Lung Ultrasound in Small Animals, The Vet Blue (Bedside Lung Ultrasound Exam) for Respiratory Distress

ABVP 2015

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INTRODUCTION AND HISTORY

The use of lung ultrasound dates back into the late 1980s, notably with the ultrasound diagnosis in 1987 of pneumothorax (PTX) by a veterinarian, an equine practitioner, Dr. Norman Rantanen. Within a year, the ultrasound diagnosis of PTX was similarly described in human medicine. In 1988, Dr. Roy Philly dubbed the ultrasound probe the "modern stethoscope," a remarkable foresight made unbelievably 27 years ago. More recently, the ultrasound probe has been dubbed the "visual stethoscope" (Moore 2011) because lung ultrasound artifacts are objectively and clearly discernible independent of patient or ambient noise. Moreover, lung ultrasound has been definitively shown to exceed traditional means of chest auscultation and supine chest radiography in humans with common respiratory conditions (Volpicelli 2012; Lichtenstein 2008). As long ago as 1997, the lung ultrasound finding, then referred to as comet tails, representing forms of interstitial edema was documented in humans by Lichtenstein and colleagues.

In 2004, Jambrik and colleagues refocused lung sonographers on the pursuit of lung pathology in non-trauma subsets of human patients. In 2006, Volpicelli and colleagues reenforced a scanning format and additionally showed that the counting of ultrasound lung rockets (also called B-lines) correlated with the degree of lung edema found on computerized tomography. In *Chest* 2008, Lichtenstein and colleagues published a clinical paper in which they showed that a pattern-based, regional approach, called the BLUE Protocol, could diagnose the most common presenting causes of respiratory disease in human patients with high sensitivity, specificity and accuracy including asthma, COPD, lung edema, PTE, and pneumonia. The BLUE protocol had a remarkable overall accuracy of 90.5%, and the BLUE exam only took minutes helping direct clinical course and diagnostics without the insensitivities of traditional means of physical examination and chest auscultation, and without the delays of waiting for chest radiography and other testing.

In another Lichtenstein publication (2009), they found a correlation between pulmonary capillary wedge pressure (invasive) and the presence of lung edema (B-lines or ultrasound lung rockets); and conversely they found that in the absence of lung edema (B-lines or ultrasound lung rockets) clinically relevant left-sided heart failure could be rapidly ruled out (minutes) with high sensitivity and specificity, point-of-care, and within minutes of patient presentation. A remarkably powerful capability for such a simple, safe, radiation-sparing, point-of-care portable imaging modality, called lung ultrasound. In 2012, an international lung ultrasound consensus statement was made by a group of international lung ultrasound experts. In an evidence-based document, statements were developed regarding the efficacy and clinical utility of lung ultrasound use for various respiratory conditions, re-affirming the positive diagnostic and monitoring potential of lung ultrasound.

However, the use of terms such as lung sliding (glide sign in veterinary medicine), and A-lines, and B-lines, C-lines and PLAP continue to thwart the evolution and widespread use of lung ultrasound. These terms are confusing and difficult to grasp in contrast to analogous terms proposed by the author and still appearing in the human literature including glide sign (veterinary term, same as lung sliding in human medicine), A-lines (same as air reverberation artifact), ultrasound lung rockets (B-lines in human medicine), and shred sign, tissue sign, and nodule sign for lung consolidation/infiltration (called C-lines, PLAP, in human literature). These terms have been proposed in the veterinary literature in a clinical review (Lisciandro 2011), textbook (*Focused Ultrasound Techniques for the Small Animal Practitioner*, Wiley 2014), and in peer-reviewed clinical study by Lisciandro and colleagues (2014).

USE OF LUNG ULTRASOUND FORMATS IN SMALL ANIMALS

The reluctance to proactively apply lung ultrasound to small animals with respiratory distress is irrational in many respects. The overriding belief that air-filled lung creates insurmountable obstacles, and the continued belief in small animal medicine that imaging lung is difficult to perform leading to mistakes, perpetuate lung ultrasound's delayed use in small animals (dogs and cats). Thoracic FAST called TFAST (Lisciandro *et al*. 2008) was the first standardized abbreviated ultrasound exam of the thorax that included the chest tube site (CTS) for lung surveillance for detection of PTX. Because of the finding of lung pathology found during TFAST^3, the author extended lung surveillance from the TFAST^3 CTS with the addition of 6 more lung views. The name of this novel regionally based lung ultrasound exam is Vet BLUE ("Vet" for veterinary and "BLUE" blue for cyanosis and bedside lung ultrasound exam) (Lisciandro *et al*. 2014). The Vet BLUE regional sites include the caudodorsal lung lobe region (cdll), the perihilar lung lobe region (phll), the middle lung lobe region (mdll), and the cranial lung lobe region (crll). Each is named as a region because the naming do not directly correlate with anatomical names of lung lobes.

Patient Preparation

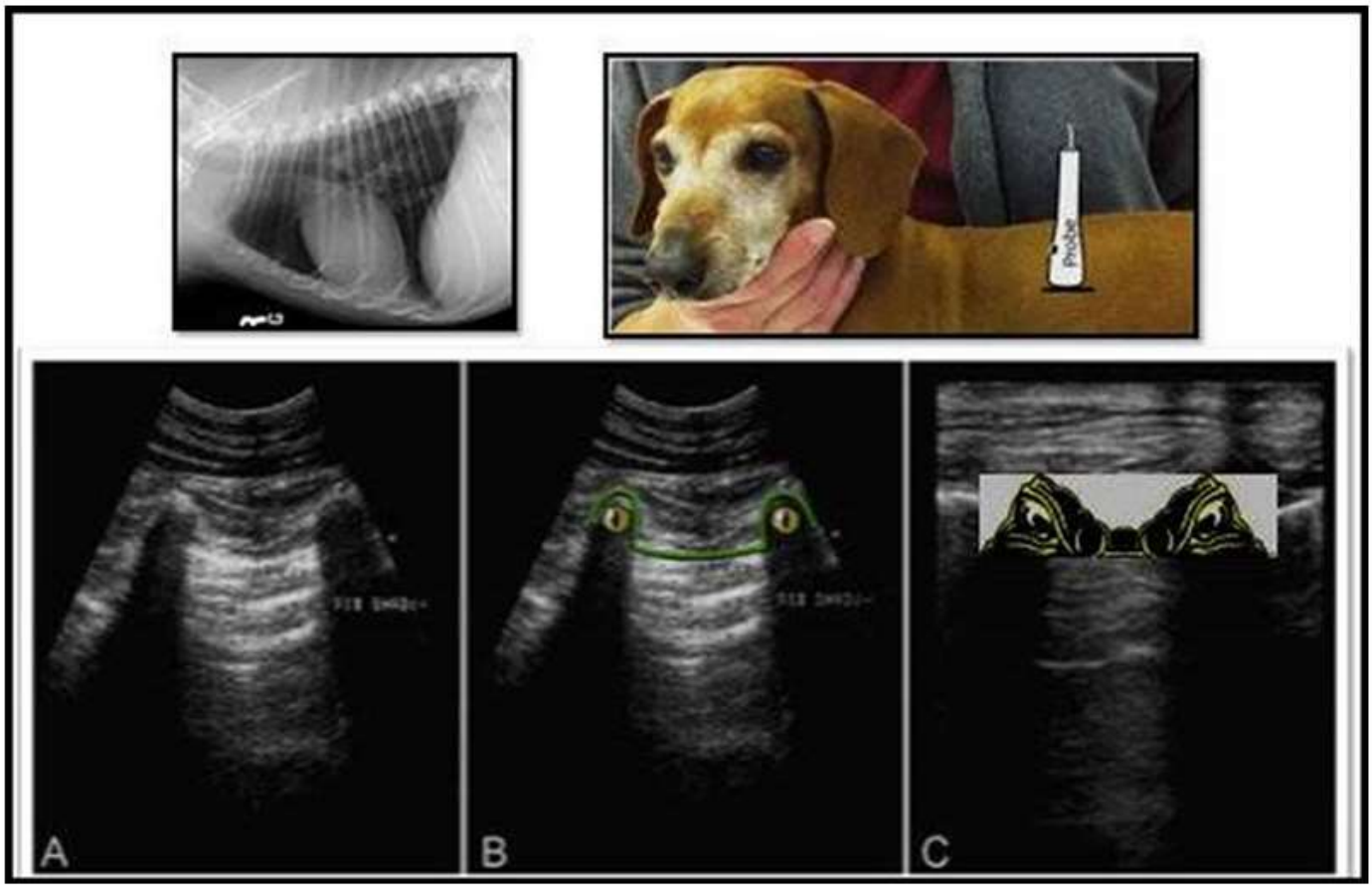
No sites are shaved! All images shown by the author are unshaved sites at which the fur is parted and alcohol is applied to the skin and a small amount of acoustic gel to the probe head (most ultrasound manufacturers warn against placing alcohol on the probe head because of alcohol's damaging effects-check with your ultrasound machine manufacturer). **No images from cases in this talk were shaved.**

Patient Positioning

TFAST^3 and **Vet BLUE** are **performed in sternal recumbency or standing in respiratory distressed or compromised small animals**. TFAST^3 consists of 5-points as follows: the **stationary** horizontally probe-positioned **left and right** chest tube site (CTS) view; the dynamically spotlighted **left and right** pericardial site (PCS) view; and the **newer 5th point DH view** (Lisciandro 2011), for the rapid detection of pleural and pericardial effusion and in some instances lung pathology (Lisciandro 2014).

THE "GATOR SIGN" - BASIC LUNG ULTRASOUND ORIENTATION

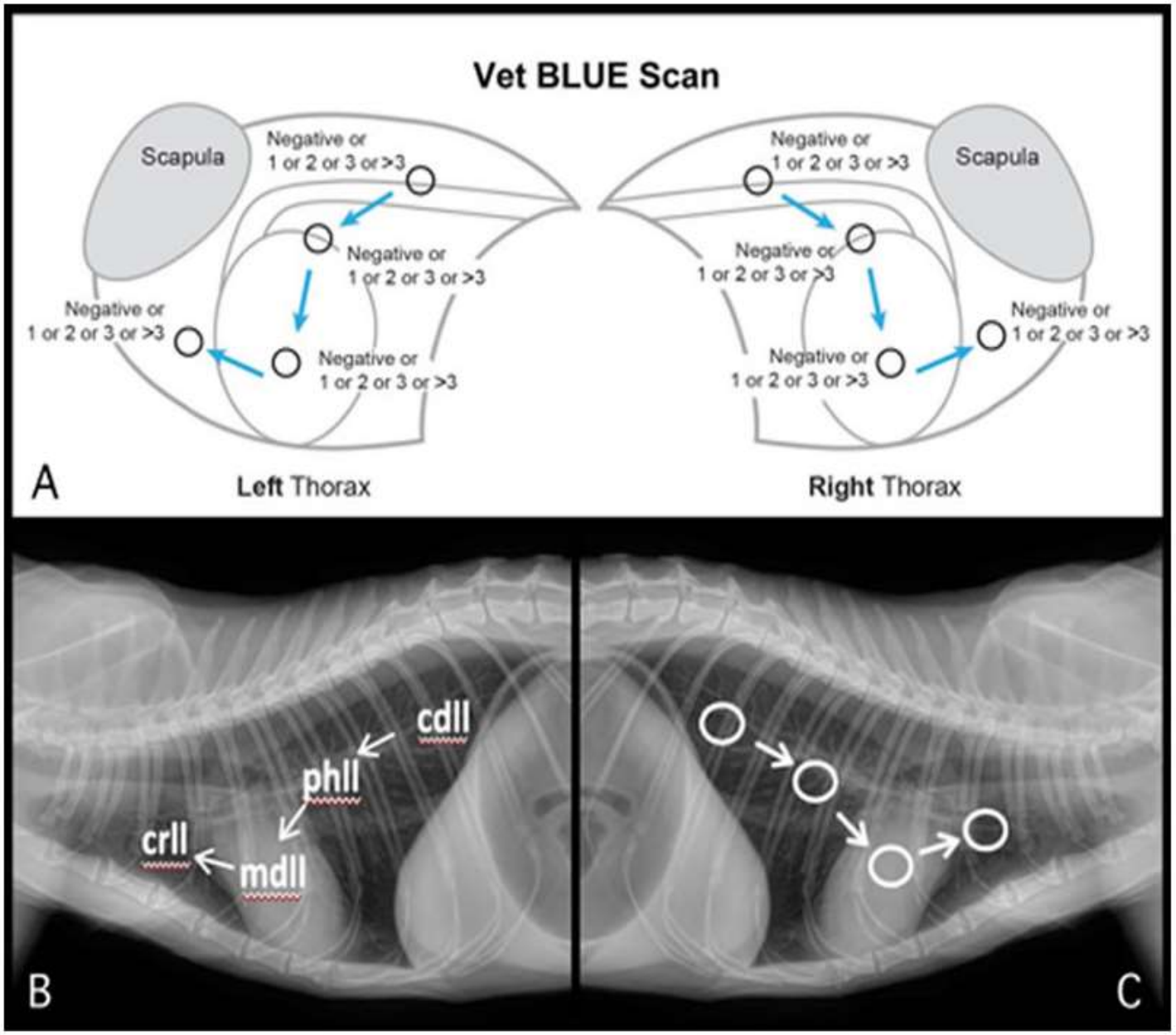
Figure 1. Probe orientation

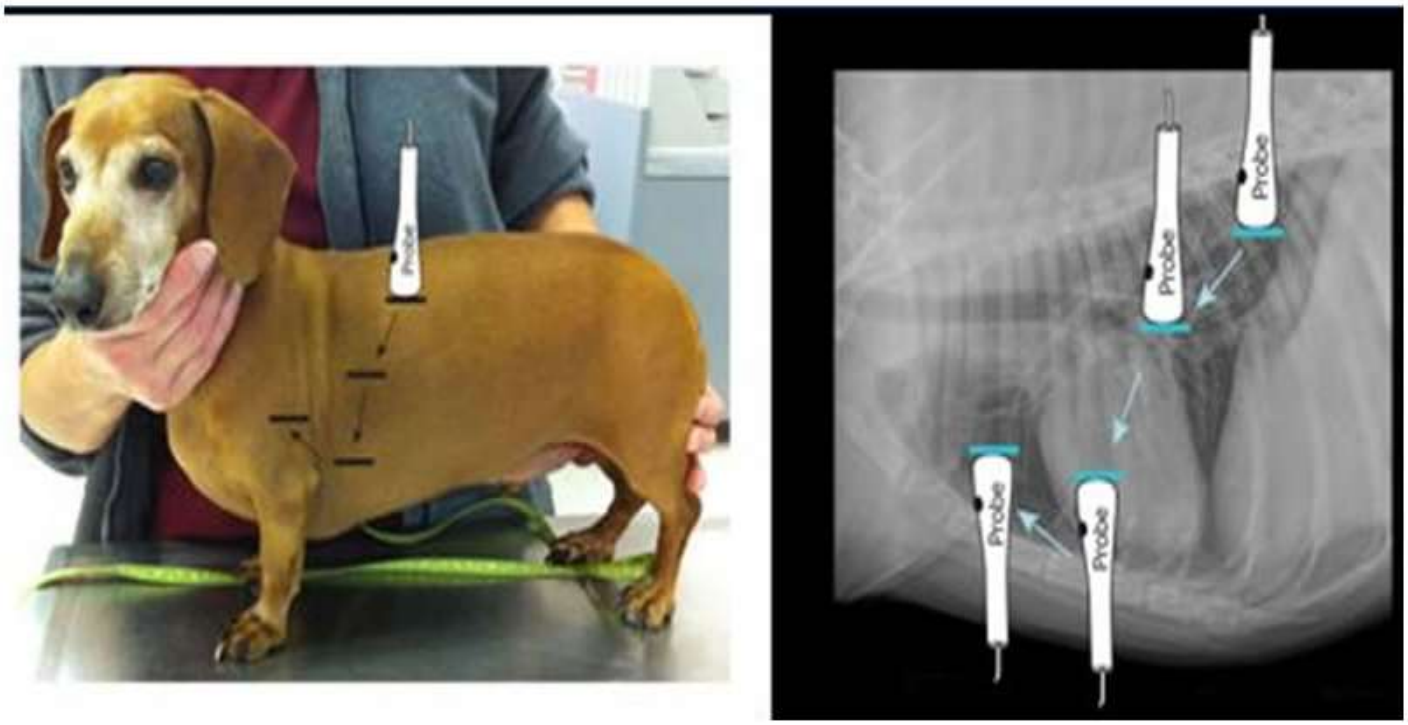


Lung ultrasound orientation **is ALWAYS the same** with the visualization of the **gator sign to properly identify the pulmonary-pleural interface or the "lung line"** (the surface of the lung). The **probe is held** perpendicular to the long axis of the ribs; **depth** is generally set between **4–6 cm**; **frequency** is generally set between **5–10 MHz**; and **a microconvex probe** is preferred over a linear probe because the probe is acceptable for AFAST3, TFAST3 and Vet BLUE (Global FAST3). A phase-array or sector probe is not recommended because its focal point is too small. A liner probe may be used; however, it is not ideal for the AFAST3 and TFAST3 portions of Global FAST3 (GFAST3). The rounded rib heads are likened to the eyes, and the pulmonary-pleural (PP-line) interface to the bridge of its nose, as a partially submerged gator (alligator) peers at the sonographer. The proximal white line is the focus of **all** lung ultrasound. The major orientation error is looking beyond the PP-line (or "lung line") and mistaking A-line artifacts for the PP-line or "lung line."

VET BLUE EXAMINATION

Figure 2. The Vet BLUE examination





The **Vet BLUE lung examination** is a **screening test** performed identically as the probe is positioned at the CTS view of TFAST[3]. The probe is then moved through regional locations that are bilaterally applied as follows: **caudodorsal lung lobe region** (cdll - same as the TFAST[3] CTS view, upper third, 8–9th intercostal space), **perihilar lung lobe region** (phll - 6–7th intercostal space, middle third), **middle lung lobe region** (mdll - 4–5th intercostal space, lower third), and **cranial lung lobe region** (crll - 2nd–3rd intercostal space, lower third). The **maximum number of ULRs** over the respective single intercostal space at each view is recorded. The counting system is as follows: **1, 2, 3, >3** (when ULRs are still recognized as individuals), and **infinity ∞** (when the ULRs blend into one another becoming confluent [also called white lung]).

Key Point

Perform the Vet BLUE the same way every time. We suggest that you begin on the **left** and go from dorsal to ventral, move to the right side and do the same, dorsal to ventral. This allows you to think about the pattern in the same manner every time and helps you remember the findings at each site. Also, by completing the Vet BLUE at the right cranial lung lobe region (crll) increase your depth, and do your right TFAST pericardial view and proceed with the increased depth to AFAST and Global FAST (GFAST) is finished in < 4 minutes by the appropriately trained sonographer!

VET BLUE FOR RESPIRATORY DISTRESS - 5 BASIC LUNG ULTRASOUND FINDINGS

"Wet Lung" vs. "Dry Lung" - Basic Lung Ultrasound 101

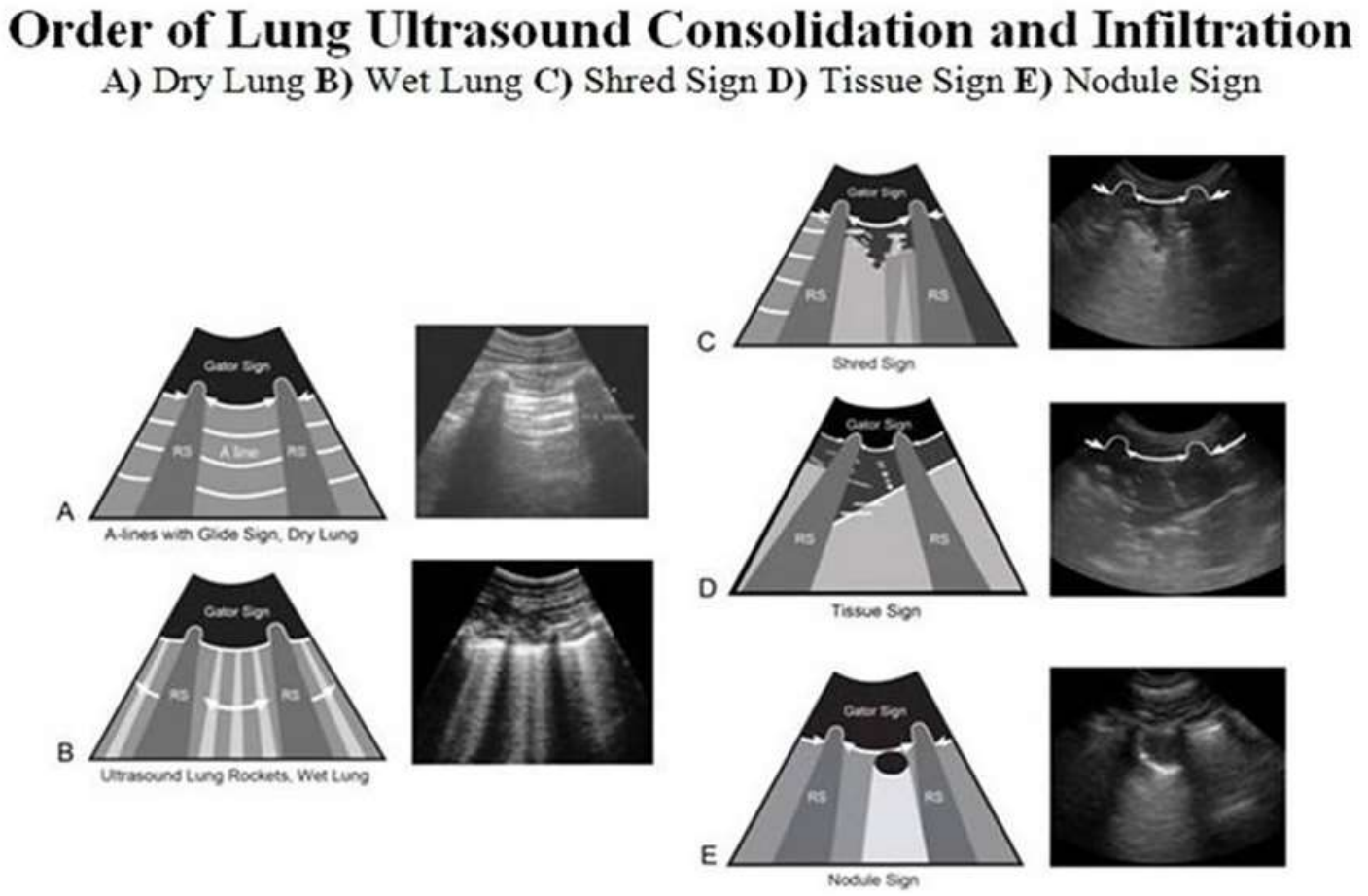
Shred Sign, Tissue Sign, Nodule Sign - Advanced Lung Ultrasound 202

Wet vs. Dry Lung

Basic easily recognizable lung ultrasoundfindings are categoriazed into **the wet lung** vs. **dry lung concept** (Lisciandro 2011). A glide sign with A-lines (reverberation artifact) at the lung line is considered **"dry lung"** only to be confounded with PTX (A-lines and no glide sign). However, many patients in which the probability

of PTX is very low, then spending additional time finding the glide sign becomes less important and A-lines alone suffice. **Ultrasound lung rockets (ULRs)** are considered **"wet lung"** and oscillate to and fro with inspiration and expiration and must extend to the far field obliterating A-lines (Lisciandro 2011).

Figure 3. The 5 basic lung ultrasound findings in degree of least to most consolidation/ infiltration



A) Dry lung (glide sign with A-lines), B) Wet lung (ultrasound lung rockets also called B-lines), C) Shred sign (air still moving through consolidated lung), D) Tissue sign (no aeration, also referred to as hepatization), E) Nodule sign.

Regionally based Respiratory Pattern-based Approach Using Vet BLUE

See Chapter 10: The Vet BLUE Lung Scan.In: *Focused Ultrasound Techniques for the Small Animal Practitioner*, Wiley ©2014 and FASTVet.com © 2014.

Vet BLUE Diagnostic Algorithm for Respiratory Diseases and Conditions

See Chapter 10: The Vet BLUE Lung Scan. In: *Focused Ultrasound Techniques for the Small Animal Practitioner*, Wiley ©2014 and FASTVet.com © 2014.

References

(see AFAST and TFAST Proceedings)

1. Lisciandro GR, *et al*. Frequency and number of ultrasound lung rockets (B-lines) using a regionally based lung ultrasound examination named vet BLUE (veterinary bedside lung ultrasound exam) in dogs with radiographically normal lung findings. *Vet Radiol Ultrasound*. 2014;55(3):315–322.

2. Lisciandro GR. Abdominal (AFAST) and thoracic (TFAST) focused assessment with sonography for trauma, triage, and tracking (monitoring) in small animal emergency and critical care. *J Vet Emerg Crit Care*. 2011;21(2):104–119.

3. Lisciandro GR. Chapter 55: Ultrasound in animals. In: Lumb PD, Karakitsos D, eds. *Critical Care Ultrasound* (human textbook). St. Louis, MO: Elsevier; 2014.

4. Lisciandro GR. Chapter 9: The thoracic FAST³ (TFAST³) exam; Chapter 10: The Vet BLUE lung scan. In: Lisciandro GR, ed. *Focused Ultrasound for the Small Animal Practitioner*. Ames, IA: Wiley Blackwell; 2014.

5. Lisciandro GR, Armenise A. Chapter 16: Focused or COAST³ - Cardiopulmonary resuscitation (CPR), Global FAST (GFAST³) and the FAST-ABCDE exam. In: Lisciandro GR, ed. *Focused Ultrasound for the Small Animal Practitioner*. Ames, IA: Wiley Blackwell; 2014.

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