WEBINAR

Veterinary POCUS: Understanding and Diagnosing Lung Consolidation, It's Easier Than You Think!

December 2022

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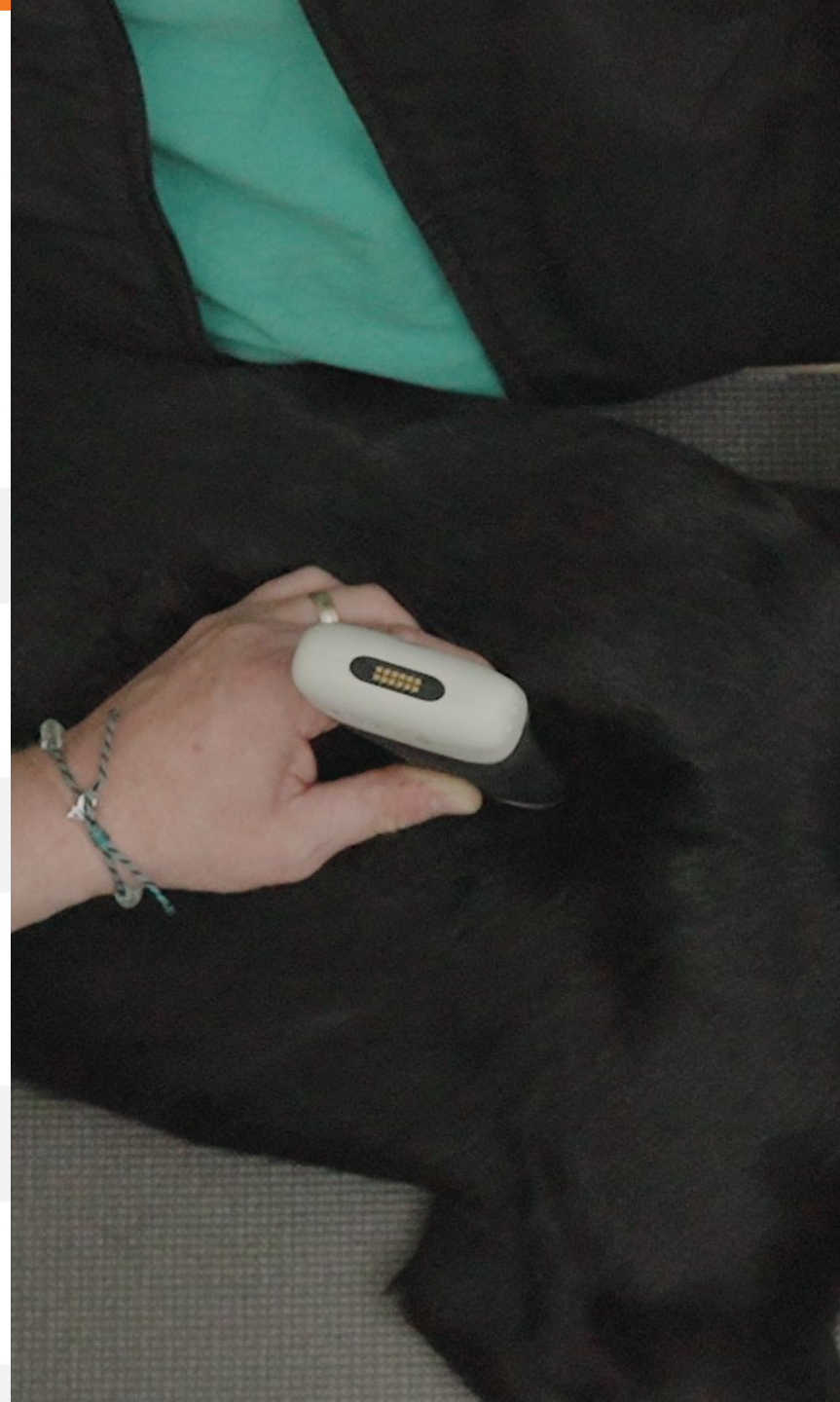


Your Host

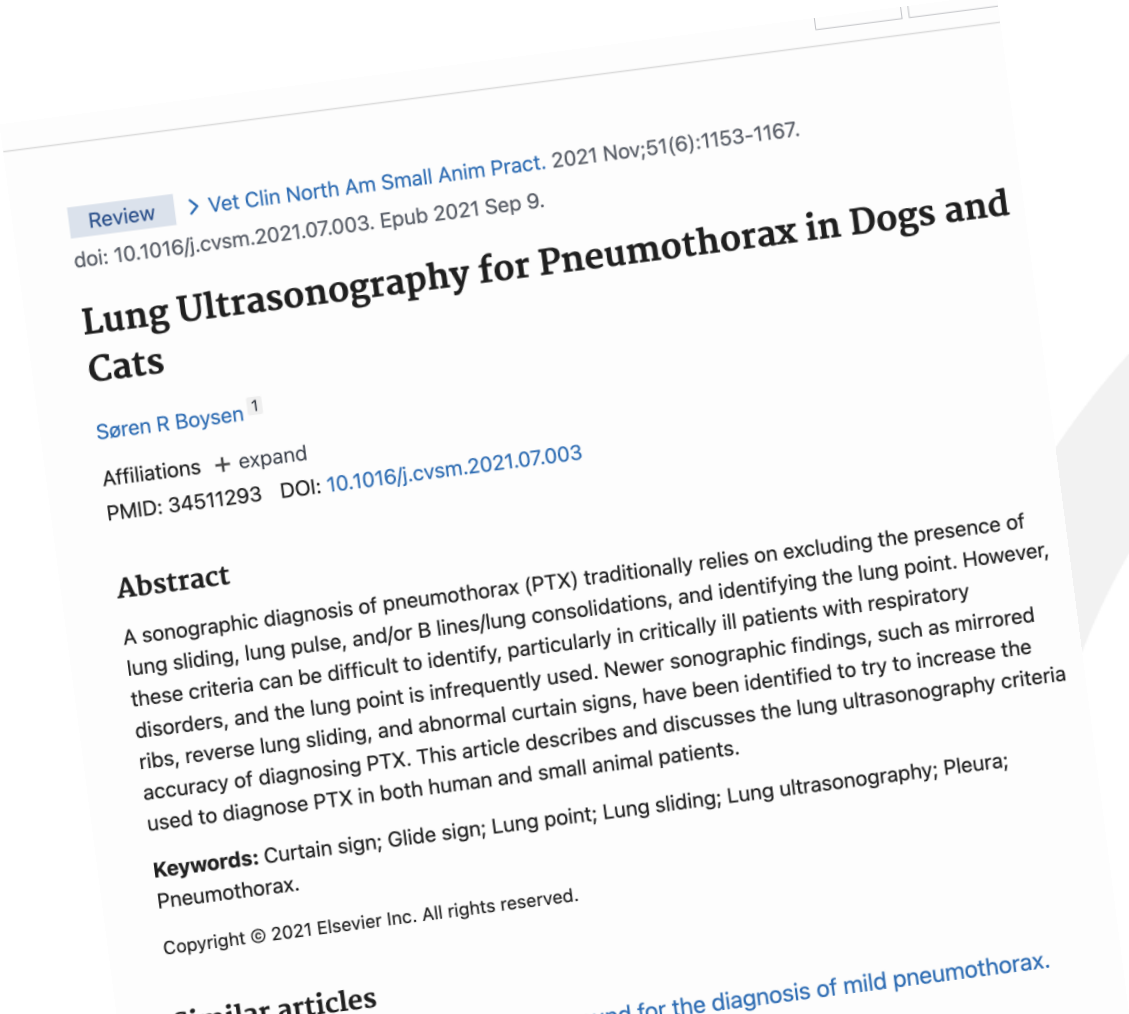
Dr. Oron Frenkel, MD, MS

Emergency Physician & POCUS Educator

Chairman, Clarius Medical Advisory Board

clarius Ultrasound Anywhere

Lung Ultrasonography for Pneumothorax in Dogs and Cats



Review > Vet Clin North Am Small Anim Pract. 2021 Nov;51(6):1153-1167.
doi: 10.1016/j.cvsm.2021.07.003. Epub 2021 Sep 9.

Lung Ultrasonography for Pneumothorax in Dogs and Cats

Søren R Boysen [1]

Affiliations + expand

PMID: 34511293 DOI: 10.1016/j.cvsm.2021.07.003

Abstract

A sonographic diagnosis of pneumothorax (PTX) traditionally relies on excluding the presence of lung sliding, lung pulse, and/or B lines/lung consolidations, and identifying the lung point. However, these criteria can be difficult to identify, particularly in critically ill patients with respiratory disorders, and the lung point is infrequently used. Newer sonographic findings, such as mirrored ribs, reverse lung sliding, and abnormal curtain signs, have been identified to try to increase the accuracy of diagnosing PTX. This article describes and discusses the lung ultrasonography criteria used to diagnose PTX in both human and small animal patients.

Keywords: Curtain sign; Glide sign; Lung point; Lung sliding; Lung ultrasonography; Pleura; Pneumothorax.

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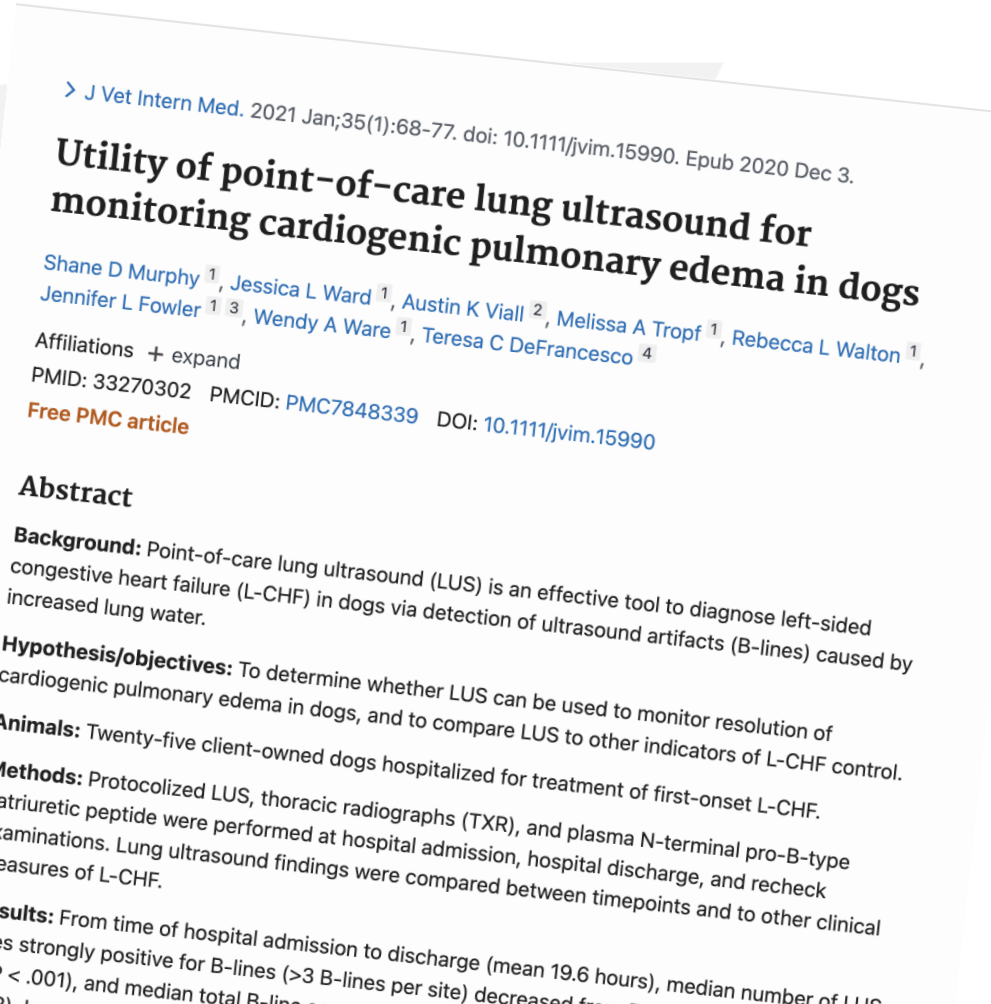
Utility of point-of-care lung ultrasound for monitoring cardiogenic pulmonary edema in dogs

Point-of-care lung ultrasound (LUS) is an effective tool to diagnose left-sided congestive heart failure (L-CHF) in dogs via detection of ultrasound artifacts (B-lines) caused by increased lung water.

Murphy SD, Ward JL, Viall AK, Tropf MA, Walton RL, Fowler JL, Ware WA, DeFrancesco TC. Utility of point-of-care lung ultrasound for monitoring cardiogenic pulmonary edema in dogs. J Vet Intern Med. 2021 Jan;35(1):68-77. doi: 10.1111/jvim.15990. Epub 2020 Dec 3. PMID: 33270302; PMCID: PMC7848339.



J Vet Intern Med. 2021 Jan;35(1):68-77. doi: 10.1111/jvim.15990. Epub 2020 Dec 3.

Utility of point-of-care lung ultrasound for monitoring cardiogenic pulmonary edema in dogs

Shane D Murphy [1], Jessica L Ward [1], Austin K Viall [2], Melissa A Tropf [1], Rebecca L Walton [1], Jennifer L Fowler [1 3], Wendy A Ware [1], Teresa C DeFrancesco [4]

Affiliations + expand

PMID: 33270302 PMCID: PMC7848339 DOI: 10.1111/jvim.15990

Free PMC article

Abstract

Background: Point-of-care lung ultrasound (LUS) is an effective tool to diagnose left-sided congestive heart failure (L-CHF) in dogs via detection of ultrasound artifacts (B-lines) caused by increased lung water.

Hypothesis/objectives: To determine whether LUS can be used to monitor resolution of cardiogenic pulmonary edema in dogs, and to compare LUS to other indicators of L-CHF control.

Animals: Twenty-five client-owned dogs hospitalized for treatment of first-onset L-CHF.

Methods: Protocolized LUS, thoracic radiographs (TXR), and plasma N-terminal pro-B-type natriuretic peptide were performed at hospital admission, hospital discharge, and recheck examinations. Lung ultrasound findings were compared between timepoints and to other clinical measures of L-CHF.

Results: From time of hospital admission to discharge (mean 19.6 hours), median number of LUS sites strongly positive for B-lines (>3 B-lines per site) decreased fr... 5; P < .001), and median total B-line... 002).

Lung Ultrasound for Imaging of B-Lines in Dogs and Cats-A Prospective Study Investigating Agreement between Three Types of Transducers and the Accuracy in Diagnosing Cardiogenic Pulmonary Edema, Pneumonia and Lung Neoplasia

› Animals (Basel). 2021 Nov 16;11(11):3279. doi: 10.3390/ani11113279.

Lung Ultrasound for Imaging of B-Lines in Dogs and Cats-A Prospective Study Investigating Agreement between Three Types of Transducers and the Accuracy in Diagnosing Cardiogenic Pulmonary Edema, Pneumonia and Lung Neoplasia

Andrzej Łobaczewski [1], Michał Czopowicz [2], Agata Moroz [2], Marcin Mickiewicz [2], Marta Stabińska [3], Hanna Petelicka [4], Tadeusz Frymus [5], Olga Szaluś-Jordanow [5]

Affiliations + expand

PMID: 34828010 PMCID: PMC8614539 DOI: 10.3390/ani11113279

Free PMC article

Abstract

Transthoracic heart and lung ultrasound (LUS) was performed in 200 dogs and cats with dyspnea to evaluate the agreement between the results obtained using three types of transducers (microconvex, linear, and phased array) and to determine the accuracy of LUS in discriminating between three conditions commonly causing dyspnea in companion animals: cardiogenic pulmonary edema (CPE), pneumonia, and lung neoplasm. The agreement beyond chance was assessed using the weighted Cohen's kappa coefficient (κ_w). The highest values of κ_w (>0.9) were observed for the pair of microconvex and linear transducers. To quantify B-lines the lung ultrasound score (LUS_{score}) was developed as a sum of points describing the occurrence of B-lines for each of 8 standardized thoracic locations. The accuracy of LUS_{score} was determined using the

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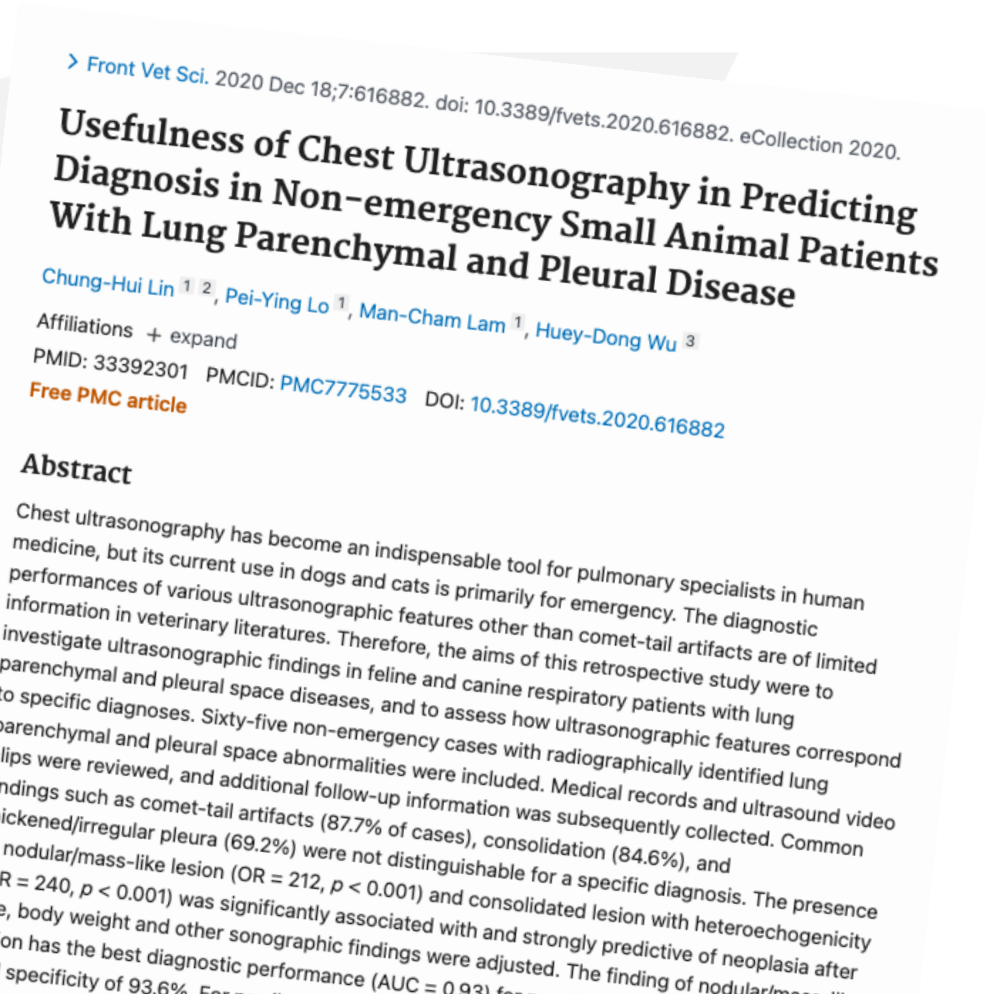
Usefulness of Chest Ultrasonography in Predicting Diagnosis in Non-emergency Small Animal Patients With Lung Parenchymal and Pleural Disease

These findings demonstrate the value of chest ultrasonography in predicting diagnosis in non-emergency cases. The application of thoracic ultrasound in small animal respiratory patients as part of non-invasive assessment warrants further investigation.

Lin CH, Lo PY, Lam MC, Wu HD. Usefulness of Chest Ultrasonography in Predicting Diagnosis in Non-emergency Small Animal Patients With Lung Parenchymal and Pleural Disease. Front Vet Sci. 2020 Dec 18;7:616882. doi: 10.3389/fvets.2020.616882. PMID: 33392301; PMCID: PMC7775533.



Front Vet Sci. 2020 Dec 18;7:616882. doi: 10.3389/fvets.2020.616882. eCollection 2020.

Usefulness of Chest Ultrasonography in Predicting Diagnosis in Non-emergency Small Animal Patients With Lung Parenchymal and Pleural Disease

Chung-Hui Lin [1 2], Pei-Ying Lo [1], Man-Cham Lam [1], Huey-Dong Wu [3]

Affiliations + expand

PMID: 33392301 PMCID: PMC7775533 DOI: 10.3389/fvets.2020.616882

Free PMC article

Abstract

Chest ultrasonography has become an indispensable tool for pulmonary specialists in human medicine, but its current use in dogs and cats is primarily for emergency. The diagnostic performances of various ultrasonographic features other than comet-tail artifacts are of limited information in veterinary literatures. Therefore, the aims of this retrospective study were to investigate ultrasonographic findings in feline and canine respiratory patients with lung parenchymal and pleural space diseases, and to assess how ultrasonographic features correspond to specific diagnoses. Sixty-five non-emergency cases with radiographically identified lung parenchymal and pleural space abnormalities were included. Medical records and ultrasound video clips were reviewed, and additional follow-up information was subsequently collected. Common findings such as comet-tail artifacts (87.7% of cases), consolidation (84.6%), and thickened/irregular pleura (69.2%) were not distinguishable for a specific diagnosis. The presence of nodular/mass-like lesion (OR = 212, $p < 0.001$) and consolidated lesion with heteroechogenicity (OR = 240, $p < 0.001$) was significantly associated with and strongly predictive of neoplasia after age, body weight and other sonographic findings were adjusted. The finding of nodular/mass-like lesion has the best diagnostic performance (AUC = 0.93) for and specificity of 93.6%. For

Comparison of lung ultrasound, chest radiographs, C-reactive protein, and clinical findings in dogs treated for aspiration pneumonia

J Vet Intern Med. 2022 Mar;36(2):743-752. doi: 10.1111/jvim.16379. Epub 2022 Mar 5.

Comparison of lung ultrasound, chest radiographs, C-reactive protein, and clinical findings in dogs treated for aspiration pneumonia

Nina Fernandes Rodrigues [1], Léna Giraud [1], Géraldine Bolen [1], Aline Fastrès [1], Cécile Clercx [1], Søren Boysen [2], Frédéric Billen [1], Kris Gommeren [1]

Affiliations + expand

PMID: 35247005 PMCID: PMC8965265 DOI: 10.1111/jvim.16379

Free PMC article

Abstract

Background: Comparison of clinical findings, chest radiographs (CXR), lung ultrasound (LUS) findings, and C-reactive protein (CRP) concentrations at admission and serial follow-up in dogs with aspiration pneumonia (AP) is lacking.

Hypothesis: Lung ultrasound lesions in dogs with AP are similar to those described in humans with community-acquired pneumonia (comAP); the severity of CXR and LUS lesions are similar; normalization of CRP concentration precedes resolution of imaging abnormalities and more closely reflects the clinical improvement of dogs.

Animals: Seventeen dogs with AP.

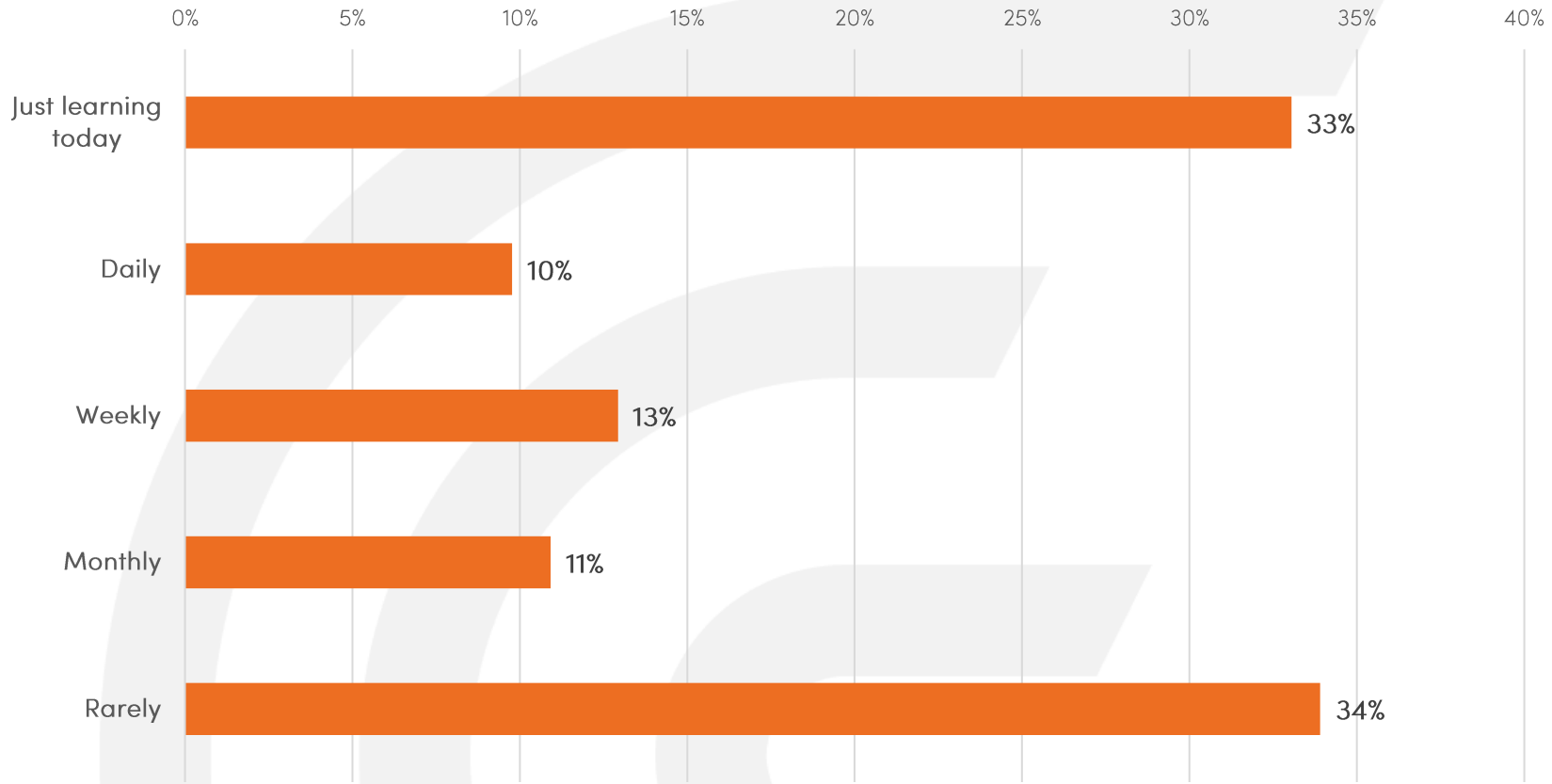
Methods: Prospective observational study. Clinical examination, CXR, LUS, and CRP measurements performed at admission (n = 17), 2 weeks (n = 13), and 1 month after diagnosis (n = [illegible] dogs received antimicrobial therapy. Lung ultrasound and CXR canine aspiration scoring [illegible] LUS in 14 of 17

Lung ultrasound findings resemble those of humans with comAP and differ from CXR findings. Shred signs and high CRP concentrations better reflect clinical findings during serial evaluation of dogs.

Fernandes Rodrigues N, Giraud L, Bolen G, Fastrès A, Clercx C, Boysen S, Billen F, Gommeren K. Comparison of lung ultrasound, chest radiographs, C-reactive protein, and clinical findings in dogs treated for aspiration pneumonia. J Vet Intern Med. 2022 Mar;36(2):743-752. doi: 10.1111/jvim.16379. Epub 2022 Mar 5. PMID: 35247005; PMCID: PMC8965265.

Poll

How frequently are you using ultrasound to image the lungs?



Your Expert Guest Speakers

Dr. Soren Boysen, DVM, DACVECC
Professor, Veterinary Clinical & Diagnostic Sciences, University of Calgary

Dr. Serge Chalhoub, BSc, DVM, DACVIM
Senior Instructor, Veterinary Clinical & Diagnostic Sciences, University of Calgary

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Veterinary POCUS: Understanding and Diagnosing Lung Consolidation, It's Easier Than You Think!

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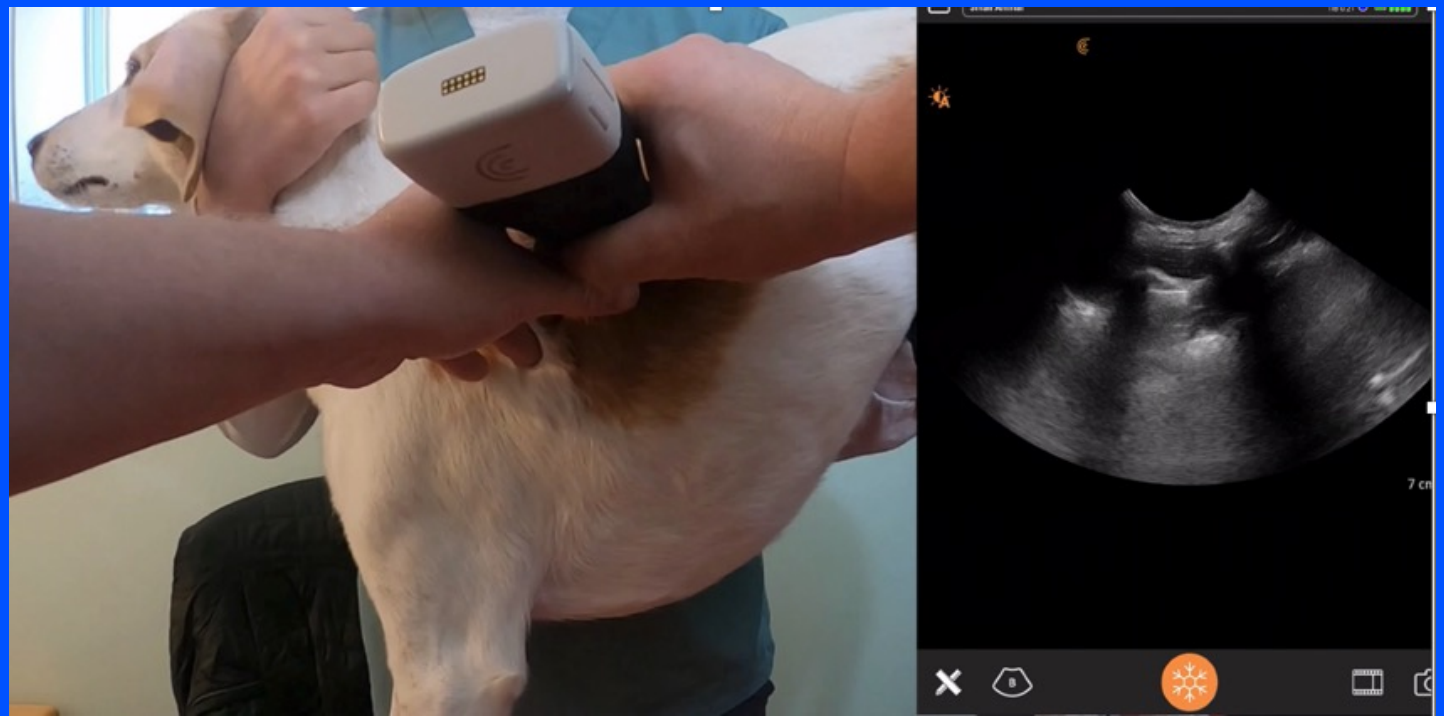
In relation to this presentation, we receive conference honorariums, but otherwise declare no conflicts of interest

Objectives for today

- Review pleura and lung ultrasound with a focus on lung consolidations
- Describe the difference between B-lines and lung consolidations
- Classify the different types of lung consolidation
- List differential diagnoses for lung consolidations



Prior Sessions: Pleura and Lung Ultrasound (PLUS)

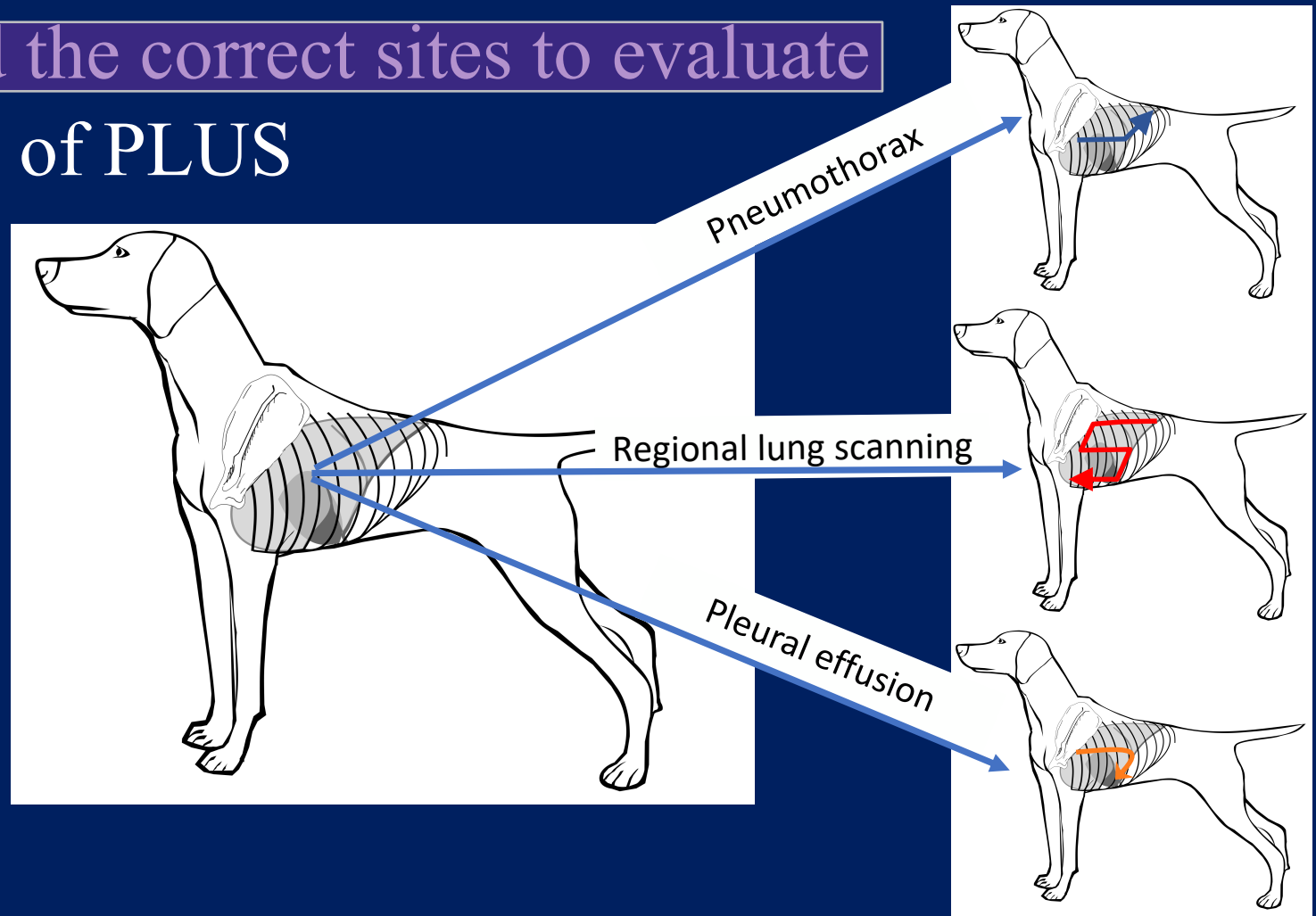
https://clarius.com/webinar/veterinary-point-of-care-pleural-space-and-lung-ultrasound-for-everyday-practice/

https://clarius.com/webinar/veterinary-pocus-differentiating-primary-cardiac-from-pulmonary-and-pleural-space-diseases/

- Normal & how to find the correct sites to evaluate
- The 4 key pathologies of PLUS

1. Pleural space
   a) Pneumothorax
   b) Pleural effusion

2. Lung parenchymal
   a) Increased B lines
   b) Consolidations

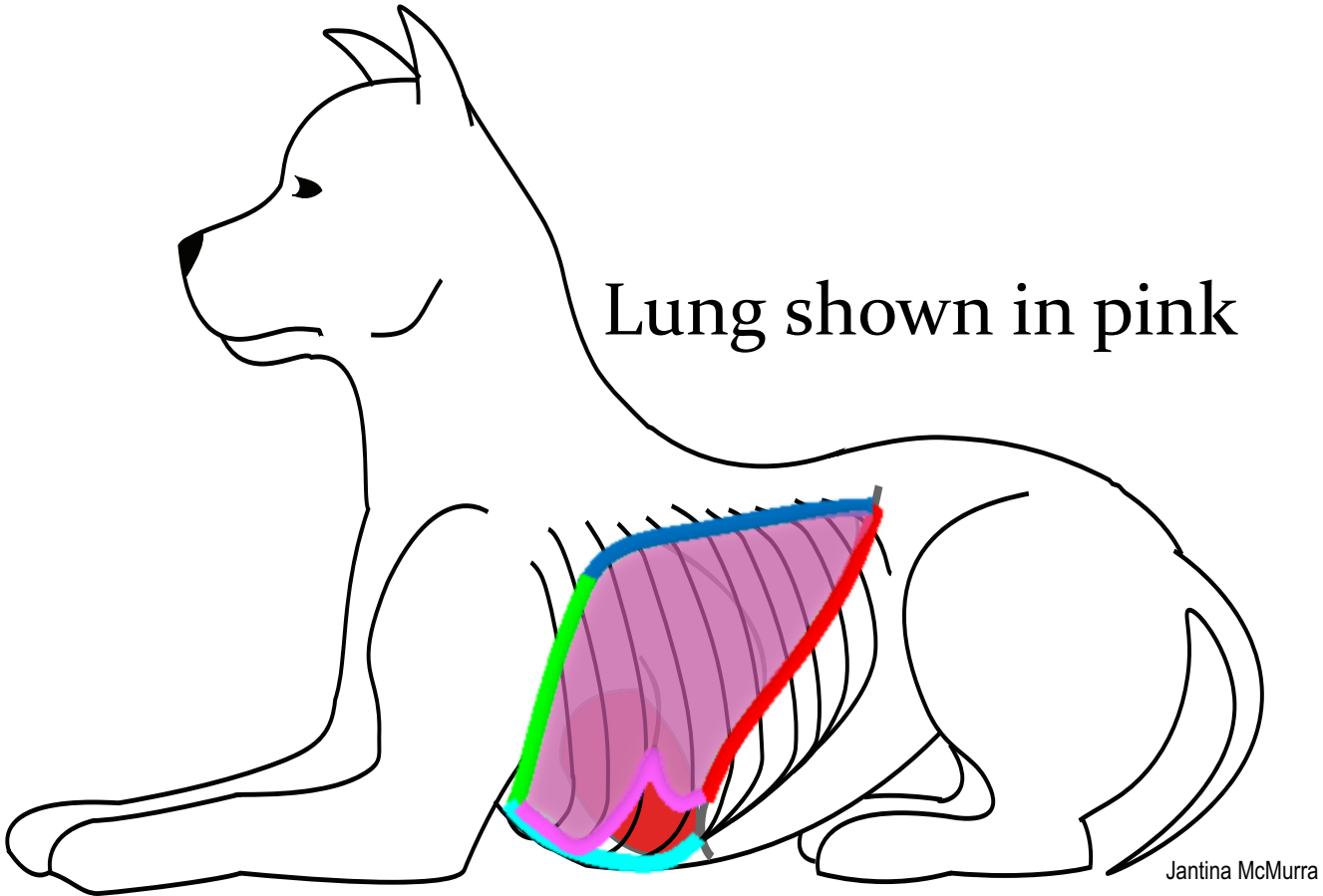


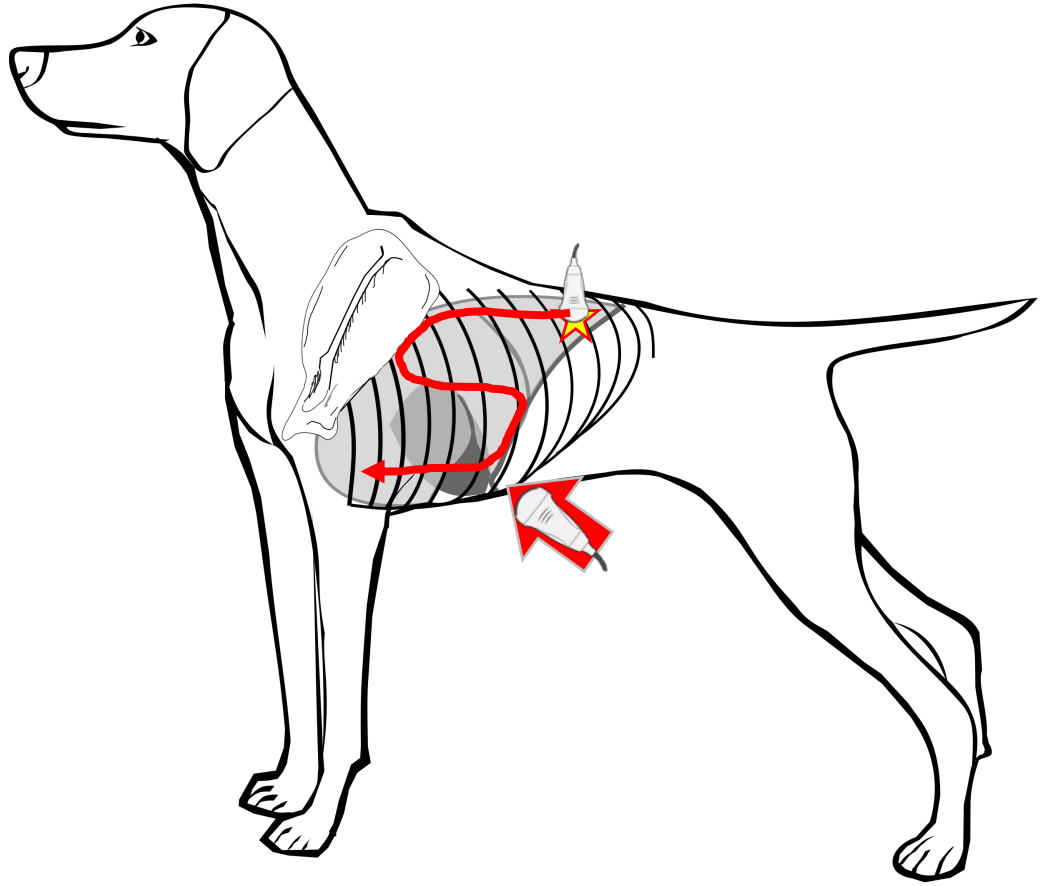
On the menu: Pleura and Lung Ultrasound (PLUS)

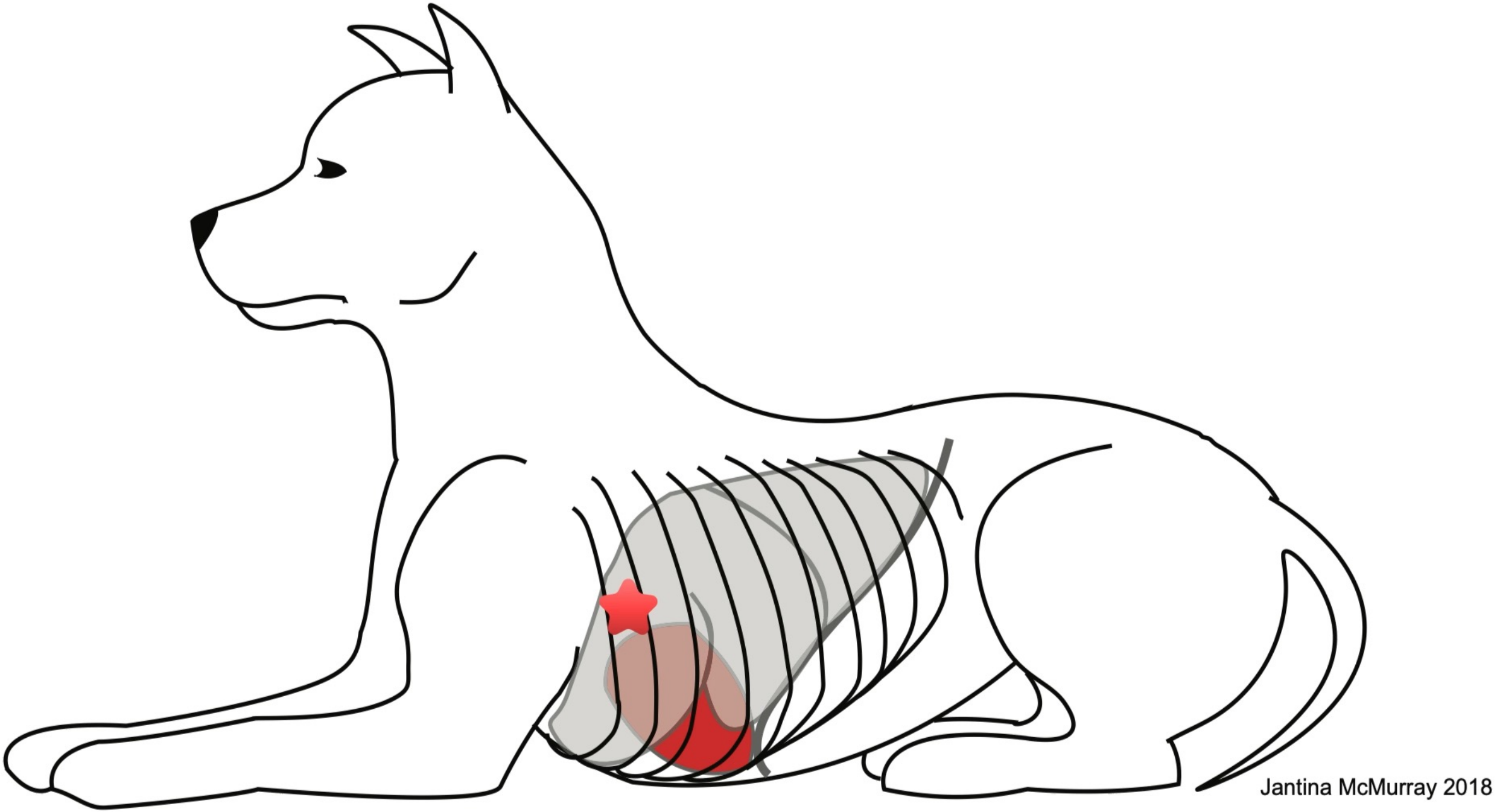
1. Abnormal Lung Ultrasound Findings
    1. Increased B-lines
    2. Consolidations
        I. Partial
            a) Shred
            b) Nodule
            c) (Wedge)
        II. Translobar

How to scan the lung (vs. the pleural space)

- Step 1: Start at the caudal dorsal site (we will show you how to find this site soon)
- Step 2: Scan multiple lung regions (S shaped pattern)
- Step 3: Include the subxiphoid site

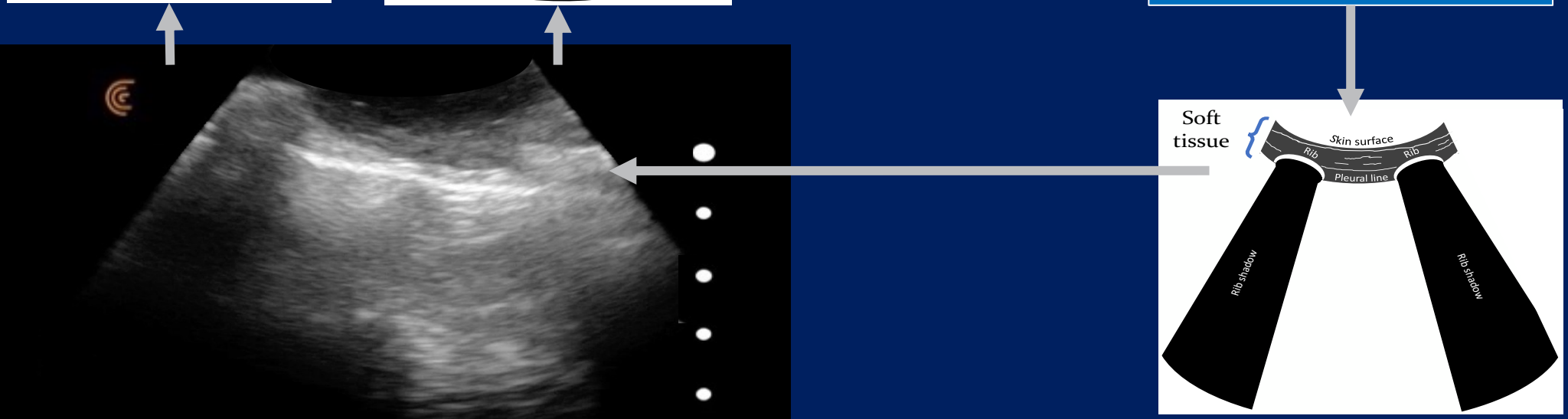




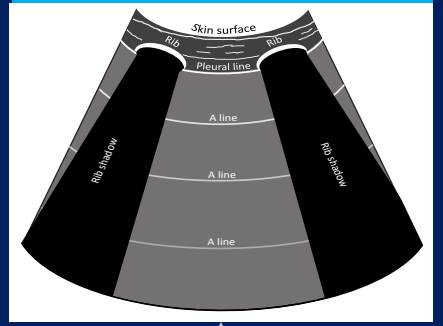

Jantina McMurray 2018

If lung sliding visible:
Assess the lungs for 3 main findings

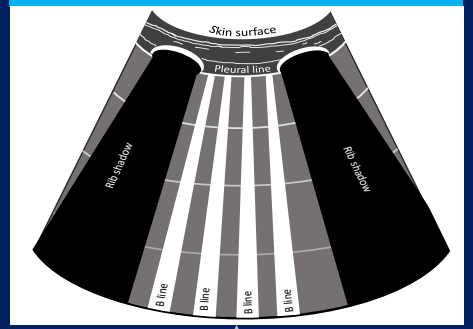
Lung sliding present?



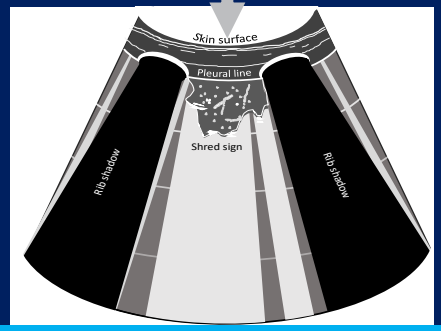
1 Normal lung surface



2 Increased B-lines



3 Lung consolidation



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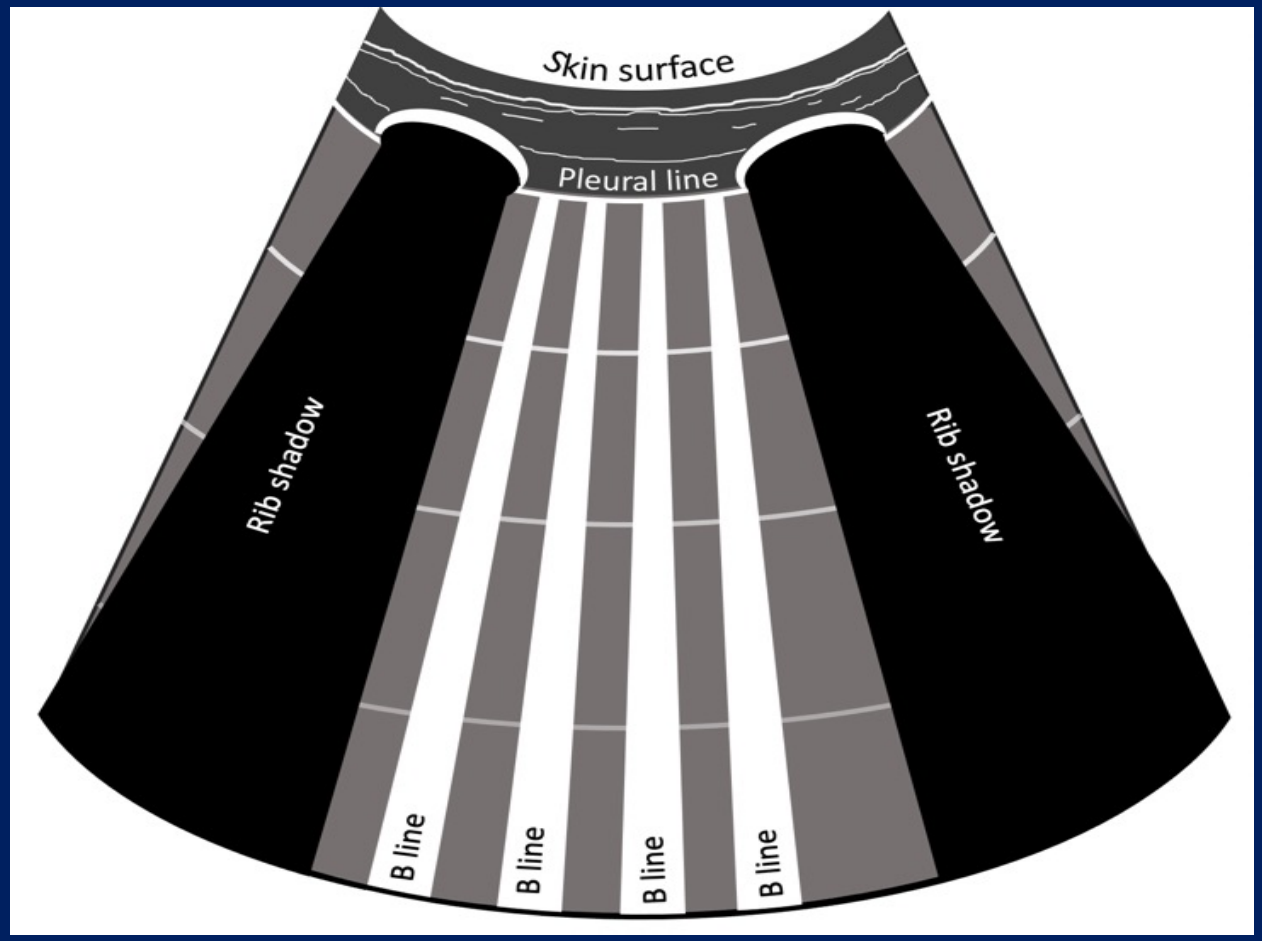
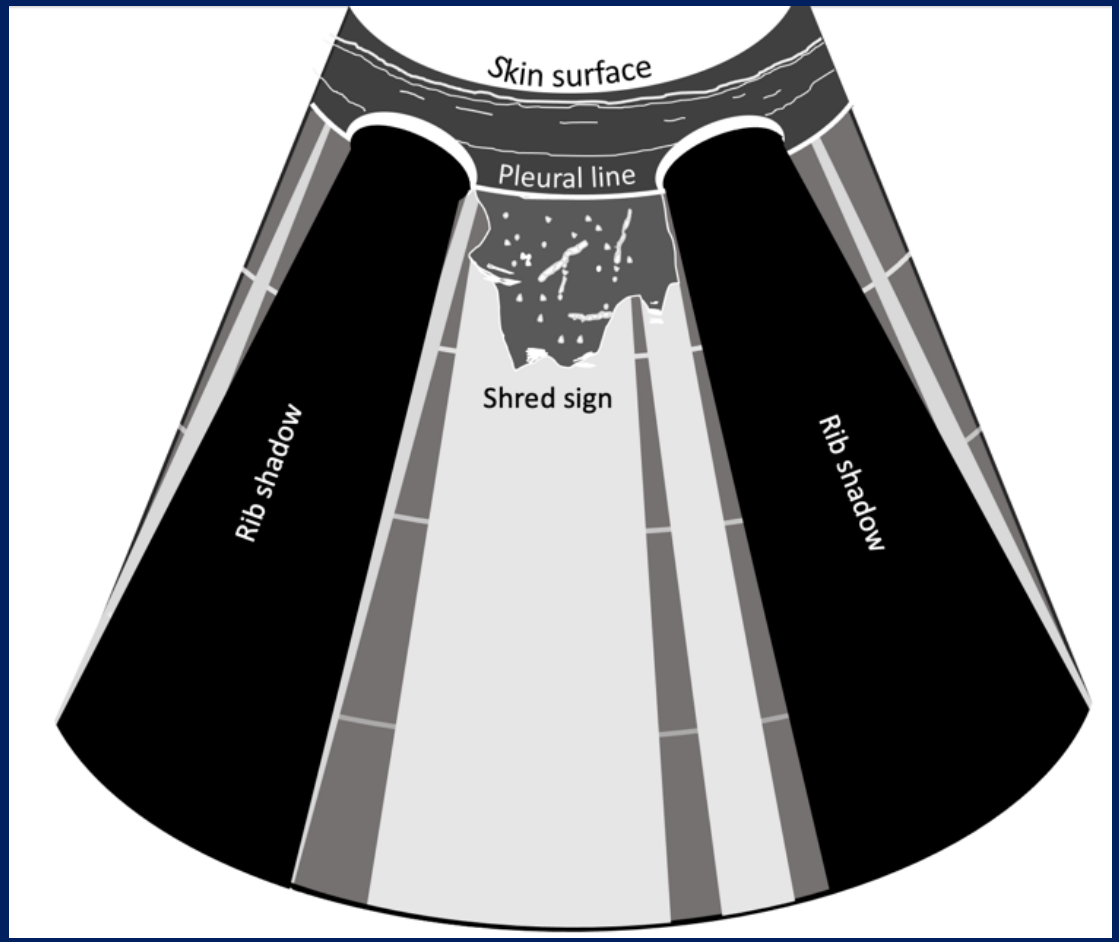
Detecting lung pathology

What determines if B lines or lung consolidations are seen?

- The percentage of air in the lung below the lung surface

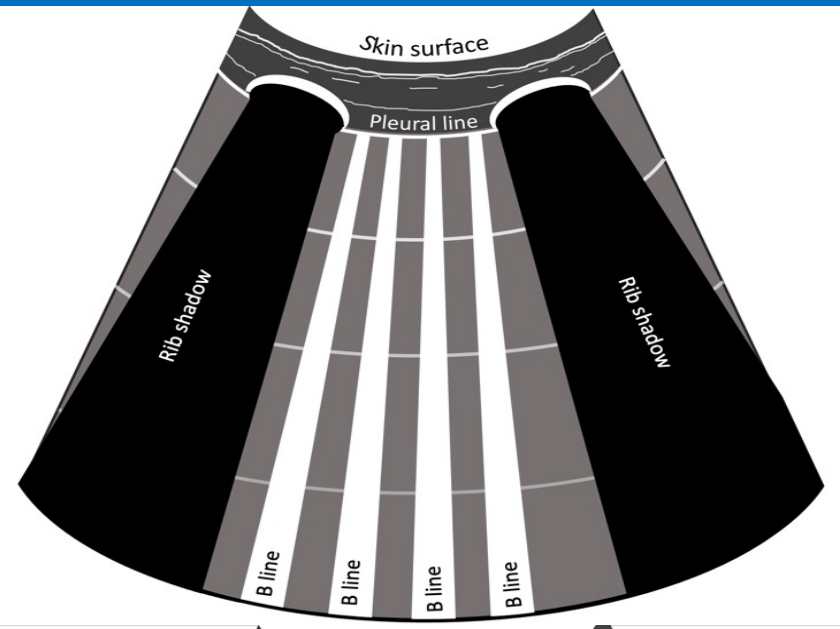


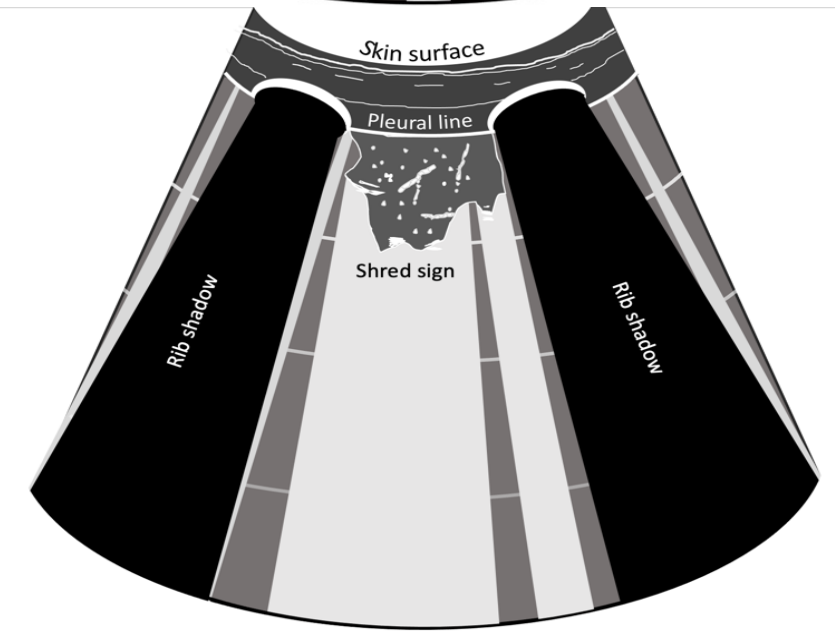


Detecting lung pathology

If > 10% air in the peripheral lung the beam is reflected
You only see lung surface artifacts = B lines

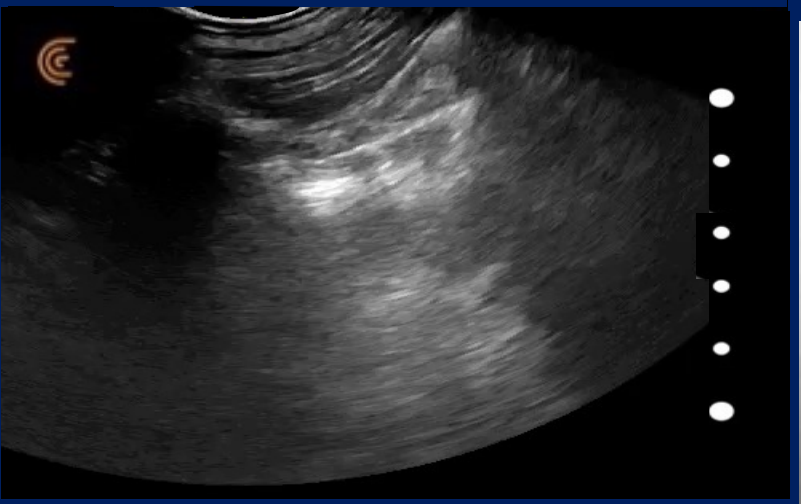
If < 10% air in the peripheral lung the beam travels through the lung as if it is soft tissue (no air interference)
You see actual lung = lung consolidations



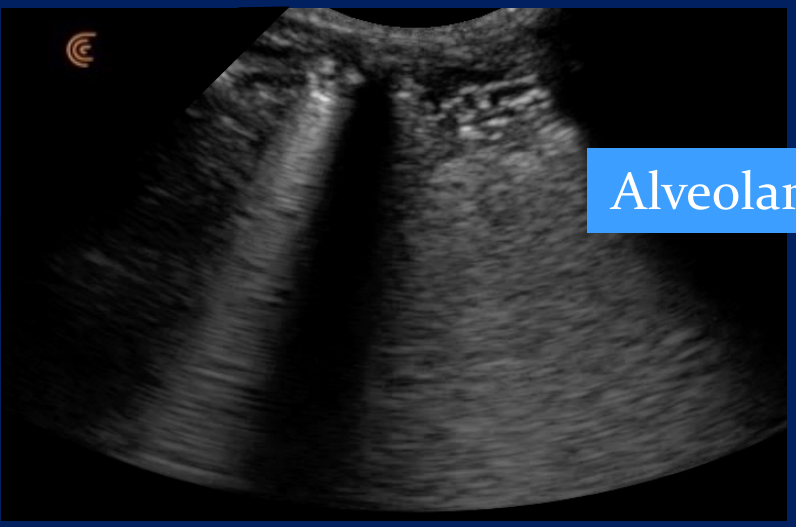


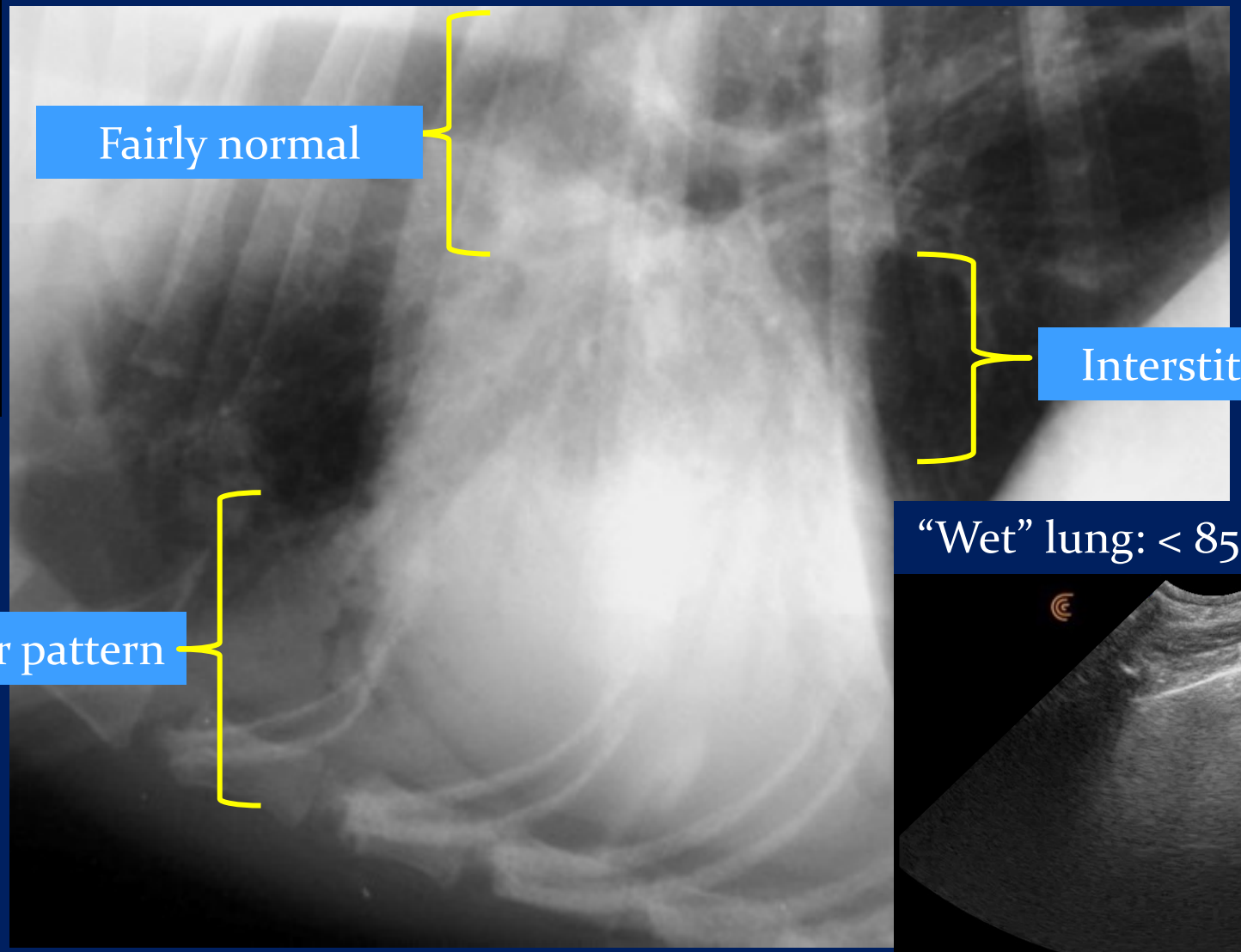
Radiographs vs. lung ultrasound

"Dry" lung: > 85% air



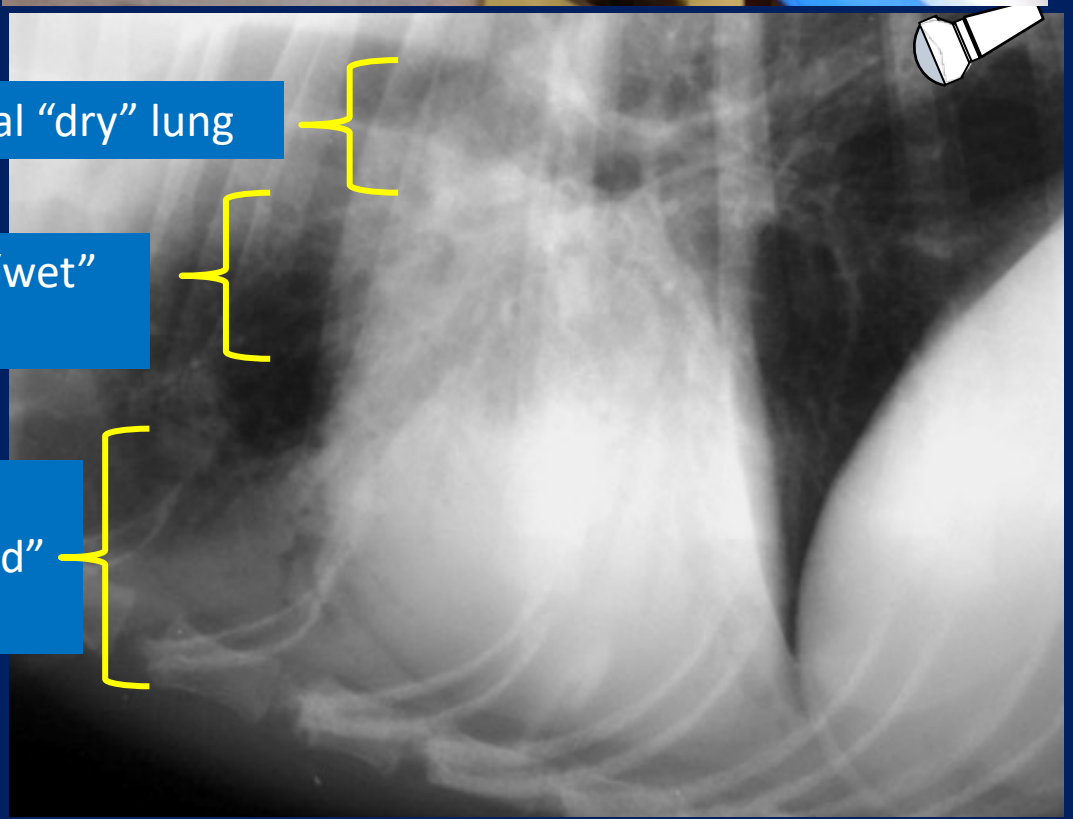
"Consolidated" lung: < 10% air





"Wet" lung: < 85%, > 10 % air

Distribution of LUS findings often helpful, along with history and other clinical findings = The PLUS profile!



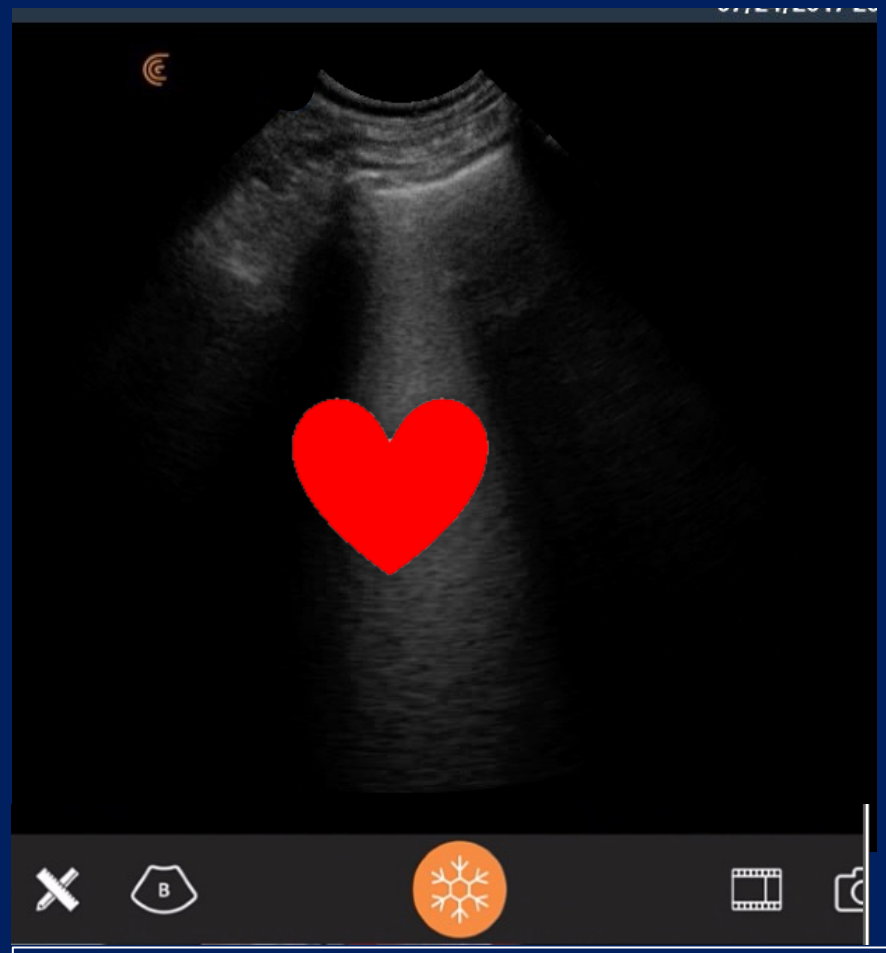
Subpleural consolidation and irregular lung surfaces

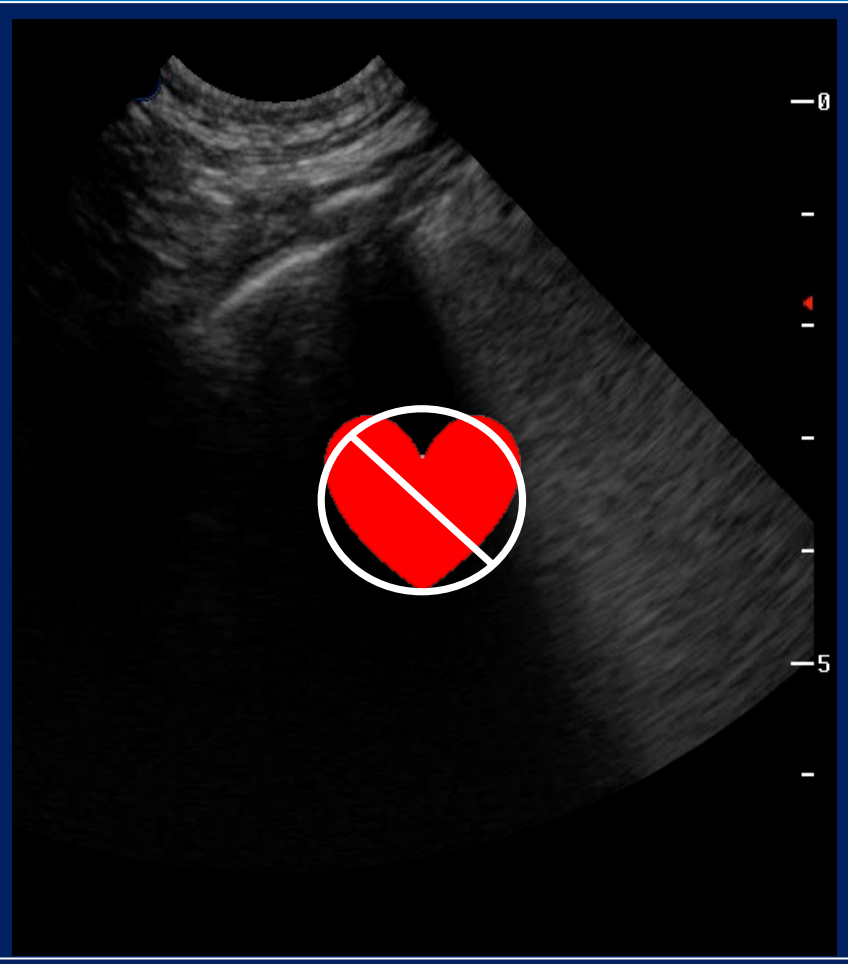
	ACUTE CARDIOGENIC PULMONARY EDEMA	ACUTE LUNG INJURY/ACUTE RESPIRATORY DISTRESS SYNDROME	INTERSTITIAL PNEUMONIA
Clinical course	Acute or acute on chronic	Acute	Acute, subacute or chronic
B-lines	Multiple B lines bilaterally and diffusely especially in the anterior lung fields	Multiple, scattered diffuse B lines bilaterally. Can be heterogeneous with spared areas	Heterogeneous distribution, more at bases usually
Pleural surface morphology	Regular, smooth	Irregular	Irregular
Subpleural consolidations	Absent	Present	Either
Pleural effusions	Usually present and bilateral	Either	Usually absent
Echocardiogram	Abnormal	Normal initially	Can have signs of right ventricular dysfunction/ pulmonary hypertension if long standing

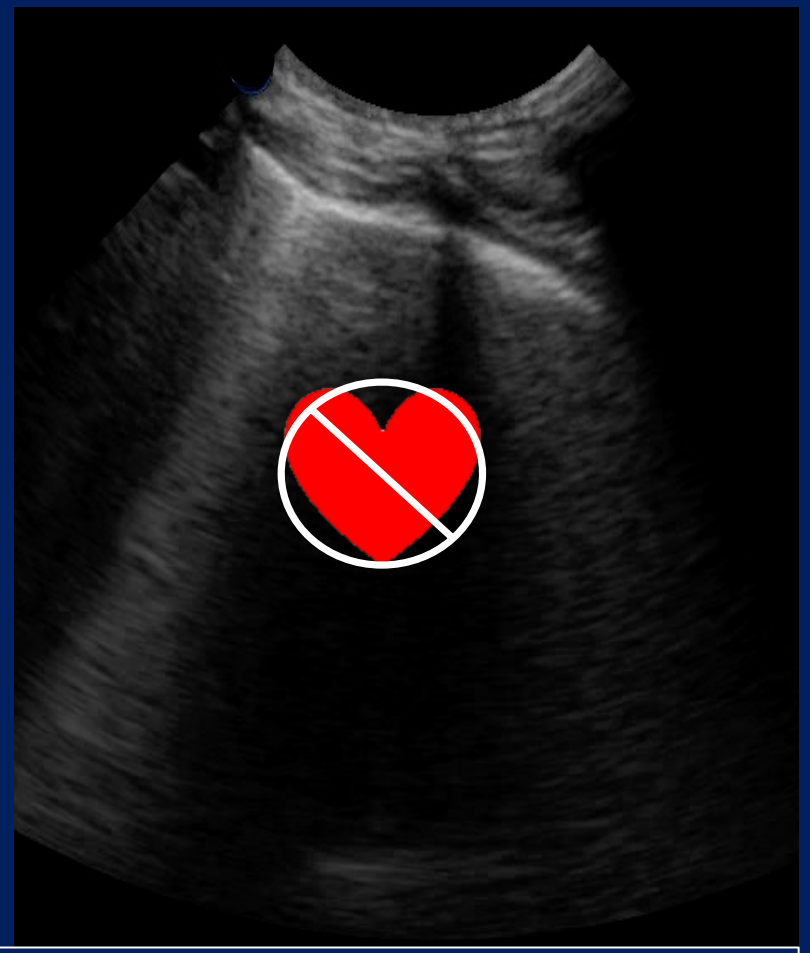
Clinical Medicine Insights: Circulatory, Respiratory and Pulmonary Medicine 2016:10 1–9 doi: 10.4137/CCRPM.S33382.

Irregular pleural surfaces

Smooth/irregular lung surface - subpleural consolidation: Y/N?







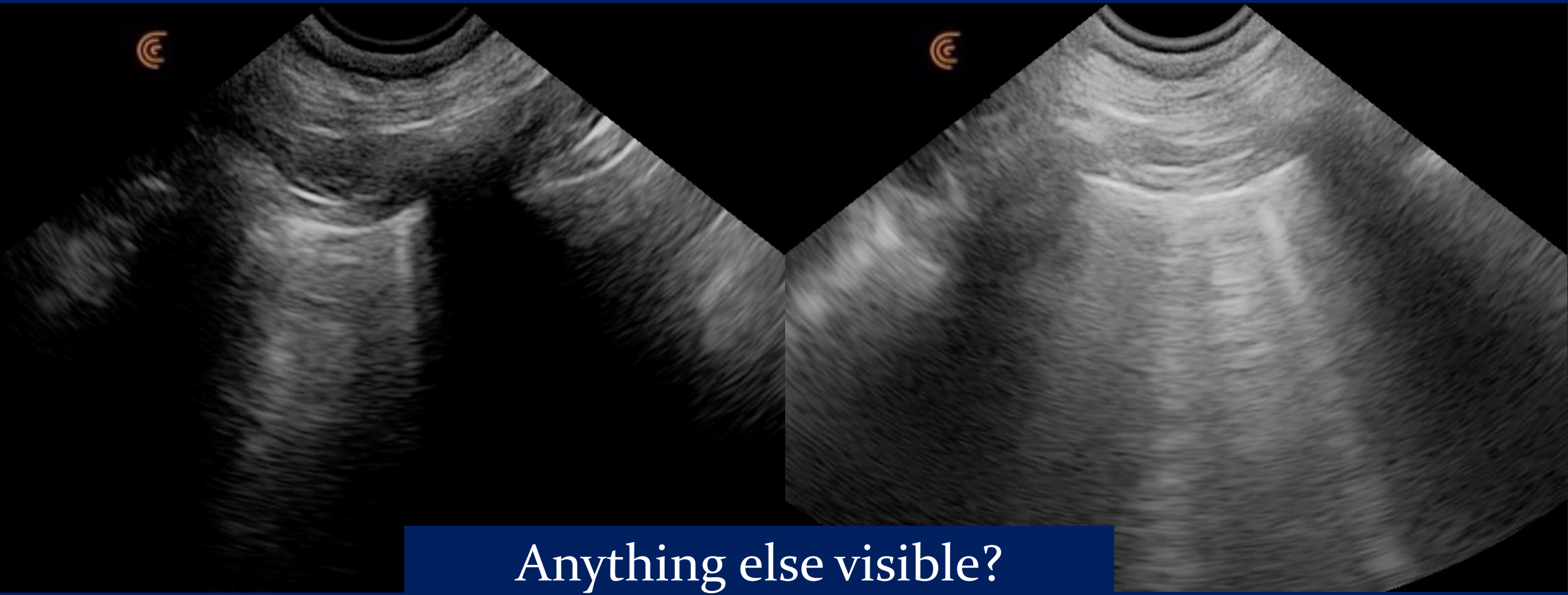
When B lines are present pay attention to the thickness and character of the pleural line and look for consolidation: less likely cardiac?

Chloe: 8-year-old Golden

- Presents for decreased activity and appetite
  - Started 3 days ago
  - Heart rate 88 bpm
  - RR 32 BPM, no effort
  - T 38.4 C (101.6 F)
  - Occasional cough
  - Normal thoracic auscultation

Thoughts?

POCUS finding?

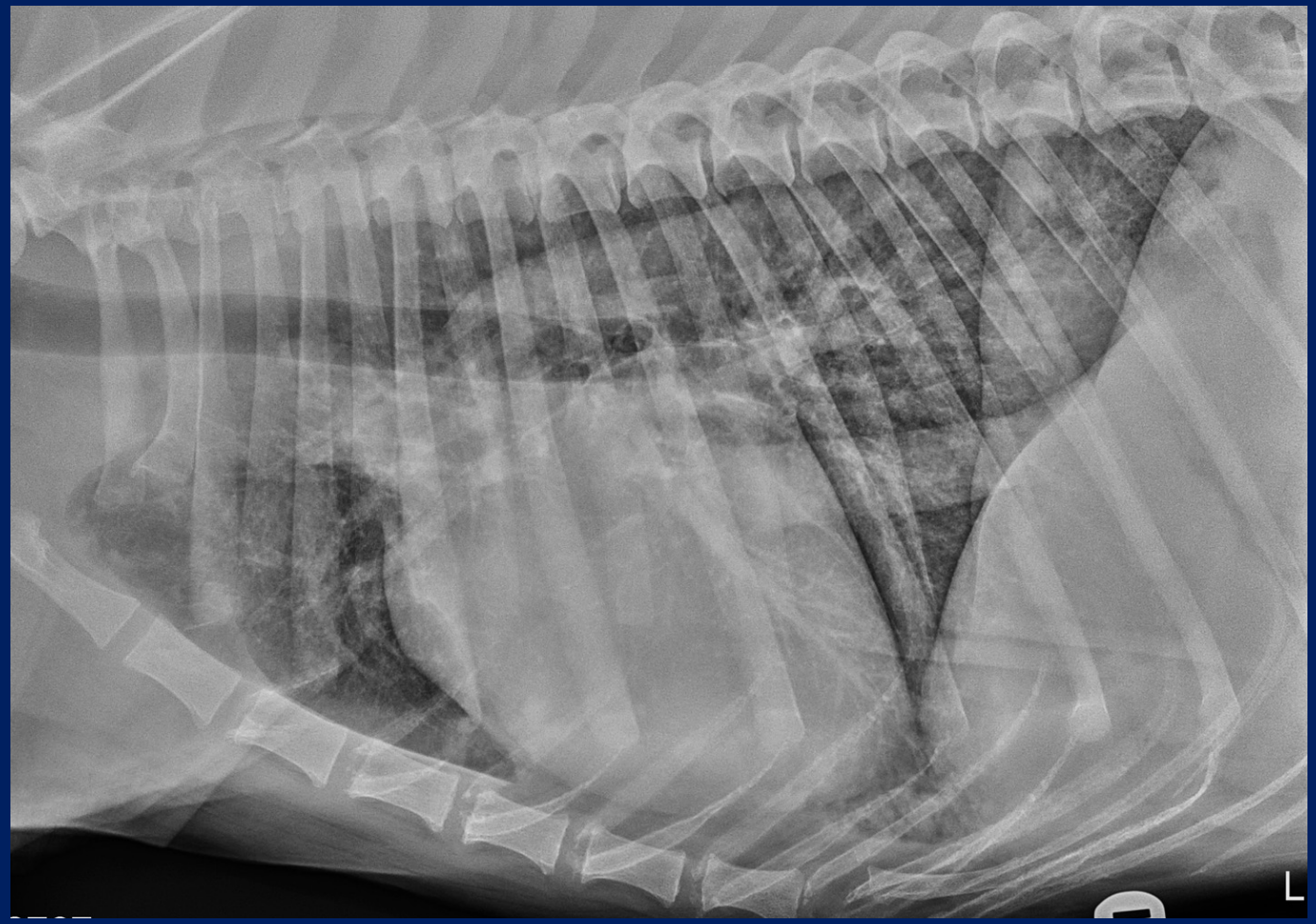


Anything else visible?

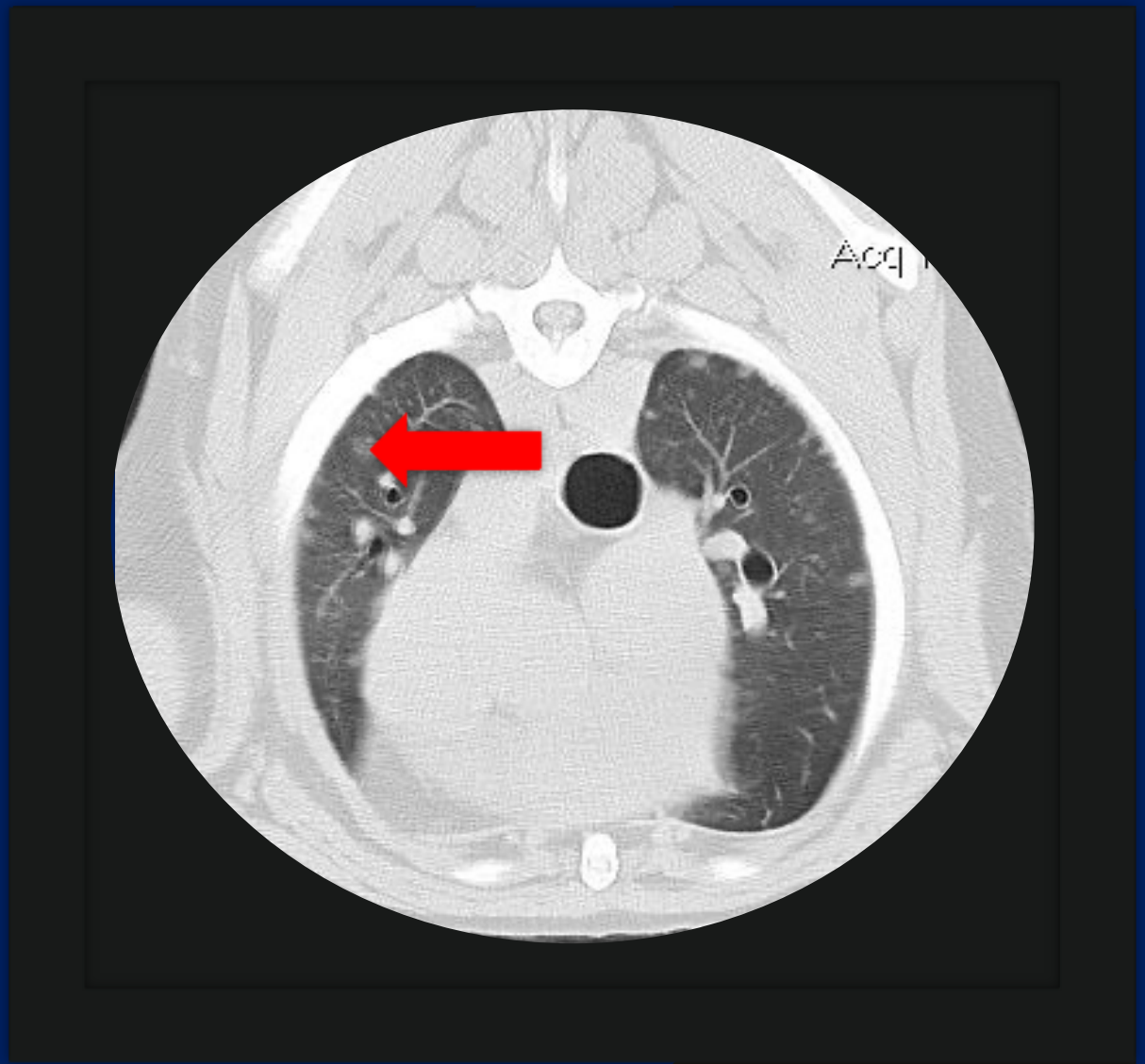
Thoughts?

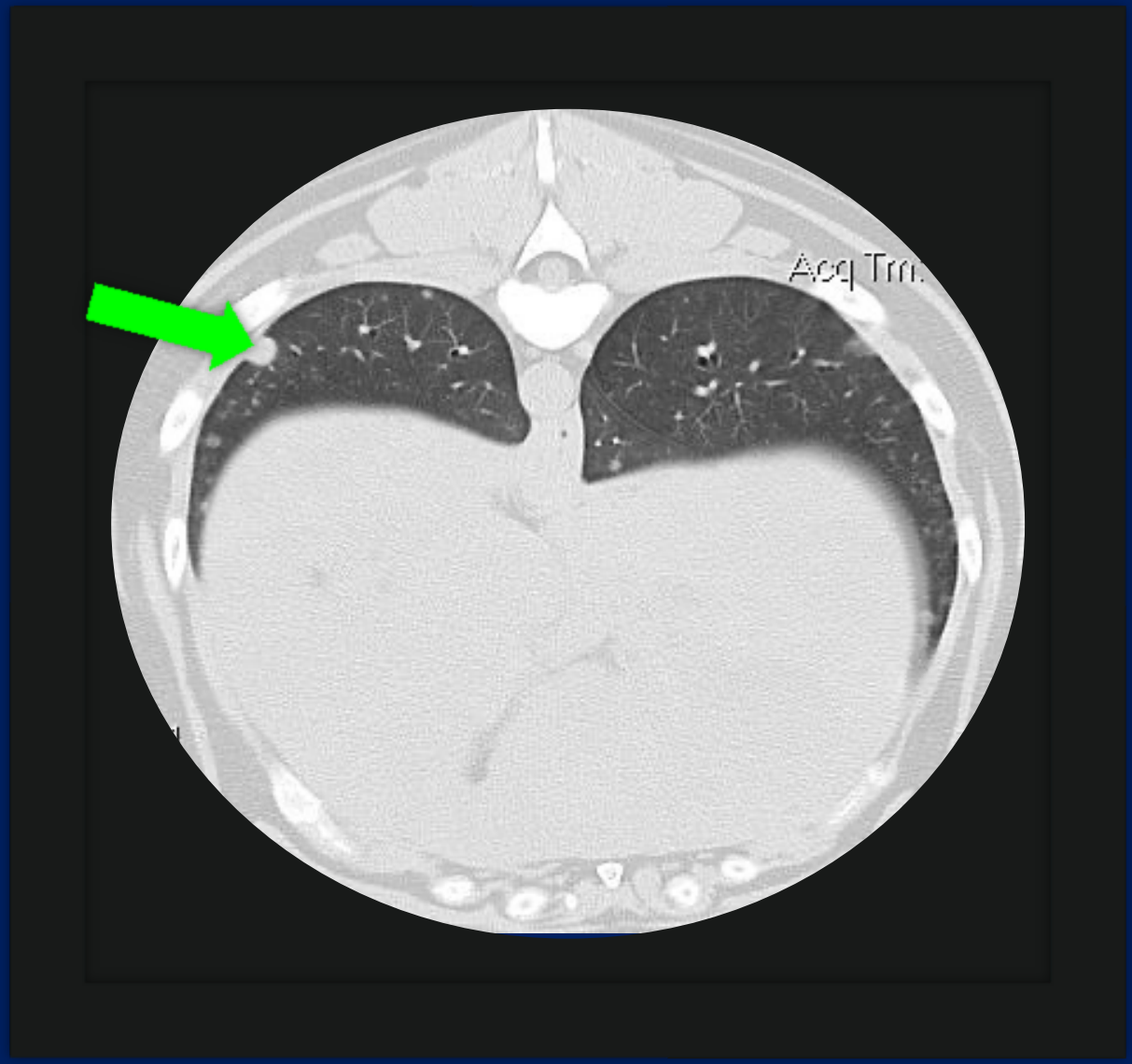
Chloe: 8-year-old Golden

Age related interstitial pattern

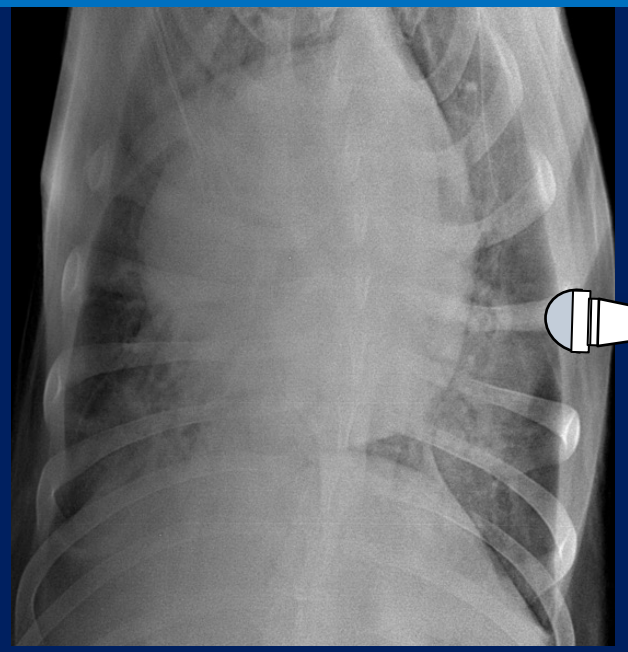


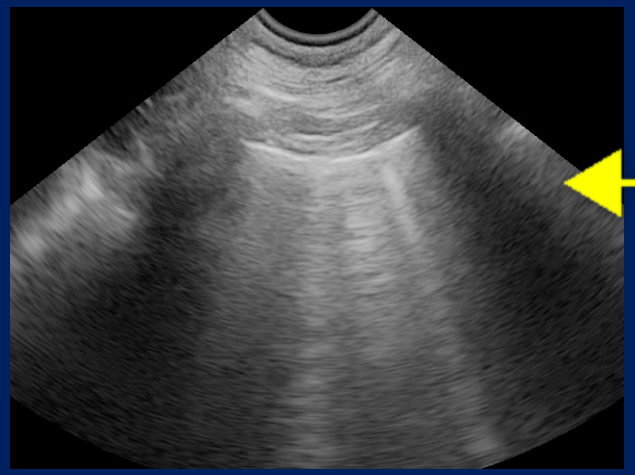
CT for Chloe





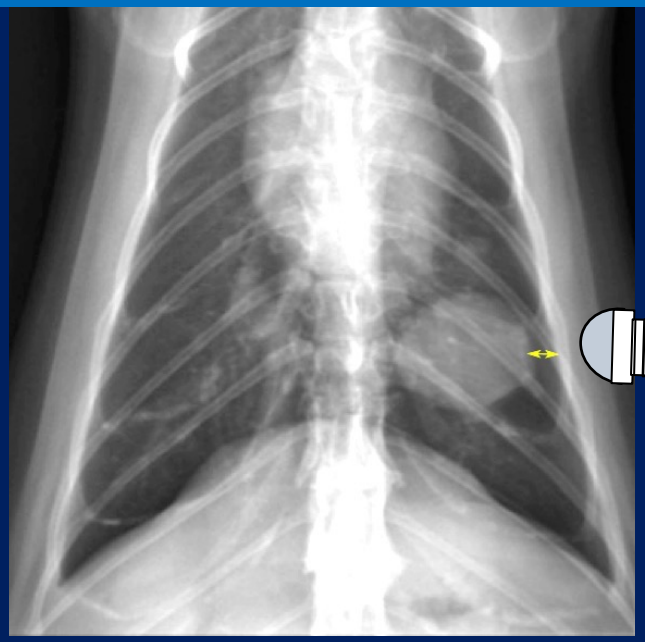
Lung ultrasound

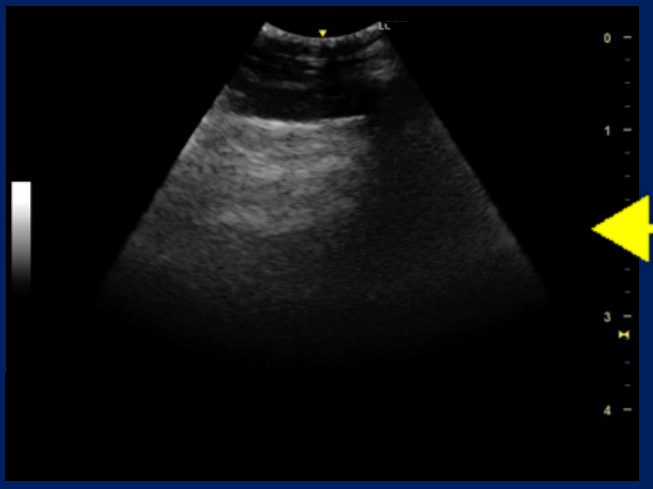




- Can only detect lung injury at the periphery
  - 95% of human pathology that causes “wet” lung reaches the lung surface
  - Therefore it is detectable via lung ultrasound
  - Likely similar in veterinary patients

LUS is a surface imaging technique





Lung consolidation: 3 criteria to diagnose

1. Should arise from the "pleural line”*
2. Should have a tissue like pattern (similar to liver)
3. Distal lung boundaries must be present

Armenisie, JSAP 2019

PAPER

Veterinary-focused assessment with sonography for trauma-airway, breathing, circulation, disability and exposure: a prospective observational study in 64 canine trauma patients

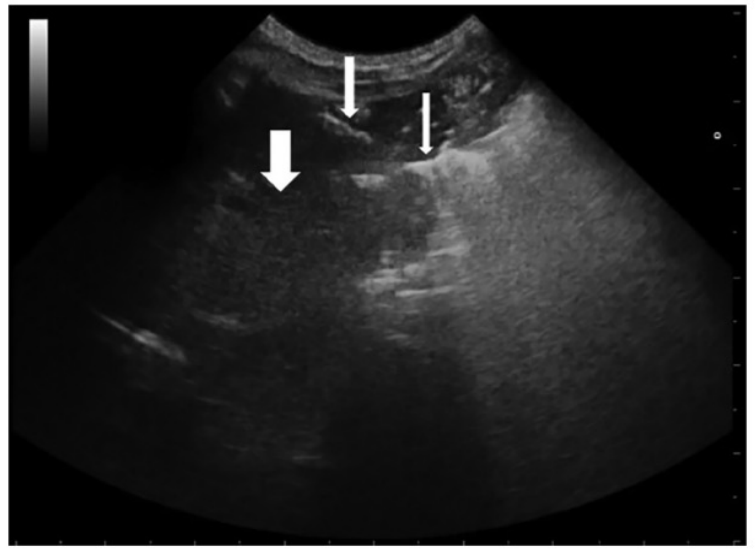


FIG 5. Lung consolidation: substantial alveolar consolidation without air bronchograms (liver-like pattern) (thick white arrow), air bronchogram shown longitudinally (medium white arrow), and B-lines arising from bronchi (thin white arrow). The small white punctate foci are transvers (“end on”) bronchograms (not labelled)

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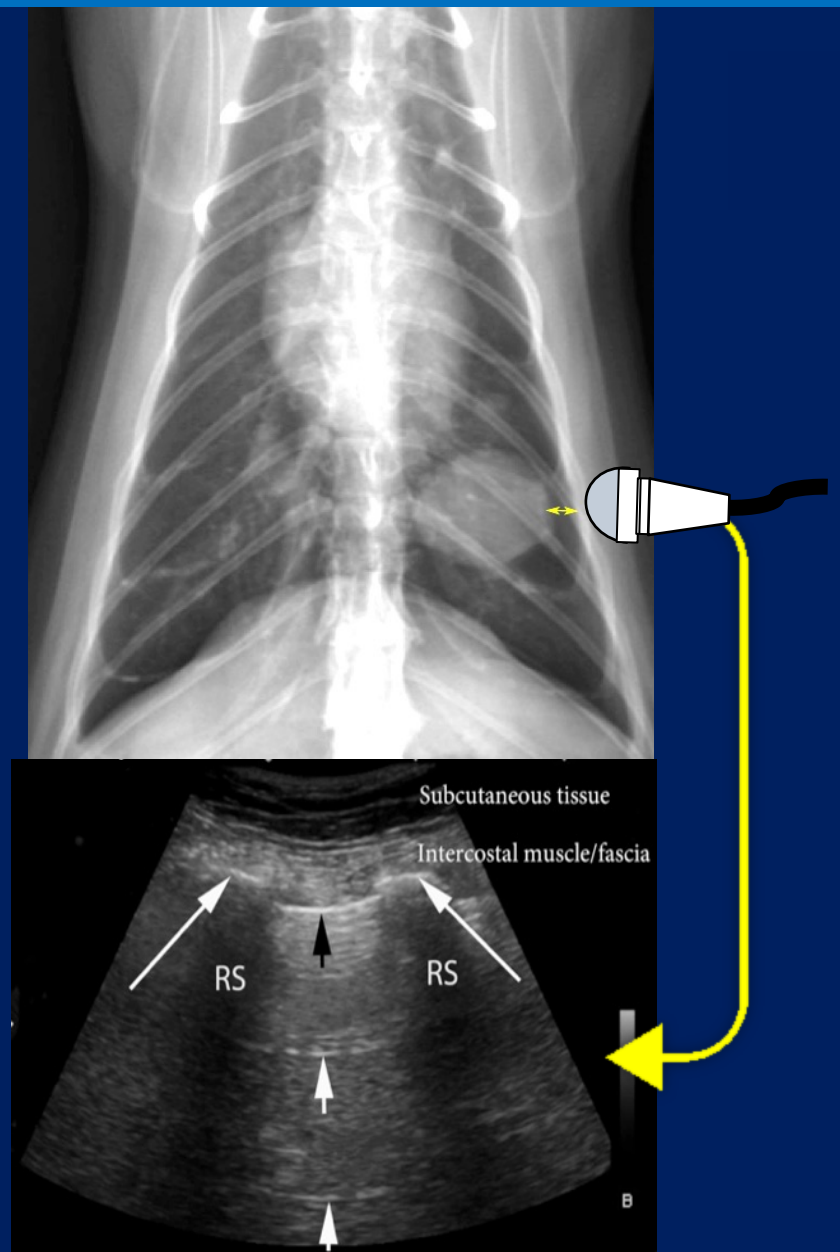
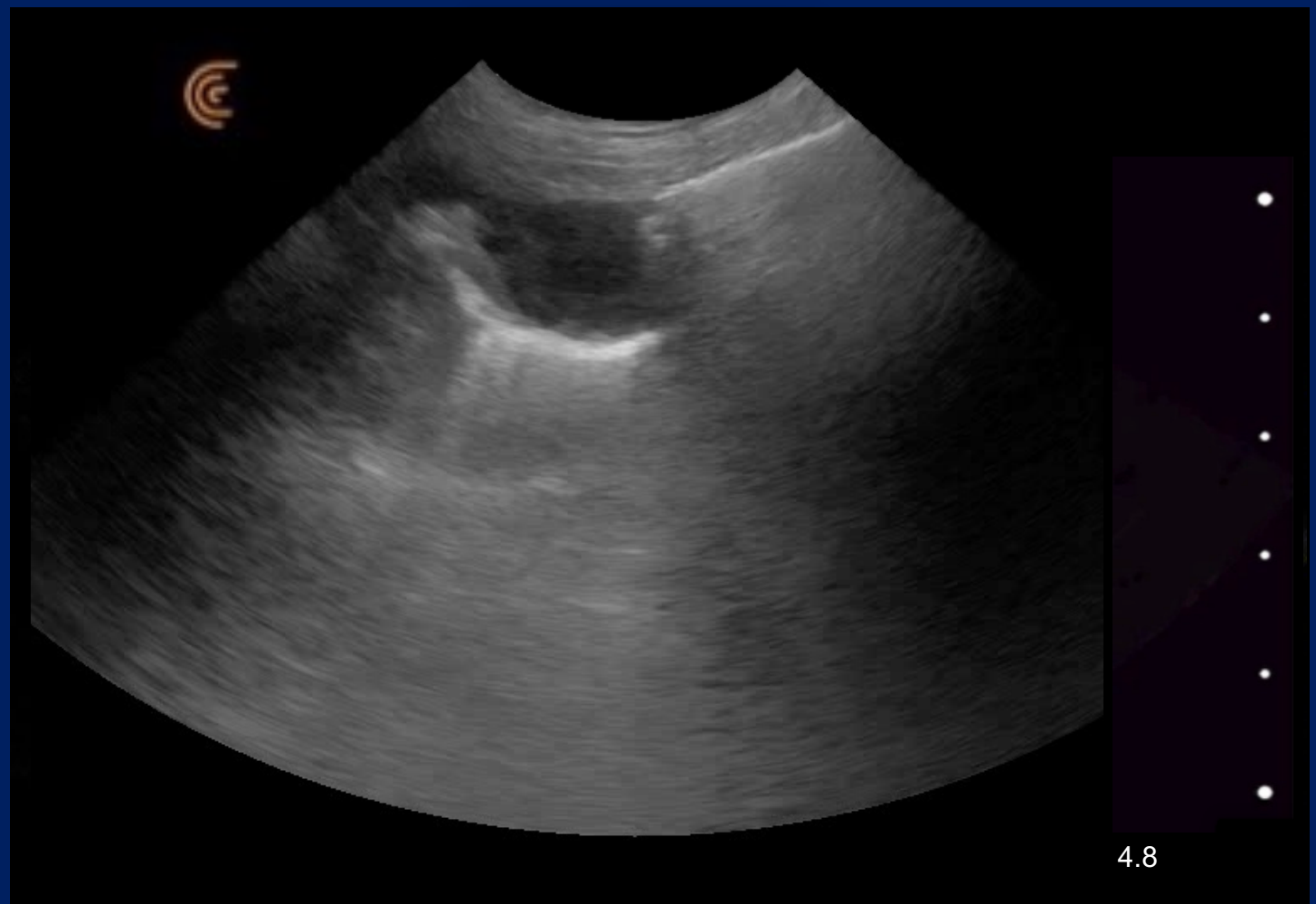
1. Arise from pleural line

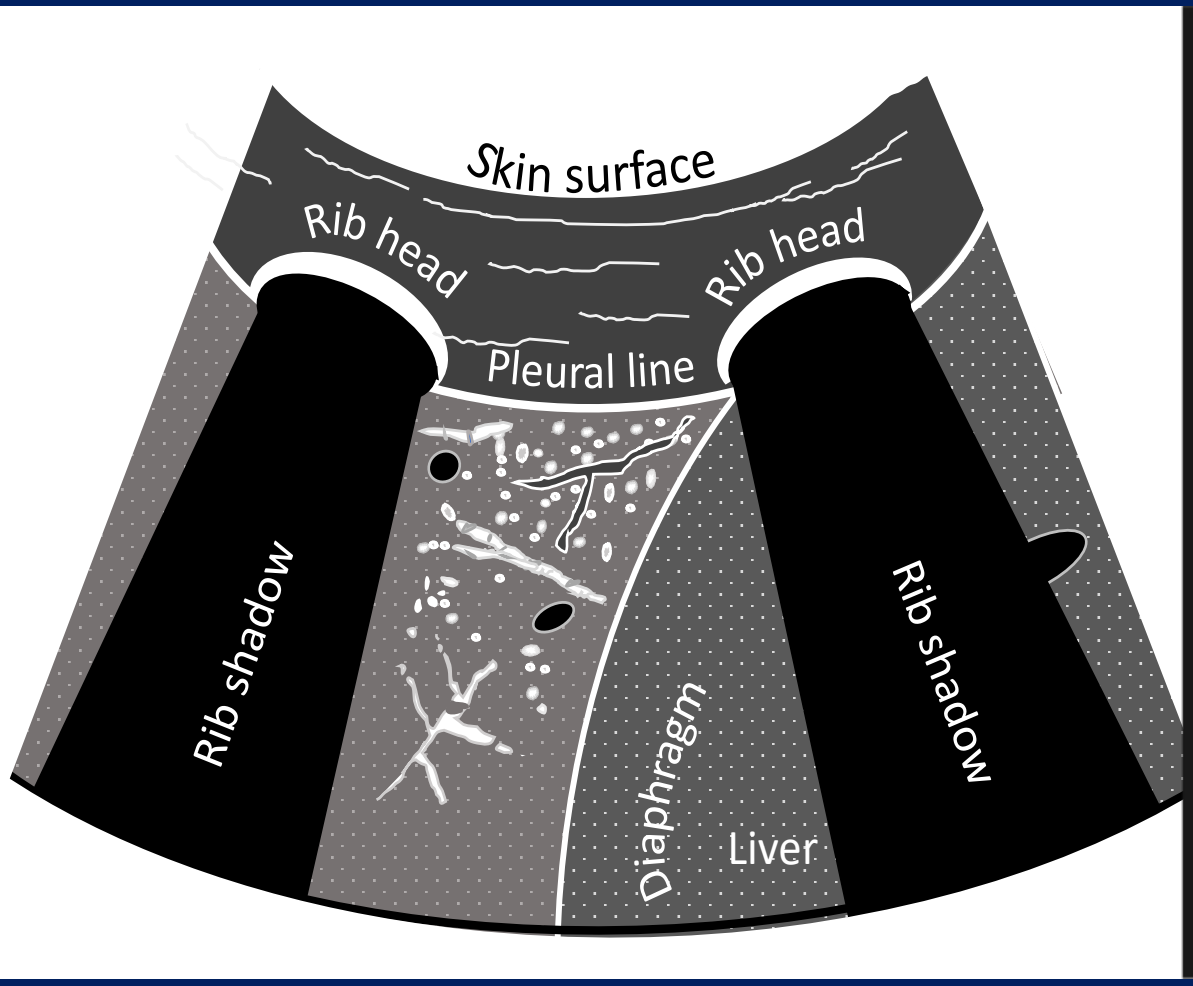


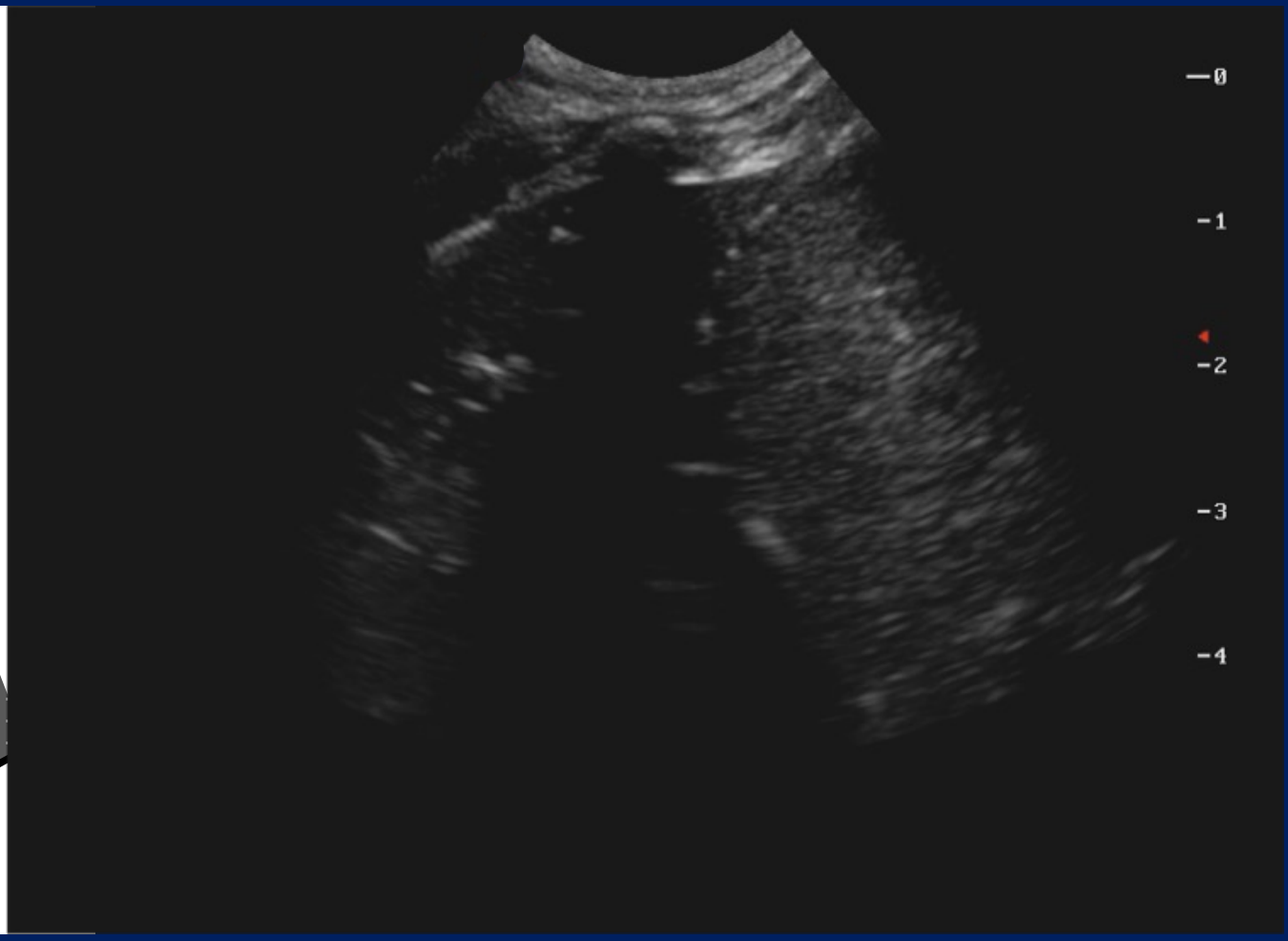
Must reach the lung surface!!!



2. Tissue like pattern

Similar soft tissue appearance to liver





3. Distal lung boundaries

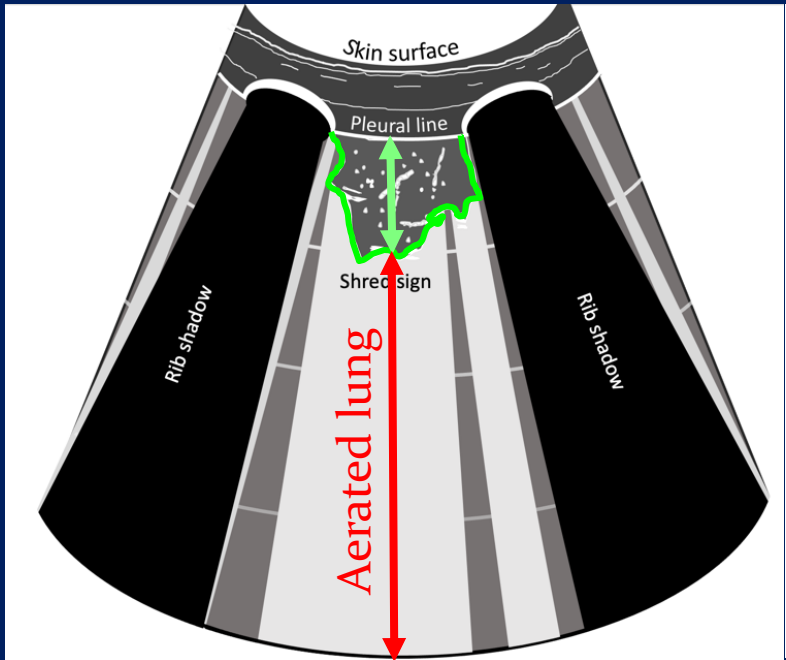
Helps define the type of consolidation ….

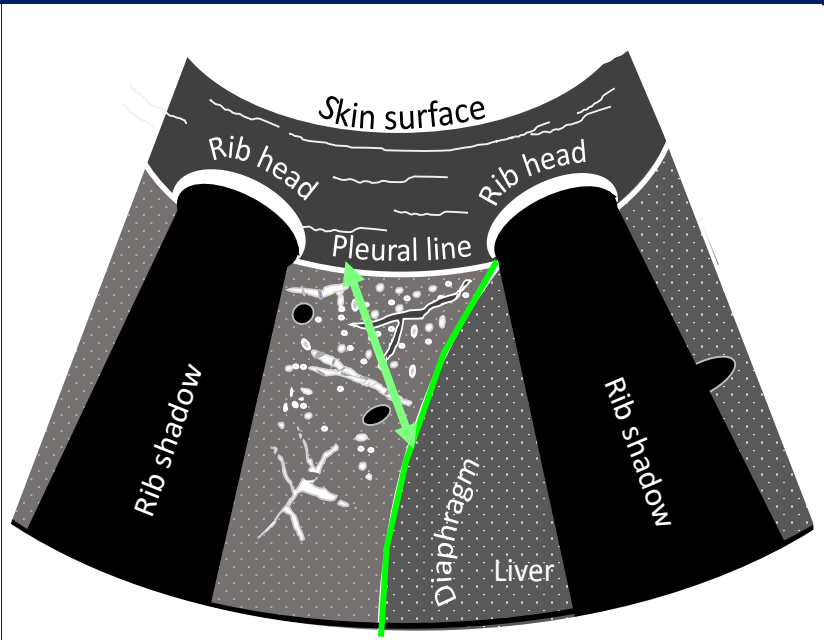
Consolidation does not extend surface to surface:

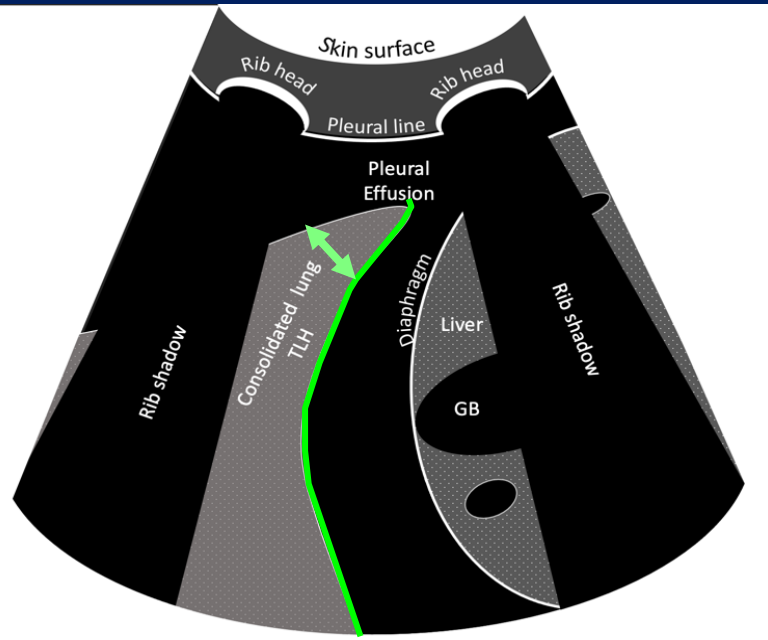
- Partial consolidation

Consolidation that extends surface to surface:

- Trans-lobar hepatization



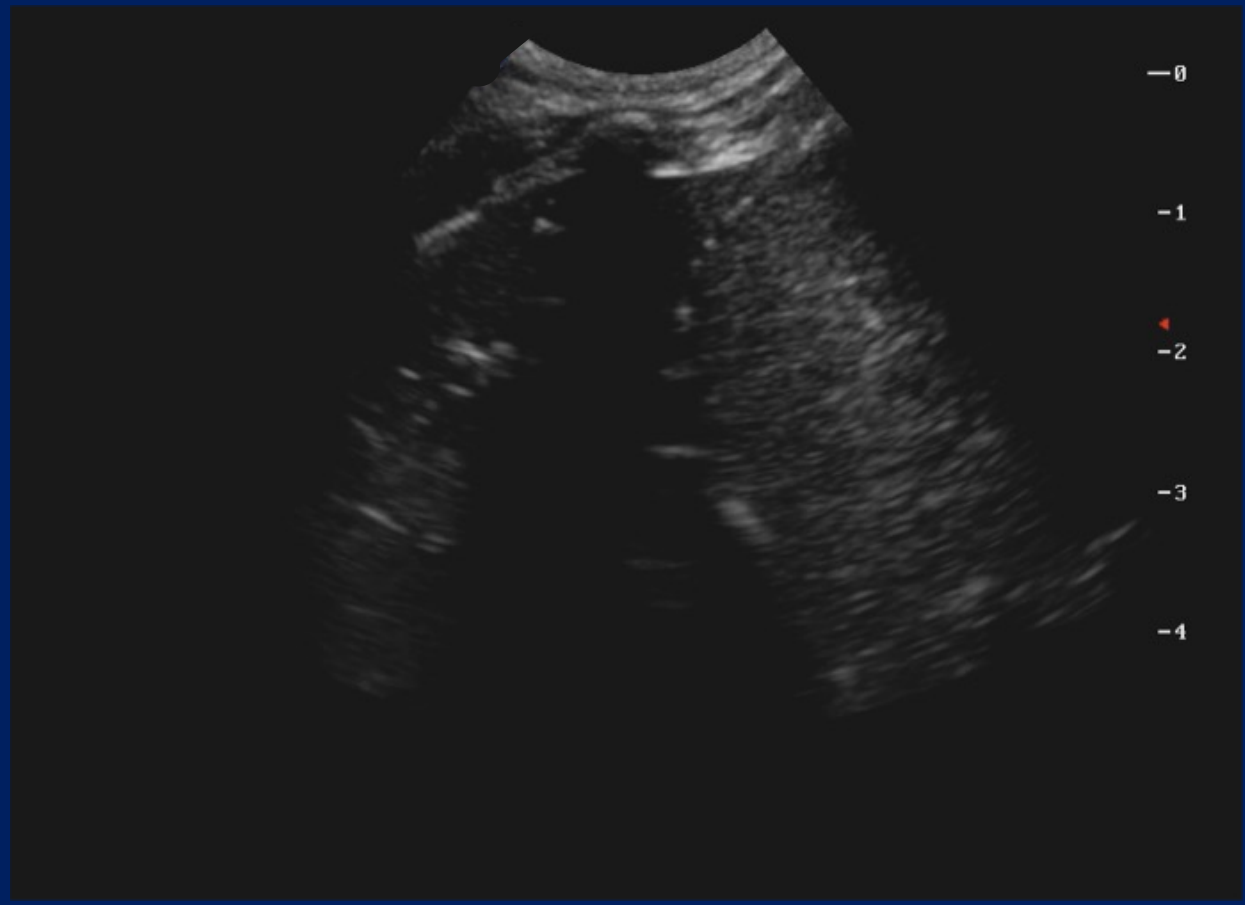




3. Lung consolidation: shred vs hepatisation

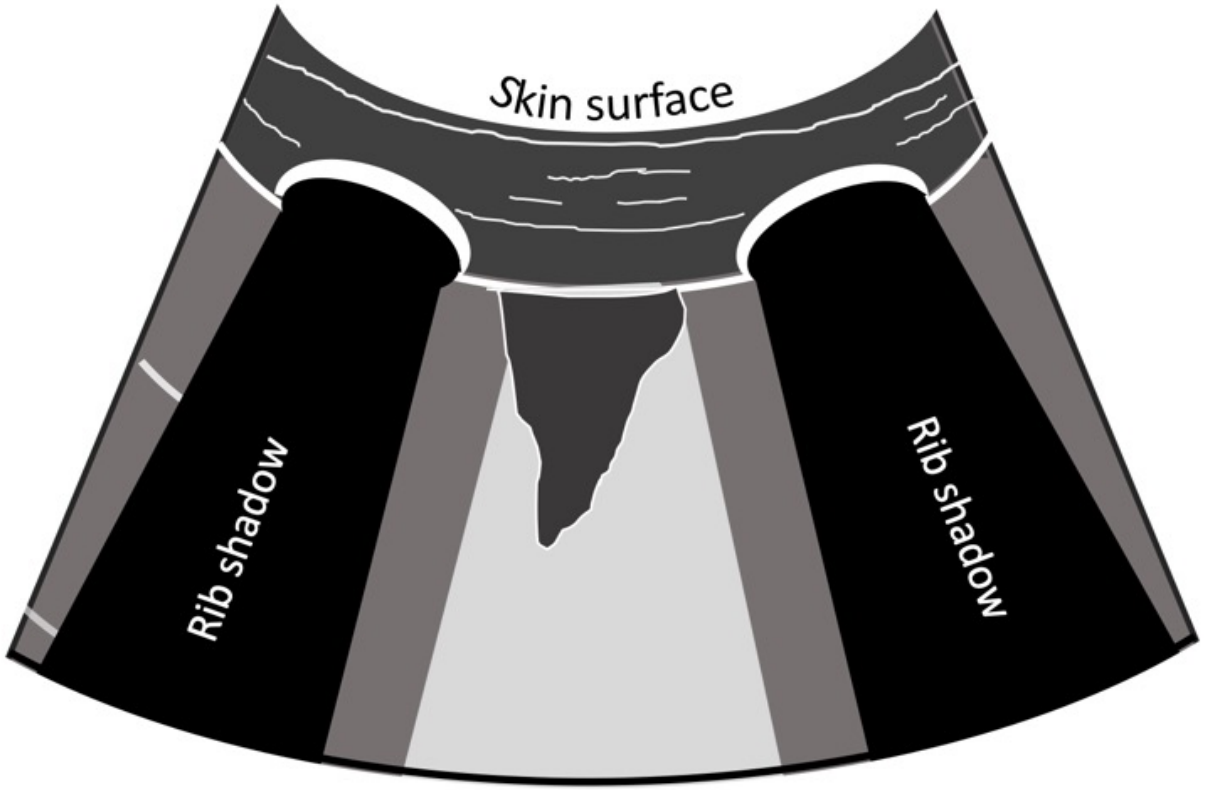
Partial or complete?

Partial or complete?



Can you see the diaphragm curving away from the chest wall?

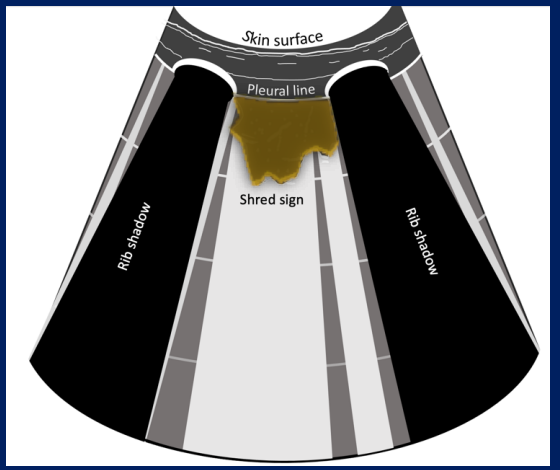
Other consolidations exist…

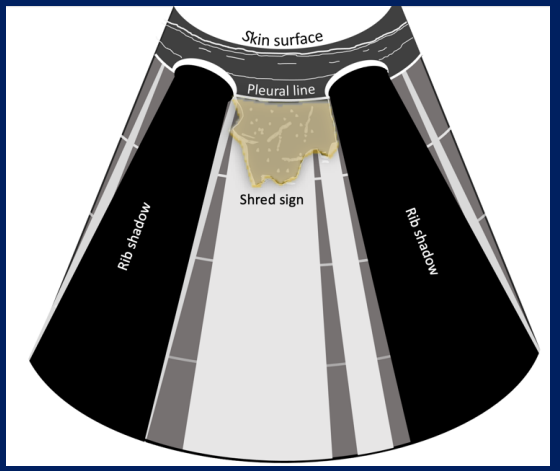


Triangular ” wedge” shape lesions may occur with pulmonary embolism but not well studied in veterinary medicine

Causes of lung consolidation: decreased aerated lung

- Air may be replaced by…
  - Fluid*******
    - Blood
    - Pus
    - Aspirated gastric content
    - Other fluid types
  - Cells
    - Neoplastic
    - Inflammatory
    - Fibrotic



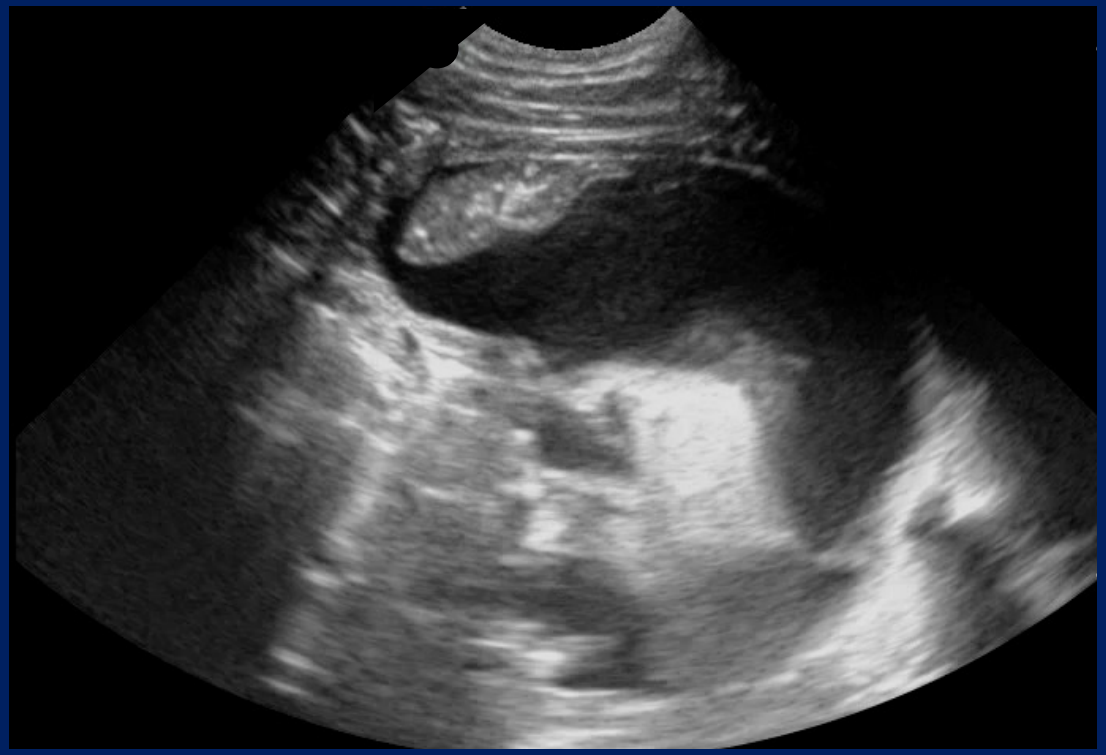


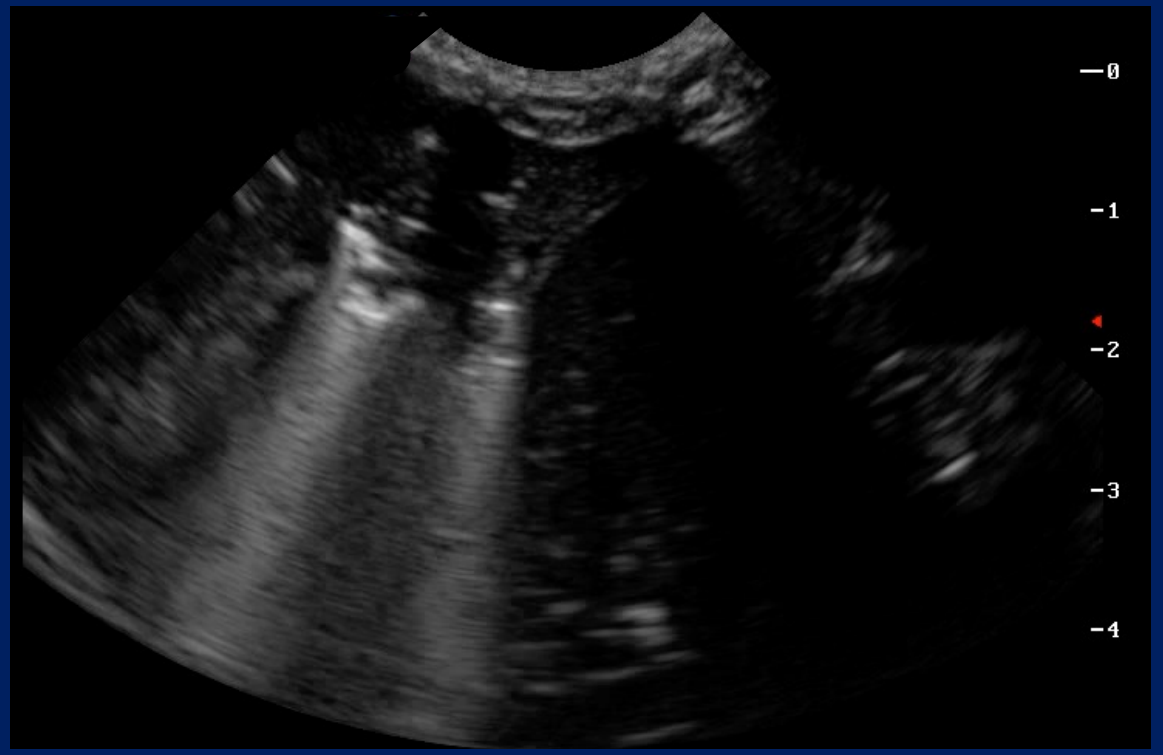
Decreased air in the alveoli due to atelectasis/collapse will also cause increased B lines and even consolidation!!

Why do we care about consolidation?

Simple answer: not having air in the lung is a problem

Is it always serious underlying lung pathology?



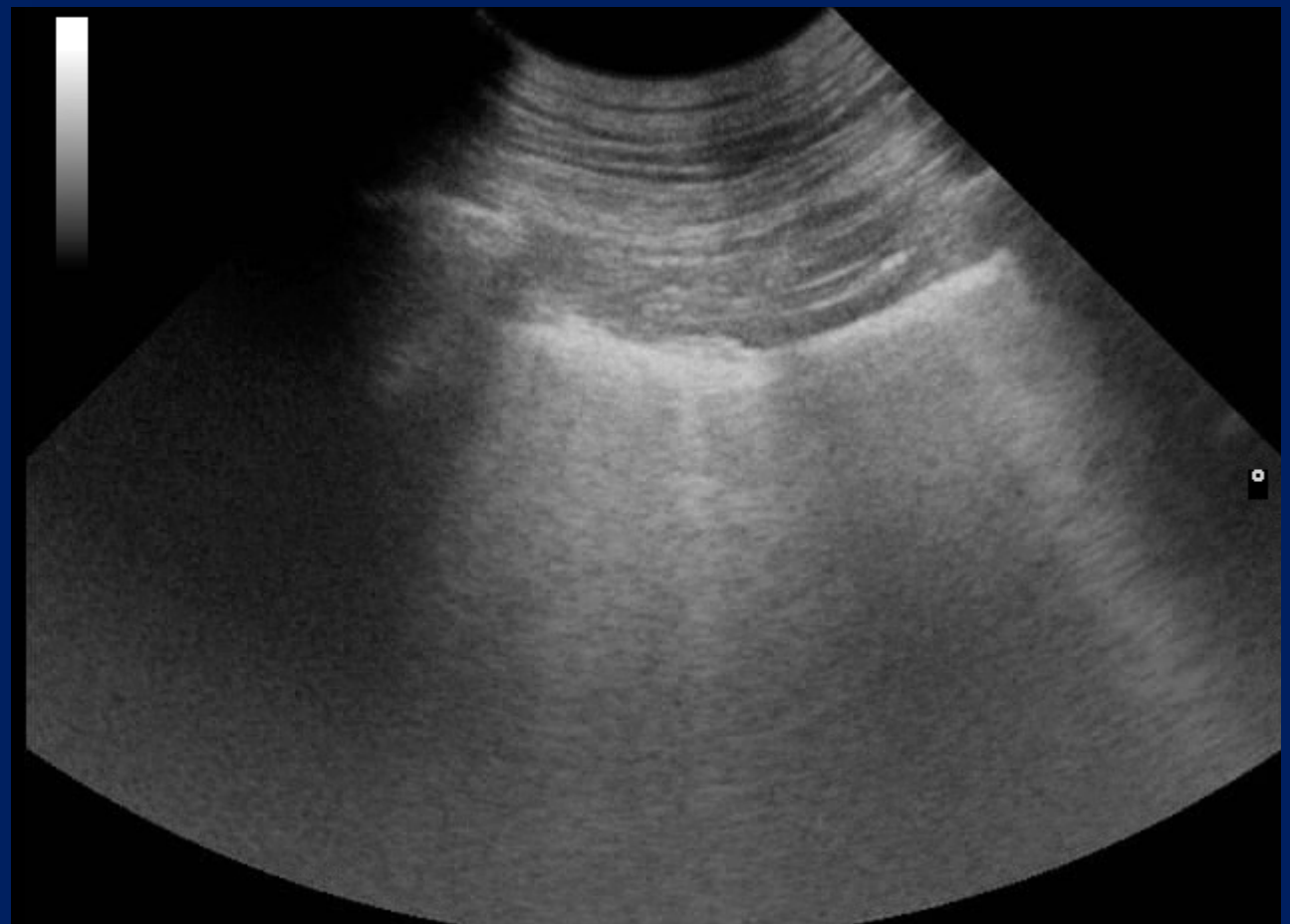


Air bronchograms

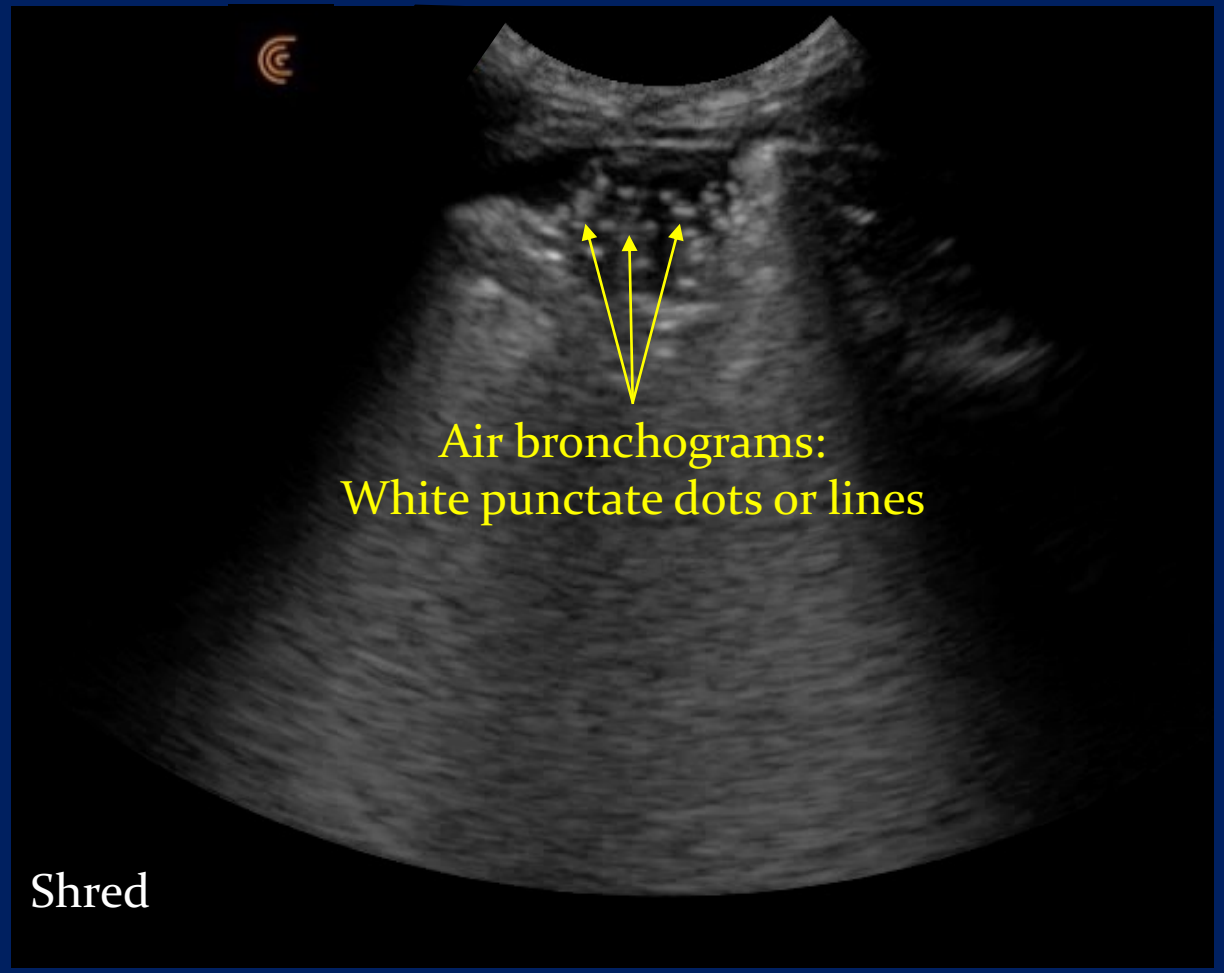
- Air bronchograms occur with partial and complete lung consolidation
- Can be visualized on lung ultrasound as punctate echogenic foci or “worms”

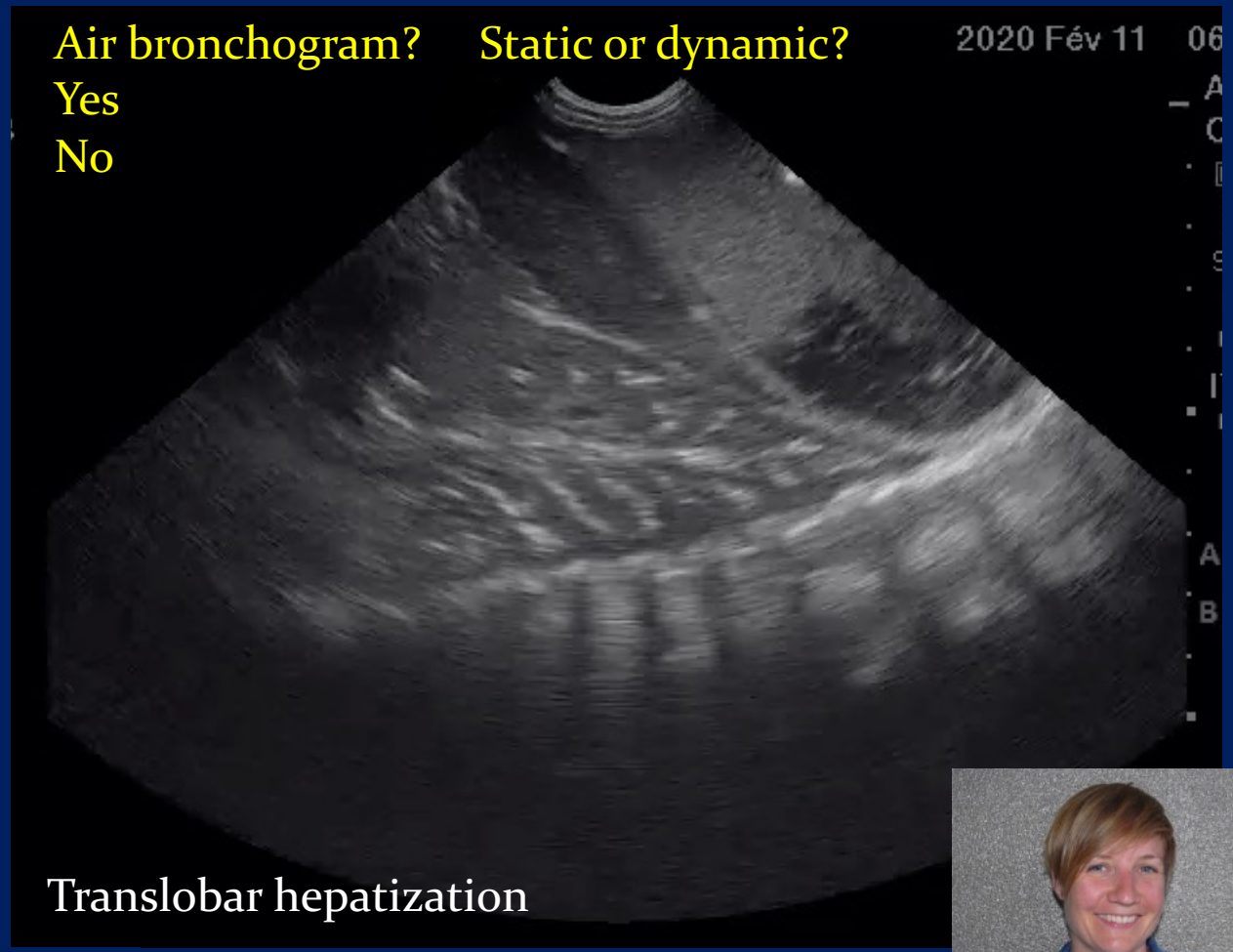
Air bronchograms

- Air bronchograms occur with partial and complete lung consolidation
- Can be visualized on lung ultrasound as punctate echogenic foci or “worms”



Air bronchograms: Y/N?

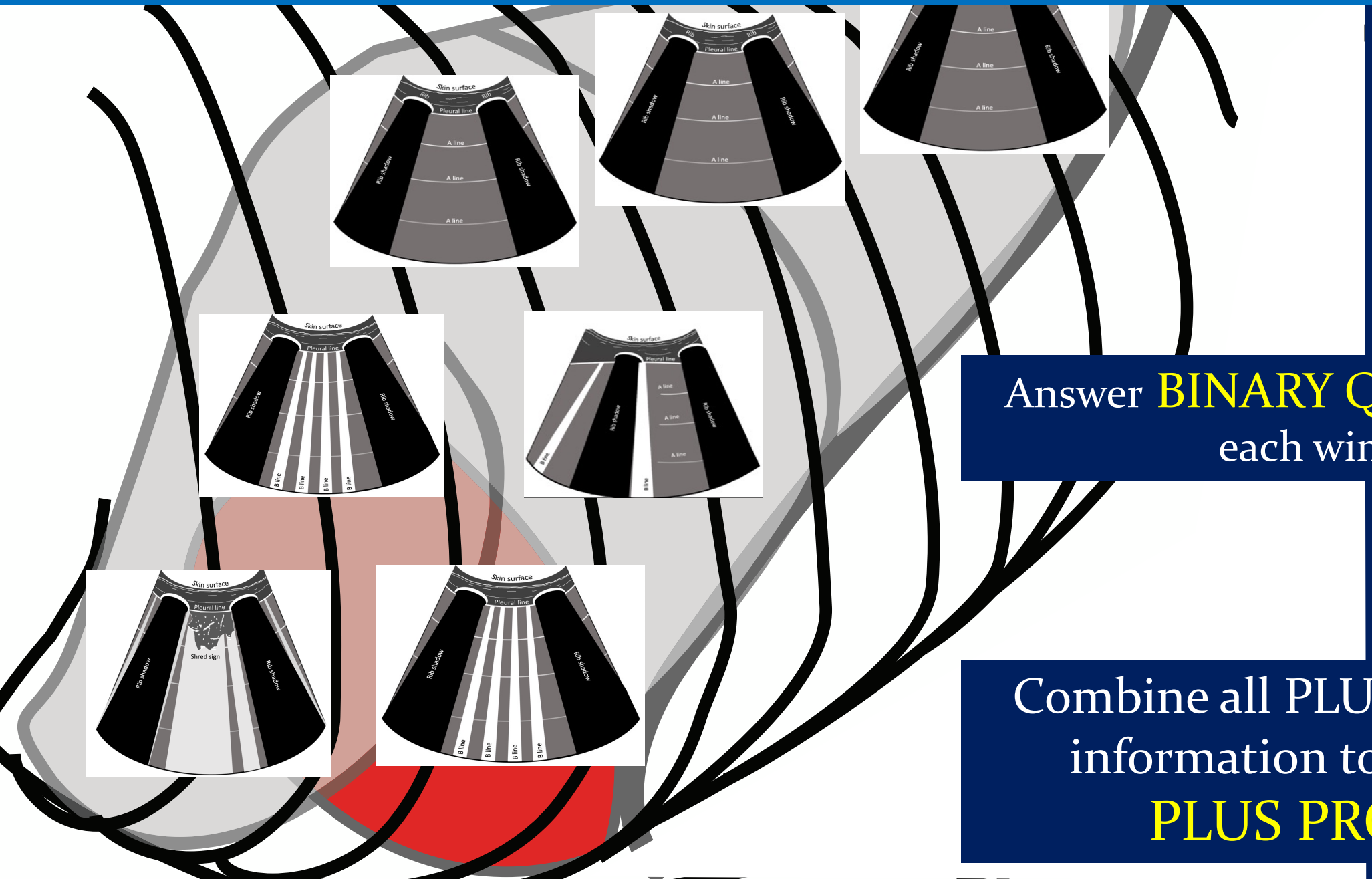




Dr Celine Nevoret

If you see air bronchograms:
Dynamic = pathology
Static may be seen with pathology or atelectasis

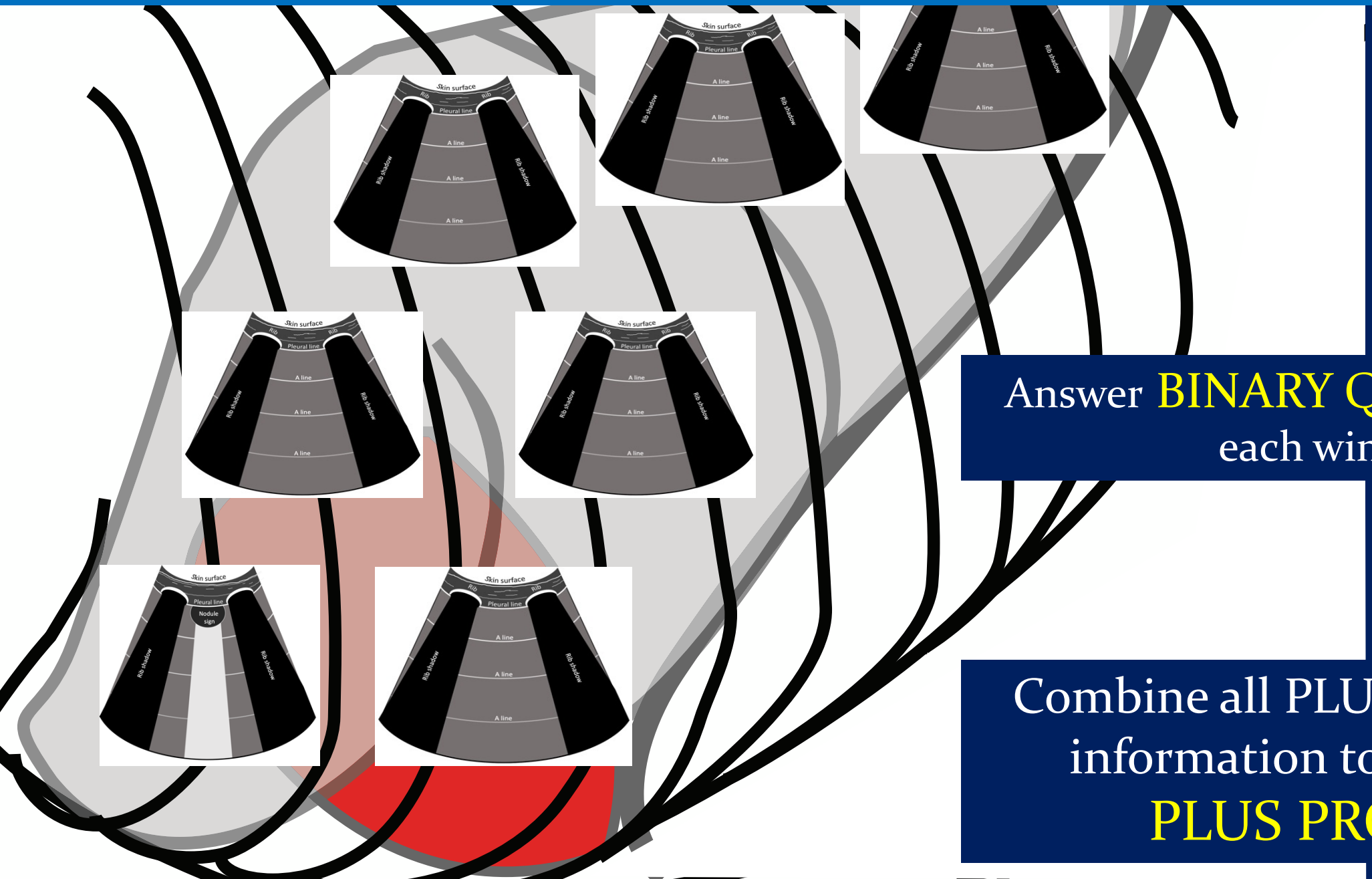
Assess each window but also consider the entire hemithorax



Answer BINARY QUESTIONS at each window

Combine all PLUS and clinical information to create the PLUS PROFILE

Assess each window but also consider the entire hemithorax

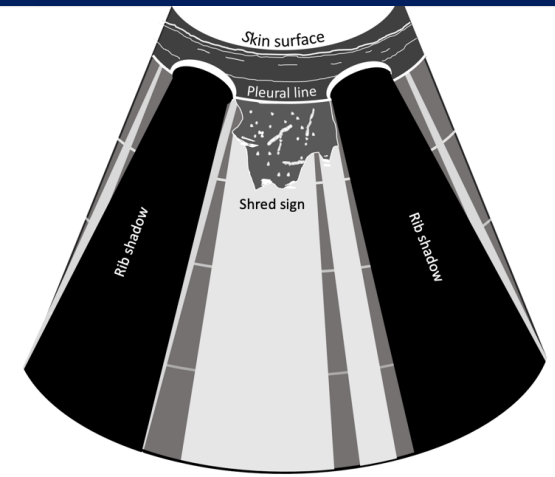


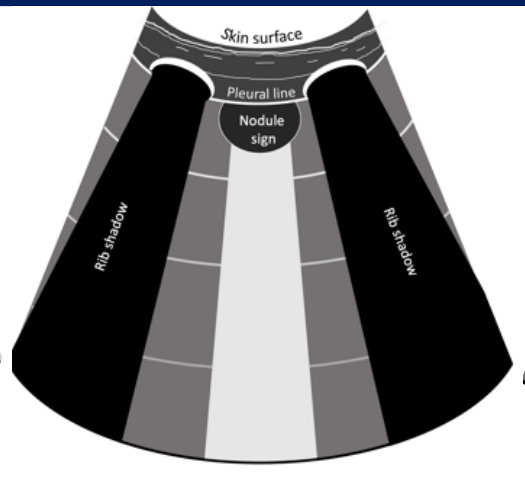
Answer BINARY QUESTIONS at each window

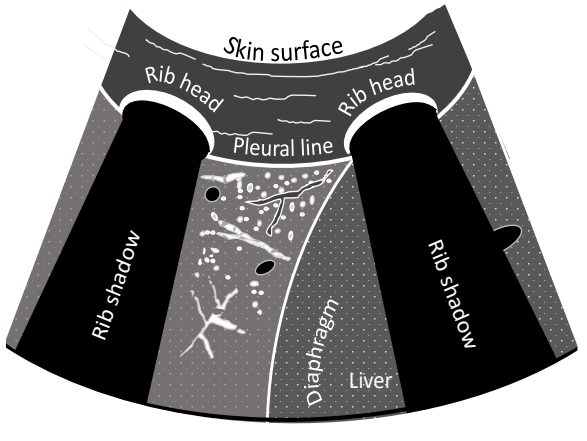
Combine all PLUS and clinical information to create the PLUS PROFILE

Summary: Lung consolidations

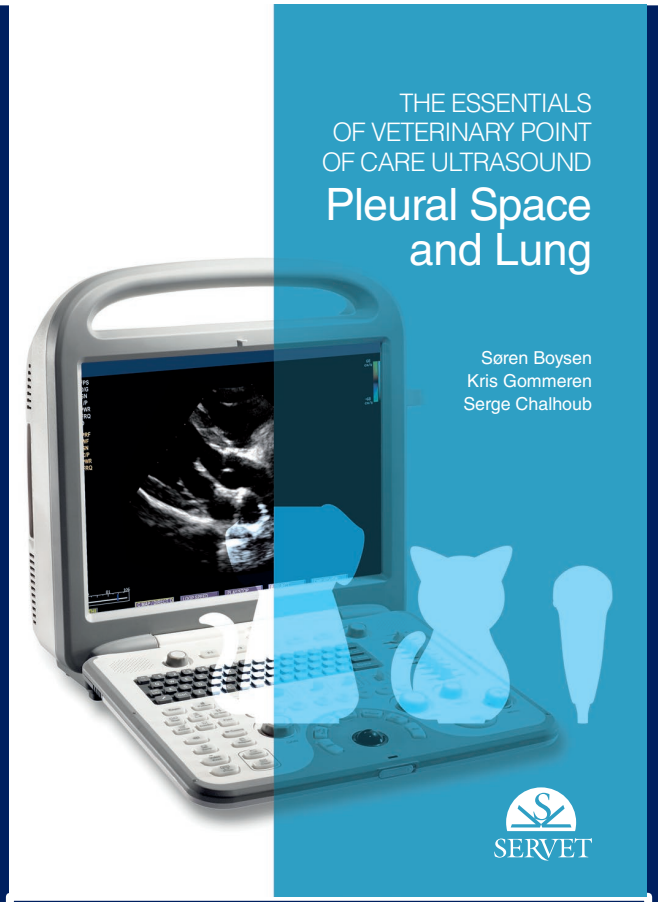
1. When there is less than 5-10% air in the lung the ultrasound beam can traverse lung tissue = lung consolidation
2. There are many types of consolidation: 3 are common
    1. Shred sign
    2. Nodule sign
    3. Hepatization/trans-lobar sign







Questions?



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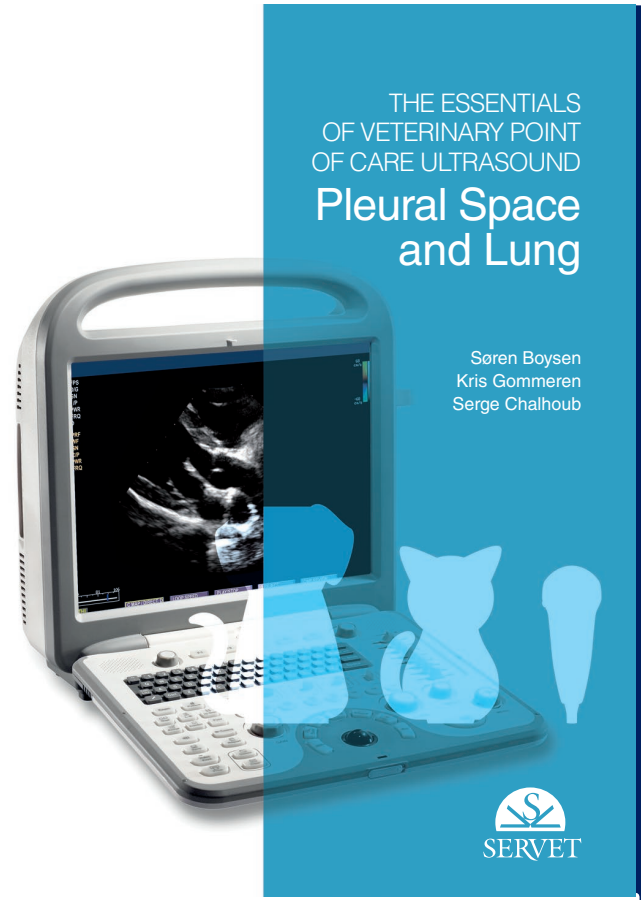

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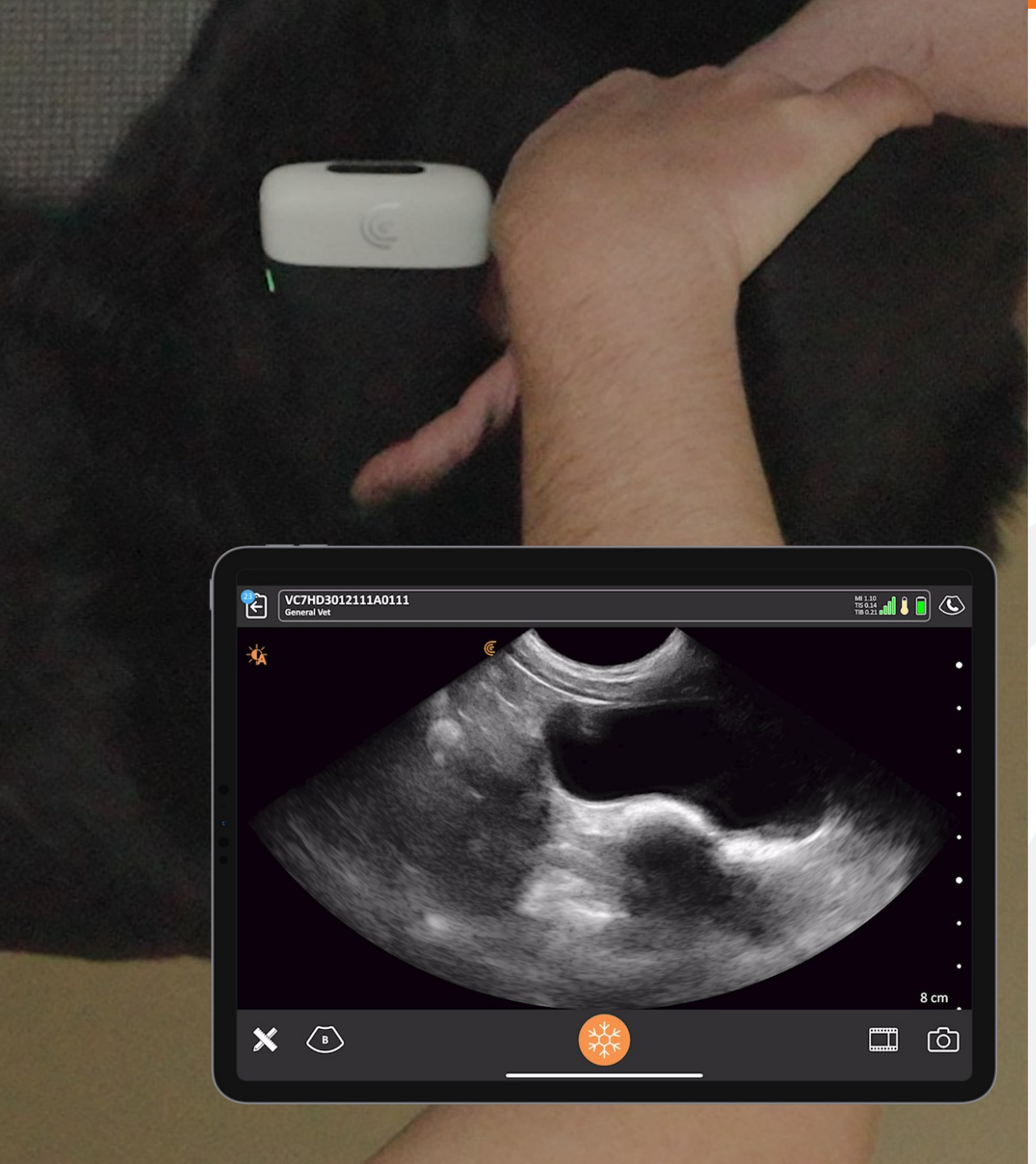

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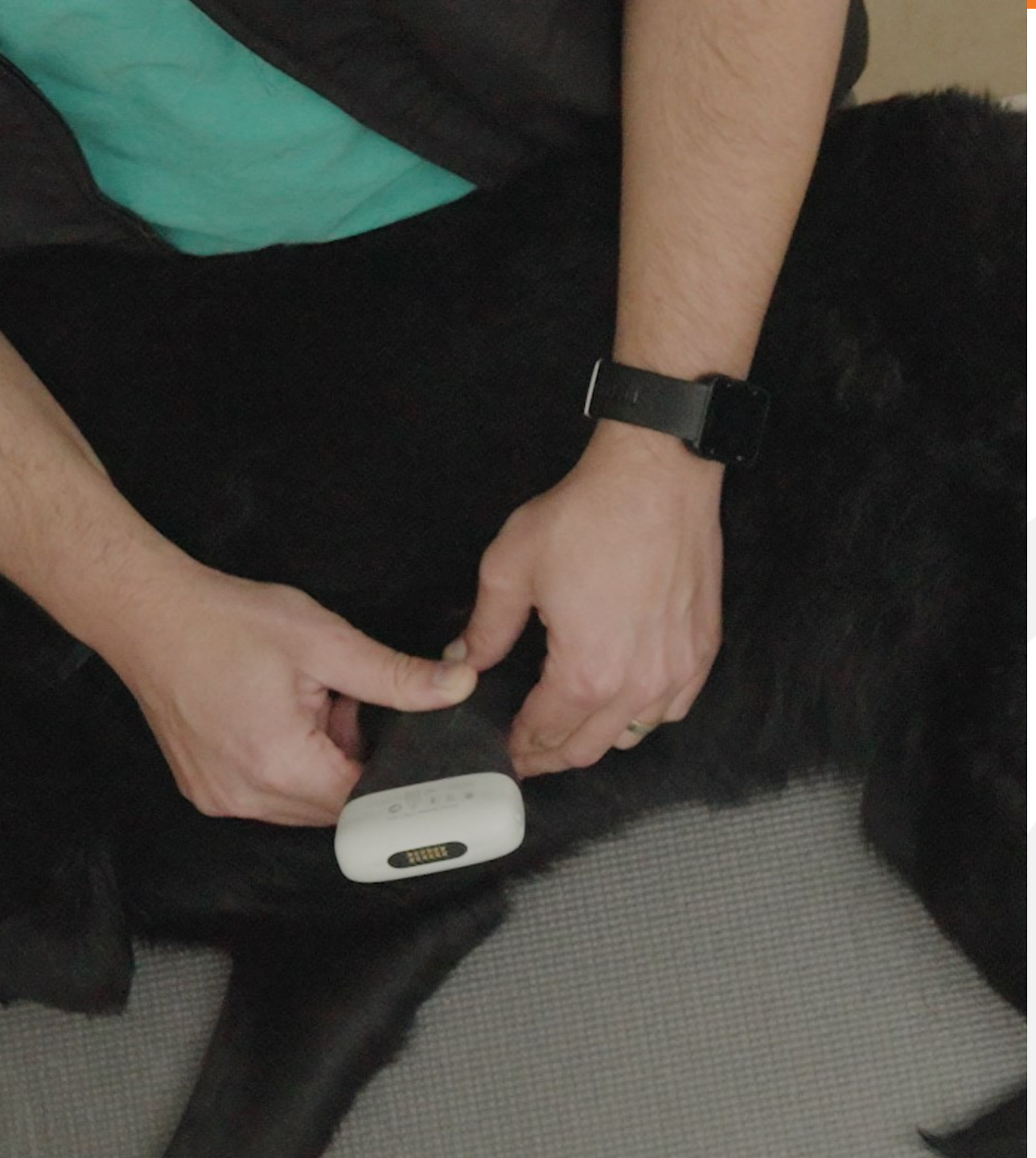

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Veterinary POCUS: Diagnosing Canine Pericardial Effusion in Seconds

Dr. Soren Boysen, DVM, DACVECC

Dr. Serge Chalhoub, DVM, DACVIM

Tuesday, February 14th, 2023

2 PM Pacific | 9 PM GMT

Questions?

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Thank you!