The NEW ENGLAND JOURNAL of MEDICINE

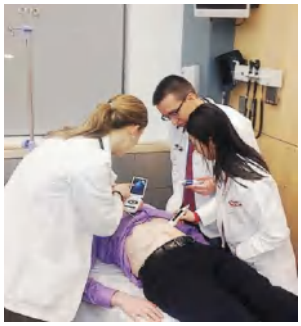
PERSPECTIVE

Point-of-Care Ultrasound in Medical Education — Stop Listening and Look

Scott D. Solomon, M.D., and Fidencio Saldana, M.D.

N Engl J Med 2014; 370:1083-1085 | March 20, 2014 | DOI: 10.1056/NEJMp1311944

A generation of physicians will need to be trained to view this technology as an extension of their senses, just as many generations have viewed the stethoscope. That development will require the medical education community to embrace and incorporate the technology throughout the curriculum.



Respirology

Respirology. 2019 Aug 27. doi: 10.1111/resp.13692.

EDITORIAL

Time to embrace POCUS as part of the bedside diagnosis of respiratory diseases

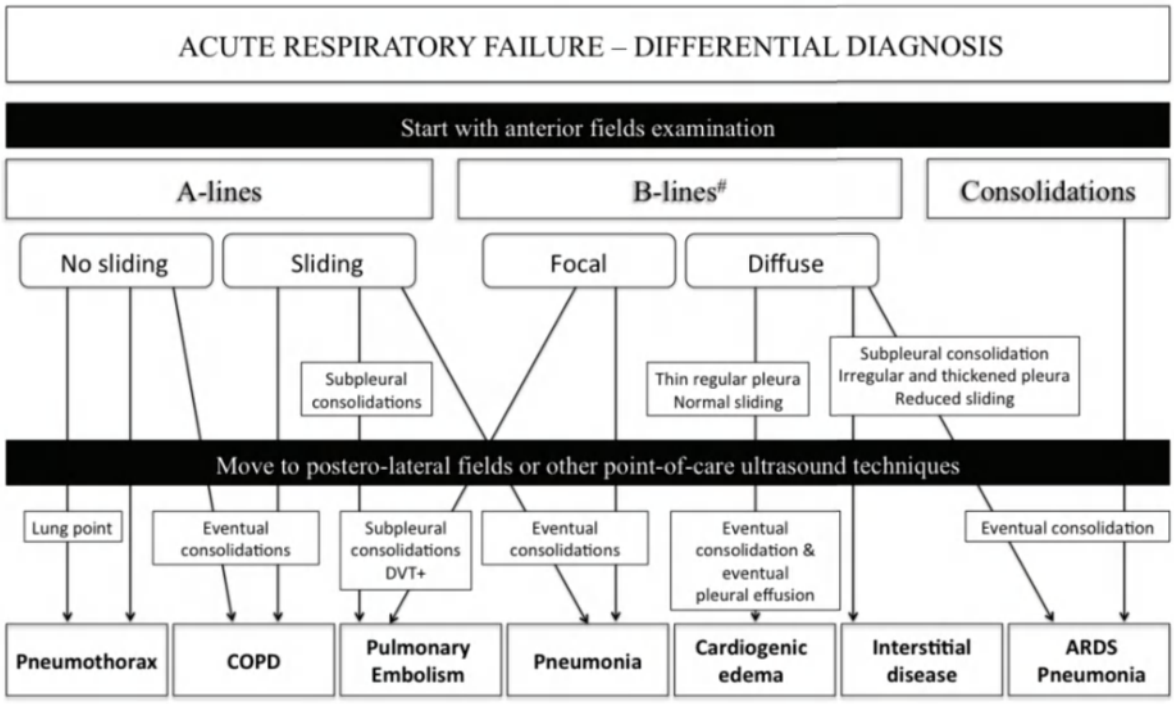
肺超声是急危重症超声应用中不可或缺的重要内容，对多种急慢性疾病的肺部评估意义重大！

Table 1 Ultrasonographic patterns in common diseases causing dyspnoea†

Disease	Ultrasound findings
ADHF	>2 B-lines in ≥2 adjacent areas bilaterally associated with lung sliding and regular pleural line, bilateral pleural effusions, left ventricular dysfunction, IVC >2.1 cm and <50% collapsibility
ARDS	Bilateral patchy B-lines (at least three per scan) with reduced or abolish lung sliding and irregular/thickened pleural line (i.e. trace or non-translobar consolidations), eventual translobar consolidations
Pneumonia	Focal unilateral B-lines, lung consolidation, dynamic air bronchogram, shred sign,‡ reduced or absent lung sliding, ipsilateral simple or complex pleural effusion
COPD, asthma	Bilateral A-lines with lung sliding, reduced or absent lung sliding in severe cases (blebs)
Pulmonary embolism	Bilateral A-lines, focal B-lines, small wedge-shaped consolidations (infarcts), pleural effusion may be present, dilated right ventricle, dilated IVC with low collapsibility, deep venous thrombosis
Pneumothorax	A-lines with absent lung sliding, lung point, absent anterior B-lines
Pleural effusion	Anechoic/hypoechoic/echogenic fluid collection with passive lung atelectasis, quad sign,§ pleural or diaphragmatic nodularity/thickening suggests malignancy
Cardiac tamponade	Circumferential pericardial effusions, dilated IVC with <50% inspiratory collapse, right atrial systolic collapse, right ventricular diastolic collapse

Lung Ultrasound for Critically Ill Patients

Francesco Mojoli [1,2], Bélaid Bouhemad [3,4], Silvia Mongodi [2], and Daniel Lichtenstein [5]



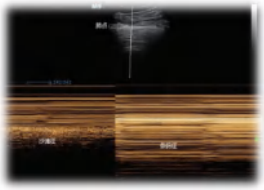
Am J Respir Crit Care Med. 2019 Mar 15;199(6):701-714

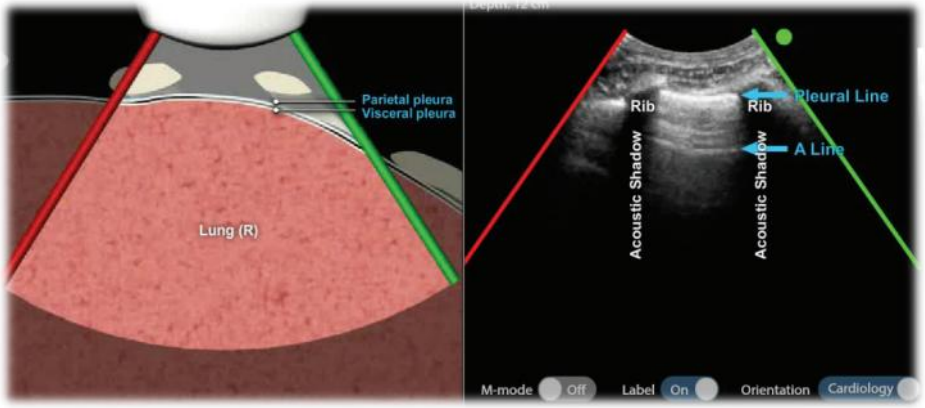
二、肺超声基础

肺超声的12个基本征象

1. 胸膜线
2. 肺滑移征
3. A线
4. B线
5. 肝样变
6. 碎片征

7. 支气管充气征
8. 肺搏动
9. 液性暗区
10. 沙滩征
11. 平流层征
12. 肺点





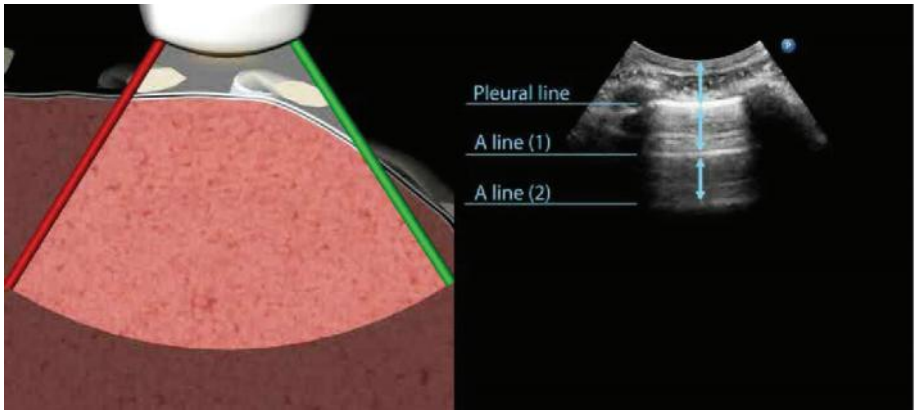
1. 胸膜线

2. 肺滑移征

3. A线

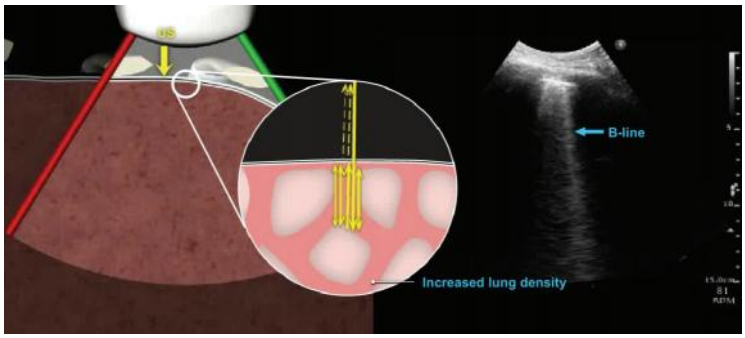
- 与胸膜线**平行**、**重复**的、**等距**的数条高回声线；
- 其间距等于皮肤到胸膜线的距离。

注意：若肺深部有病变，未累及胸膜线下肺组织，则超声下为正常肺征象，容易漏诊。



4. B线

- 由胸膜线发出
- 激光束样高回声条
- 无衰减直达屏幕边缘
- 随呼吸运动
- A线消失



5. 肝样变

类似肝实质样软组织回声

6. 碎片征

不规则的碎片状强回声

7. 支气管充气征

动态支气管充气征

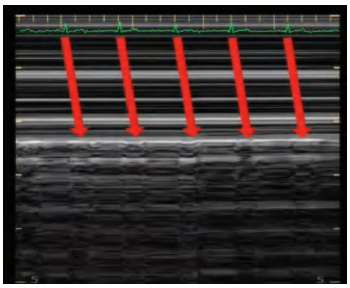
多见于肺炎

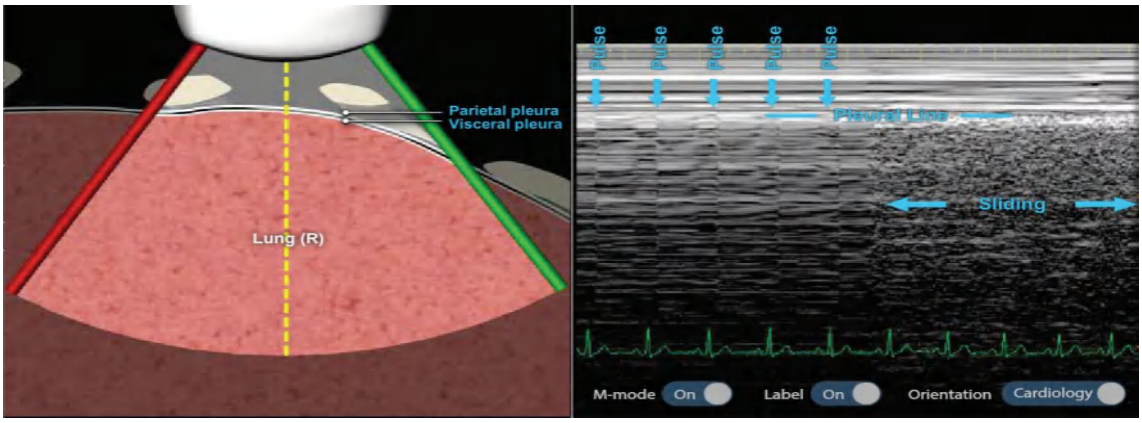
静态支气管充气征

常见于肺不张

8. 肺搏动

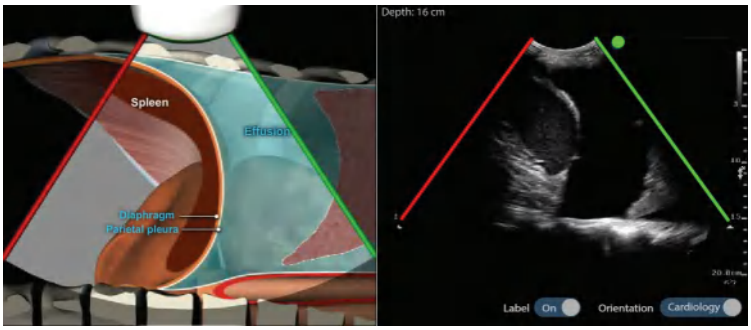
肺搏动是完全性肺不张早期的诊断性征象。心脏的跳动可通过不张的肺组织传导至胸膜，引起胸膜线震动。

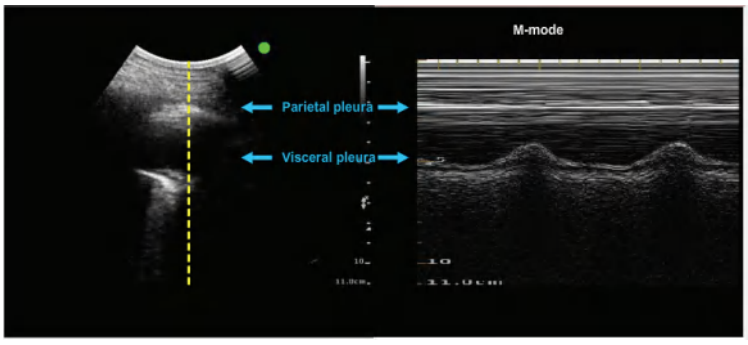




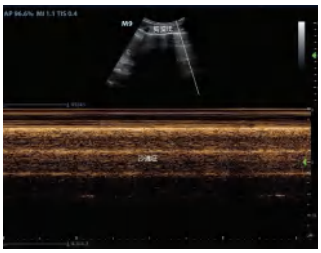
9. 液性暗区

大多胸腔积液是无回声性的，胸膜线和压缩不张的肺组织清晰可见。

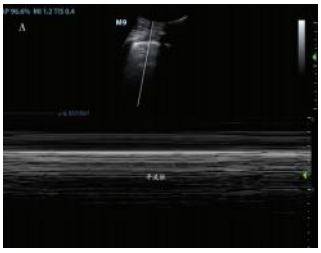




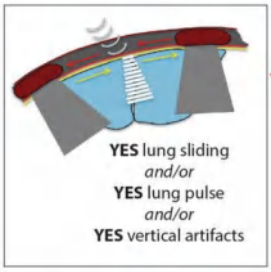
10-12. 沙滩征，平流层征和肺点

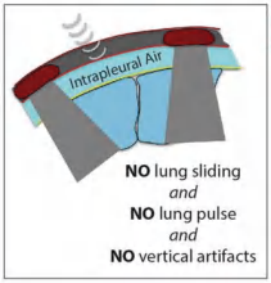


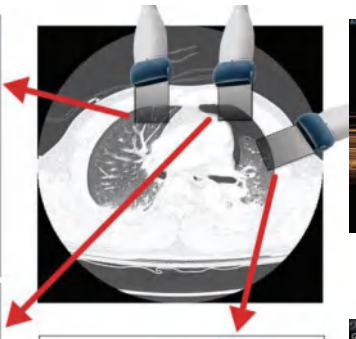
沙滩征

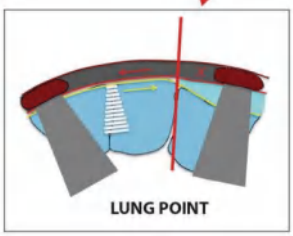


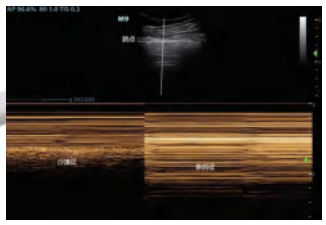
平流层征











肺点

三、呼吸衰竭的肺超声应用

✓ 应用1：定性和定量诊断气胸

Pneumothorax

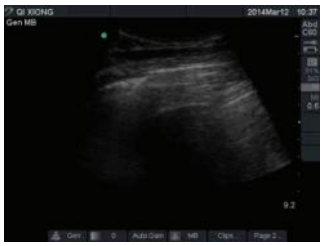
Technique

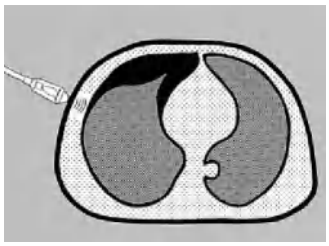
Statement code B-D1-S1 (strong recommendation: level A of evidence)

- The sonographic signs of pneumothorax include the following:
  - Presence of lung point(s)
  - Absence of lung sliding
  - Absence of B-lines
  - Absence of lung pulse

B-D1-S2 (strong: level A)

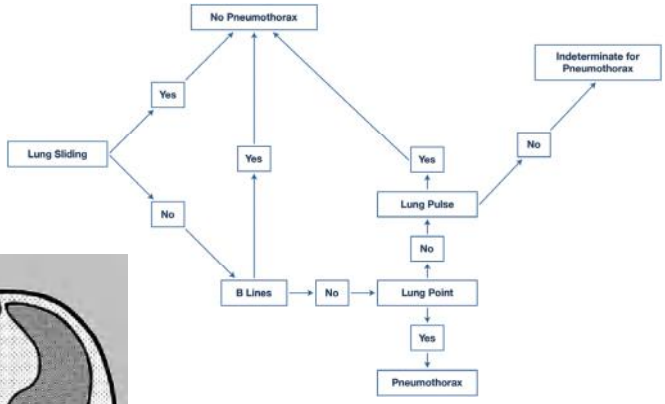
- In the supine patient, the sonographic technique consists of exploration of the least gravitationally dependent areas progressing more laterally.
- Adjunct techniques such as M-mode and color Doppler may be used.





CONFERENCE REPORTS AND EXPERT PANEL

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



Intensive Care Med (2012) 38:577–591
Intensive Care Med. 2019 Sep;45(9):1200-1211

CHEST Original Research

PULMONARY PROCEDURES

Diagnosis of Pneumothorax by Radiography and Ultrasonography

A Meta-analysis

Wu Ding, MM; Yuehong Shen, MM; Jianxin Yang, MM; Xiaojun He, MM; and Mao Zhang, MD

20篇英文文献纳入分析

	敏感性	特异性	AUC
超 声	0.88	0.99	0.996
胸 片	0.52	1.0	0.944

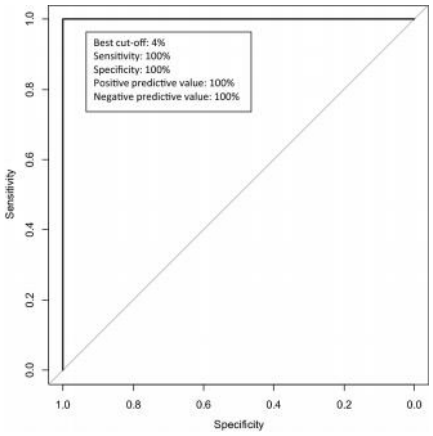
CHEST 2011; 140(4):859–866

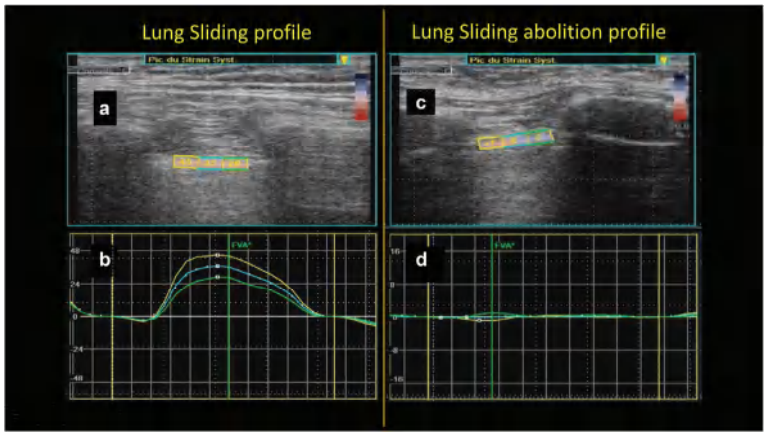
Intensive Care Medicine
September 2019, Volume 45, Issue 9, pp 1212–1218 | Cite as

Speckle tracking quantification of lung sliding for the diagnosis of pneumothorax: a multicentric observational study

Authors | Authors and affiliations

Gary Duclos, Xavier Bobbia, Thibaut Markarian, Laurent Muller, Camille Cheyssac, Sarah Castillon, Noémie Resseguier, Alain Boussuges, Giovanni Volpicelli, Marc Leone, Laurent Zieleskiewicz





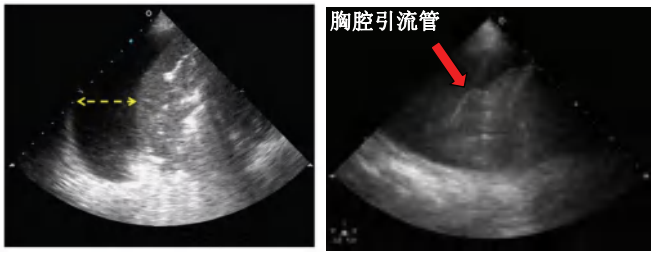
斑点追踪技术可使肺滑动量化，检测肺滑动是否消失

Intensive Care Med. 2019 Sep;45(9):1212-1218

✓ 应用2：辅助胸腔积液的诊治

- 确诊胸腔积液
- 了解积液的性质

- 准确估算积液量，指导处理
- 引导胸腔穿刺引流
- 评估穿刺效果和并发症



Brogi et al. Critical Care (2017) 21:325
DOI 10.1186/s13054-017-1897-5

Critical Care

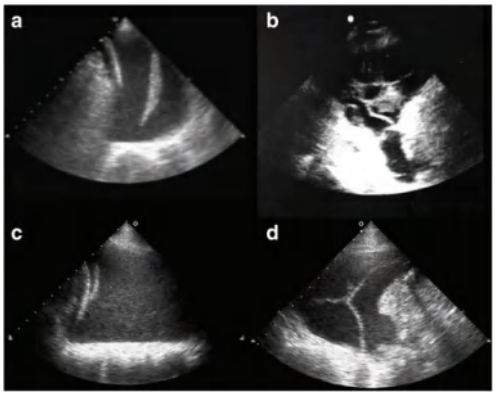
REVIEW Open Access

Thoracic ultrasound for pleural effusion in the intensive care unit: a narrative review from diagnosis to treatment

E. Brogi[1*], L. Gargani[2], E. Bignami[3], F. Barbariol[4], A. Marra[5], F. Forfori[1] and L. Vetrugno[4]

Table 1 Assessment of fluid volume

Authors	Patients	Position	Derived formula	Results	Mean prediction error[a]/ mean bias[b]	Limits of agreements[c]/ standard error[d]
Vignon et al. [29]	Mechanically ventilated and not ventilated patients	Supine	NA	Pleural effusion > 800 mL predicted when the distance is: > 45 mm (right; sensitivity 94%, specificity 76%); > 50 mm (left; sensitivity 100%, specificity 67%) Positive linear correlation between distance and volume: $r = 088$; $r^2 = 0.72$; $p < 0.0001$	28 ± 146 mL[b]	−286 mL and +343mL[c]
Roch et al. [30]	Mechanicall ventilated patients	Supine with arm abducted	NA	A distance between lung and posterior chest wall at the lung base > 5 cm predicted a drained volume > 500 mL (sensitivity 83%, specificity 90%, positive predictive value 91%, negative predictive value 82%)	NA	NA
Balik et al. [31]	Mechanically ventilated patients	Supine with mild trunk elevation at 15°	V(ml) = 20 × Sep (mm)	Positive linear correlation between distance (Sep) and volume: $r = 0.72$; $r^2 = 0.52$; $p < 0.001$	158.4 ± 160.6[a]	NA
Usta et al. [32]	Spontaneous breathing patients after cardiac surgery	Sitting	V (ml) = 16 × D (mm)	Positive linear correlation between D and V: $r = 0.89$, $r^2 = 0.79$; $p < 0.001$	−21.1 ± 97.78[a]	97.42[d]
Remérand et al. [33]	Critically ill patients	Supine	V (ml) = $L_{US} \times A_{US}$	Positive linear correlation between ultrasound V and drained V ($r = 0.84$, $p < 0.001$) and with CT V ($r = 0.90$, $p < 0.001$).	−33[b]	−292 to + 227 mL[c]



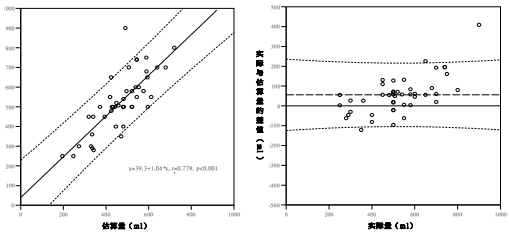
Crit Care. 2017 Dec 28;21(1):325

中国急救医学 2007年 10月第 27卷第 10期 Chin J Crit Care Med, Oct. 2007, Vol 27, No. 10

论 著

机械通气患者胸腔积液分布形态与精确定量的研究

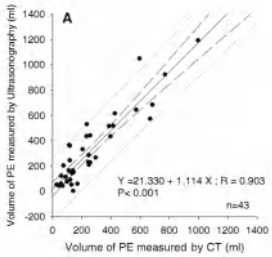
张 茂， 杨俭新， 刘志海， 干建新， 徐少文， 江观玉



中华超声影像学杂志 2011 年 2 月第 20 卷第 2 期 Chin J Ultrasonogr, February 2011, Vol 20, No. 2

危重患者胸腔积液超声测量新方法的建立与应用

张茂 杨俭新 徐善祥 巴立 刘志海 洪玉才 干建新 徐少文



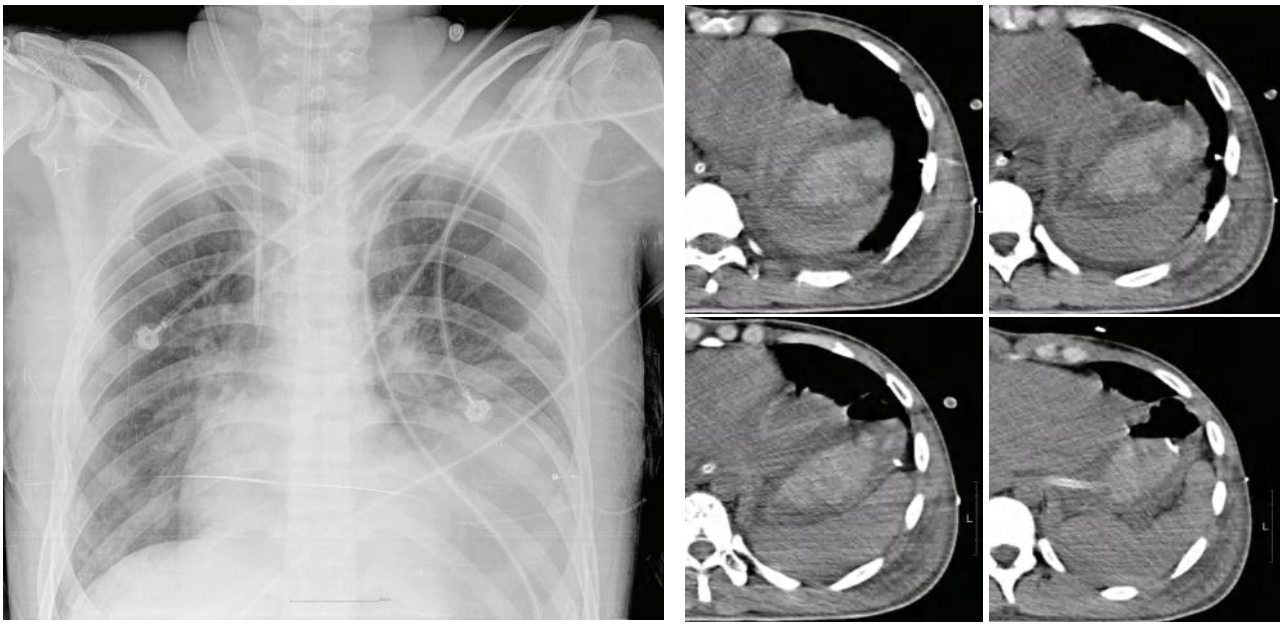
Intensive Care Med
DOI 10.1007/s00134-010-1769-9

ORIGINAL

Francis Remérand
Jean Dellamonica
Zhang Mao
Fabio Ferrari
Belaïd Bouhemad
Yang Jianxin

Multiplane ultrasound approach to quantify pleural effusion at the bedside

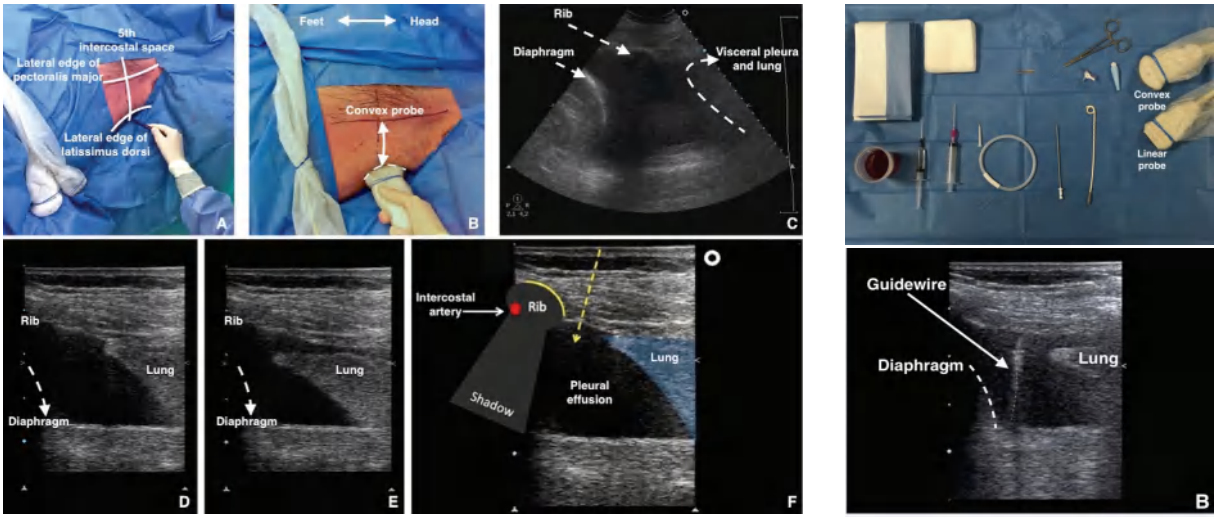
解剖标志引导的胸腔积液引流有潜在风险



ORIGINAL ARTICLE Open Access

An easier and safe affair, pleural drainage with ultrasound in critical patient: a technical note

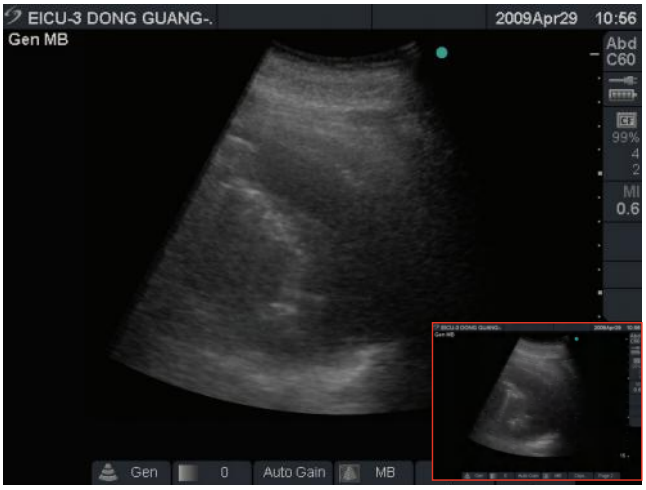
Luigi Vetrugno[1], Giovanni Maria Guadagnin[1*], Daniele Orso[1], Enrico Boero[2], Elena Bignami[3] and Tiziana Bove[1]



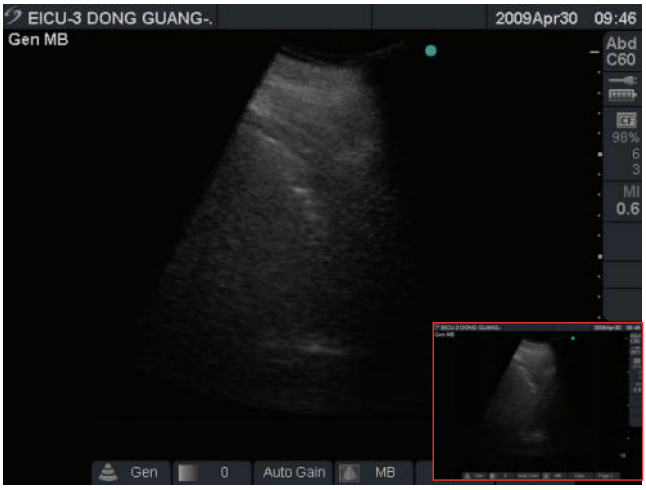
超声提高危重患者胸腔积液穿刺引流的安全性

Crit Ultrasound J. 2018 Aug 1;10(1):18

超声能快速评估引流的效果和并发症

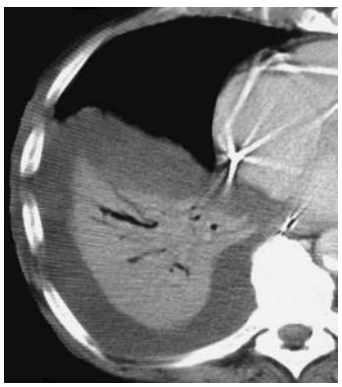


引流前



引流后

✓ 应用3：评估肺实变/肺不张



Crit Ultrasound J (2009) 1:13–16
DOI 10.1007/s13089-009-0003-x

ORIGINAL ARTICLE

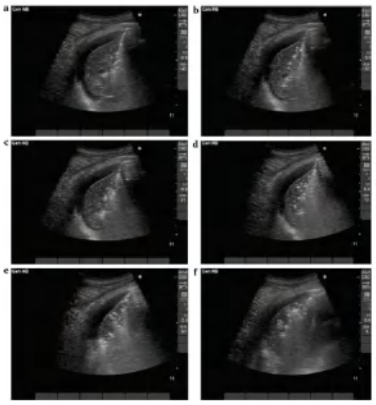
Detection of lung atelectasis/consolidation by ultrasound in multiple trauma patients with mechanical ventilation

Jian-xin Yang · Mao Zhang · Zhi-hai Liu · Li Ba · Jian-xin Gan · Shao-wen Xu

Table 1 Efficacy of ultrasound in the diagnosis of lung atelectasis/consolidation

CT	Ultrasound		
	Positive	Negative	Total
Positive	126	28	154
Negative	0	170	170
Total	126	198	324

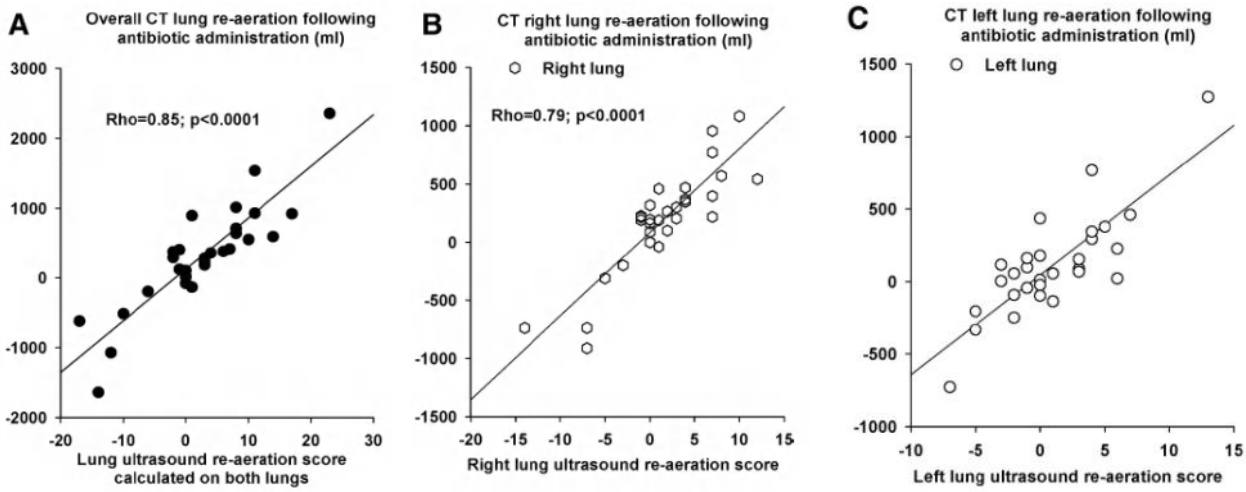
A concordance test showed a *Kappa* coefficient of 0.825 ($P = 0.031$)



Crit Ultrasound J, 2009, 1(1):13-16

Ultrasound assessment of antibiotic-induced pulmonary reaeration in ventilator-associated pneumonia*

Bélaïd Bouhemad, MD, PhD; Zhi-Hai Liu, MD; Charlotte Arbelot, MD; Mao Zhang, MD; Fabio Ferarri, MD, PhD; Morgan Le-Guen, MD; Martin Girard, MD; Qin Lu, MD, PhD; Jean-Jacques Rouby, MD, PhD



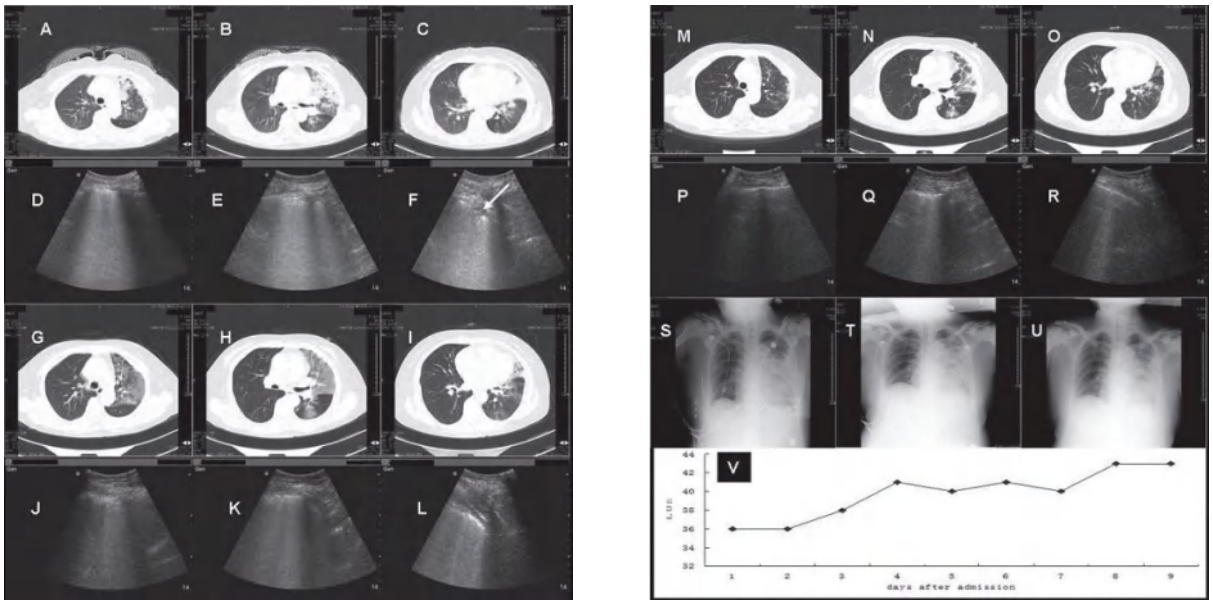
Crit Care Med, 2010, 38(1):84-92

Shen *et al. Critical Care* 2013, 17:438
http://ccforum.com/content/17/3/438

CRITICAL CARE

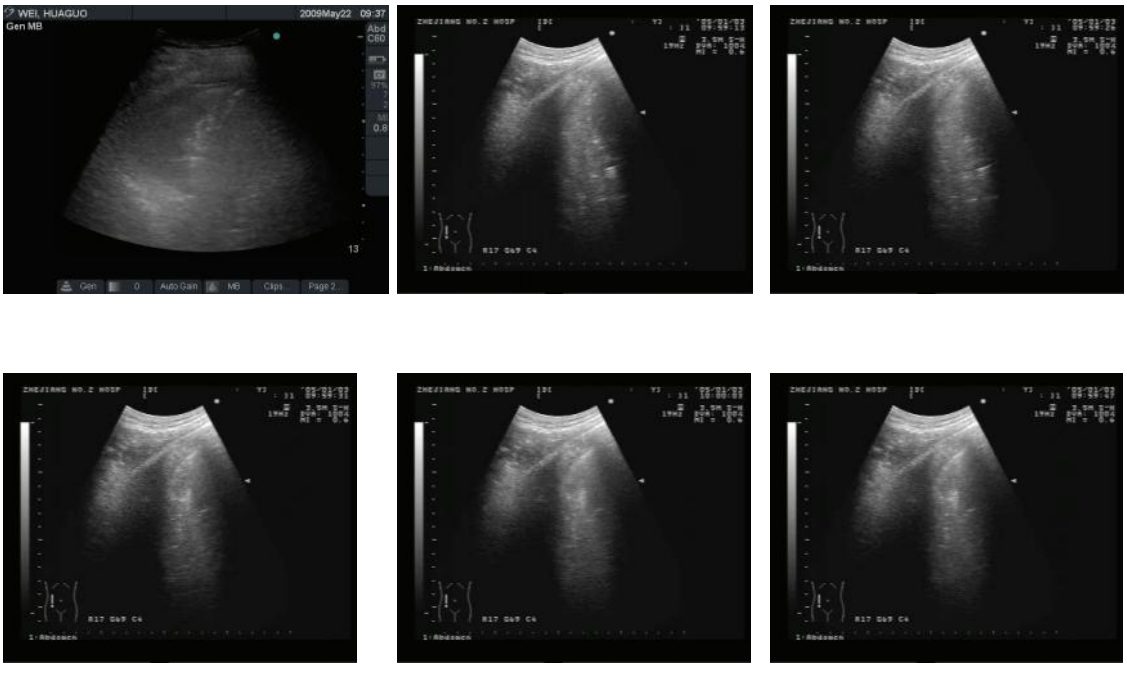
Dynamic assessment of lung injury by ultrasound in a case with H7N9 influenza

Peng Shen[1], You-ming Zong[1], Jing Shu[1], Yun-chao Shi[1], Wen-jun Zhu[2], Hui-jiang Qian[3], Mao-xian Yang[1] and Mao Zhang[*4]



Critical Care 2013, 17:438

✓ 应用4：指导呼吸机设置/脱机

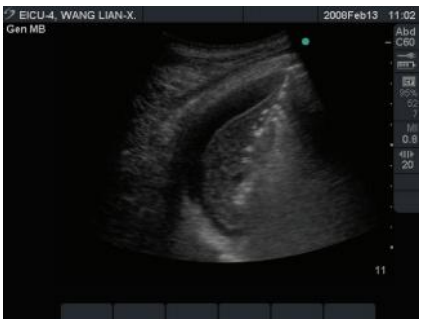


超声显示不同水平PEEP的肺复张效果

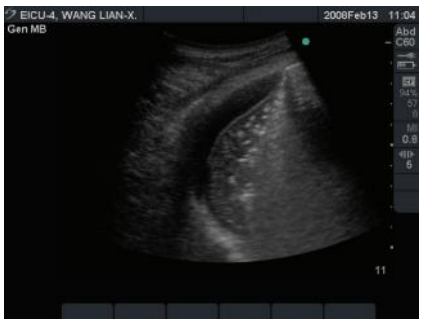
PEEP=0cmH$_2$O

PEEP=5cmH$_2$O

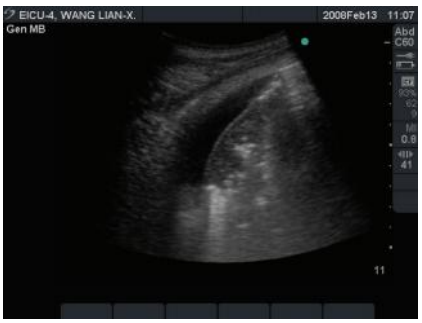
PEEP=10cmH$_2$O



PEEP=15cmH$_2$O



PEEP=20cmH$_2$O



PEEP=25cmH$_2$O

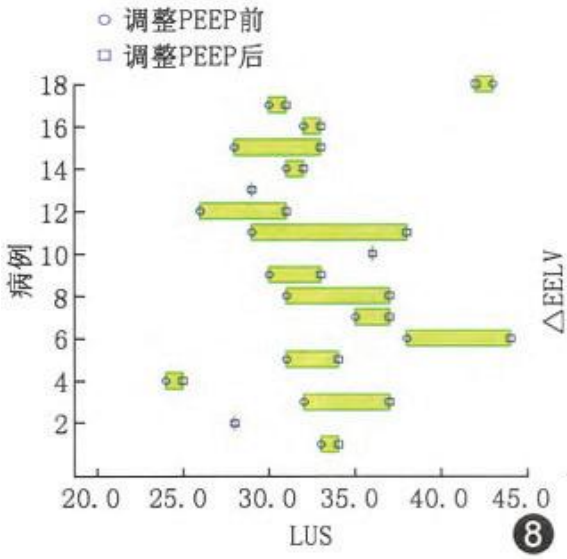
左下肺不张纤支镜治疗的效果

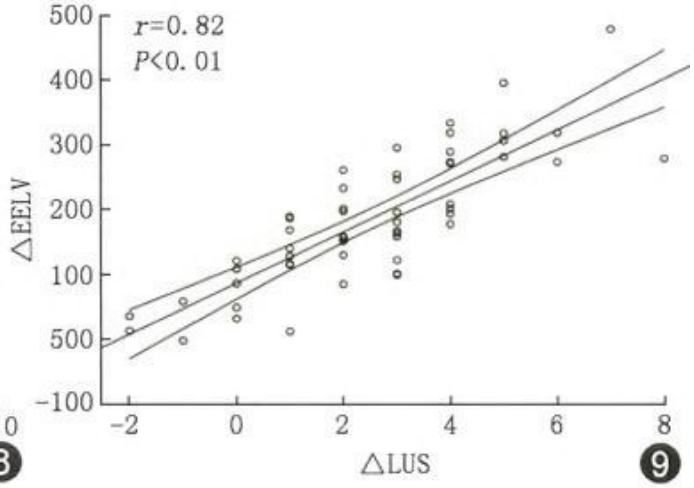
纤支镜治疗前（10:45）

纤支镜治疗后（11:06）

床旁超声对机械通气患者呼气末正压诱导肺容积改变的评估价值

沈鹏　罗汝斌　高玉芝　王吉文　张茂

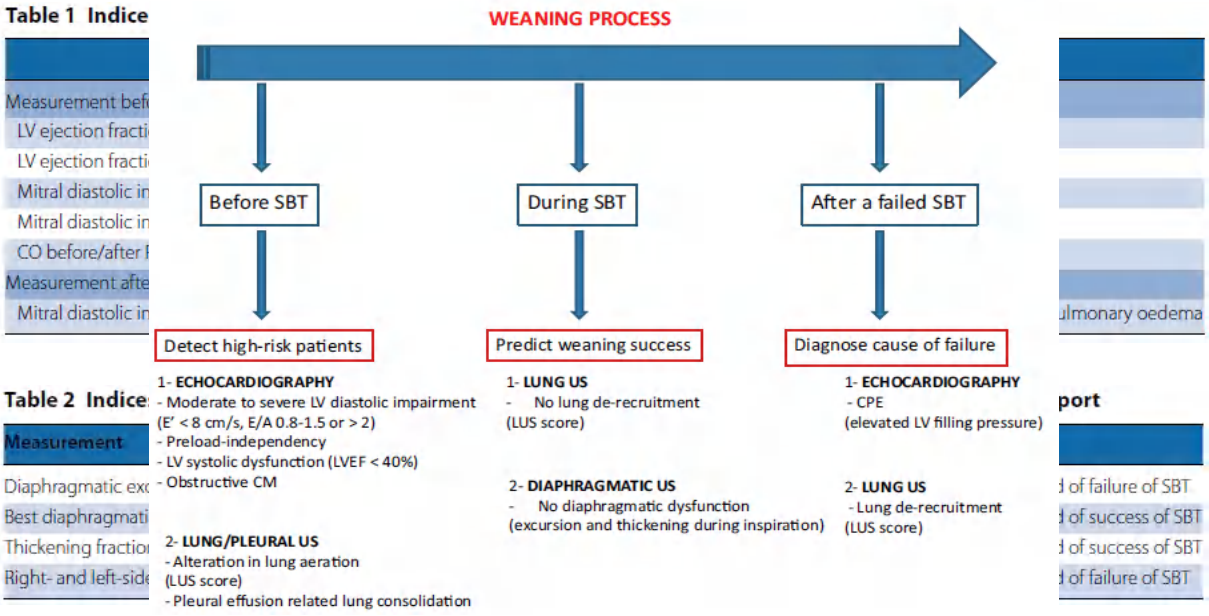




中华结核和呼吸杂志, 2014, 37(5): 332-336.

REVIEW

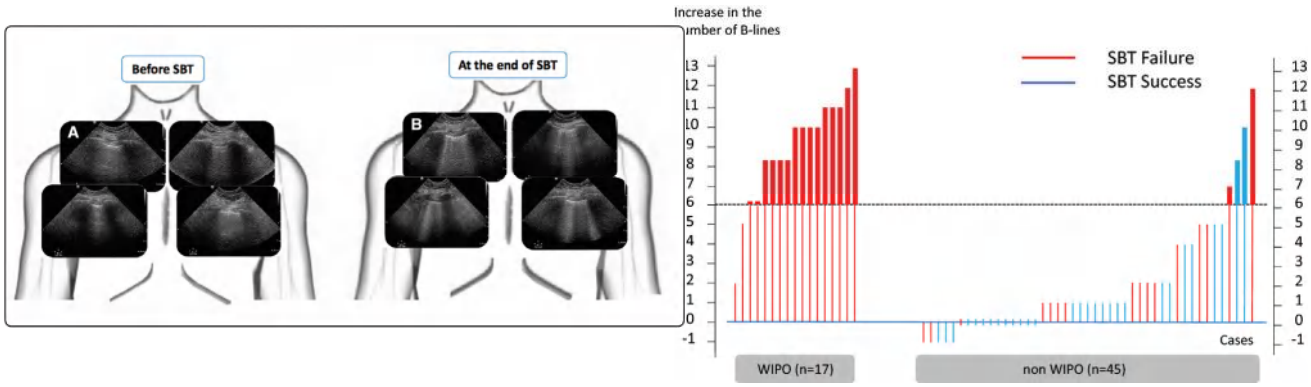
Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung



Intensive Care Med,2016,online

Intensive Care Medicine
May 2019, Volume 45, Issue 5, pp 601–608 | Cite as

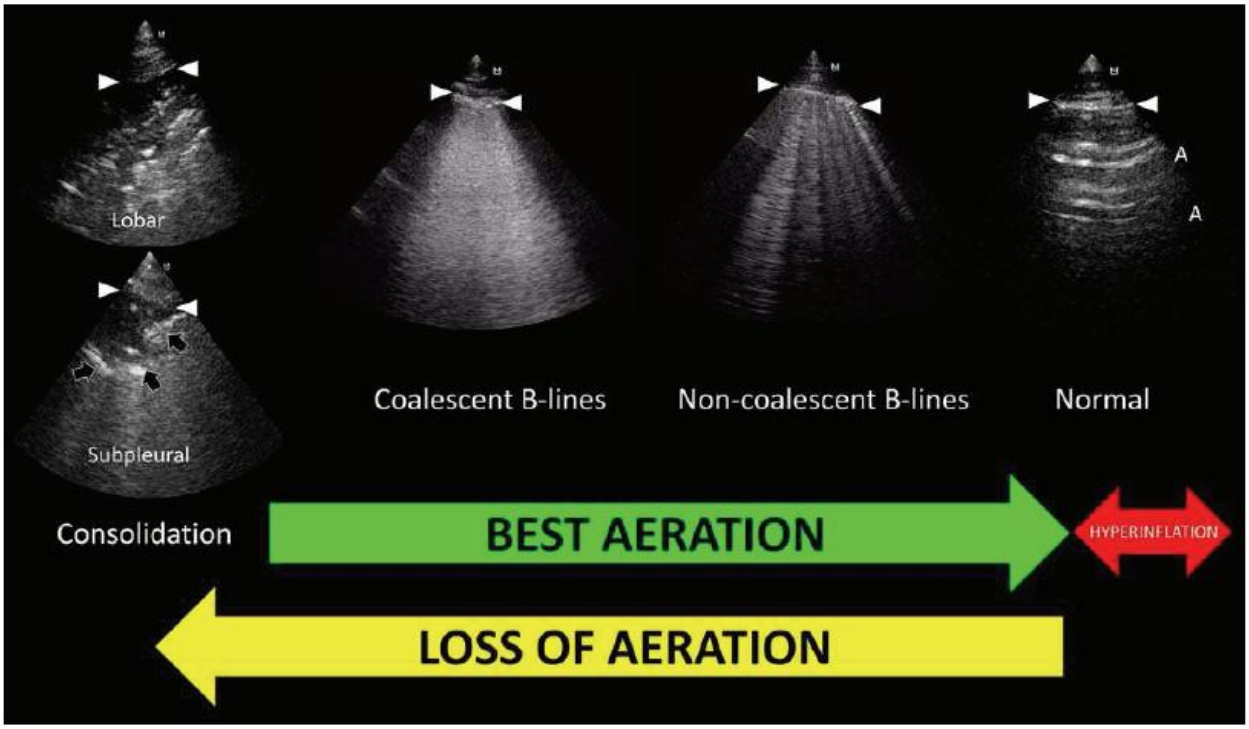
Lung ultrasound allows the diagnosis of weaning-induced pulmonary oedema



Weaning from mechanical ventilation may induce weaning induced pulmonary oedema (WIPO). That lung ultrasound was able to detect the occurrence of WIPO, by showing that a value of 6 in the increase of B lines on four anterior points of the chest wall provides the best accuracy.

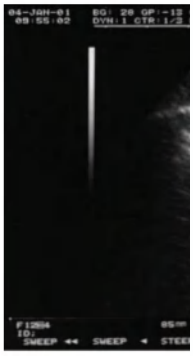
Intensive Care Med (2019) 45:601–608

✓ 应用5：评估肺水肿



J Ultrasound Med. 2018 May 6

超声能够反映肺水肿的程度



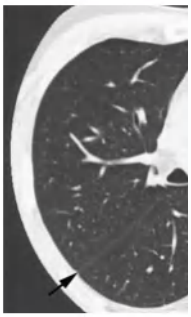
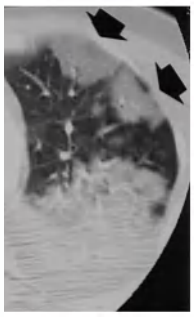


Table 1
Lung ultrasonography findings of ACPE and ARDS

	ACPE	ARDS
Clinical setting	Acute	Acute
B-lines	Always present	Always present
Distribution of B-lines	Bilateral and symmetric distribution	Non-homogeneous distribution, presence of spared areas
Pleural line abnormalities	Absent	Present, typical
Reduction or absence of lung sliding	Absent	Present
Lung pulse	Absent	Present
Consolidations	Absent	Frequent in the posterior areas

ACPE acute cardiogenic pulmonary edema, *ARDS* adult respiratory distress syndrome



CHEST 2009; 136:1014–1020
Intensive Care Med (2019) 45:1200–1211

Global and Regional Diagnostic Accuracy of Lung Ultrasound Compared to CT in Patients With Acute Respiratory Distress Syndrome

Davide Chiumello;Michele Umbrello;Giuseppe Sferrazza Papa;Alessio Angileri;Martina Gurgitano;Paolo Formenti;Silvia Coppola;Sara Froio;Antonio Cammaroto;Gianpaolo Carrafiello;

TABLE 2. Global Diagnostic Accuracy of Lung Ultrasound

CT Scan Pattern	Area Under the Receiver Operating Characteristic Curve	Sensitivity % (95% CI)	Specificity % (95% CI)	Positive Predictive Value % (95% CI)	Negative Predictive Value % (95% CI)
Normally areated	0.933 (0.885–0.981)	88.6 (75.4–96.2)	97.9 (95.8–99.2)	84.8 (71.1–93.7)	98.5 (96.6–99.5)
Alveolar-interstitial	0.854 (0.821–0.887)	83.2 (74.6–90.9)	90.3 (87.9–93.0)	65.7 (54.8–77.1)	97.4 (95.0–98.9)
Consolidated	0.851 (0.818–0.884)	82.7 (78.4–86.8)	90.2 (88.9–93.2)	90.4 (86.0–95.2)	86.9 (81.7–91.0)
Pleural effusion	0.954 (0.928–0.981)	92.3 (85.4–96.6)	98.6 (96.4–99.6)	96.0 (90.1–98.9)	97.2 (94.5–98.8)

Data are expressed as the weighted diagnostic statistics (95% CI); positive predictive value and negative predictive value are calculated assuming that the population prevalence of the CT scan pattern is equal to the sample prevalence.

TABLE 3. Regional Diagnostic Accuracy of Lung Ultrasound

	Anterior Lung Region		Lateral Lung Region		Posterior Lung Region	
CT scan pattern	Sensitivity % (95% CI)	Specificity % (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)
Normally areated	88.2 (72.5–96.7)	95.7 (89.5–98.8)	90.0 (55.5–99.7)	97.5 (92.7–99.5)	–	–
Alveolar-interstitial	85.0 (70.2–94.3)	87.5 (78.7–93.6)	88.2 (63.6–98.5)	91.0 (84.1–95.6)	100.0 (2.5–100.0)	96.9 (92.1–99.1)
Consolidated	81.1 (68.0–90.6)	93.3 (85.1–97.8)	82.9 (72.5–90.6)	88.5 (76.6–95.6)	87.8 (75.2–95.4)	96.2 (89.3–99.2)
Pleural effusion	100.0 (2.5–100.0)	100.0 (97.1–100.0)	84.0 (63.9–95.5)	99.0 (94.7–100.0)	94.9 (87.4–98.6)	94.0 (83.5–98.7)

Data are expressed as the weighted diagnostic statistics (95% CI).
Dashes indicate that in the posterior lung regions no normally aerated patterns were found, so the diagnostic statistics could not be calculated.

Crit Care Med. 2019 Aug 26