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1. Point of care **ultrasound**: the visual stethoscope of the 21st century.
Gillman LM, Kirkpatrick AW.
Scand J Trauma Resusc Emerg Med. 2012 Mar 9;20(1):18. [Epub ahead of print]
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1. **Ultrasound** imaging and use of B-lines for functional **lung** evaluation in neurocritical care: A prospective, observational study.
Bilotta F, Giudici LD, Zeppa IO, Guerra C, Stazi E, Rosa G.
Eur J Anaesthesiol. 2012 Mar 13. [Epub ahead of print]
PMID: 23492935 [PubMed - as supplied by publisher]
Related citations

Comparative Diagnostic Performances of Auscultation, Chest Radiography, and Lung Ultrasonography in Acute Respiratory Distress Syndrome

Daniel Lichtenstein, M.D., Ivan Goldstein, M.D.,† Eric Mourgeon, M.D.,† Philippe Cluzel, M.D., Ph.D.,‡ Philippe Grenier, M.D.,§ Jean-Jacques Rouby, M.D., Ph.D.‖*

Table 1. Sensitivity and Specificity of Auscultation, Chest Radiography, and Lung Ultrasonography for Diagnosing Pleural Effusion, Alveolar Consolidation, and Alveolar–Interstitial Syndrome in 384 Lung Regions in 32 Critically Ill Patients with ARDS

	Auscultation, %	Chest Radiography, %	Lung Ultrasonography, %
Pleural effusion			
Sensitivity	42	39	92
Specificity	90	85	93
Diagnostic accuracy	61	47	93
Alveolar consolidation			
Sensitivity	8	68	93
Specificity	100	95	100
Diagnostic accuracy	36	75	97
Alveolar–interstitial syndrome			
Sensitivity	34	60	98
Specificity	90	100	88
Diagnostic accuracy	55	72	95

ARDS = acute respiratory distress syndrome.

Anesthesiology 2004; 100:9–15

Intensive Care Med (2008) 34:243–249
DOI 10.1007/s00134-007-0923-5

CLINICAL COMMENTARY

Antoine Vieillard-Baron
Michel Slama
Bernard Cholley
Gérard Janvier
Philippe Vignon

Echocardiography in the intensive care unit: from evolution to revolution?

La leçon dânatomie du professeur Tulp

Rembrandt 1632

Bangkok: langage universel

Pourquoi l'échographie pulmonaire?

1) Faite au chevet du patient avec équipement portatif
2) Utile dans le transport des patients critiques

A

Pourquoi l'échographie pulmonaire?

3) Simple, facile à apprendre et reproductible
4) Source d'information critique sur l'anatomie, la physiologie et les pathologies pulmonaires ainsi que les interactions cardio-pulmonaires
5) Peut être répétée pour guider les interventions et vérifier leur efficacité
6) Aucune irradiation: idéal pour les enfants et les ♀ enceintes

Pourquoi l'échographie pulmonaire?

7) Recommandations dans la formation des spécialistes en soins intensifs

CHEST Consensus Statement

American College of Chest Physicians/ La Société de Réanimation de Langue Française Statement on Competence in Critical Care Ultrasonography*

Paul H. Mayo, MD; Yannick Beaulieu, MD; Peter Doelken, MD; David Feller-Kopman, MD; Christopher Harrod, MS; Adolfo Kaplan, MD; John Oropello, MD; Antoine Vieillard-Baron, MD; Olivier Axler, MD; Daniel Lichtenstein, MD; Eric Maury, MD; Michel Slama, MD; and Philippe Vignon, MD

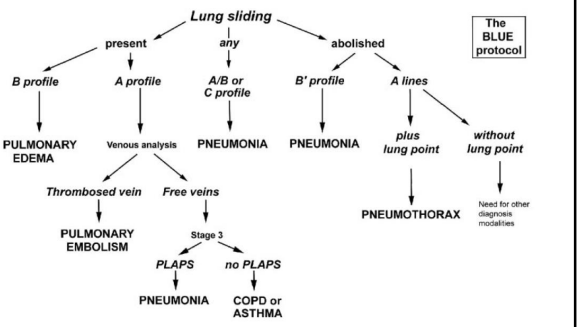
(CHEST 2009; 135:1050–1060)

Table 2—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Lung Ultrasonography*

Knowledge of the basic semiology of lung ultrasound: A-lines, B-lines, sliding lung, lung point
Identification and characterization of consolidated lung: identification of tissue density lung, with or without air bronchograms
Identification and characterization of air artifacts suggestive of the normal aeration pattern: A-lines with sliding lung
Identification and characterization of air artifacts suggestive of alveolar interstitial pattern: number and location of B lines
Knowledge of the limitations of not visualizing lung sliding/B lines
Identification and characterization of air artifacts to rule out pneumothorax: presence of sliding lung, presence of B-lines
Identification and characterization of findings that rule in pneumothorax: presence of lung point (both by 2D imaging and M-mode)

Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure: The BLUE Protocol

Daniel A. Lichtenstein and Gilbert A. Mezière



Chest 2008;134:117-125

Perioperative Point-of-Care Ultrasonography

The Past and the Future Are in Anesthesiologists' Hands

"Numerous studies have shown that ultrasound is more sensitive than chest x-ray for pneumothorax

standard practice in many centers. With appropriate training and development, point-of-care ultrasound of the chest, including evaluation for pneumothorax and other techniques, may be standard practice among anesthesiologists 10 yr from now.

Johnson D. Anesthesiology 2011;115:260-2

Comment ai-je appris?

Dr Daniel Lichenstein

Dr Sylvain Bélisle

http://www.ceurf.net

L'ABCD de l'échographie pulmonaire

- Airway: prise en charge des VRS
- Breathing:
  - ✓ Etiologies des ↓ compliance or ↑ résistance
  - ✓ Etiologie de l'hypoxie et de l'hypercapnie
- Circulation: diagnostic des causes d'états de choc comme l'hémothorax & le pneumothorax
- Diagnostiques: empyème, pneumonie, paralysie diaphragmatique

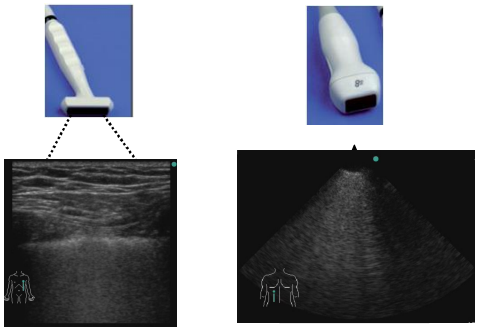
Échographie pulmonaire

- L'interface air/liquide contribue à l'apparition d'artéfacts (mismatch d'impédance)
- Les régions superficielles sont évaluées sauf si une pathologie est présente
- Le but n'est pas l'identification des structures pas l'interprétation des artéfacts

Échographie pulmonaire

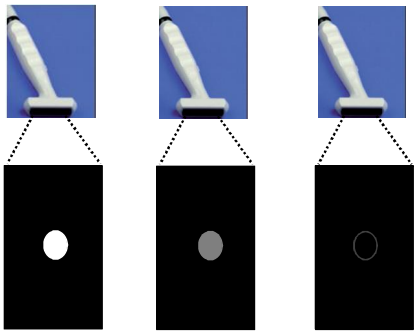
"Making facts from artefacts"

Terminologie échographique



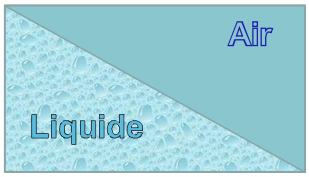
Linéaire | Phasique ou microconvexe

Terminologie échographique

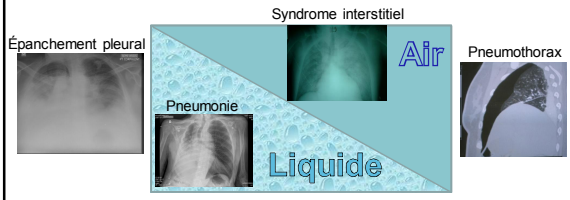


Hyperéchogénique | Isoéchoïque | Anéchoïque

Contenu pulmonaire



Contenu pulmonaire

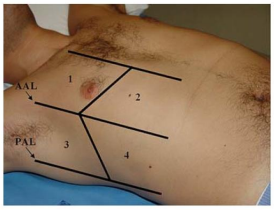


Échographie pulmonaire: approche

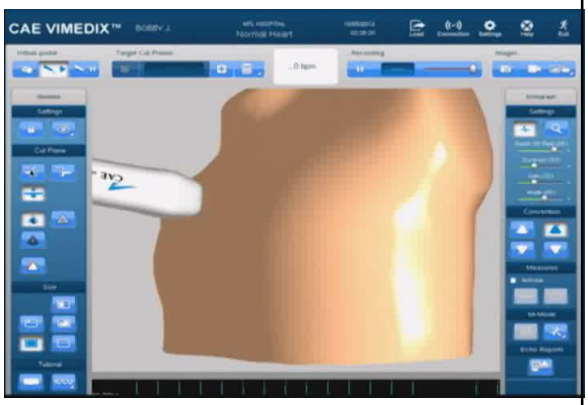
1- Sonde linéaire + phasique (3.5-10 MHz)
2- Gain bas-modéré
3- 5-8 cm de profondeur
4- Scan longitudinal du poumon
(4 à 6 régions/poumon)
5- Examen complémentaire
(analyse veineuse,cardiaque etc)

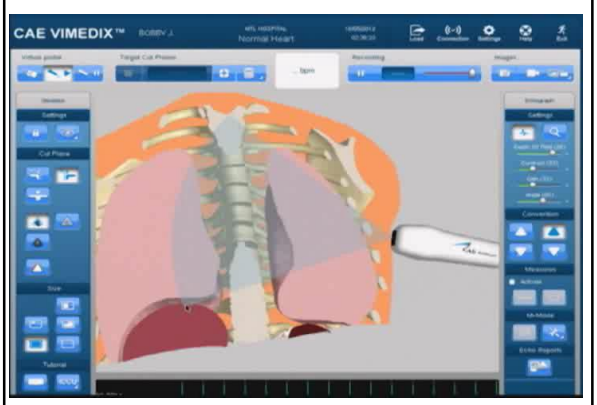
Échographie pulmonaire: approche

Régions antérieures (1-2): pneumothorax (98%)
syndrome interstitiel



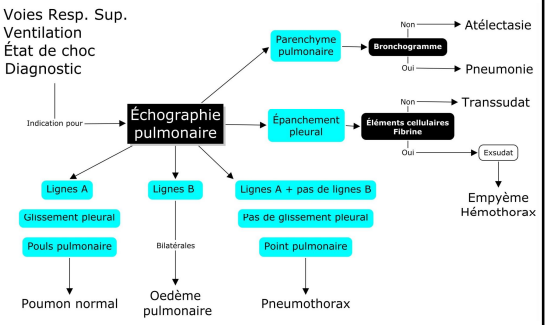
Régions latérales (3-4): épanchements pleuraux
consolidations: atélectasie ou pneumonie
fonction diaghragmatique (nerf phrénique)





Notre approche

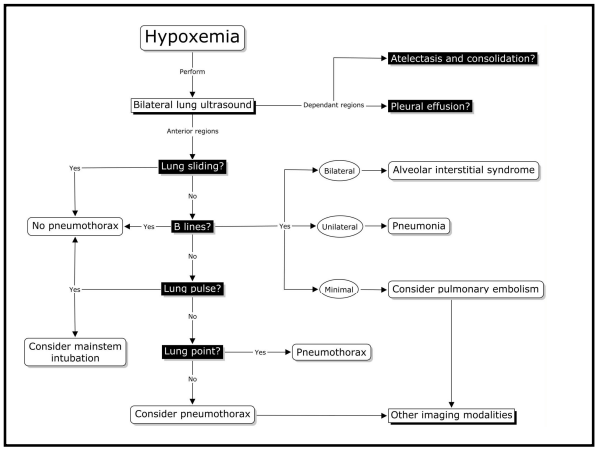
A: Voies Resp. Sup.
B: Ventilation
C: État de choc
D: Diagnostic

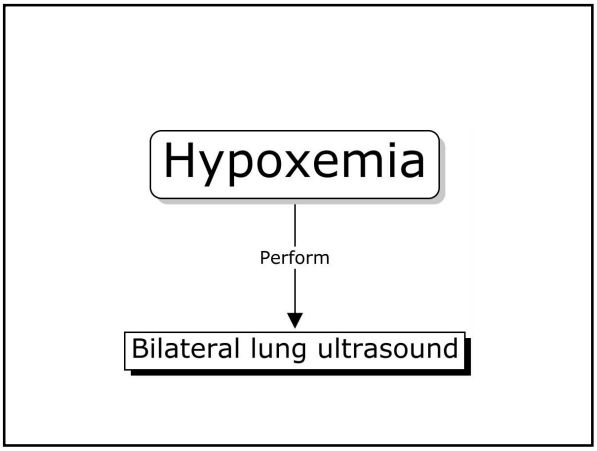


Basic concepts in the use of thoracic and lung ultrasound

Eric Piette[a], Raoul Daoust[b], and André Denault[c]

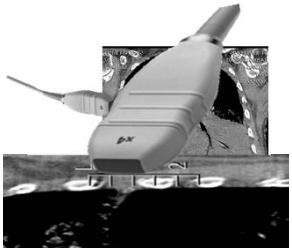
Curr Opin Anesthesiol 2012

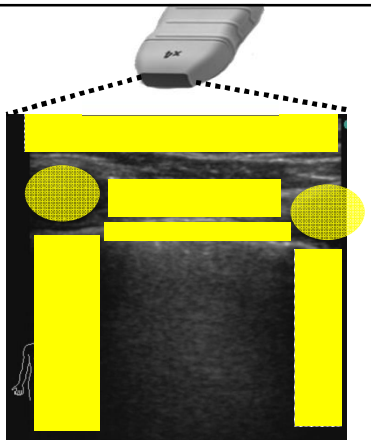




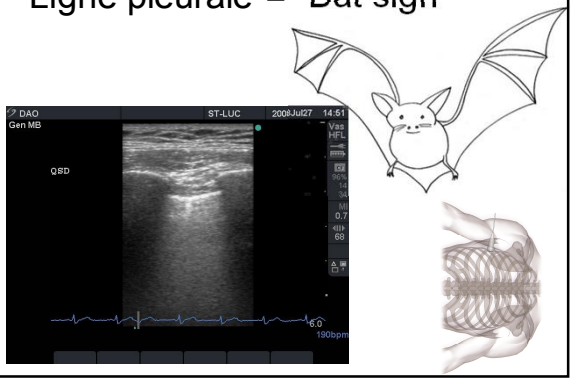
Nomenclature: “sliding lung” ou glissement pleural

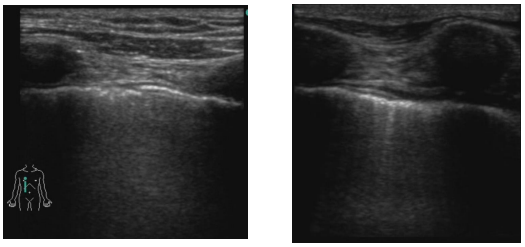
- Mouvement horizontal de la ligne pleurale
- 5 mm sous la partie inférieure des côtes
- Hyperéchoïque (blanc)
- Bouge avec la respiration
- Amplitude maximale à la base pulmonaire
- Correspond au mouvement de la plèvre viscérale sur la plèvre pariétale





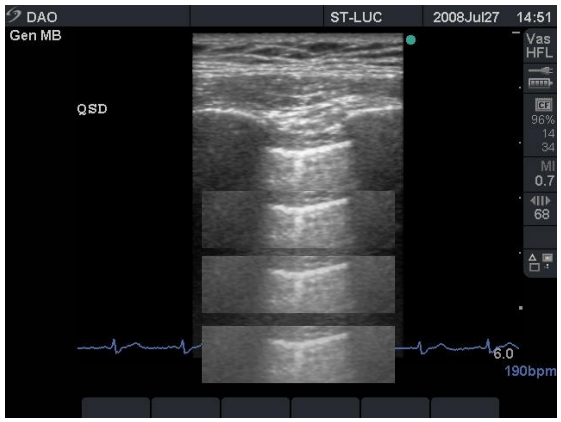
Ligne pleurale = “Bat sign”





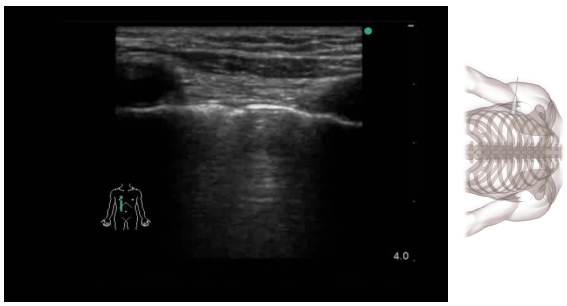
Nomenclature: lignes A

- Lignes horizontales
- Lignes hyperéchoïque qui originent de la ligne pleurale
- Les lignes sont parallèles et à une distance identique à la distance entre la sonde d'écho et la ligne pleurale
- Les lignes se répètent plusieurs fois = réverbérations de la ligne pleurale



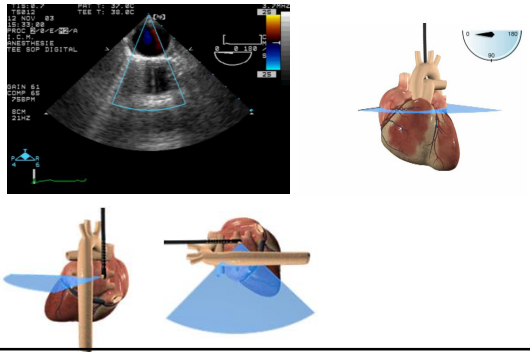
Glissement pleural ou sliding lung

Glissement pleural ou sliding lung

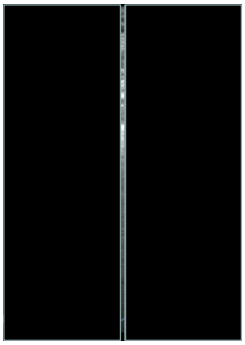


Glissement pleural ou sliding lung

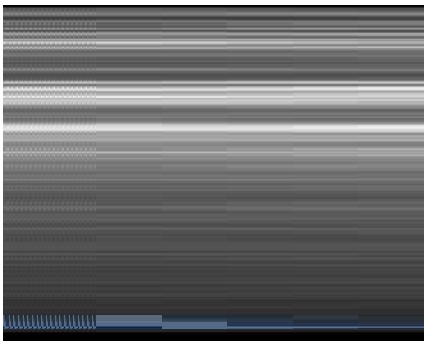
Réverberation

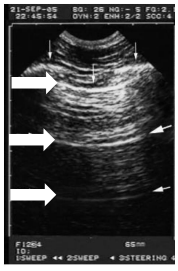


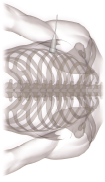
Mode 2D et mode M



Mode 2D et mode M

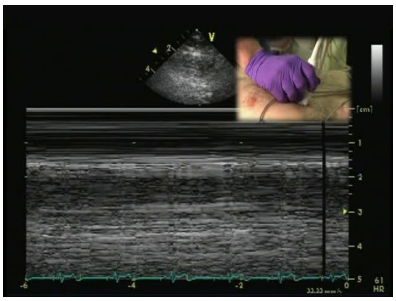


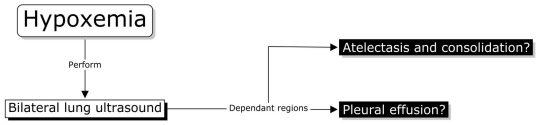




Lignes A = artéfacts horizontaux répétitifs
qui originent de la ligne pleurale
En mode M cet artéfact génère un aspect sablonneux.
Ceci se nomme le "*seashore sign*ou la plage de sable

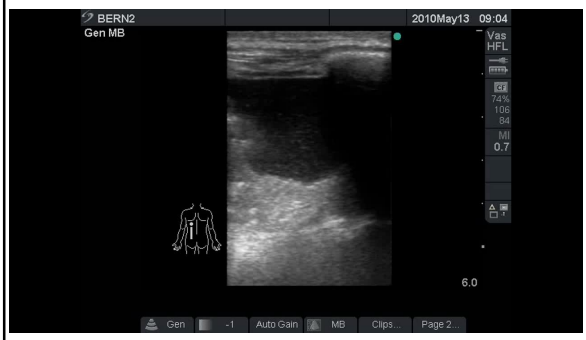
Mode M

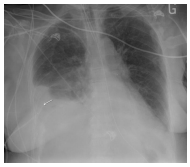




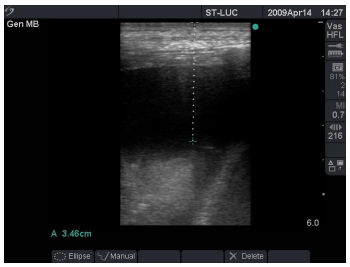
Épanchement pleural

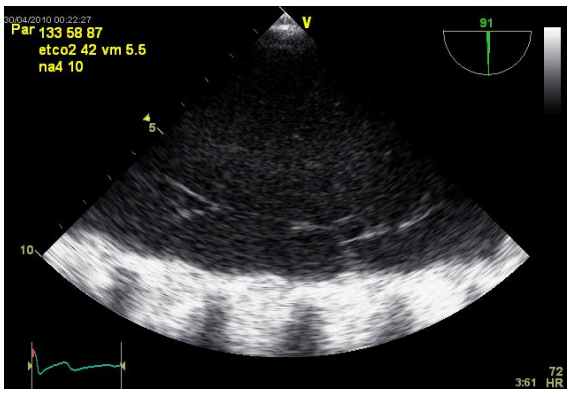
- Collection dans la cavité thoracique limitée par le diaphragme et la plèvre
- La dimension change avec la respiration
- Associé avec atélectasie et/ou consolidation
- Types:
  - Simple: anéchoïque (transsudat ou exudat) = aiguille + pigtail
  - Complexe: iso ou hyperéchogénique (exsudat) = drain thoracique ou chirurgie

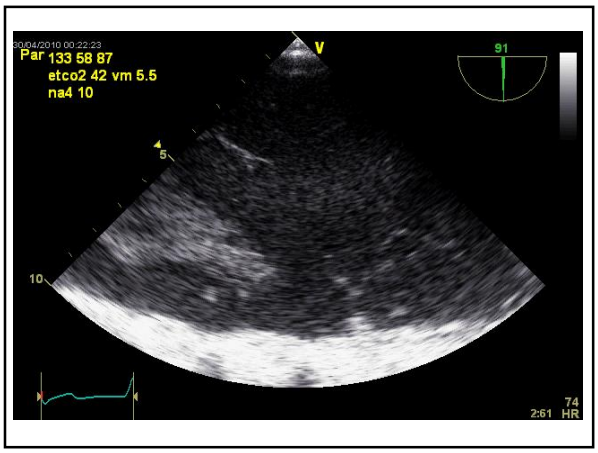




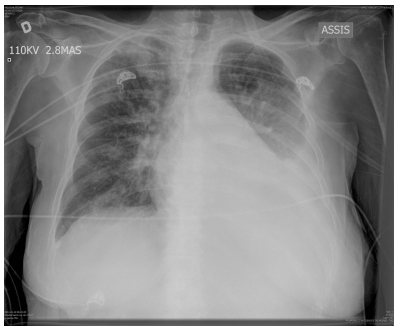
Poumon droit:
sonde linéaire

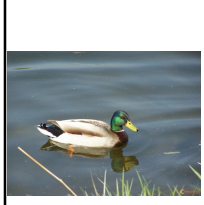


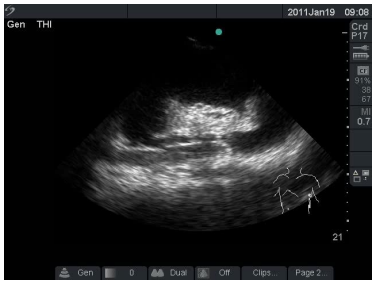


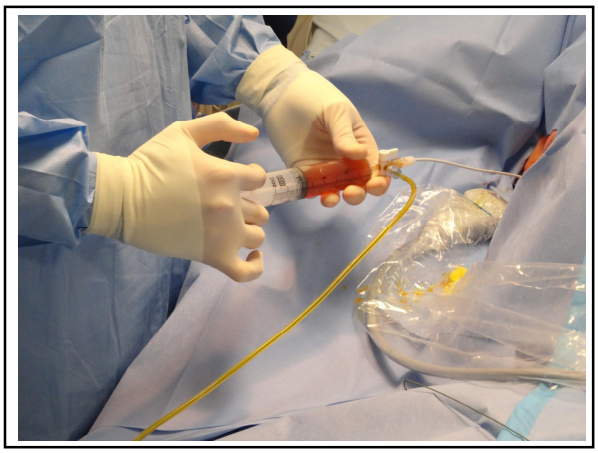


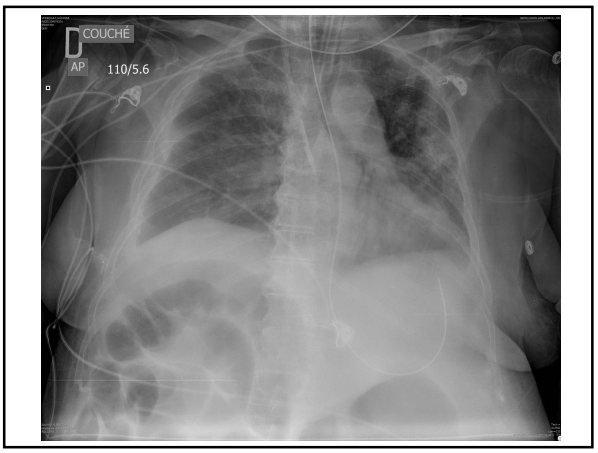
Homme de 67 ans: Lac Brome?

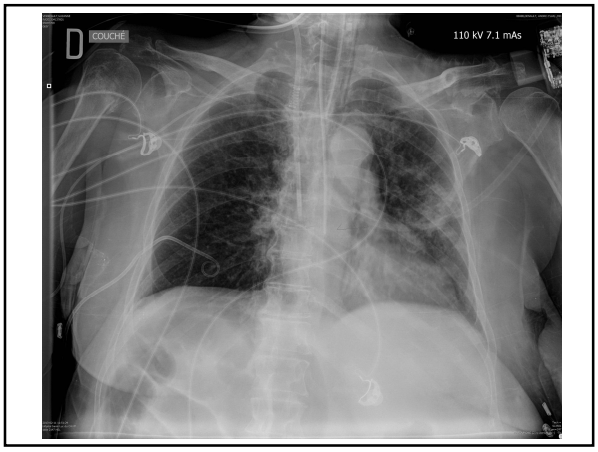


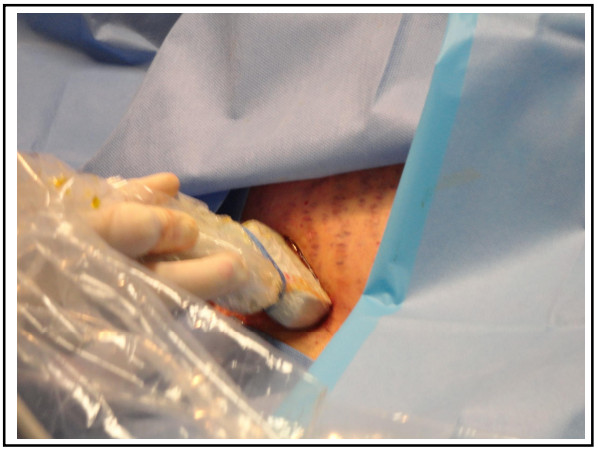


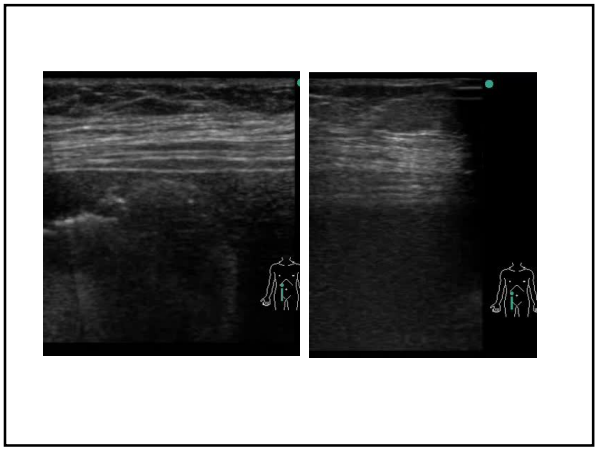


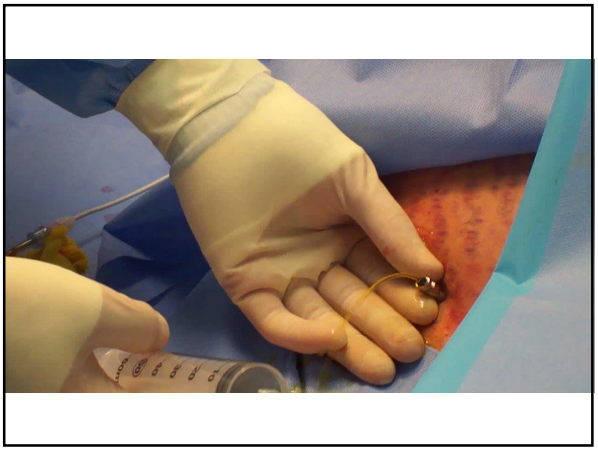



COUCHÉ
AP
110/5.6


COUCHÉ
110 kV 7.1 mAs



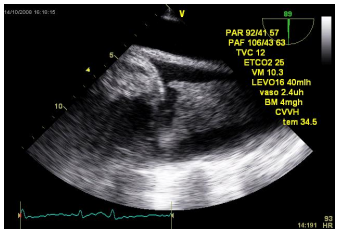


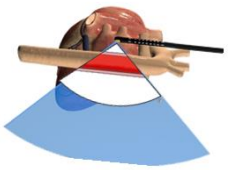


Atélectasie et pneumonie

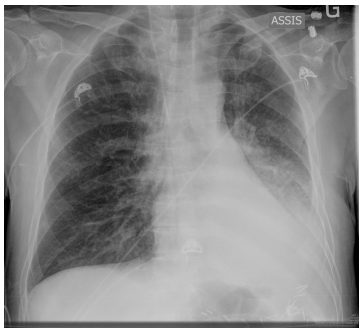
- Région pulmonaire d'un aspect isoéchoïque dont les dimensions ne changent pas avec la respiration
- Aspect homogène: atélectasie
- Aspect hétérogène avec zones hyperéchogéniques (bronchogrammes) suggestif de pneumonie

Atélectasie

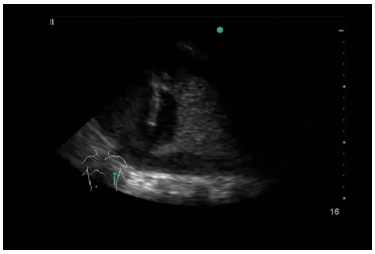


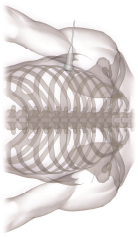


Atélectasie ou pneumonie?



Atélectasie ou pneumonie?

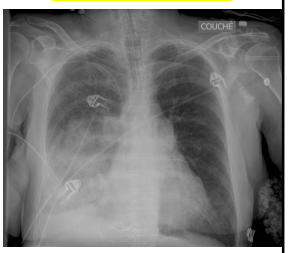




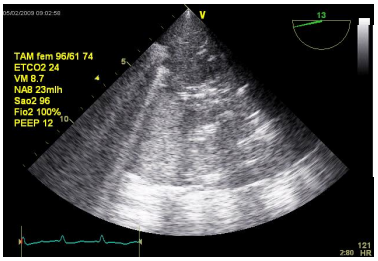
♀ de 58 ans instable après greffe hépatique

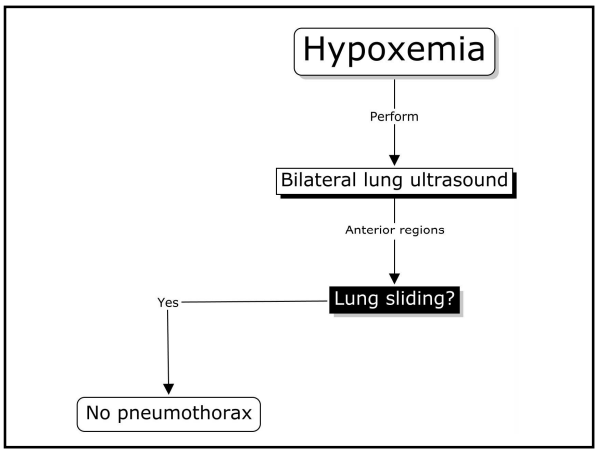
Avant l'épisode

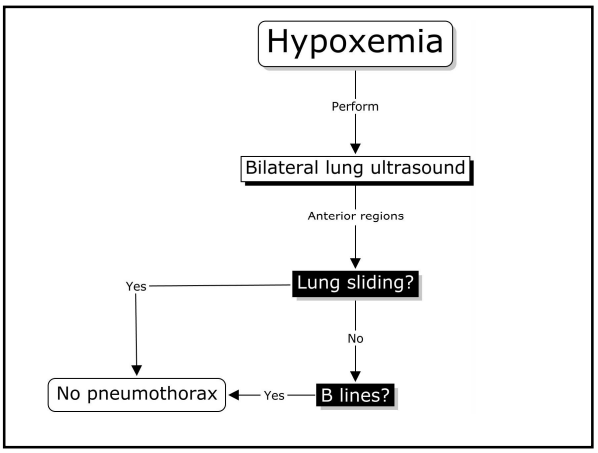
Pendant l'épisode



♀ de 58 ans instable après greffe hépatique

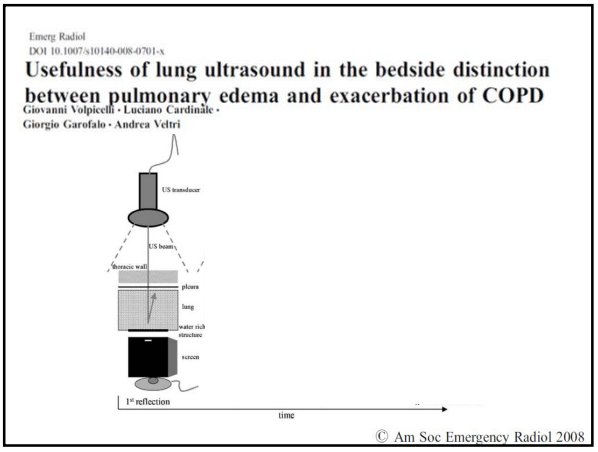


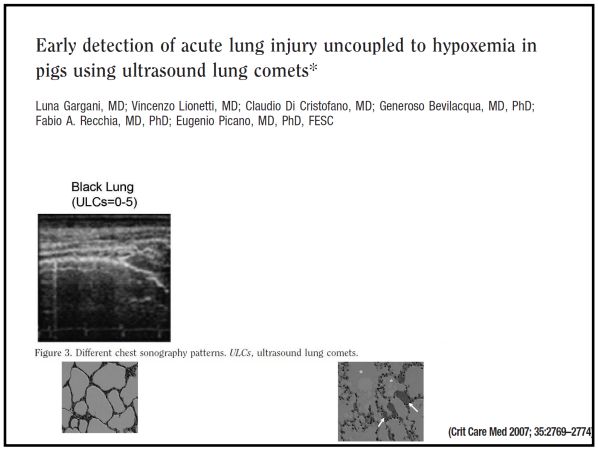




Nomenclature: lignes B ou queues de comètes

- Lignes verticales
- Lignes hyperéchoïques qui originent de la ligne pleurale
- Les lignes sont perpendiculaires à la ligne pleurale
- Les lignes effacent les lignes A
- Normal d'en avoir 1 en région antérieure et 33% de patients en ont dans les régions dépendantes = réverbérations de l'oedème alvéolaire ou interstitiel (lignes de Kerley B)

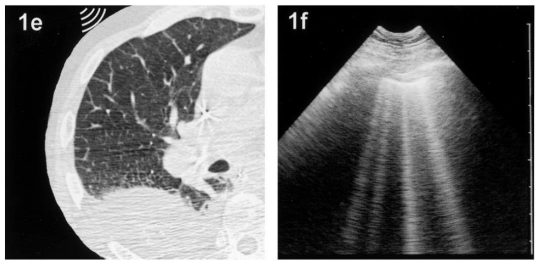




Syndrome alvéolo-interstitiel (OAP, ARDS, maladie interstitielle)

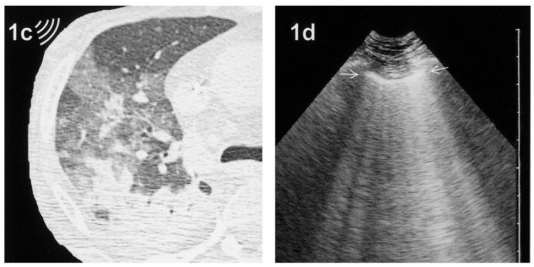
- Présence de > 2 lignes B dans une région
- Équivalent aux lignes B de Kerley
- Types:
  7±1 mm entre les lignes: oedème interstitiel
  < 3 mm entre les lignes: oedème alvéolaire

Oedème pulmonaire: 7±1 mm entre les lignes B



Anesthesiology, V 100, No 1, Jan 2004

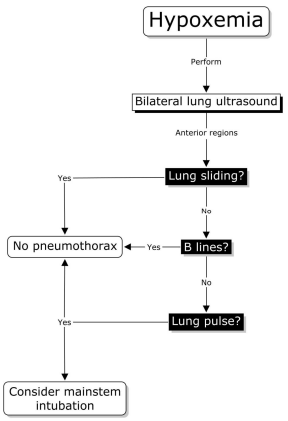
Oedème pulmonaire: 3 mm entre les lignes B



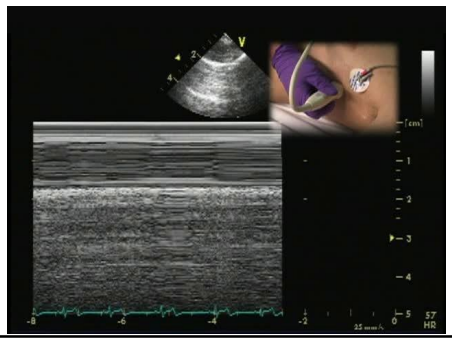
Anesthesiology, V 100, No 1, Jan 2004

Utilités des lignes B

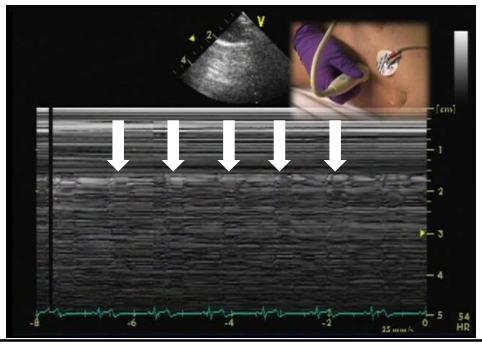
- Diagnostic de l'oedème pulmonaire
  - ✓ Thérapie: lasix ou dialyse
- Corrélation avec le NYHA et la fonction cardiaque systolique et diastolique
- Corrélation avec le BNP et le "wedge"
- Valeur pronostique en survie
- Diminuent après la dialyse



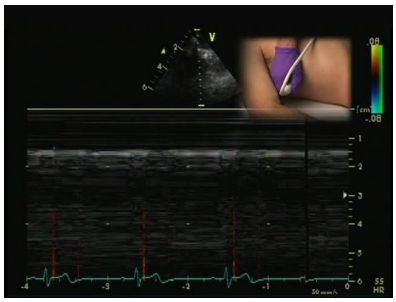
En apnée: pulsations cardiaques = "lung pulse" ou pouls pulmonaire



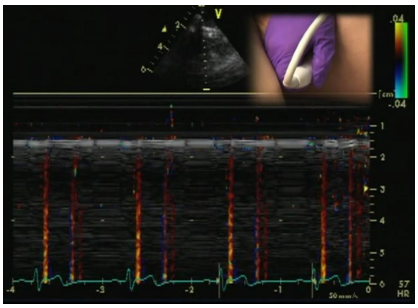
Mode M: battements cardiaques



Mode M et + Doppler couleur: pouls pulmonaire



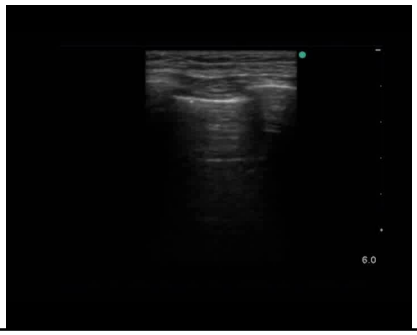
Mode M et + Doppler couleur: pouls pulmonaire



♀ de 68 ans: désaturation et hypotension post-intubation

- Absence ou faible murmure vésiculaire à droite.
- Diagnostique différentiel?

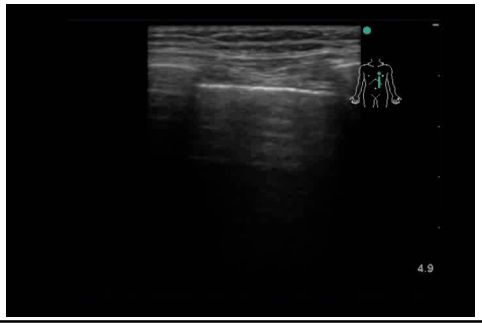
Désaturation soudaine post-intubation: poumon droit



Désaturation soudaine post-intubation: poumon droit

ZOOM

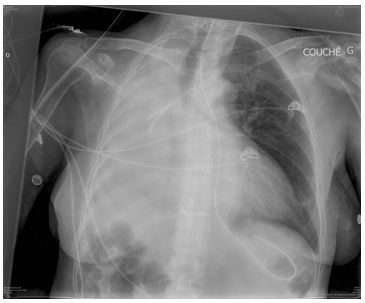
Désaturation soudaine post-intubation: poumon gauche



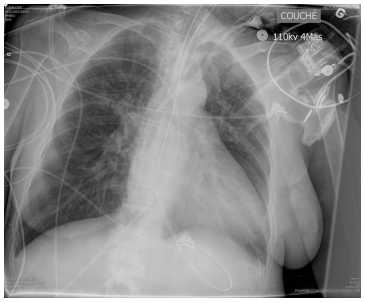
Désaturation soudaine post-intubation: poumon gauche

ZOOM

Pré-bronchoscopie



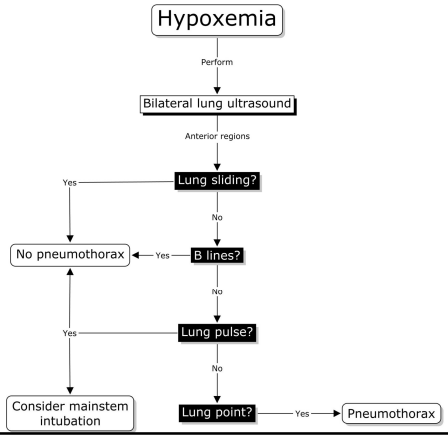
Post-bronchoscopie



A: prise en charge des VRS

- Intubation endobronchique droite:
  - ✓ Glissement pleural à droite seulement
  - ✓ Pas de glissement pleural à gauche
  - ✓ Pulsations pulmonaires cardiaques à gauche en qq secondes
  - ✓ Mouvement diaphragmatique exagéré à droite
- Pouls pulmonaire a une sensibilité de 90% pour le diagnostic de l'intubation endobronchique

Intensive Care Medecine 2003

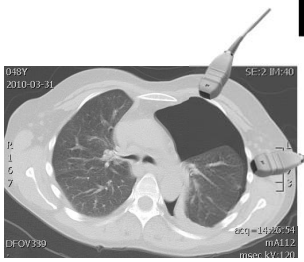


Pneumothorax

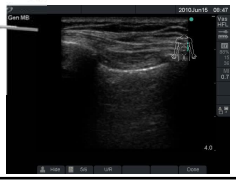
- Critères
  - ✓ Lignes A seulement
  - ✓ Point pulmonaire
- Exclusion: (*** au site de l'examen)
  - ✓ Présence d'un glissement pleural
  - ✓ Présence d'un pouls pulmonaire
  - ✓ Présence de lignes B

Point pulmonaire

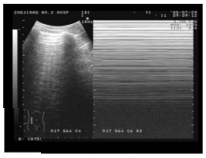
Pas de glissement pleural



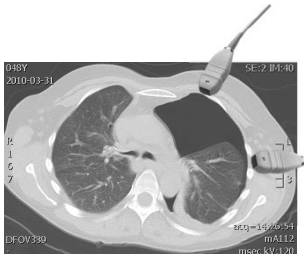
Glissement pleural



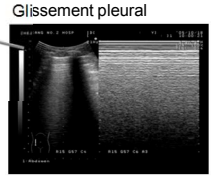
Point pulmonaire



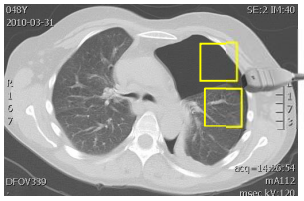
Pas de glissement pleural



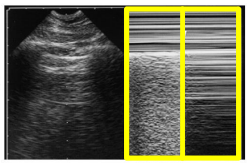
Glissement pleural



Point pulmonaire

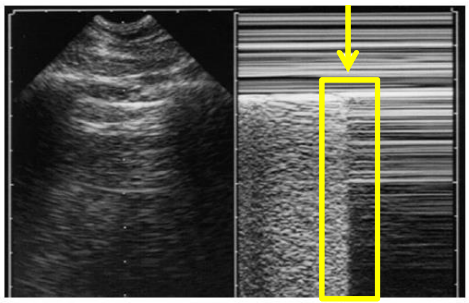


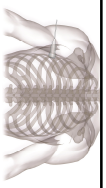
Pas de glissement pleural

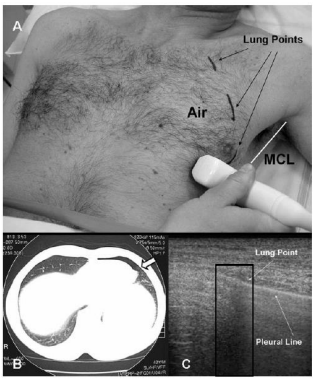


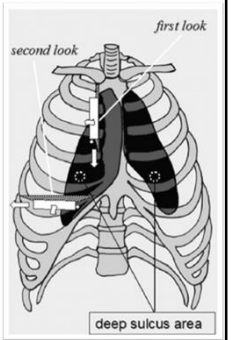
Glissement pleural

Point pulmonaire









Gino Soldati, CHEST / 133 / 1 / JANUARY, 2008

The Journal of TRAUMA® *Injury, Infection, and Critical Care*

Surgeon-Performed Ultrasound for Pneumothorax in the Trauma Suite

Jason L. Knudtzon, MD, Jonathan M. Dort, MD, FACS, Stephen D. Helmer, PhD, and R. Stephen Smith, MD, RDMS, FACS

Background: Surgeon-performed ultrasound has become ubiquitous in the trauma suite. Initial reports suggest that sonography may be used for the detection of pneumothorax. The purpose of this study was to evaluate the efficacy of sonography to rule out the presence of a pneumothorax in the trauma population.

Methods: A prospective analysis of 328 consecutive trauma patients at an American College of Surgeons-verified Level I trauma center was undertaken. Thoracic ultrasound was performed before chest radiography. The presence or absence of a "sliding-lung" sign or "comet-tail" artifact was recorded.

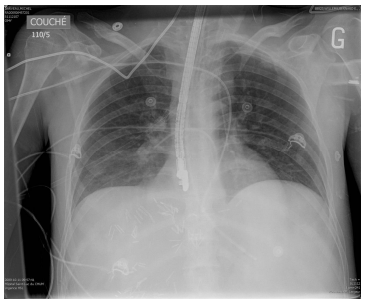
Results: Of 328 evaluations, there were 312 true-negatives, 12 true-positives, 1 false-negative, 1 false-positive, and 2 exclusions. Specificity, negative predictive value, and accuracy were 99.7%, 99.7%, and 99.4%, respectively.

Conclusion: Ultrasound is a reliable modality for the diagnosis of pneumothorax in the injured patient. This modality may serve as an adjunct or precursor to routine chest radiography in the evaluation of injured patients.

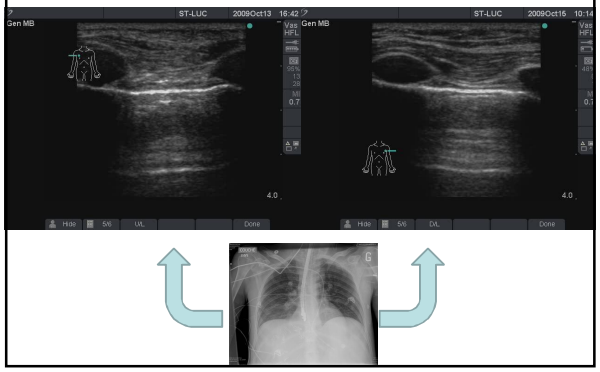
Key Words: Ultrasound, Trauma, Pneumothorax, Lung-sliding, Comet-tail.

J Trauma. 2004;56:527–530.

‖ de 42 ans post-greffe de foie



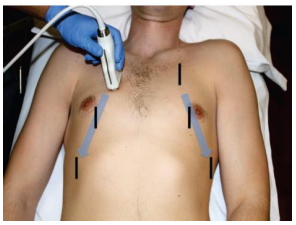
‖ de 42 ans post-greffe de foie: désaturation



Poumon droit:

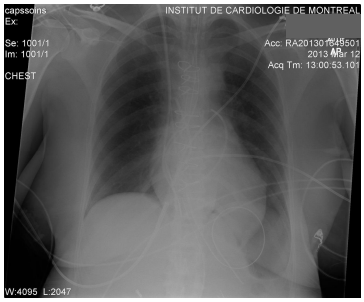
Intraoperative Pneumothorax Identified with Transthoracic Ultrasound

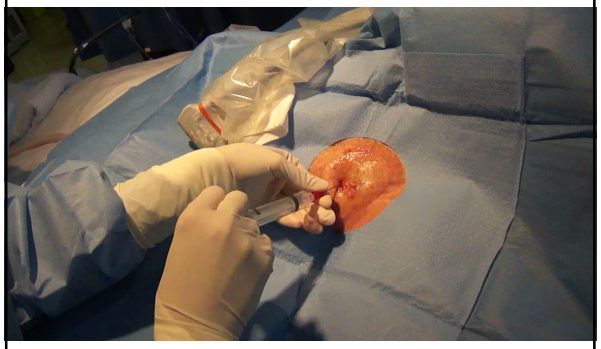
Kenichi Ueda, M.D.,* Waseemuddin Ahmed, M.D.,† Alan F. Ross, M.D.‡

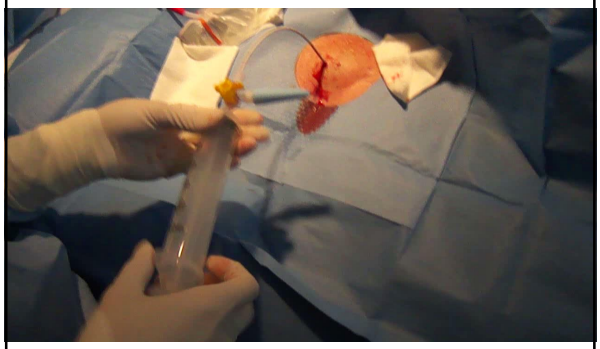


Anesthesiology 2011;115:653-5

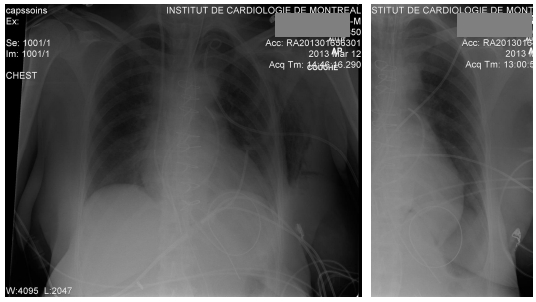
Femme de 57 ans post Bentall





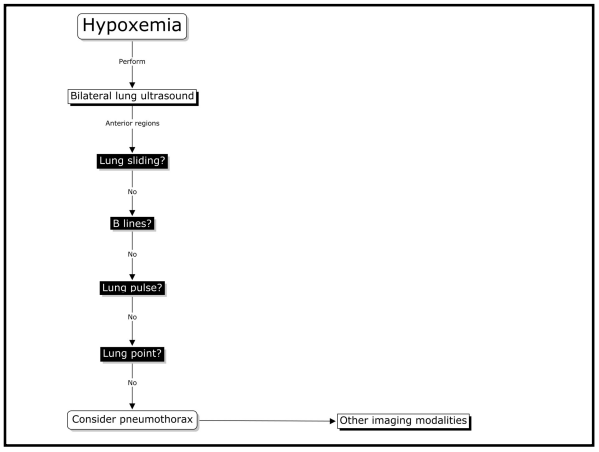


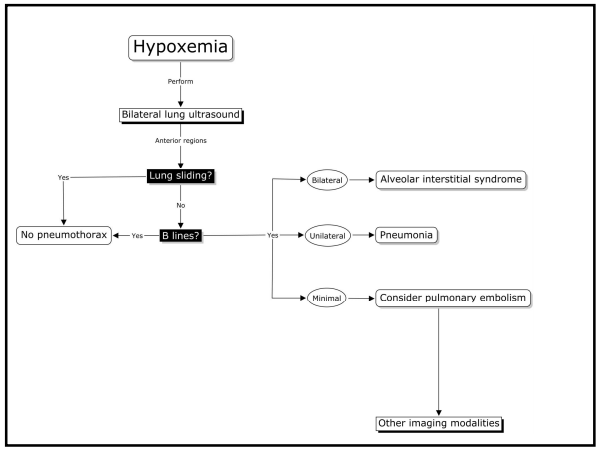
Post drainage



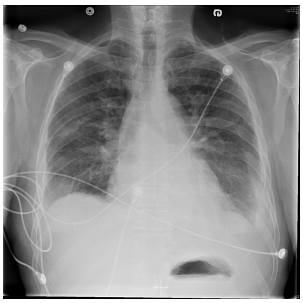
Absence de glissement pleural ≠ pneumothorax

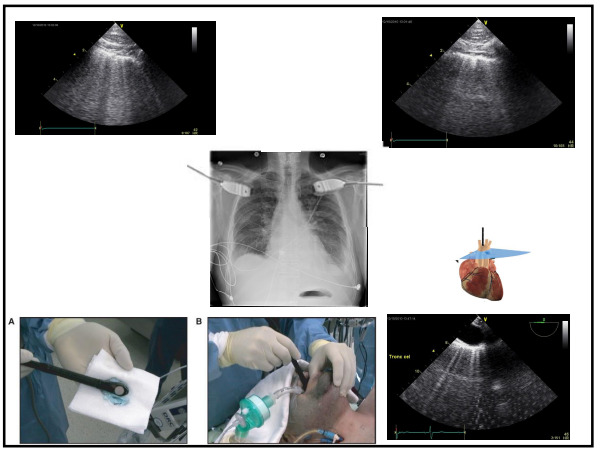
- Poumon immobilisé
  - ✓ Intubation endobronchique
  - ✓ ARDS sévère
  - ✓ Adhérences pleurale
  - ✓ Hyperinflation sévère, emphysème bulleux
- Plèvres sont séparées
  - ✓ Drain thoracique
  - ✓ Atélectasie significative
  - ✓ Épanchement

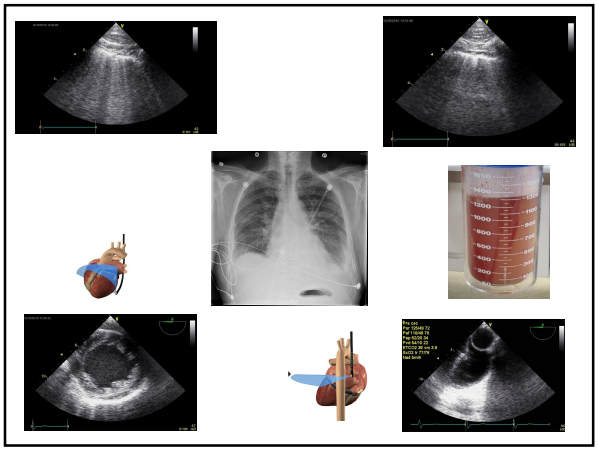


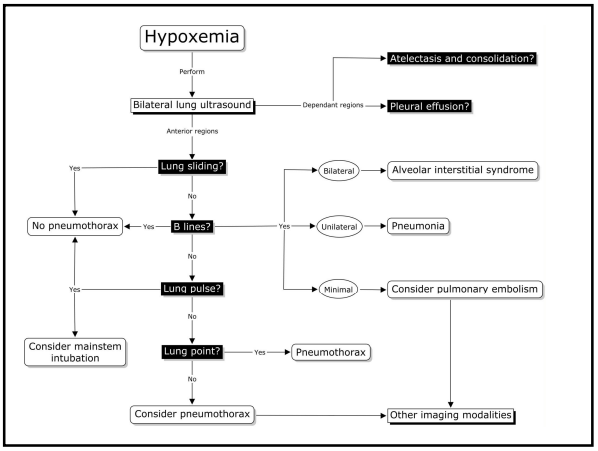


‖ de 86 ans pré-opératoire







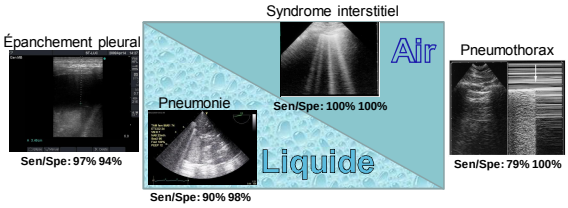


Limitations de l'échographie pulmonaire

- Nécessite équipement d'ultrason
- Nécessite une fenêtre sur le thorax
  - ✓ Pansements
  - ✓ Obésité morbide
  - ✓ Emphysème sous-cutané
- Structures thoraciques centrales non visualisées
- Examen dépendant de l'opérateur
- Formation nécessaire

Limitations de l'échographie pulmonaire

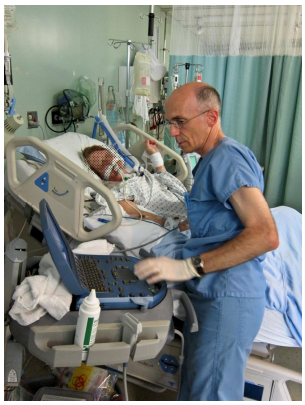
Contenu pulmonaire



Stéthoscope

Stethos = paroi thoracique

Scopein = observer



En résumé

- L'échographie pulmonaire est actuellement utilisée par plusieurs spécialités à travers le monde
- Ses indications sont pertinentes dans la prise en charge des patients aux soins intensifs, à l'urgence et en salle d'opération
- La formation en échographie pulmonaire fait partie des programmes d'éducation en soins intensifs, anesthésie et médecine d'urgence

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Assistant de recherche
Inhalothérapeute

Dre Chantale Lafond.
Pneumologue

Remerciements