

肺エコー入門
The Blue Protocol

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**COI開示: FUJIFILM, JICAのコンサルタント
 ケニアでのPOCUS指導**

2020年2月 ケニア、ナイロビ

I am a consultant of FUJIFILM Corp, Japan in association to the project funded by Japan International Cooperation Agency (JICA) concerning the “SDGs Business Verification Survey with the Private Sector for Point of Care Ultrasound through Professional Capacity Development in Kenya”



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Acknowledgement: 謝辞

Nilam J. Soni先生
 山田徹先生
 北野有佳先生
 吉野俊平先生
 ケアネットの皆様
 本日参加されている皆さま

3

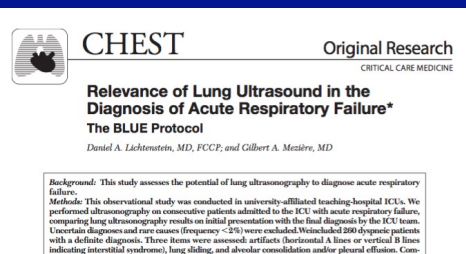
**Acknowledgement 謝辞:
 Dr. Daniel Lichtenstein**

2005年10月、モントリオールにて 2013年10月 ポストンにて



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The BLUE Protocol



Lichtenstein DA, CHEST 2008; 134:117–125

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The BLUE Protocol

Bedside
 Lung
 Ultrasound in
 Emergency

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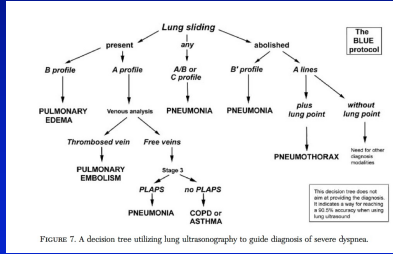


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lichtenstein DA, CHEST 2008; 134:117–125

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鍵となる所見

Lung Sliding

- A Lines – A profile
- B Lines – B profile
- C - profile
- PLAPS (Posterolateral alveolar and or pleural syndrome)



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鍵となる所見

Lung Sliding

- A Lines – A profile
- B Lines – B profile
- C - profile
- PLAPS (Posterolateral alveolar and or pleural syndrome)



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鍵となる所見: Lung Sliding

- 存在すれば: 気胸はなし
存在しないと: 臓側胸膜が壁側胸膜に対し
- 1) スライドしていない
 - 1) 急性・慢性の癒着、無気肺、無呼吸
 - 2) 分離している
 - 2) 気胸、肺切除後

Lichtenstein DA, CHEST 2008; 134:117–125

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Lung Slidingがない ≠ 気胸

- 存在すれば: 気胸はなし
存在しないと: 臓側胸膜が壁側胸膜に対し
- 1) スライドしていない
 - 1) 急性・慢性の癒着、無気肺、無呼吸
 - 2) 分離している
 - 2) 気胸、肺切除後

Lichtenstein DA, CHEST 2008; 134:117–125

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Lung Sliding

Table 1—Results of Analysis of Lung Sliding

	Disappearance of Anterior "Lung Sliding"	Presence of Anterior Lung Sliding	Inconclusive
Proved pneumothorax	41	0	2
Proved absence of pneumothorax (CT)	6	62	0

Lichtenstein DA, Menu Y, CHEST 1995; 108: 1345-48

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Lung Sliding = 気胸はなし

Lung Sliding が存在
すれば気胸なし



Lichtenstein DA, CHEST 2008; 134:117-125

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Lung Slidingがない ≠ 気胸

Lung sliding が無いからと
いって気胸とは限らない
1) 壁側胸膜とスライドしてない
癒着、無気肺、無呼吸
2) 壁側胸膜から分離している
気胸、肺切除後



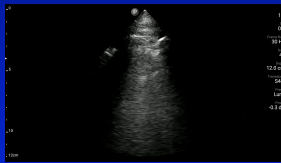
Lichtenstein DA, CHEST 2008; 134:117-125

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COVID-19と肺エコー(1) Thick, irregular pleura

COVID: Thick, irregular pleura

NOT COVID: Smooth pleural line



Courtesy of Dr. Kosuke Yasukawa

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鍵となる所見: A Lines

Lung Sliding
A Lines – A profile
B Lines – B profile
C - profile
PLAPS



Lichtenstein DA, CHEST 2008; 134:117-125

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鍵となる所見: A Lines

胸膜のライン(平行な白い線)
が繰り返される状態
= そこに空気がある

A lines + sliding lung=正常



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A Lines Reverberation artifact




Feldman MK, Katyal S, Blackwood MS, RadioGraphics 2009; 29:1179-1189


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A profile: 「正常」 Sliding Lung + A-Lines

Sliding Lung



A-lines




Lichtenstein DA, CHEST 2008; 134:117-125

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A profile: 「正常」 Sliding Lung + A-Lines

前胸部優位の
(1) 両側A lines
(2) Lung Sliding (+)
(3) 局所的なB linesが
あってもよい



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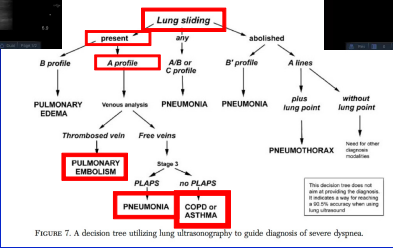


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lichtenstein DA, CHEST 2008; 134:117-125

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A profile: 鑑別

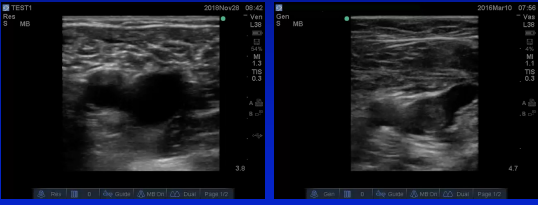
気管支喘息
COPD
肺塞栓症
肺炎



10

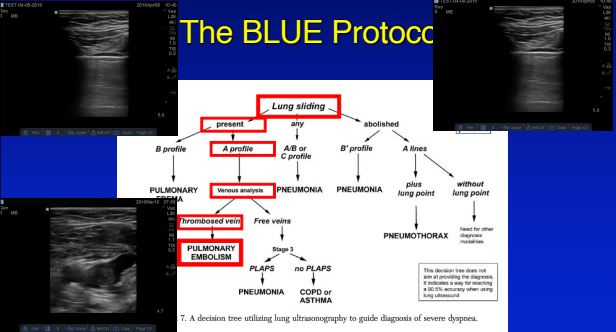
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Venous Analysis



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

Lichtenstein DA, CHEST 2008; 134:117-125

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A profile + DVT: Pulmonary Embolism

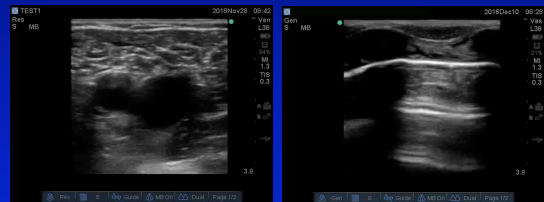


Sensitivity: 81%
Specificity: 99%

Lichtenstein DA, CHEST 2008; 134:117-125

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A profile + Free Vein



Lichtenstein DA, CHEST 2008; 134:117-125

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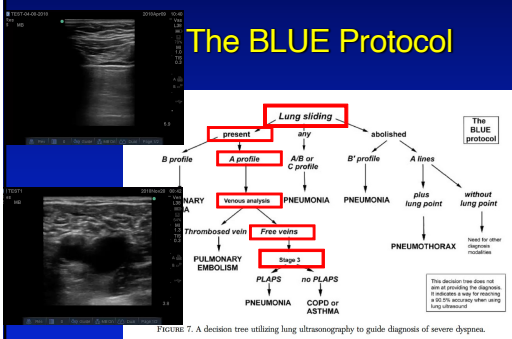


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lichtenstein DA, CHEST 2008; 134:117-125

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鍵となる所見: PLAPS

Lung Sliding
A Lines – A profile
B Lines – B profile
C Profile
PLAPS



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PLAPS

PosteroLateral
Alveolar and/or
Pleural
Syndrome



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PLAPS

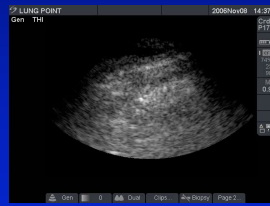


Lichtenstein DA, Meziere GA, CHEST 2008; 134:117-125

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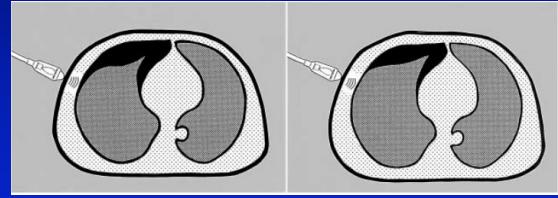
A' profile (A without lung sliding)

- ? Lung point → Pneumothorax
- (-) Lung point → Needs further study



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Lung Points



Lichtenstein D, Mezière G, Biderman P, Gepner A. The "lung point": an ultrasound sign specific to pneumothorax. *Intensive Care Med.* 2000 Oct;26(10):1434-40.

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鍵となる所見: B Lines

- Lung Sliding
- A Lines – A profile
- B Lines – B profile
- C profile
- PLAPS



Lichtenstein DA, *CHEST* 2008; 134:117–125

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鍵となる所見: B Lines

- 胸膜から縦に伸びる白い線
- Lung slidingでA lineは消失
- 1視野に3本以上のB lines = B+ lines
- 「3本は異常」Lichtenstein

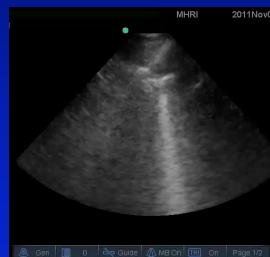


Lichtenstein DA. Current Misconceptions in Lung Ultrasound: A Short Guide for Experts. *Chest.* 2019 Jul;156(1):21-25

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B Lines

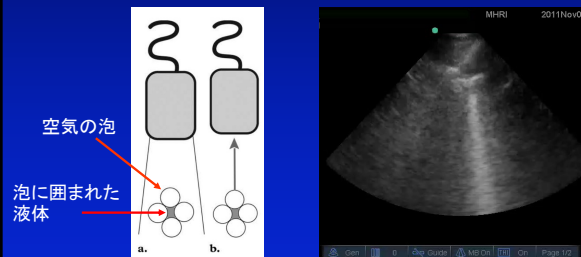
- 小葉間隔壁の肥厚・浮腫などを検出



Lichtenstein DA, *CHEST* 2008; 134:117–125

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B Lines Ring down (comet tail) Artifact

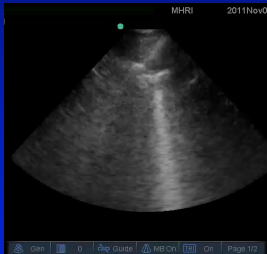


Feldman MK, Katyal S, Blackwood MS, *RadioGraphics* 2009; 29:1179-1189

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B Lines 7つの特徴

1. This is a comet-tail artifact
2. It arises from the pleural line
3. It is well defined and laser-like
4. It is hyperechoic
5. It is long, spreading out without fading to the edge of the screen
6. It erases, or obliterates, the A-lines
7. It moves with lung sliding



Lichtenstein DA, Whole Body Ultrasonography in the Critically Ill, Springer 2010

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B7 Lines (Septal rockets)

Sparse b lines
7mm間隔で別れたB line
小葉間隔壁の肥厚
肋間に3-4本のB linesが
観察できる



Lichtenstein DA, Current Misconceptions in Lung Ultrasound: A Short Guide for Experts. Chest. 2019 Jul;156(1):21-25

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B3 Lines (Glass rockets)

3 mm間隔で別れたB line
B7-lineより多い
スリガラス様
肋間に5本以上のB Lines
が確認できる



Lichtenstein DA, Current Misconceptions in Lung Ultrasound: A Short Guide for Experts. Chest. 2019 Jul;156(1):21-25

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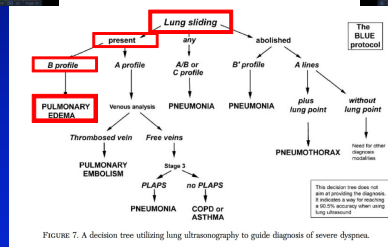
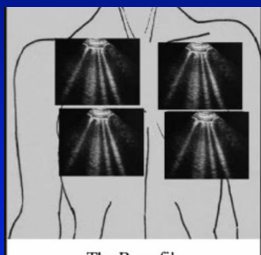


FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lichtenstein DA, CHEST 2008; 134:117-125

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B profile: 肺水腫

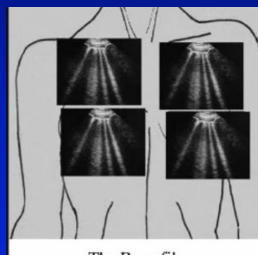


両側びまん性B line
1、B lineあり
2、Sliding lungsあり
肺水腫に対して
感度97%、特異度95%

Lichtenstein DA, CHEST 2008; 134:117-125

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B' profile: 肺炎



B lineあり
かつ
sliding lungs(-)
→肺炎を示唆
感度11%、特異度100%

Lichtenstein DA, CHEST 2008; 134:117-125

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

Lichtenstein DA, CHEST 2008; 134:117-125

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AB Profile: 肺炎

肺炎に対して
感度 14%
特異度 100%

Lichtenstein DA, CHEST 2008; 134:117-125

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COVID-19と肺エコー (2) Confluent B-lines

Glass rockets Confluent B-lines

Images: Courtesy from Dr. Kosuke Yasukawa

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鍵となる所見: C Profile

Lung Sliding
A Lines – A profile
B Lines – B profile
C profile
PLAPS

Lichtenstein DA, CHEST 2008; 134:117-125

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C Profile

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C Profile: 肺炎



前胸部のconsolidation

感度 11%
特異度 99%

Lichtenstein DA, CHEST 2008; 134:117-125

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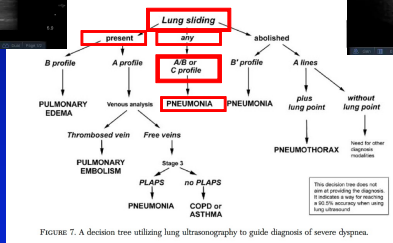



FIGURE 7. A decision tree utilizing lung ultrasonography to guide diagnosis of severe dyspnea.

Lichtenstein DA, CHEST 2008; 134:117-125

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C Profile: Pneumonia



Sensitivity: 11%
Specificity: 99%

Lichtenstein DA, CHEST 2008; 134:117-125

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Pneumonia所見 (combined)

A profile + PLAPS	感度 89%
B' profile	特異度 94%
A/B profile	
C profile	

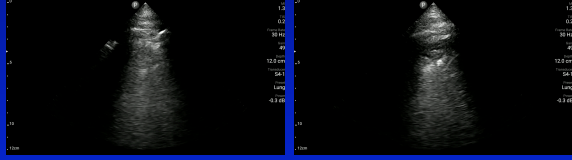
Lichtenstein DA, CHEST 2008; 134:117-125

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COVID-19と肺エコー (3)

Subpleural consolidation to consolidation

Subpleural consolidation	Consolidation
--------------------------	---------------



Courtesy of Dr. Kosuke Yasukawa

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パターン

A profile: 前胸部優位の両側性 A lines + lung sliding
 A' profile: 両側性 A lines + lung sliding無し
 B profile: 前胸部優位の両側性 B+lines + lung sliding
 B' profile: B profile + lung sliding無し
 A/B profile: 片側はA line, もう片側はB+ lines
 C profile: 前胸部優位の肺泡コンソリデーション
 PLAPS profile: Posterolateral Alveolar and/or Pleural Syndrome

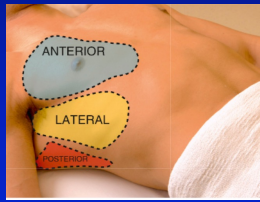
59

よくある質問

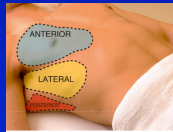
何か所をスキャンしたらいいですか？

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Ultrasound Zones



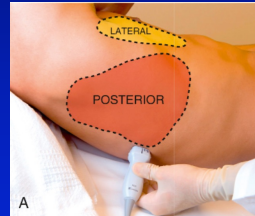
Zone 1: Anterior
仰臥位で前胸壁をスキャン
Zone 2: Lateral
側壁を追加でスキャン



Lichtenstein DA, CHEST 2008; 134:117-125
Point of Care ULTRASOUND Section2:Lung and pleura ELSEVIER SAUNDERS社 より引用

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Ultrasound Zones

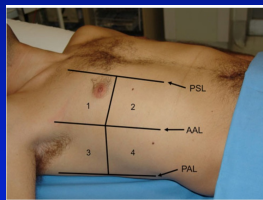


Zone 3: Posterior
やや側臥位にして
胸部側後壁をスキャン

Point of Care ULTRASOUND Section2:Lung and pleura ELSEVIER SAUNDERS社 より引用

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International Guideline Interstitial Syndrome Protocols



International Liaison Committee on Lung Ultrasound (ILC-LUS) for International Consensus Conference on Lung Ultrasound (IC-LUS). International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med. 2012 Apr;38(4):577-91.

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本コースではBLUEプロトコルのコンセプトを用い
片側4か所をスキャンします

BLUE Exam
Points



Point 1



Point 2



Point 3



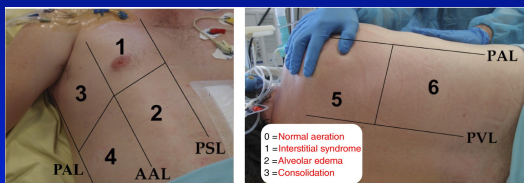
Point 4

詳しくはハンズオンで！

Point of Care ULTRASOUND Section2:Lung and pleura ELSEVIER SAUNDERS社 より引用

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Beyond POCUS 1: 肺エコースコア(LUS)



Rouby JJ, Arbellet C, Gao Y, Zhang M, Lv J, An Y, Wang C, Bin D, Barbas CSV, Dexheimer Neto FL, Prior Calababoli F, Lima E, Cebeay A, Perbet S, Constantin JM; APECHO study group. Training for Lung Ultrasound Score Measurement in Critically Ill Patients. Am J Respir Crit Care Med. 2018 Mar 20.

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肺エコースコアをCOVID予後予測に使う

Original Research

Point-of-Care Lung Ultrasound for COVID-19: Findings and Prognostic Implications From 105 Consecutive Patients

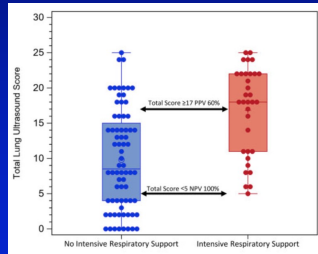
Kosuke Yasukawa, MD¹, Taro Minami, MD^{2,3}, David R. Boulware, MD, MPH⁴,
Ayako Shimada, MS⁵, and Ernest A. Fischer, MD, MS⁶

Journal of Intensive Care Medicine
2021, Vol. 36(5) 334-342
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DOI: 10.1177/0885066620988811
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SAGE

Yasukawa K, Minami T, et al, Journal of Intensive Care Medicine 2021

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肺エコースコア (LUS)



Yasukawa K, Minami T, et al, Journal of Intensive Care Medicine 2021

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よくある質問2 どのプローベを使ったらよいでしょうか？



- (1) マイクロコンベックス (Original: Lichtenstein)
- (2) コンベックス
- (3) セクター (Phased-array)
- (4) リニア (Vascular) (lung sliding)

個人的には・・・

それぞれの違いがわかっていたらよいでしょう

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Beyond POCUS 2: AIによるCOVID-19の診断

Open access Original research

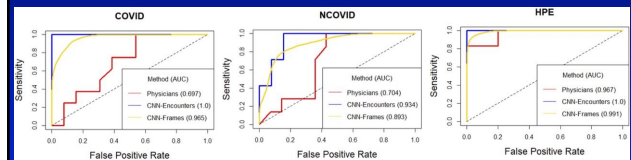
BMJ Open Development of a convolutional neural network to differentiate among the etiology of similar appearing pathological B lines on lung ultrasound: a deep learning study

Robert Arntfield¹, Blake VanBerlo², Thamer Alaifan¹, Nathan Phelps³, Matthew White¹, Rushil Chaudhary⁴, Jordan Ho², Derek Wu²

Arntfield R et al, BMJ Open. 2021 Mar 5;11(3):e045120.

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結果 AIは人間の診断を超えたでしょうか？

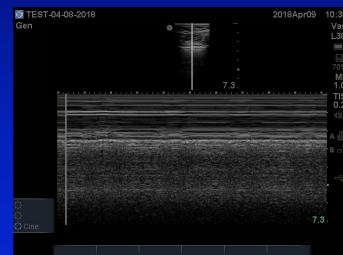


Arntfield R et al, BMJ Open. 2021 Mar 5;11(3):e045120.

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応用問題

これは何でしょう？ (M-Mode)

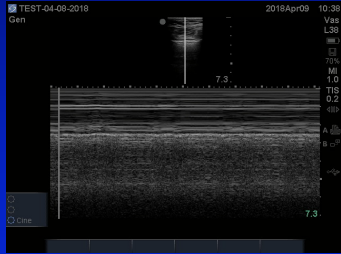


Lichtenstein DA, CHEST 2008; 134:117-125

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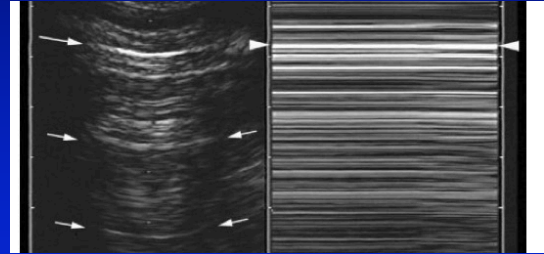
これは何でしょう? (M-Mode)
Sea-Shore sign: 正常



Lichtenstein DA, CHEST 2008; 134:117-125

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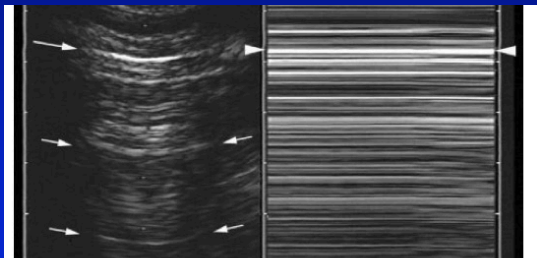
これは何でしょう?



Lichtenstein DA, CHEST 2008; 134:117-125

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Sliding lungの消失:
Stratosphere sign → 気胸



Lichtenstein DA, CHEST 2008; 134:117-125

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まとめ1: 肺エコーの鍵となる所見

- Lung Sliding
- A Lines – A profile
- B Lines – B profile
- C - profile
- PLAPS (Posterolateral alveolar and or pleural syndrome)



Lichtenstein DA, CHEST 2008; 134:117-125

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まとめ2: 肺エコーには限界がある
認識して上手に使いましょう

"Physicians master LUCI when they can master its limits."

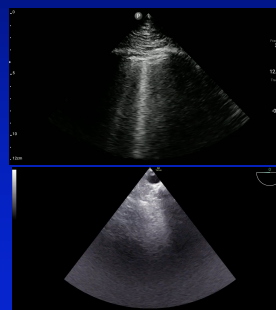
by Daniel Lichtenstein

LUCI: Lung Ultrasound in Critically Ill

Lichtenstein DA. Current Misconceptions in Lung Ultrasound: A Short Guide for Experts. Chest. 2019 Jul;156(1):21-25

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まとめ3: 肺エコーの現在・未来



肺エコーを使ったCOVID-19の診断・追跡
肺エコーとAI
TEEを使った肺エコー

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ご静聴誠に有り難うございました

南太郎
Taro Minami, MD

ご質問あればお気軽に！

E-mail:
nantaro@gmail.com
taro_minami@brown.edu



Robert Thom, Laennec and the Stethoscope, courtesy of University of Michigan Museum of Art