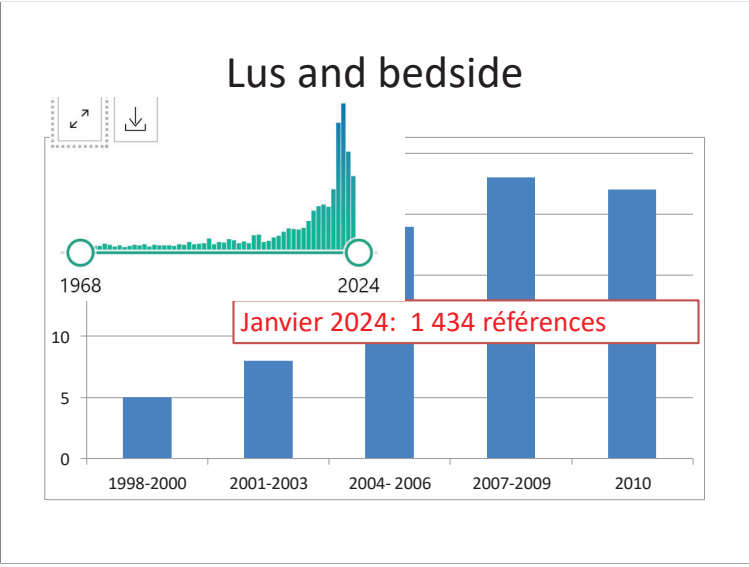



Echo pleuro-pulmonaire en réanimation

**DU TUSAR 2026**  
**Dr Riu Poulenc ( Chu Toulouse)**




### D lichtenstein and lung ultrason >30 références

Réani



Disponible en ligne sur  
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[www.em-consulte.com](http://www.em-consulte.com)




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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 Charot*

Disponible sur Internet le 26 septembre 2008

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

**CONFERENCE REPORTS AND EXPERT PANEL**

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




- Giovanni Volpicelli
- Mahmoud Elbarbary
- Michael Blaivas
- Daniel A. Lichtenstein
- Gebhard Mathis
- Andrew W. Kirkpatrick
- Lawrence Melniker
- Luna Gargani
- Vicki E. Noble
- Gabriele Via
- Anthony Dean
- James W. Tsung
- Gino Soldati
- Roberto Copetti
- Belaid Bouhemad
- Angelika Reissig
- Eustachio Agricola
- Jean-Jacques Rouby
- Charlotte Arbelot
- Andrew Liteplo
- Ashot Sargsyan
- Fernando Silva
- Richard Hoppmann
- Raoul Breitkreutz
- Armin Seibel

### 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

DOI 10.1007/s00134-011-2317-y

**ORIGINAL**

Nektaria Xirouchaki  
 Eleftherios Magkanas  
 Katerina Vaporiði

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

	consolidation	Sd interstitiel	pneumothorax	Épanchement pleural
	Se : 38 % Sp : 89 % Δc : 49 %	Se : 46 % Sp : 80 % Δc : 58 %	Se : 0 % Sp : 99 % Δc : 89 %	Se : 65 % Sp : 81 % Δc : 69 %
	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

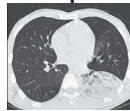
- Compact
- Facilement décontaminable, tactile
- Ni filtre, ni doppler, ni harmonique
- Sonde
- Allumage rapide

## L'appareil et la sonde

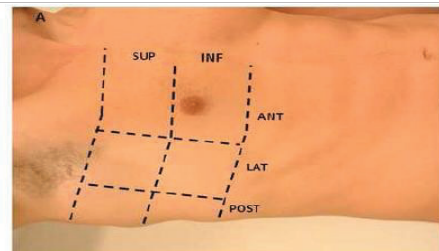
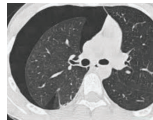
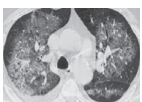


## Lieu mélange air eau

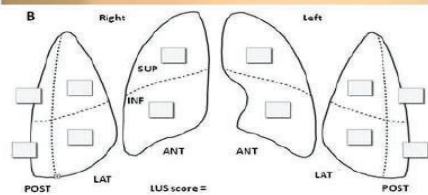
- Désordre riche en eau (pleurésie, pneumonie) dans les zones post



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

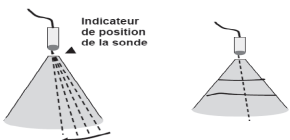
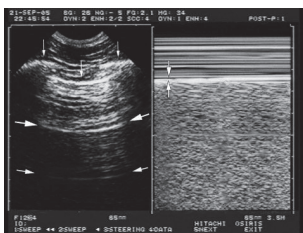


**LUS**  
 0=normal  
 1=syndrome interstitiel  
 2=Syndrome alvéolo interstitiel  
 3=condensation

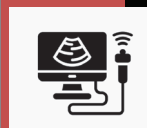
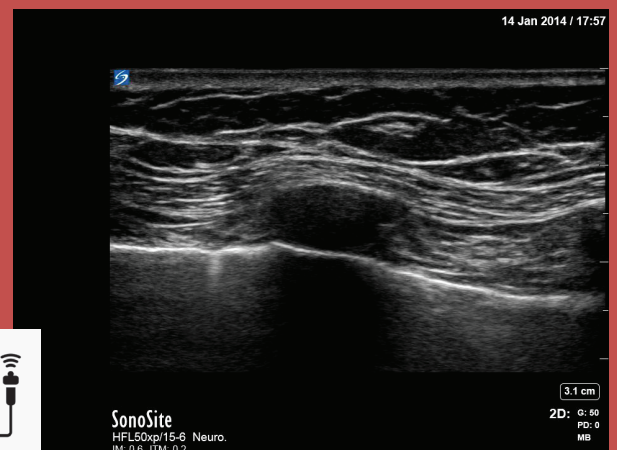


Bouhemad B, rouby JJ, Arbelot C, AJRCCM 2011

## La ligne pleurale



## Glissement pleural

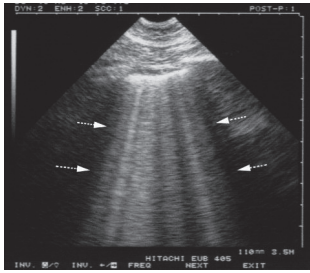


SonoSite  
 HFL50xp/15-6 Neuro.  
 IM: 0.6 ITM: 0.2

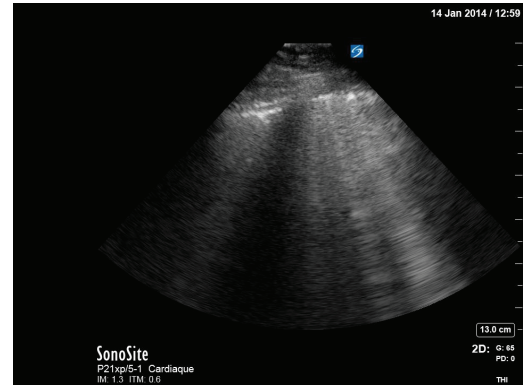
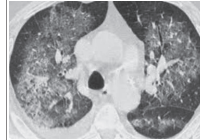
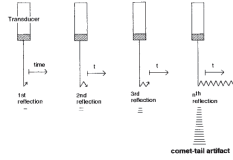
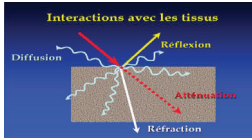
14 Jan 2014 / 17:57  
 3.1 cm  
 2D: 6: 50  
 PD: 0  
 MB

# Syndrome interstitiel

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

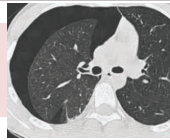


- Artéfact en queue de comète (ligne B)
- Naissent de la ligne pleurale
- En rayon laser
- Hyperéchogènes
- Descendant sans épaissements
- Effacent les lignes A
- mobiles

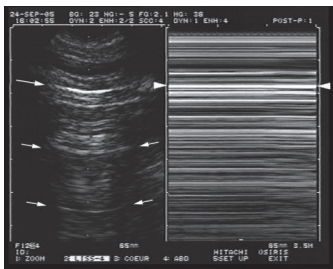


# Pneumothorax

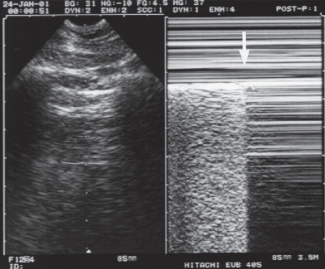
Se: 94%, Sp: 95%



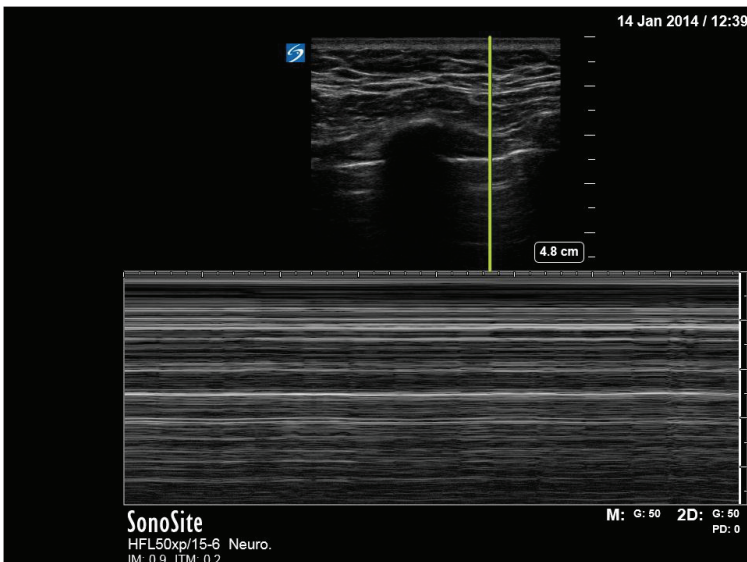
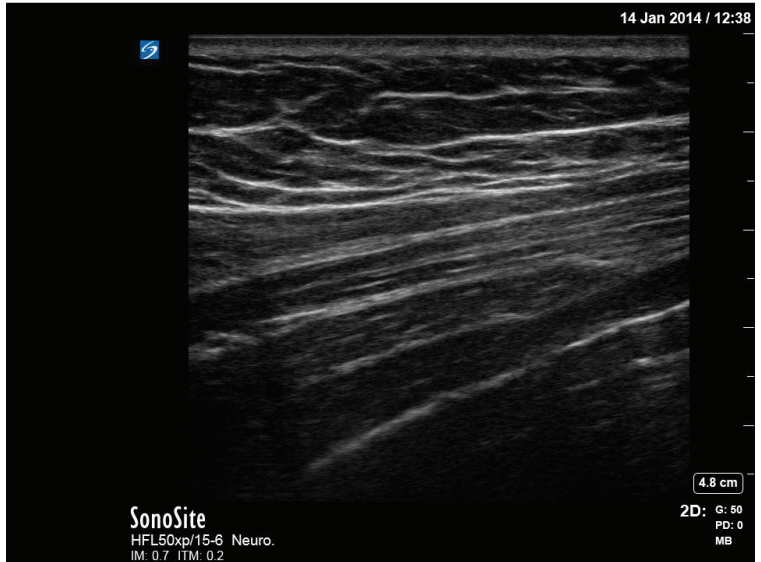
Abolition du glissement pleural  
VPP 100%



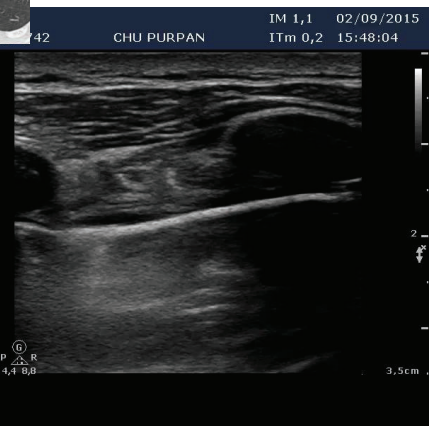
Point poumon  
Spécifique à 100%

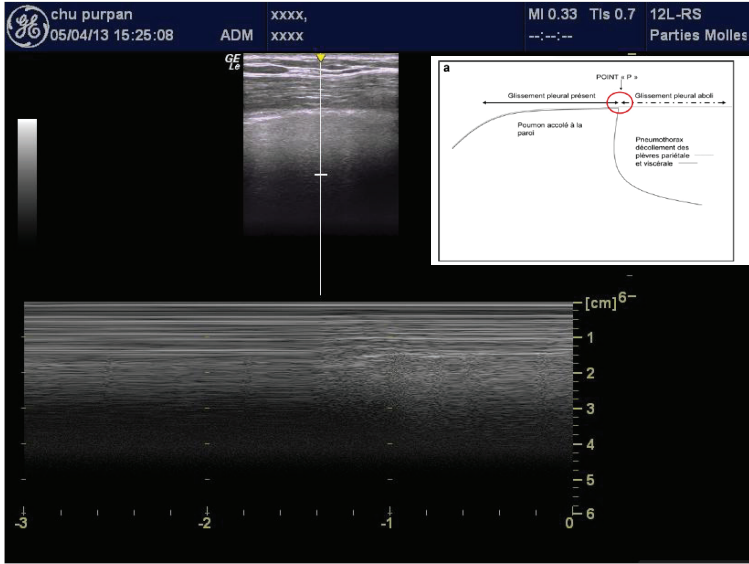


Lichtenstein D, Mezière G, Lascols N, Biderman P, Courret JP, Gepner A, et al.  
Ultrasound diagnosis of occult pneumothorax.  
Critical Care Med 2005;33:1231-8.

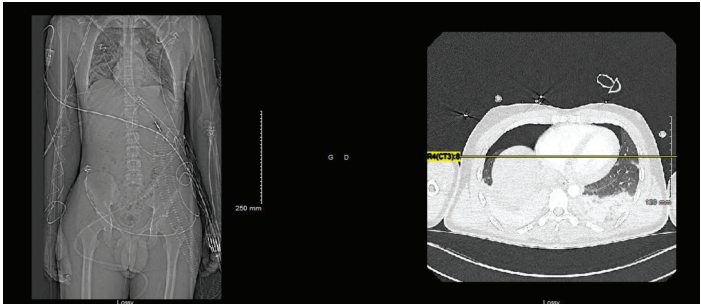


VEINE optin  
L12-3  
42Hz  
3,5cm  
2D  
HGén  
Gn 34  
C 41  
3/3/2

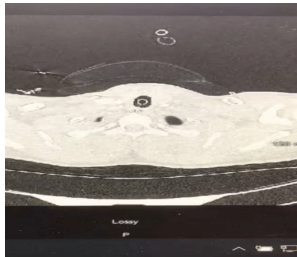




Mr D, 19 ans chute de 7 m, traumatisme crânien sévère, traumatisme thoracique et fracture ouverte du calcanéum



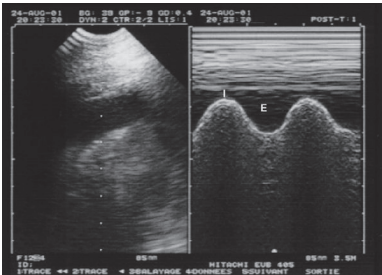
Faut il le drainer?



### Épanchement pleural

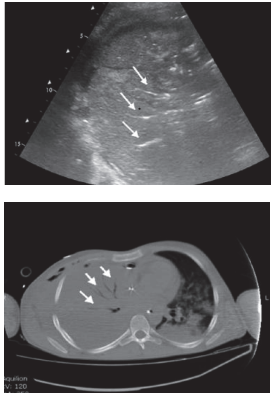
Se:94%, Sp:97%

Lichtenstein D, Mezière  
Intensive Care Med 1999;25:955-8



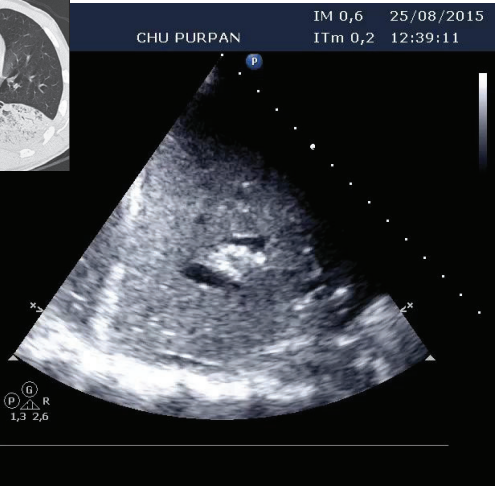
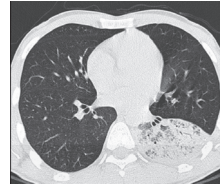
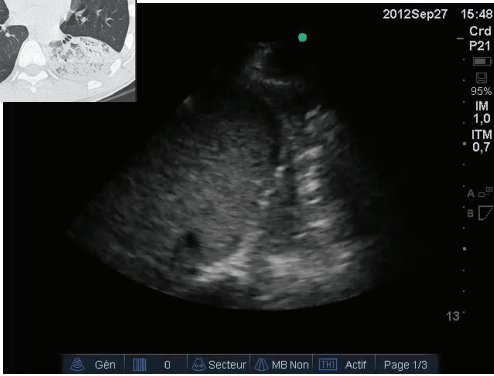
### Consolidation alvéolaire

Se:90%, Sp:98%

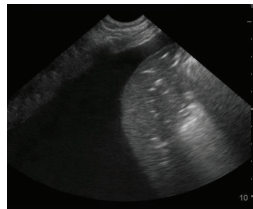
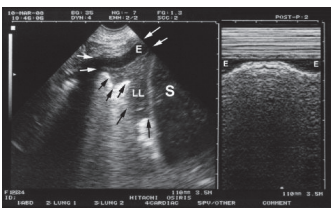


- signe du poumon tissulaire: tissu solide avec échogénéicité tissulaire (hépatisation)
- + spécifique que la RT
- Lignes hyperéchogène bronchogramme aérique

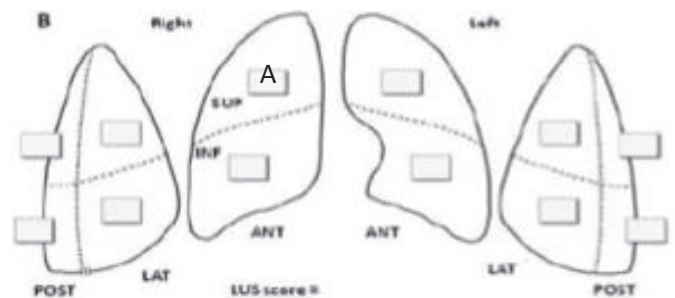
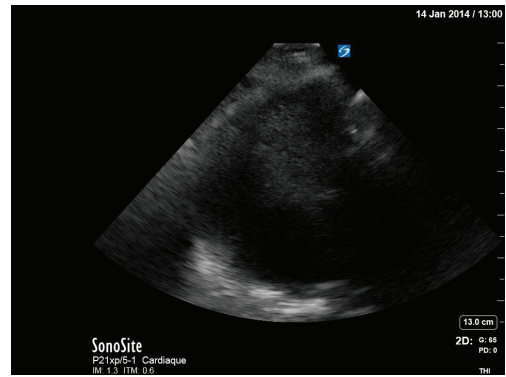
Lichtenstein D, .  
Ultrasound diagnosis of alveolar consolidation in the critically ill.  
Intensive Care Med 2004;30:276-81.

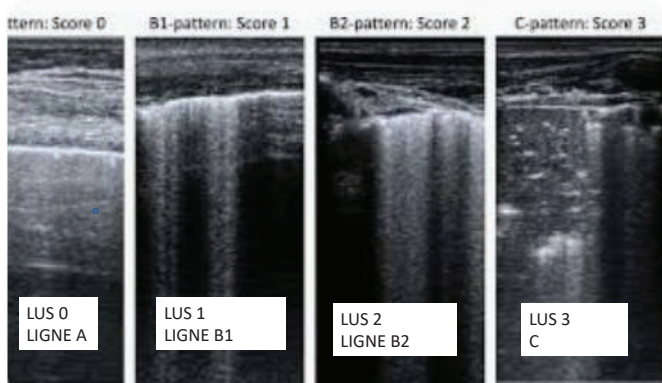


## PLAPS postero lateral alveolar and pleural syndrome

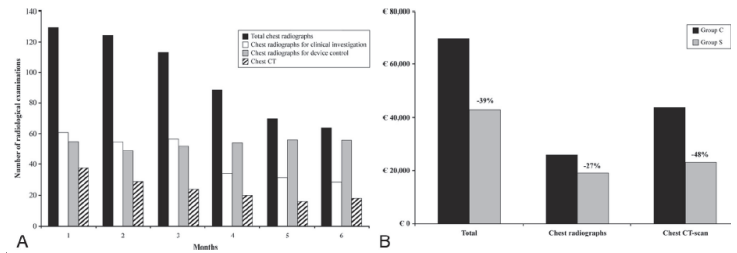


Zone 3, condensation pulmonaire et épanchement pleural  
Flèches noires = bronchogramme aérique





## Étude médico économique



6 mois, 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
- Diagnostique 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

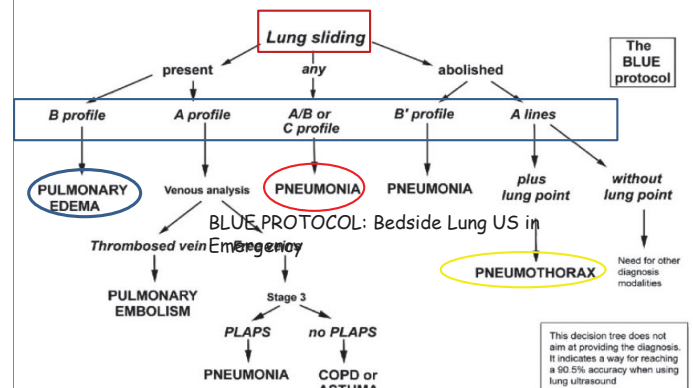


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

L'org **Conclusion : Diagnostique immédiat d'une DRA dans 90,5% des cas**

CHEST / 134 / 1 / JULY, 2008



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 Ceeraerts, 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



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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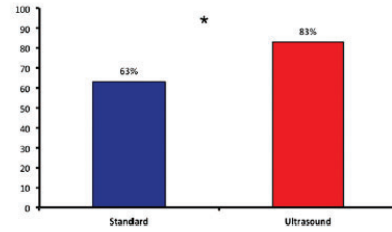


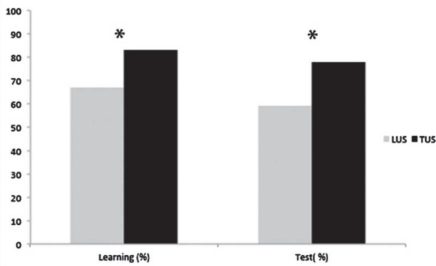
FIGURE 1. Comparative diagnostic accuracy. Each diagnostic approach (standard and ultrasound) was compared against the final diagnosis determined by a panel of experts (P < .05).

[ Original Research Critical Care ]



### 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 Mousso, 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



014. doi:10.1378/chest.14-0681

### évaluation quantitative d'un épanchement pleural

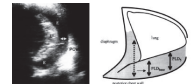
- Vignon P, Chastagner C, Berkane V, et al. Quantitative assessment of pleural effusion in critically ill patients by means of ultrasonography. Crit Care Med 2005; 33: 1757-1763.

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.



Faut il réaliser un écho guidage pour la pose d'un drain

### Reducing Iatrogenic Pneumothoraces: Using Real-Time Ultrasound Guidance for Pleural Procedures

Helgeson, Scott A. MD<sup>1</sup>; Fritz, Ashley V. DO<sup>2</sup>; Tatari, Mehmet M. MD<sup>1</sup>; Daniels, Craig E. MD<sup>3</sup>; Diaz-Gomez, Jose L. MD<sup>1,2</sup>

Author information @

Critical Care Medicine: July 2019 - Volume 47 - Issue 7 - p 903-909

TABLE 3. Primary and Secondary Endpoints by Ultrasound Marked or Guided Procedures

Endpoints	Ultrasound Marked, n = 203, n (%)	Ultrasound Guided, n = 189, n (%)	OR (95% CI)	p
Primary				
Pneumothorax rate	9 (5.01)	1 (0.70)	0.14 (0.02-0.88)	0.03



CRITICAL CARE MEDICINE

### Combined Thoracic Ultrasound Assessment during a Successful Weaning Trial Predicts Postextubation Distress

Stein Silva, M.D., Ph.D., Dalinda Al Aissa, M.D., Pierre Cocquet, M.D., Lucille Hoarau, M.D., Jean Ruiz, M.D., Fabrice Ferre, M.D., David Rousset, M.D., Michel Mora, M.D., Arnaud Mari, M.D., Olivier Fourcade, M.D., Ph.D., Béatrice Riu, M.D., Samir Jaber, M.D., Ph.D., Benoît Bataille, M.D.

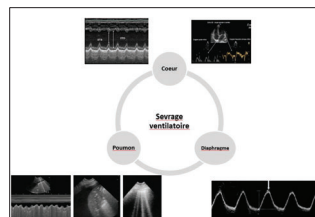
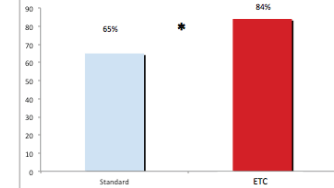


Figure 5: Précision diagnostique des causes de l'échec du sévrage ventilatoire



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

Jaime Gil-Rodríguez<sup>1,2\*</sup>, Javier Pérez de Rojas<sup>1</sup>, Pablo Aranda-Laserna<sup>3</sup>, Alberto Benavente-Fernández<sup>4</sup>, Michel Martos-Ruiz<sup>5</sup>, José-Antonio Peregrina-Rivas<sup>1</sup>, Emilio Guirao-Arrabal<sup>2</sup>

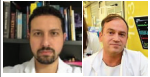
<sup>1</sup> Internal Medicine Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain  
<sup>2</sup> Preventive Medicine and Public Health Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain  
<sup>3</sup> Infectious Diseases Unit, San Cecilio University Hospital, Avenida del Conocimiento s/n, 18016 Granada, Spain



\* Crit Care Explor. 2022 Jun 8;4(6):e0719. doi: [10.1097/CCE.0000000000000719](https://doi.org/10.1097/CCE.0000000000000719)

### Lung Ultrasound to Assist ICU Admission Decision-Making Process of COVID-19 Patients With Acute Respiratory Failure

Amazigh Aguersif<sup>1</sup>, Benjamine Sartou<sup>1,2</sup>, Sihem Bouharaoua<sup>1</sup>, Lucien Gaillard<sup>1</sup>, Denis Standarovski<sup>3</sup>, Orphée Faucoz<sup>3</sup>, Guillaume Martin Blondel<sup>4</sup>, Hatem Khallel<sup>5</sup>, Claire Thalarnas<sup>6</sup>, Agnes Sommet<sup>6</sup>, Béatrice Riu<sup>2</sup>, Eric Morand<sup>3</sup>, Benoit Bataille<sup>7</sup>, Stein Silva<sup>1,2,5,8</sup>



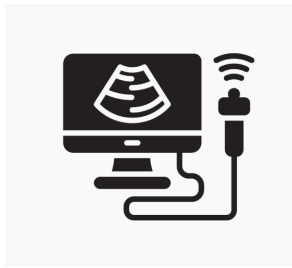
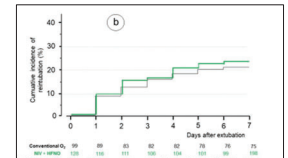
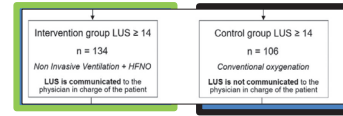
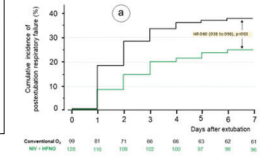
Rouby et al. Critical Care (2024) 28:391  
<https://doi.org/10.1186/s13054-024-05166-w>

Critical Care

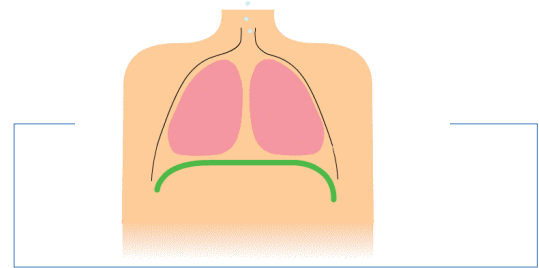
### WEANING OF non COPD patients at high-risk of extubation failure assessed by lung ultrasound: the WIN IN WEAN multicentre randomised controlled trial

Jean-Jacques Rouby<sup>1,2</sup>, Sébastien Perbet<sup>1</sup>, Jean-Pierre Quenot<sup>3</sup>, Mao Zhang<sup>4</sup>, Pascal Andreu<sup>5</sup>, Mona Asseli<sup>6</sup>

Open Access



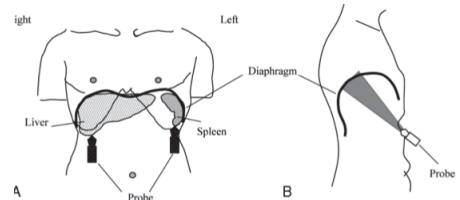
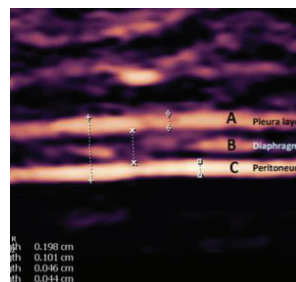
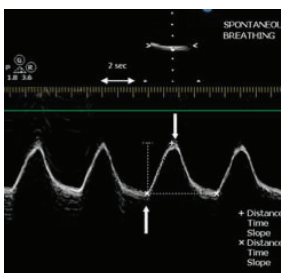
## Le diaphragme

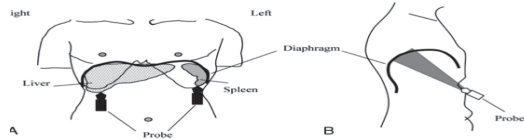


## 2 techniques US

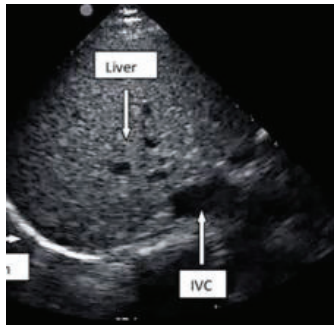
### Excursion diaphragmatique

### Fraction de raccourcissement

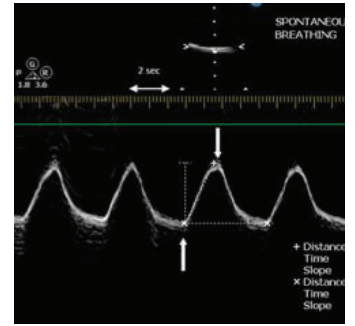
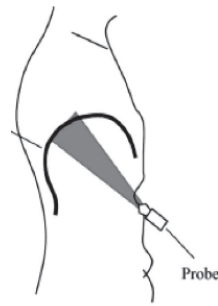
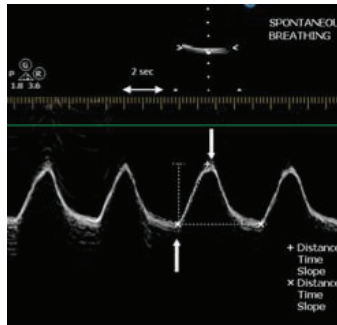




2 D



TM



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

Diaphragmatic Motion Studied by M-Mode Ultrasonography\*  
Methods, Reproducibility, and Normal Values

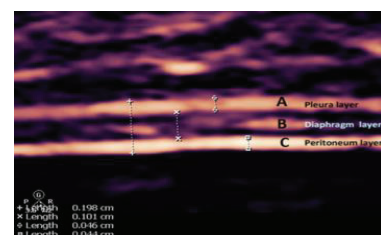
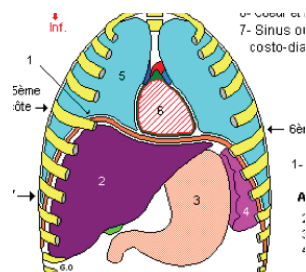
Alain Boussuges, MD, PhD; Yoann Cole, MSc; and Philippe Blanc, MD

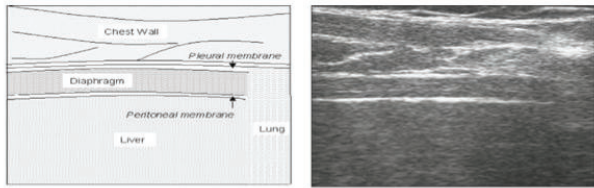
Tableau 2 : Excursions diaphragmatiques en ventilation spontanée

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

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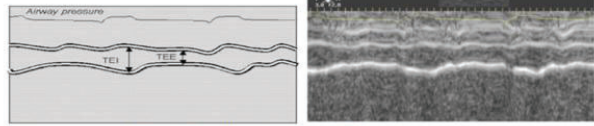
### EPAISSEUR DIAPHRAGMATIQUE





C

$$TF = (TEI - TEE) / TEE$$



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

## APPLICATIONS CLINIQUES

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

Variables	DD Group (n = 24)	Non-DD Group (n = 58)	p
<b>Demographic factors</b>			
Age, yrs	70.1 ± 11.1	64.5 ± 12.4	.06
Male	16 (67)	34 (59)	.50
Body mass index, kg/m <sup>2</sup>	21.1 ± 4.6	22.9 ± 4.8	.11
<b>Comorbidity:</b>			
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
<b>Laboratory findings</b>			
PaCO <sub>2</sub>	42.6 ± 8.3	37.3 ± 8.0	.01
PaO <sub>2</sub>	93.9 ± 24.1	101.3 ± 24.0	.20
FiO <sub>2</sub>	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
<b>Ultrasonographic findings</b>			
DE, right, mm (IQR)	7.0 (1.8-13.5)	17.9 (14.5-22.7)	<.01
DE, right, mm (n = 11) <sup>a</sup>	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) <sup>a</sup>	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	55.0 ± 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

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

Source: Clin Med (2012) 18:76-83  
DOI: 10.1093/cme/abf024

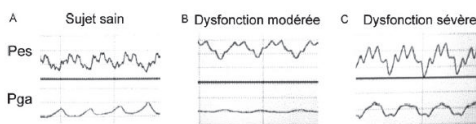
ORIGINAL

Ferasat Yliar  
Arnaud Mikato Deep  
Suzanne Olsener  
Ferdinand Yung  
Alain Lande  
Arnaud W. Thille  
Laurent Brochard

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

Table 2 Respiratory and ultrasonographic data

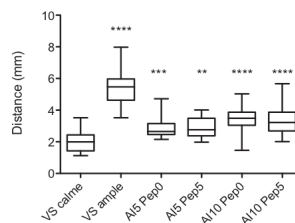
	SB	PS 5	PS 10	PS 15
V <sub>T</sub> , mL	-	324 (231-379)	402 (374-461) <sup>#</sup>	445 (388-547) <sup>#</sup>
RR, bpm	21 (18-28)	20 (18-28)	22 (19-30)	21 (17-29)
T <sub>EE</sub> , mm	2.19 (1.94-2.76)	2.26 (1.78-2.46)	2.29 (1.84-2.52)	2.27 (2.06-2.88)
T <sub>EI</sub> , mm	3.08 (2.77-4.77)	3.08 (2.34-3.51)	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)* <sup>#</sup>	16.3 (9.2-20.8)* <sup>#</sup>
PTP <sub>di</sub> , cmH <sub>2</sub> O s	13.5 (8.1-16.9)	6.2 (4.7-8.0)*	4.0 (3.3-5.4)* <sup>#</sup>	2.7 (2.1-4.3)* <sup>#</sup>



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)

