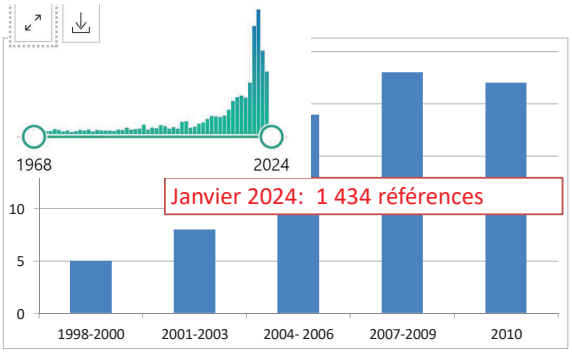
Echo pleuro-pulmonaire en réanimation

DU TUSAR 2025
Dr Riu Poulenc (Chu Toulouse)

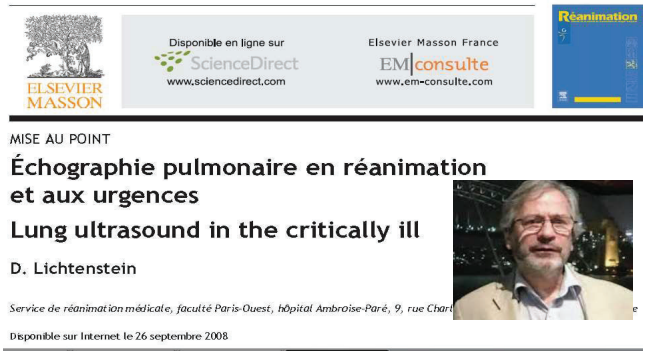
CHU TOULOUSE

POP ART Anesthésie Réanimation Toulousaine

Lus and bedside

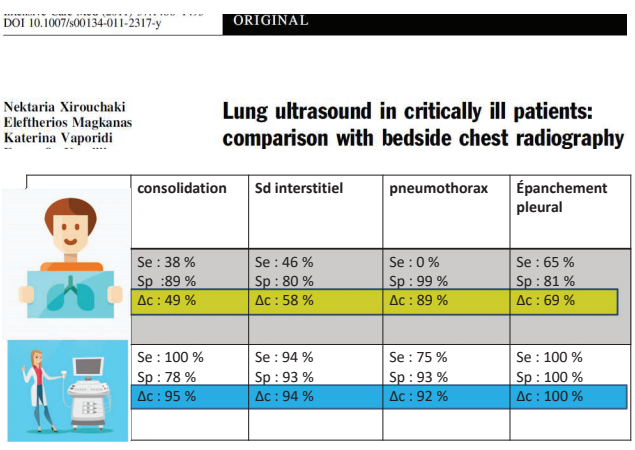


D lichtenstein and lung ultrason >30 références



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



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

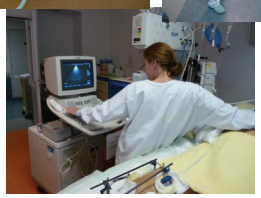
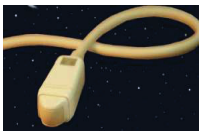
Un appareil simple

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

L'appareil et la sonde





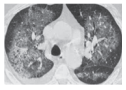
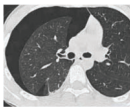



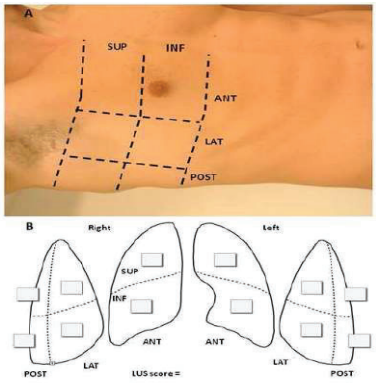
Lieu mélange air eau

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



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

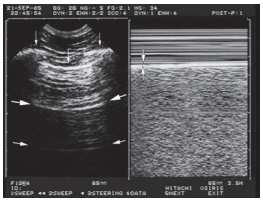



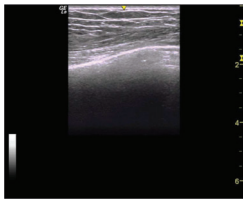
LUS
0=normal
1=syndrome interstitiel
2=Syndrome alvéolo interstitiel
3=condensation

Bouhemad B, rouby JJ, Arbelot C, AJRCCM 2011

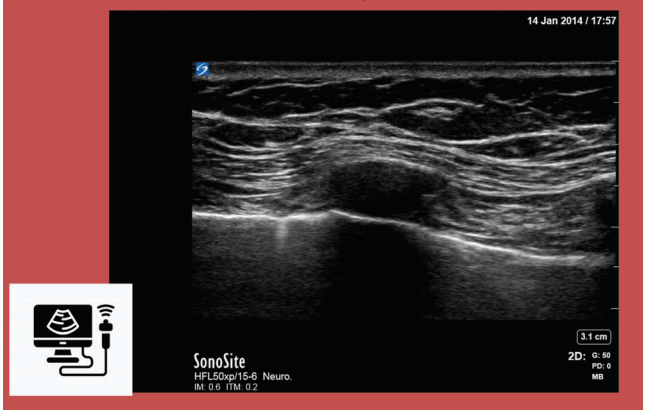
La ligne pleurale





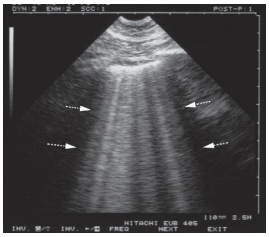


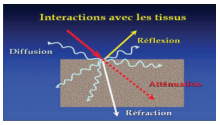
Glissement pleural



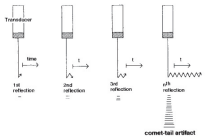
Syndrome interstitiel

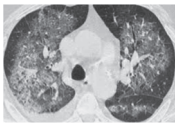
Lichtenstein D,. AM J RESPIR CRIT CARE MED 1997;156:1640-1646

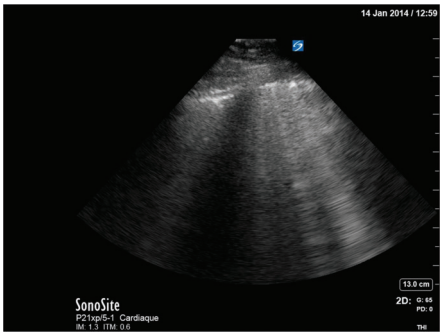




- Artéfact en queue de comète (ligne B)
- Naissent de la ligne pleurale
- En rayon laser
- Hyperéchogènes
- Descendant sans épuisements
- Effacent les lignes A
- mobiles

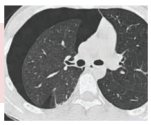




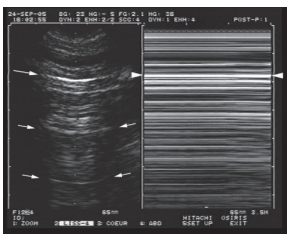


Pneumothorax

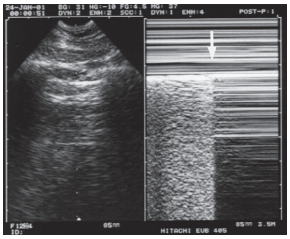
Se: 94%, Sp: 95%



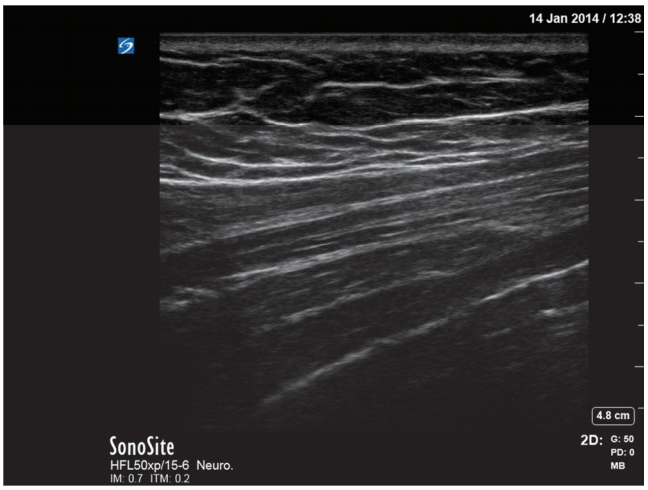
Abolition du glissement pleural
VPP 100%

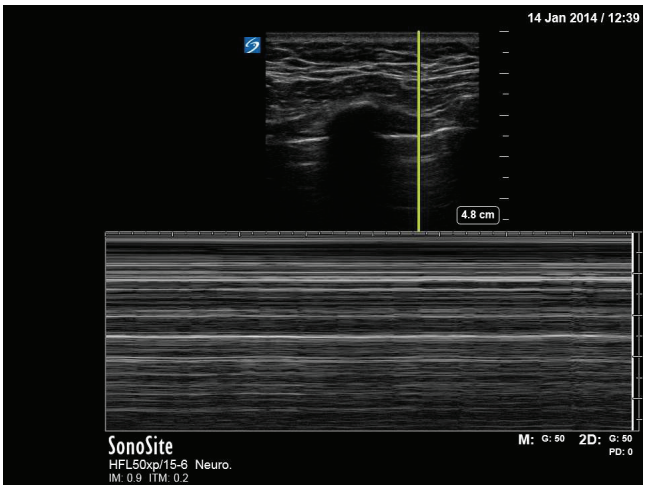


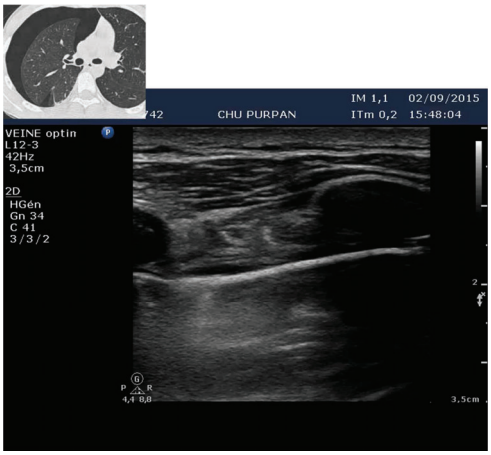
Point poumon
Spécifique à 100%

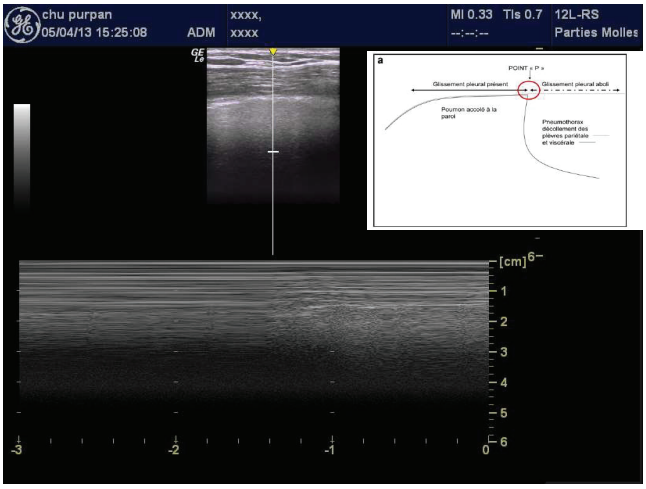


Lichtenstein D, Mezière G, Lascols N, Biderman P, Courret JP, Gepner A, et al.
Ultrasound diagnosis of occult pneumothorax.
Critical Care Med 2005;33:1231—8.

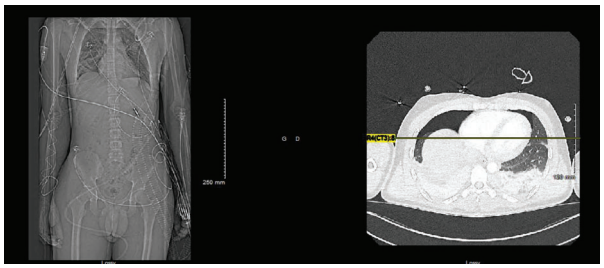




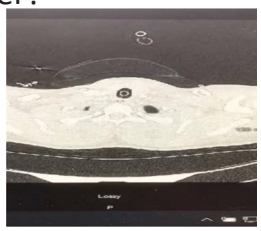


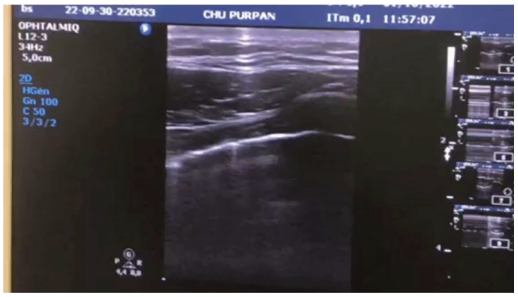


Mr D, 19 ans chute de 7 m, traumatisme crânien sévère, traumatisme thoracique et fracture ouverte du calcanéum



Faut il le drainer?

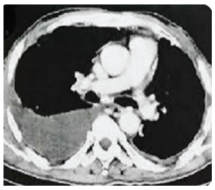


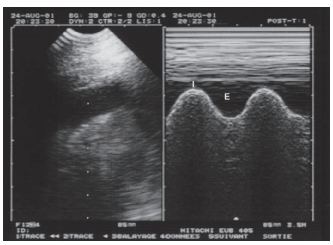


Épanchement pleural

Se:94%, Sp:97%

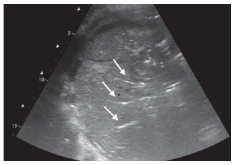
Lichtenstein D, Mezière
Intensive Care Med 1999;25:955–8

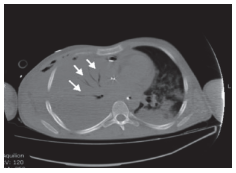




Consolidation alvéolaire

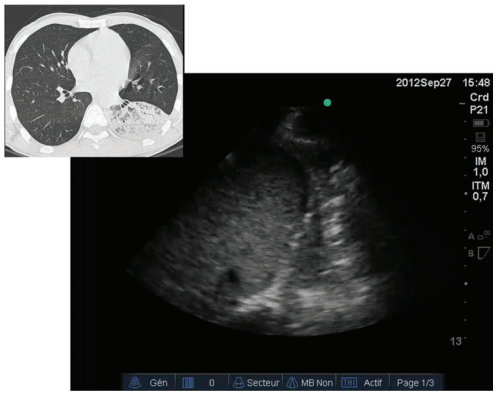
Se:90%, Sp:98%

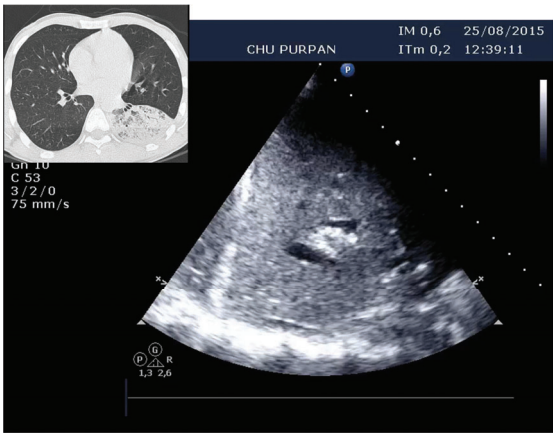




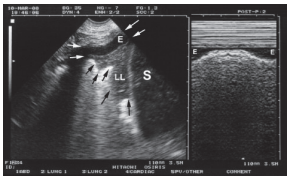
- signe du poumon tissulaire: tissu solide avec échogénicité tissulaire (hépatisation)
- + spécifique que la RT
- Lignes hyperéchogène bronchogramme aèrique

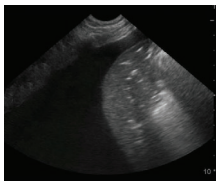
Lichtenstein D, .
Ultrasound diagnosis of alveolar consolidation in the critically ill.
Intensive Care Med 2004;30:276–81.



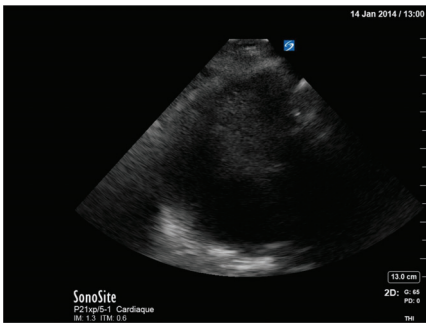


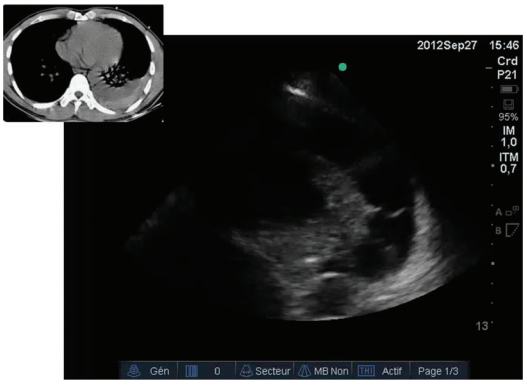
PLAPS
postero lateral alveolar and pleural syndrome

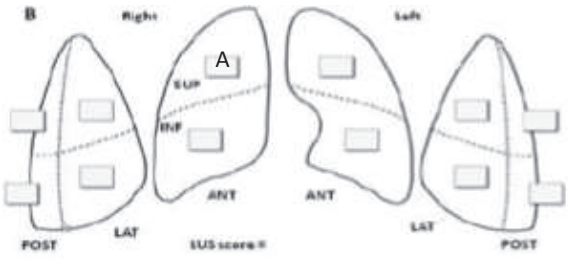


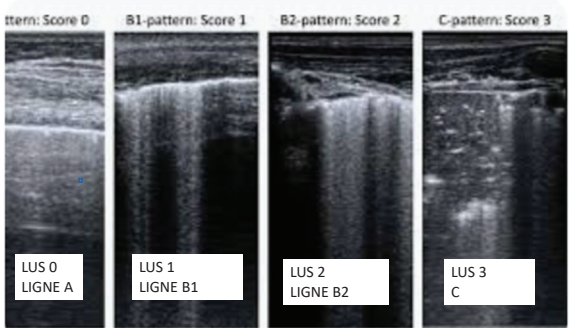


Zone 3, condensation pulmonaire et épanchement pleural
Flèches noires = bronchogramme aèrique

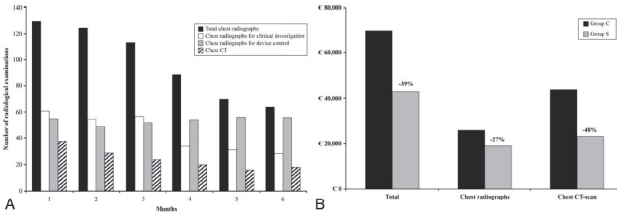








Étude médico économique



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

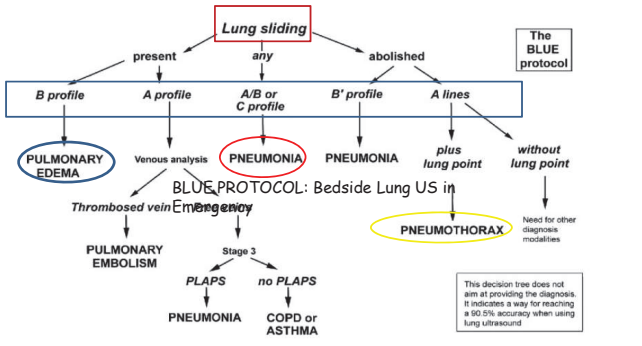
Diagnostic d'une DRA

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



BLUE PROTOCOL: Bedside Lung US in Emergency

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

.org

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


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

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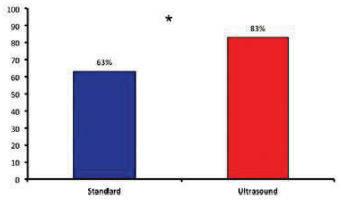


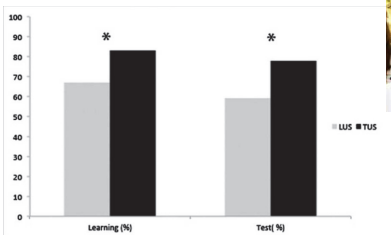
15] FIGURE 1. Comparative diagnostic accuracy. Each diagnostic ap-
16] proach (standard and ultrasound) was compared against the final diagnosis determined by a panel of experts ($P < .05$).

[Original Research **Critical Care**] 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



014. doi:10.1378/chest.14-0681

évaluation quantitative d'un épanchement pleural

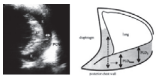
- **Vignon P**, Chastagner C, Berkane V, et al. Quantitative assessment of pleural effusion in critically ill patients by means of ultrasonography. Crit Care Med 2005; **33: 1757-**1763.

  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[1]; Fritz, Ashley V. DO[2]; Tatari, Mehmet M. MD[1]; Daniels, Craig E. MD[3]; Diaz-Gomez, Jose L. MD[1,2]

Author Information

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

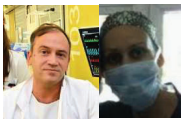
TABLE 3. Primary and Secondary Endpoints by Ultrasound Marked or Guided Procedures

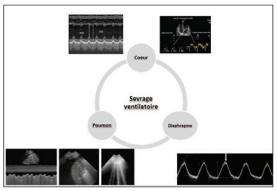
Endpoints	Ultrasound Marked, *n* = 203, *n* (%)	Ultrasound Guided, *n* = 159, *n* (%)	OR (95% CI)	*p*
Primary				
Pneumothorax rate	9 (5.01)	1 (0.70)	0.14 (0.02–0.88)	0.03

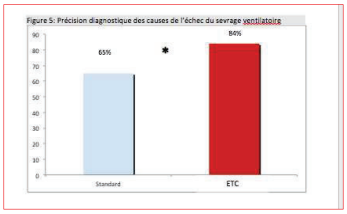
CRITICAL CARE MEDICINE

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

Stein Silva, M.D., Ph.D., Dalinda Ait 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.



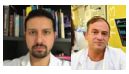




Ultrasound findings of lung ultrasonography in COVID-19: A systematic review

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



Crit Care Explor. 2022 Jun 8;4(6):e0719. doi: 10.1097/CCE.0000000000000719

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

Amazigh Aguersif [1], Benjamine Sarton [1,2], Sihem Bouharaoua [1], Lucien Gaillard [1], Denis Standarovski [3], Orphée Faucoz [3], Guillaume Martin Blondel [4], Hatem Khallel [5], Claire Thalamas [6], Agnes Sommet [6], Béatrice Riu [2], Eric Morand [3], Benoit Bataille [1], Stein Silva [1,2,✉]

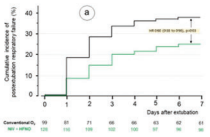
Rouby et al. Critical Care (2024) 28:391
https://doi.org/10.1186/s13054-024-05166-w

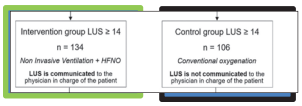
Critical Care

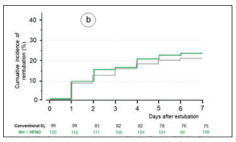
RESEARCH Open Access

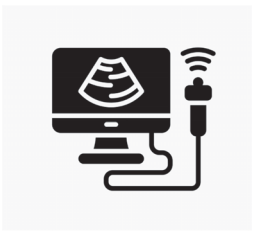
Weaning of non COPD patients at high-risk of extubation failure assessed by lung ultrasound: the WIN IN WEAN multicentre randomised controlled trial

Jean-Jacques Rouby[1*], Sébastien Perbet[2], Jean-Pierre Quenot[3], Mao Zhang[4], Pascal Andreu[3], Mona Asseli[1],

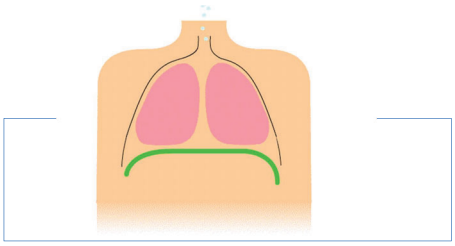






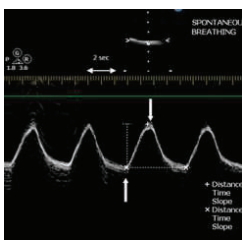


Le diaphragme

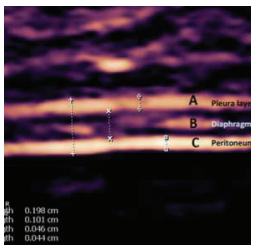


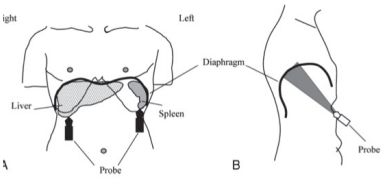
2 techniques US

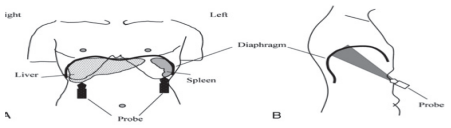
Excursion diaphragmatique



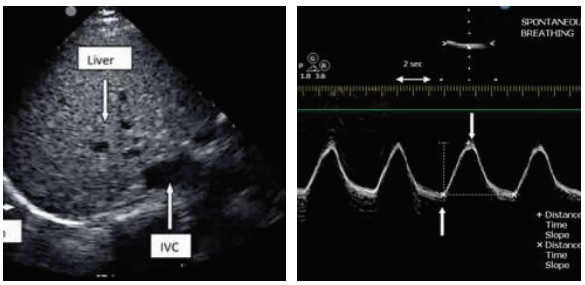
Fraction de raccourcissement

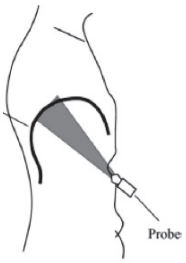


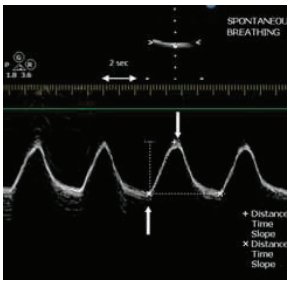




2 D **TM**







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
ULTRASONOGRAPHY

Diaphragmatic Motion Studied by M-Mode Ultrasonography*

Methods, Reproducibility, and Normal Values

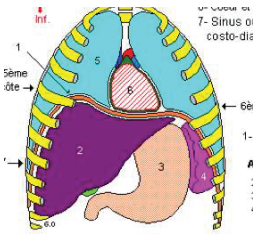
Alain Boussuges, MD, PhD; Yoann Gole, MSc; and Philippe Blanc, MD

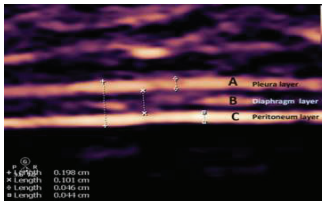
Tableau 2 : Excursions diaphragmatiques en ventilation spontanée

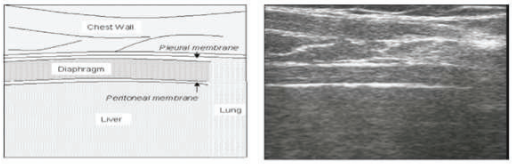
	Ventilation calme	Ventilation ample
Excursion Diaphragmatique (cm)	1,99 (IQR 1,43-2,44)	5,48 (IQR 4,63-5,98)

Hourcastagnou, Riu, Silva
Mémoire DESAR 2015

EPAISSEUR DIAPHRAGMATIQUE

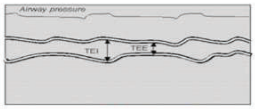


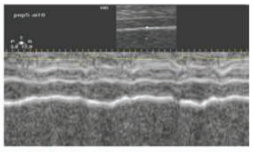




C

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*

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/m²	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

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

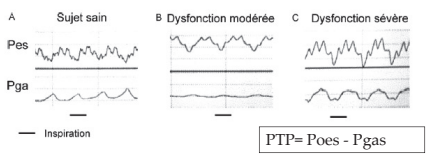
ORIGINAL

Emmanuel Vivier, Armand Mekontso Dessap, Saoussen Ellouzi, Frederic Vargas, Alexis Lozeron, Armand W. Thille, Laurent Brochard

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

Table 2 Respiratory and ultrasonographic data

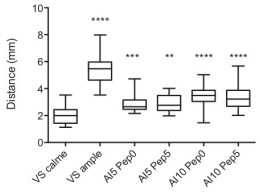
	SB	PS 5	PS 10	PS 15
V_T, mL	–	324 (231–379)	402 (374–461)#	445 (388–547)#
RR, bpm	21 (18–28)	20 (18–28)	22 (19–30)	21 (17–29)
T_{EE}, mm	2.19 (1.94–2.76)	2.26 (1.78–2.46)	2.29 (1.84–2.52)	2.27 (2.06–2.88)
T_{EI}, mm	3.08 (2.77–4.77)	3.08 (2.34–3.51)	2.73 (2.39–3.25)	2.58 (2.34–3.56)
TF, %	47.5 (35.9–63.2)	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)