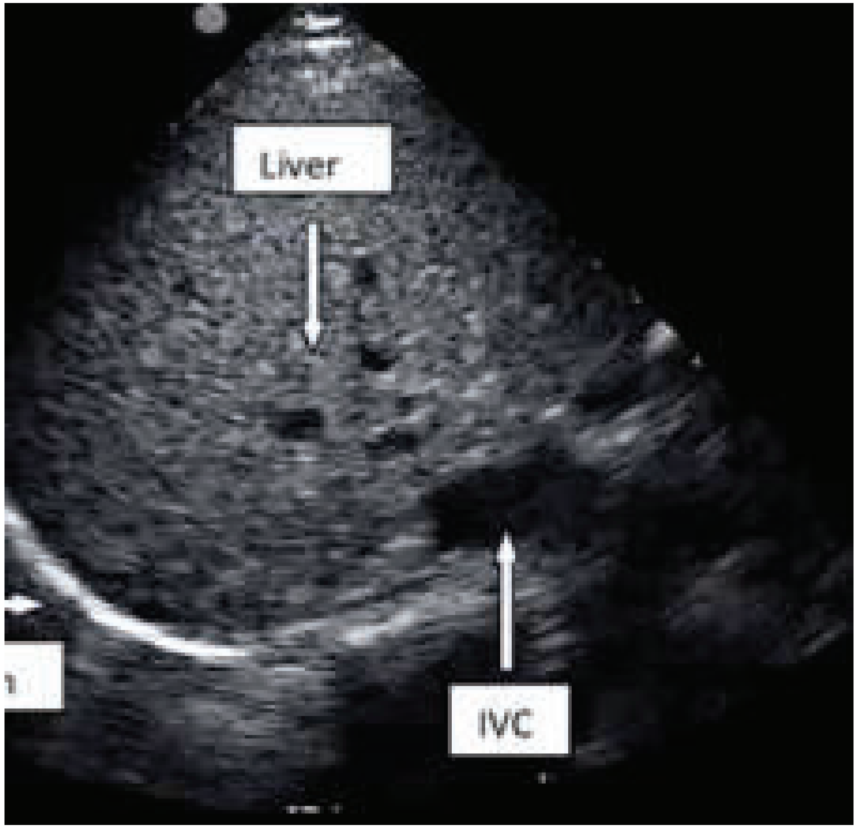
Fraction de raccourcissement



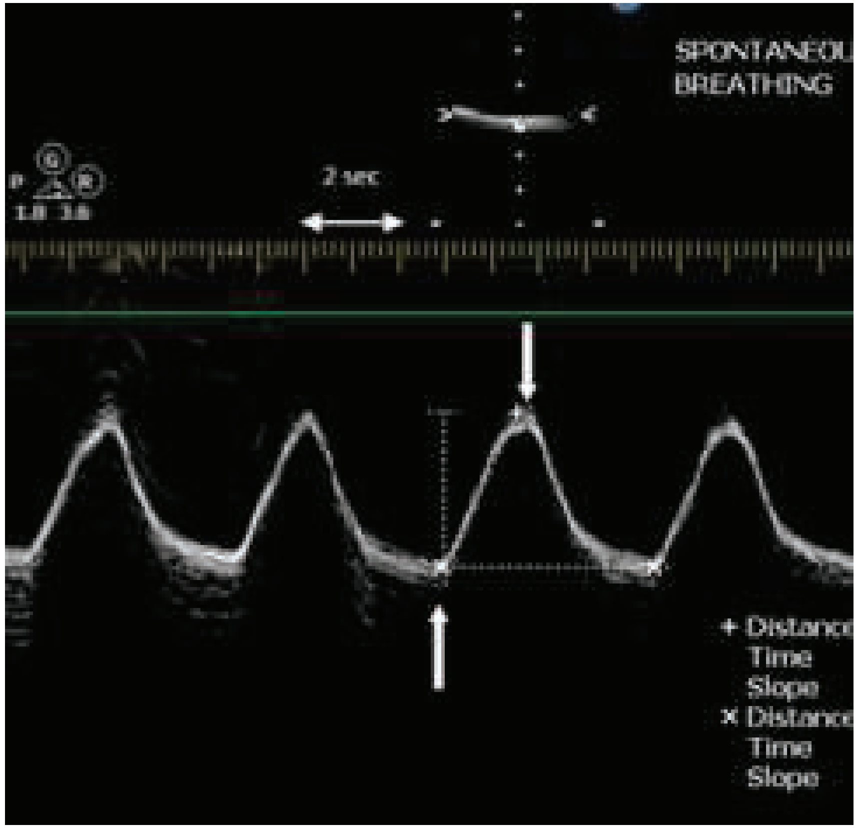

ight
Left
Diaphragm
Liver
Spleen
Probe
A
B
Probe

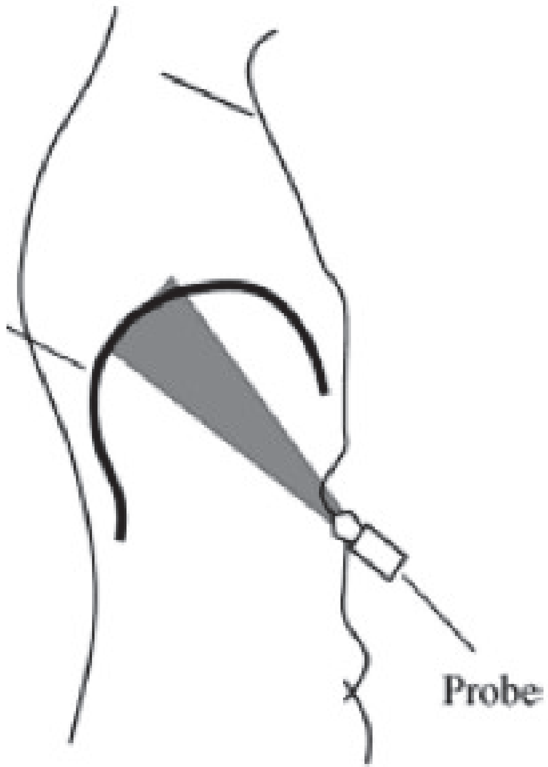

ight
Left
Diaphragm
Liver
Spleen
Probe
A
Probe
B

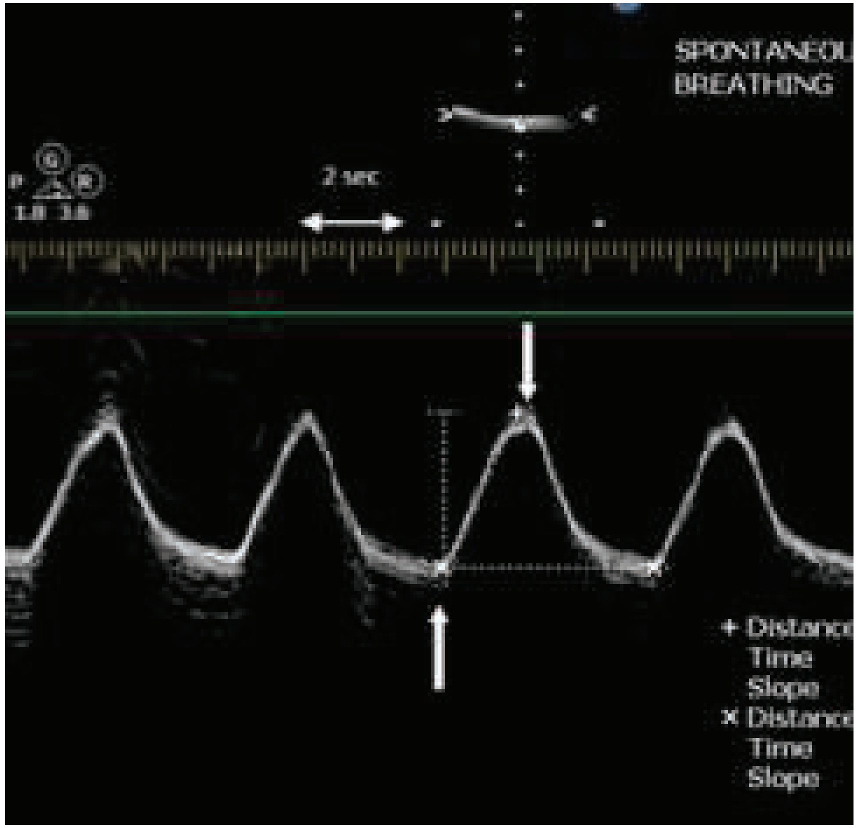
2 D


Liver
IVC

TM


SPONTANEOU
BREATHING
2 sec
+ Distance
Time
Slope
× Distance
Time
Slope





Mouvement inspiratoire est caudal

Mouvement expiratoire est céphalique

Valeurs normales chez le sujet sain

Table 2—*Right Diaphragmatic Excursions and Limit Values in Men and Women**

Variables	Men, cm	Women, cm	p Value
Quiet breathing	1.8 ± 0.3 (1.1–2.5)	1.6 ± 0.3 (1–2.2)	< 0.001
Voluntary sniffing	2.9 ± 0.6 (1.8–4.4)	2.6 ± 0.5 (1.6–3.6)	< 0.001
Deep breathing	7 ± 1.1 (4.7–9.2)	5.7 ± 1 (3.6–7.7)	< 0.001

*Data are presented as mean ± SD (5th to 95th percentile).

Faisabilité ++++
-droite: 195/210
-gauche 45/210

CHEST Original Research
ULTRASONOGRAPHY

Diaphragmatic Motion Studied by M-Mode Ultrasonography*

Methods, Reproducibility, and Normal Values

Alain Boussuges, MD, PhD; Yoann Gole, MSc; and Philippe Blanc, MD

Tableau 2 : Excursions diaphragmatiques en ventilation spontanée

	Ventilation calme	Ventilation ample
Excursion Diaphragmatique (cm)	1,99 (IQR 1,43-2,44)	5,48 (IQR 4,63-5,98)

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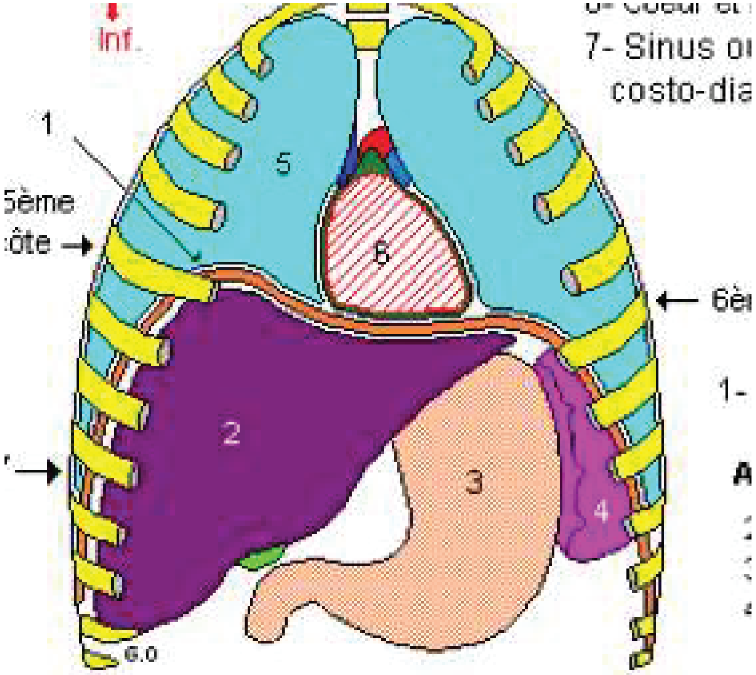
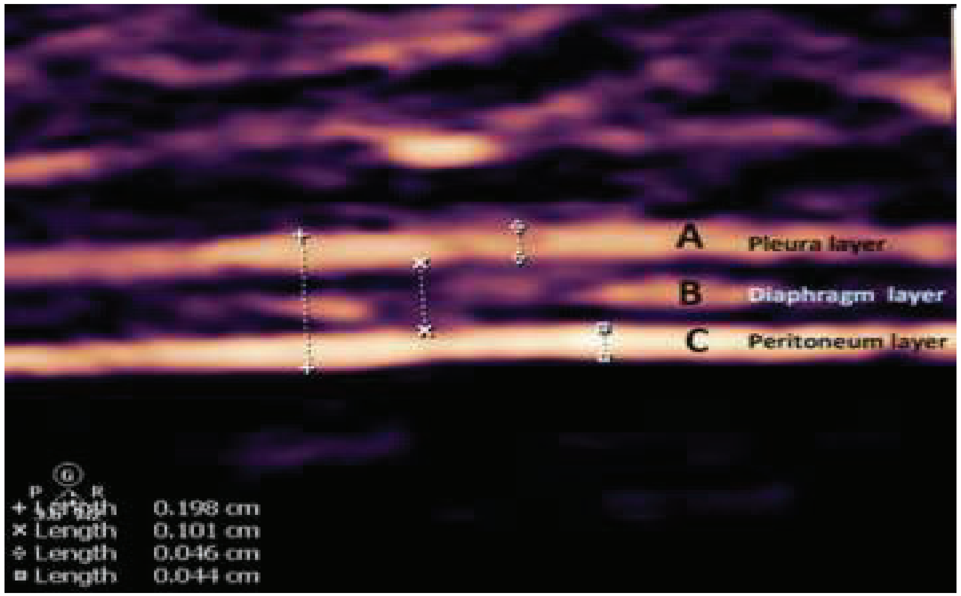
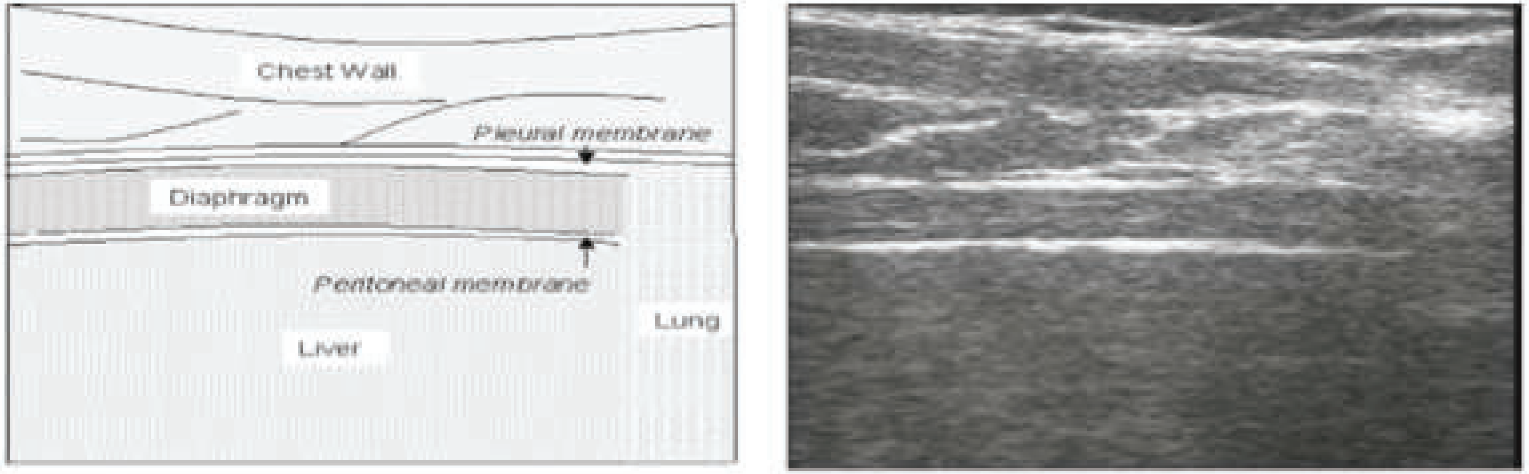
EPAISSEUR DIAPHRAGMATIQUE

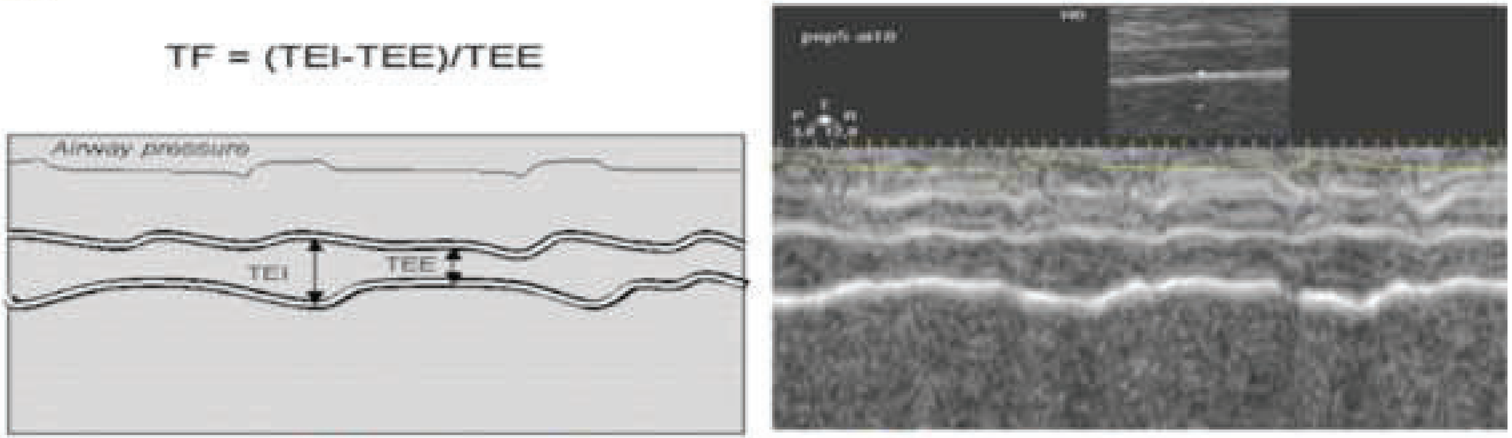

Inf.
7- Sinus ou
costo-dia
1
5ème
côte
6è
1-
5
6
2
3
4
G.0


a


A Pleura layer
B Diaphragm layer
C Peritoneum layer
+ Length 0.198 cm
× Length 0.101 cm
÷ Length 0.046 cm
¤ Length 0.044 cm



C



TEI, thickness at end inspiration; TEE, thickness at end expiration.

APPLICATIONS CLINIQUES

Diaphragm dysfunction assessed by ultrasonography: Influence on weaning from mechanical ventilation*

Won Young
Chae-Man

Variables	DD Group (n = 24)	Non-DD Group (n = 58)	*p*
Demographic factors			
Age, yrs	70.1 ± 11.1	64.5 ± 12.4	.06
Male	16 (67)	34 (59)	.50
Body mass index, kg/m^2	21.1 ± 4.6	22.9 ± 4.8	.11
Comorbidity:			
Diabetes	10 (42)	33 (57)	.23
Hypertension	11 (46)	35 (60)	.33
Chronic obstructive pulmonary disease	9 (38)	19 (33)	.80
Hypothyroidism	2 (8)	1 (2)	.20
Coronary artery bypass grafting	2 (8)	1 (2)	.20
Acute respiratory distress syndrome	4 (167)	12 (21)	.77
Laboratory findings			
$PaCO_2$	42.6 ± 8.3	37.3 ± 8.0	.01
PaO_2	93.9 ± 24.1	101.3 ± 24.0	.20
FiO_2	35.8 ± 6.5	35.9 ± 5.8	.93
Creatinine	1.1 ± 0.9	1.2 ± 1.0	.42
Sodium	139.0 ± 6.7	138.4 ± 5.4	.63
Potassium	3.7 ± 0.3	3.8 ± 0.6	.70
Calcium	8.1 ± 0.9	8.2 ± 0.9	.49
Magnesium	2.1 ± 0.2	2.1 ± 0.4	.51
Ultrasonographic findings			
DE, right, mm (IQR)	7.0 (1.8–13.5)	17.9 (14.5–22.7)	<.01
DE, right, mm (n = 11)[a]	3.0 (0.0–7.0)	18.8 (12.2–22.4)	
DE, left, mm (IQR)	7.9 (2.1–18.9)	18.0 (15.6–23.2)	<.01
DE, left, mm (n = 9)[a]	2.6 (0.0–6.2)	18.3 (12.4–23.1)	
Pleural effusion	14 (58.3)	27 (46.6)	.47
Rapid shallow breathing index	73.5 ± 23.5	55.6 ± 26.9	.01
Hospital length of stay, days (IQR)	66.0 (52.0–99.0)	42.0 (30.0–72.0)	<.01
Intensive care unit length of stay, days (IQR)	31.0 (18.5–58.5)	14.0 (10.0–33.0)	<.01

Table 2. Weaning variables of the study patients with and without DD

Variables	DD Group	Non-DD Group	*p*
Total ventilation time, hrs (IQR)	576 (374–850)	203 (109–408)	<.01
Weaning time, hrs (IQR)	401 (226–612)	90 (24–309)	<.01
Time to the spontaneous breathing trial, day (IQR)	4 (2.5–7.5)	4 (3.0–6.0)	.55
Primary weaning failure, no. (%)	20/24 (83)	34/58 (59)	<.01
Secondary weaning failure, no. (%)	10/20 (50)	10/46 (22)	.01
Died before weaning, no. (%)	4/24 (17)	12/58 (21)	.79

$$(T_{EI} - T_{EE})/T_{EE}$$

Intensive Care Med (2012) 38:796–803
DOI 10.1007/s00134-012-2547-7

ORIGINAL

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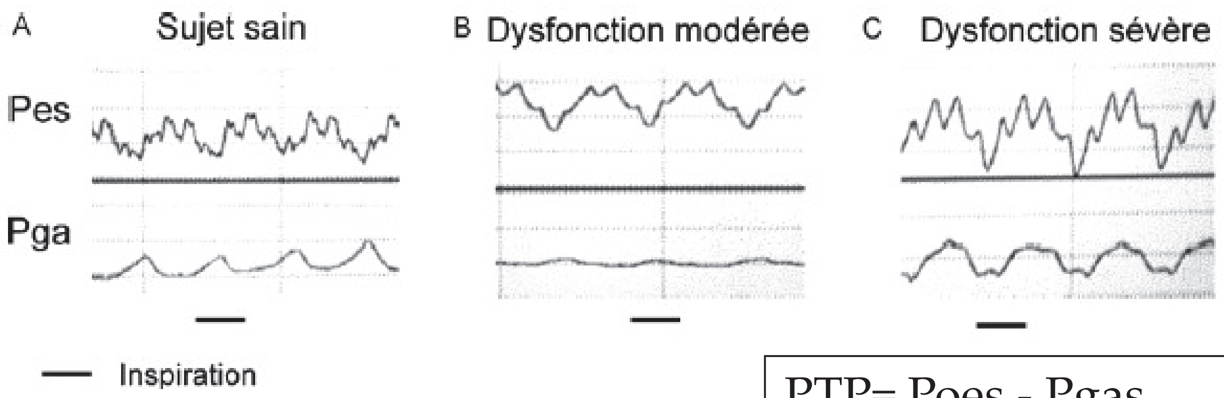
Diaphragm ultrasonography to estimate the work of breathing during non-invasive ventilation

Table 2 Respiratory and ultrasonographic data

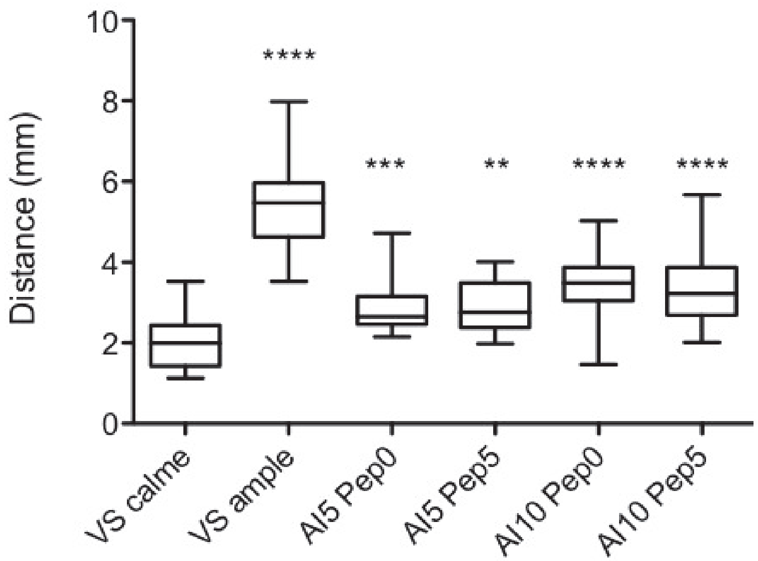
	SB	PS 5	PS 10	PS 15
V_T, mL	–	324 (231–379)	402 (374–461)#	445 (388–547)#
RR, bpm	21 (18–28)	20 (18–28)	22 (19–30)	21 (17–29)
T_{EE}, mm	2.19 (1.94–2.76)	2.26 (1.78–2.46)	2.29 (1.84–2.52)	2.27 (2.06–2.88)
T_{EI}, mm	3.08 (2.77–4.77)	3.08 (2.34–3.51)	2.73 (2.39–3.25)	2.58 (2.34–3.56)
TF, %	47.5 (35.9–63.2)	36.2 (18.6–47.2)*	22.0 (9.6–28.2)*,#	16.3 (9.2–20.8)*,#
PTP_{di}, cmH_2O s	13.5 (8.1–16.9)	6.2 (4.7–8.0)*	4.0 (3.3–5.4)*,#	2.7 (2.1–4.3)*,#¶



PTP= Poes - Pgas

Tableau 3 : Excursions diaphragmatiques en Ventilation non invasive :

Niveau de pression positive	AI 5 PEEP 0	AI 5 PEEP 5	AI 10 PEEP 0	AI 10 PEEP 5
Excursion diaphragmatique droite (cm)	2,65 (IQR 2,47- 3,15)	2,77 (IQR 2,39- 3,15)	3,49 (IQR 3,05- 3,89)	3,23 (IQR 2,69- 3,87)



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Paralysie diaphragmatique

- Mouvement paradoxale (dyskinésie diaphragmatique)