Ultrasound in the Respiratory Distress Patient: Using Vet Blue

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USE OF LUNG ULTRASOUND IN SMALL ANIMALS - THE VET BLUE®

The reluctance to proactively apply lung ultrasound (LUS) 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 LUS delayed use in small animal veterinary medicine. Thoracic FAST called TFAST® (2008) was the first standardized abbreviated veterinary ultrasound exam of the thorax that included the Chest Tube Site (CTS) for lung surveillance for detection of PTX and lung contusions. However, because of the finding of lung pathology found during TFAST, the author extended lung surveillance from the TFAST CTS with the addition of 7 more lung views applied to non-trauma subsets of small animals. The name of this novel regionally based LUS exam has been studied and published by Lisciandro and colleagues in 2014 as the Vet BLUE Protocol ("Vet" for veterinary and "BLUE" blue for cyanosis and bedside lung ultrasound exam or in emergency).

THE BASICS OF VET BLUE®

Patient Preparation

Generally no Vet BLUE 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 or alcohol-based hand sanitizer to the probe head. No images from cases in this talk were shaved.

Patient Positioning

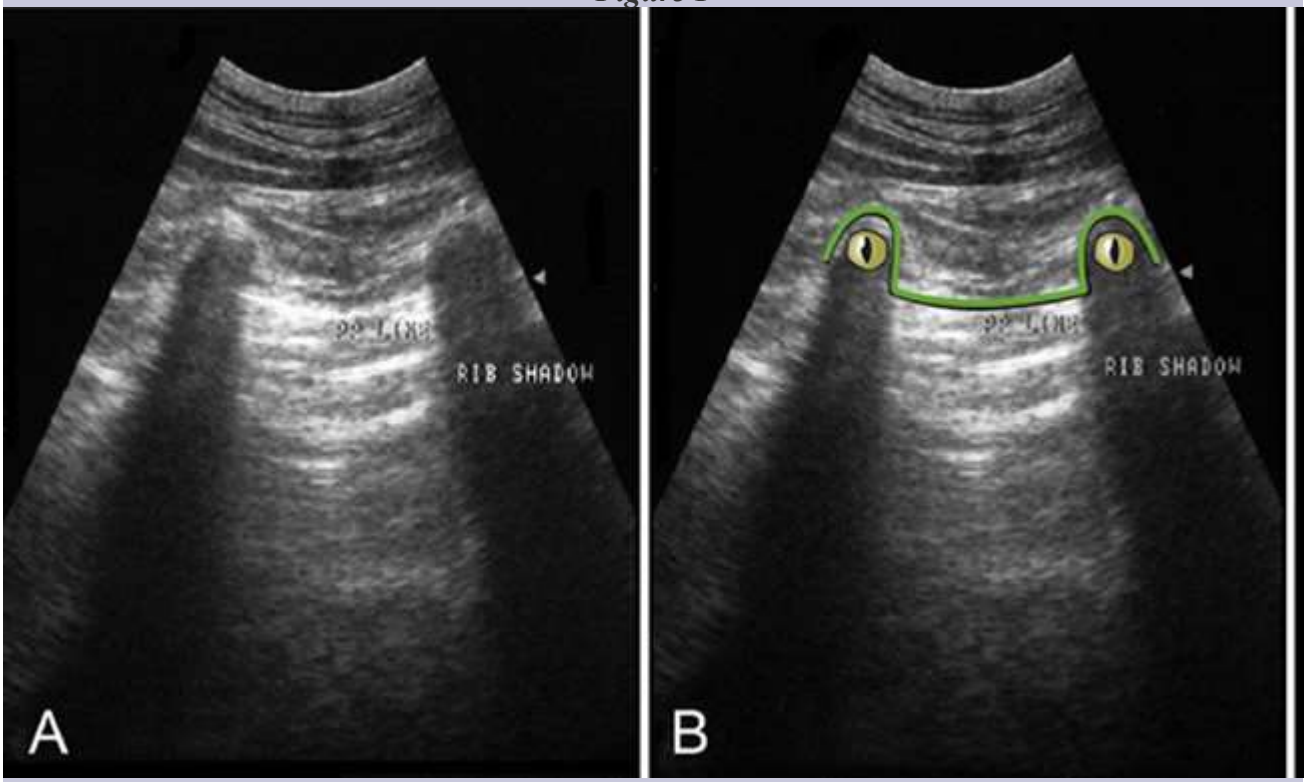
Vet BLUE is performed in sternal recumbency or standing and is safer for dogs and cats in respiratory distress. A roll of towels or paper towels under the forelegs of a cat is an easy tolerated maneuver to gain access to the lower ventral Vet BLUE and TFAST PeriCardial Site views. Vet BLUE may also be performed in dogs and cats in lateral recumbency.

Probe Orientation and Type

LUS orientation is always the same with the visualization of the "Gator Sign" to properly identify the pulmonary-pleural interface or the "Lung Line," actual surface of the lung. The probe is held perpendicular to the long axis of the ribs; depth is generally set between 4–7 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 all 3 formats — AFAST, TFAST and Vet BLUE — combined called Global FAST. A phase-array or sector probe is generally not recommended because its focal point is too small, although this is unknown. A linear probe may be used; however, it is generally not ideal for the AFAST and TFAST portions of Global FAST.

THE "GATOR SIGN" – BASIC LUNG ULTRASOUND ORIENTATION

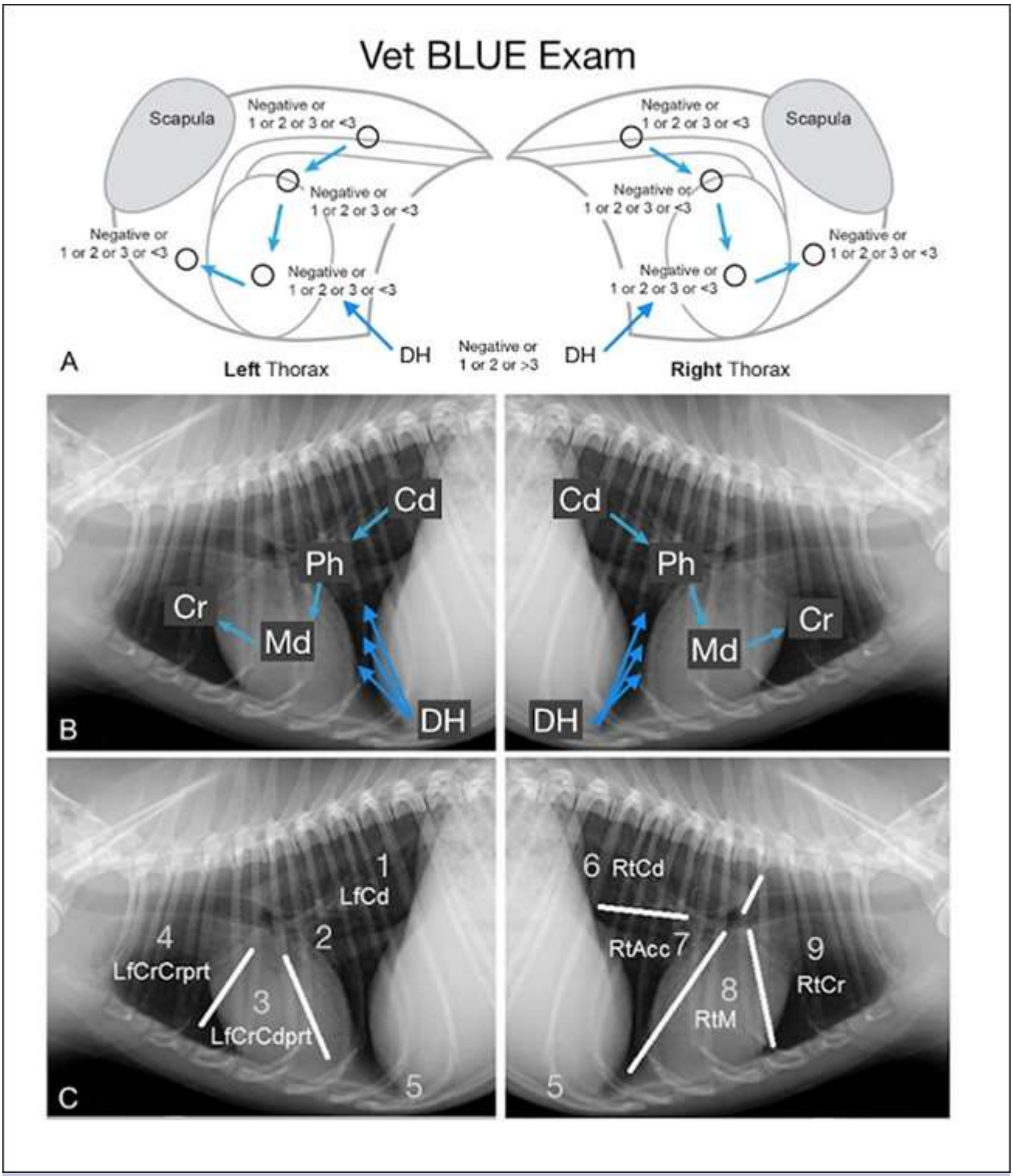
Figure 1



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 LUS. This material is reproduced with permission of John Wiley & Sons, Inc. *Focused Ultrasound Techniques for the Small Animal Practitioner*. Wiley © 2014 and FASTVet.com © 2014

HOW TO PERFORM THE VET BLUE® - 9 ACOUSTIC WINDOWS

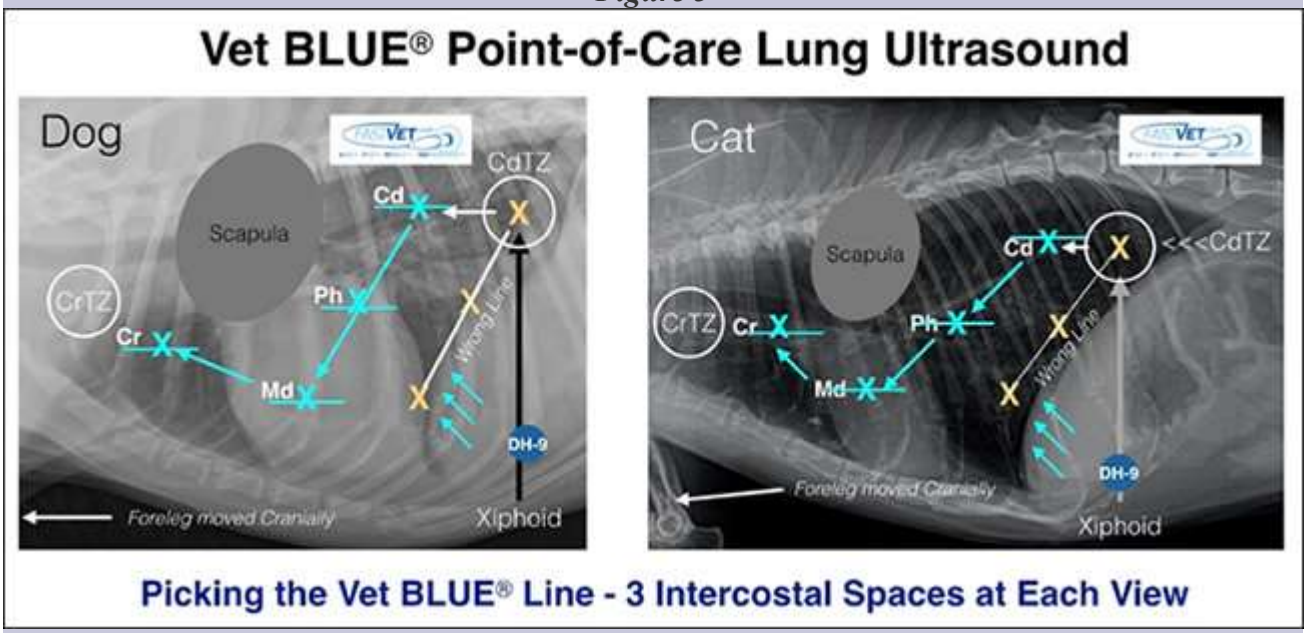
Figure 2



How to Perform

The Vet BLUE lung examination is a screening test performed identically as the probe is positioned at the CTS view of TFAST. The probe is then moved through regional locations that are bilaterally applied as follows: caudodorsal lung region (Cd - same as the TFAST[3] CTS view, upper third, 8–9th intercostal space), perihilar lung region (Ph – 6–7th intercostal space, middle third), middle lung region (Md – 4–5th intercostal space, lower third), and cranial lung region (Cr – 2nd–3rd intercostal space, lower third).

Figure 3



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Key Point

Best way to perform Vet BLUE accurately is to locate the left TFAST Chest Tube Site directly above the xiphoid in the area of the 8–10th intercostal space in the upper 1/3rd of the thorax, find the transition zone where lung and abdomen interface, then by move 2 intercostal spaces cranially to make sure the probe is over lung/pleural space and not over liver/stomach/abdominal contents. From the left TFAST CTS, which is the same as the left Vet BLUE Cd view (point 1), draw a line with your alcohol or acoustic coupling gel to the elbow, and halfway to the elbow is the Vet BLUE Ph view (point 2), and near the elbow is the Vet BLUE Md view (point 3). If the heart is in view at the Vet BLUE Md view, slide above the heart until you see the lung line. The final site is the Vet BLUE Cr view (point 4), which requires extending the foreleg cranially to get the probe placed in the 1st–2nd–3rd intercostal spaces. Define the Cr view by finding its transition zone of the thoracic inlet and lung then sliding caudally over intercostal spaces 1, 2, and 3. If too ventral at the Cr view, you will see the striations of the pectoral muscles. Now each of the views has a primary, and then secondary views by sliding an intercostal space caudally and an intercostal space cranially from the primary view **so that minimally 3 intercostal spaces are surveyed at each Vet BLUE view**. The author's preference is to start high (dorsal) on the left moving from Cd to Cr, and then do the same on the right hemithorax. By always performing in the same manner, findings are better remembered; and if you do not have the Gator Sign Orientation, then you cannot be certain that you are over lung. ***Note the diaphragmatic-hepatic view (DH) is ALSO part of Vet BLUE providing a deep window into lung not evident on the transthoracic Vet BLUE views not shown in the images above**.

VET BLUE® FOR RESPIRATORY DISTRESS – THE 6 BASIC LUNG ULTRASOUND SIGNS

Wet vs. Dry Lung

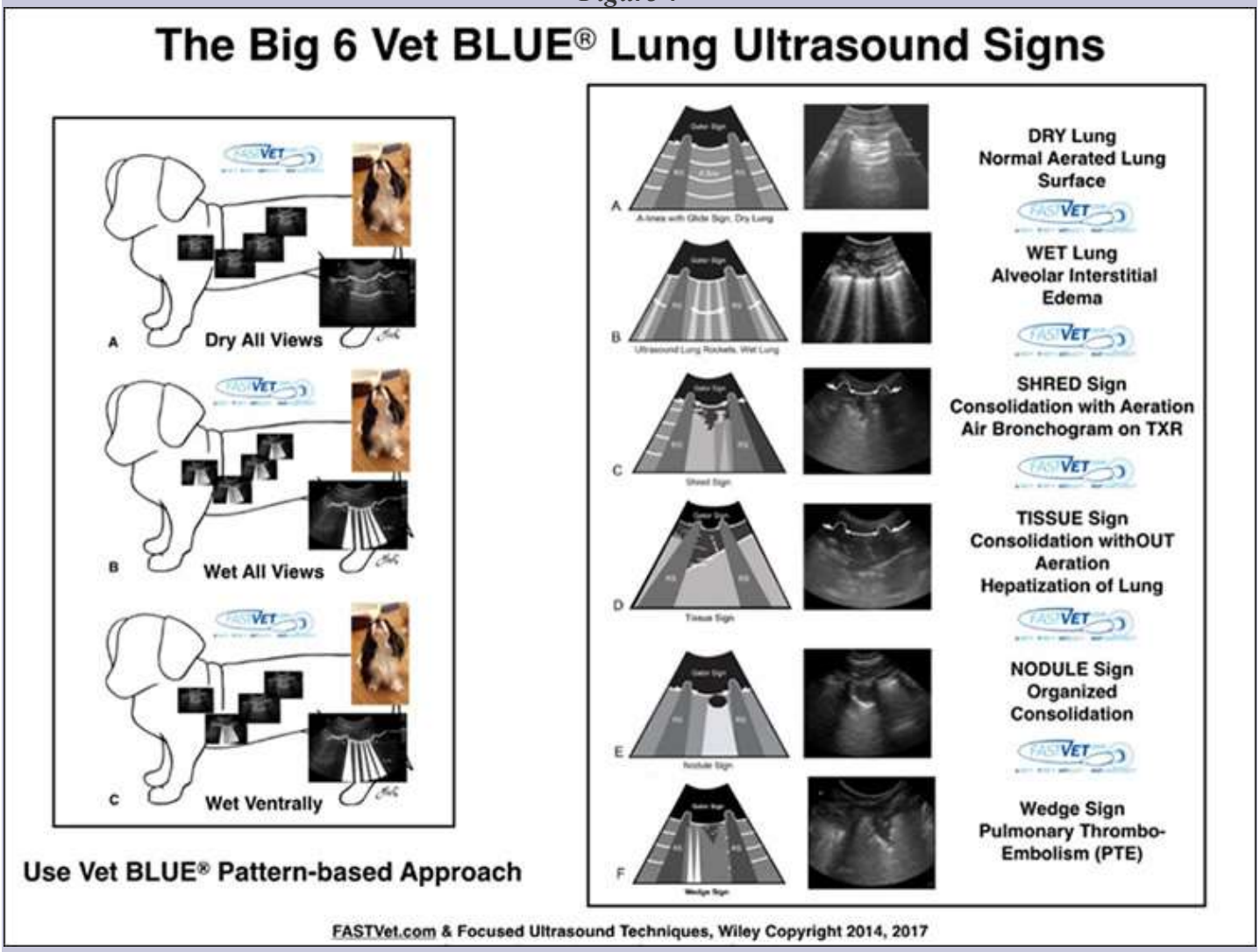
Basic Lung Ultrasound. Basic easily recognizable LUS findings are categoriazed into the Wet Lung vs. Dry Lung concept. A Glide Sign with A-lines (reverberation artifact) at the lung line is considered "Dry Lung" only to be confounded with PTX (A-lines and No Glide Sign). A-lines are horizontal lines. 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) also called B-lines are considered "Wet

Lung" and oscillate to and fro with inspiration and expiration and must extend to the far field obliterating A-lines and are vertical lines.

Shred Sign, Wedge Sign, Tissue Sign, Nodule Sign

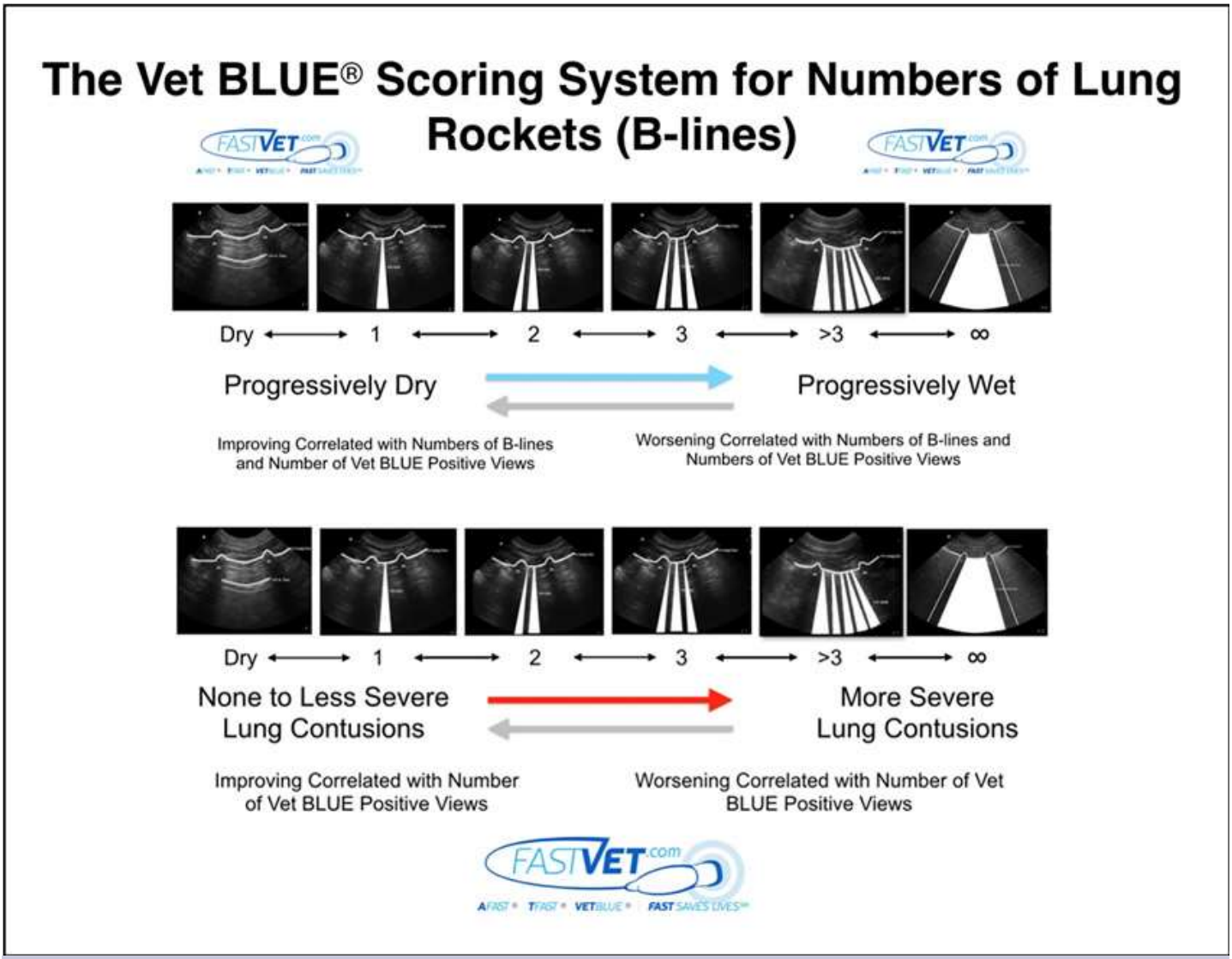
Advanced Lung Ultrasound. These are the more advanced LUS signs we have created in progressive order of increasing consolidation/infiltration. The Shred Sign is an air bronchogram on TXR or rather consolidation **with aeration** of the lung; the Tissue Sign is similar to hepatization of lung or rather consolidation **withOUT aeration**; and the Nodule Sign or rather consolidation/infiltration in discreet nodules. The Wedge Sign is a subset of the Shred Sign being triangular, and represents pulmonary thromboembolism (PTE) (infarcts at the lung periphery).

Figure 4



A) Dry Lung B) Wet Lung, ULRS (alveolar-interstitial edema) C) Shred Sign (consolidation/air bronchogram) D) Tissue Sign (consolidation/hepatization) E) Nodule Sign and F) Wedge Sign (PTE). This material is reproduced and modified with permission of John Wiley & Sons, Inc. *Focused Ultrasound Techniques for the Small Animal Practitioner*. Wiley © 2014 and FASTVet.com © 2014. Gregory Lisciandro, DVM, DABVP, DACVECC, FASTVet.com and Hill Country Veterinary Specialists. Copyright 2015, 2016, 2017, 2018.

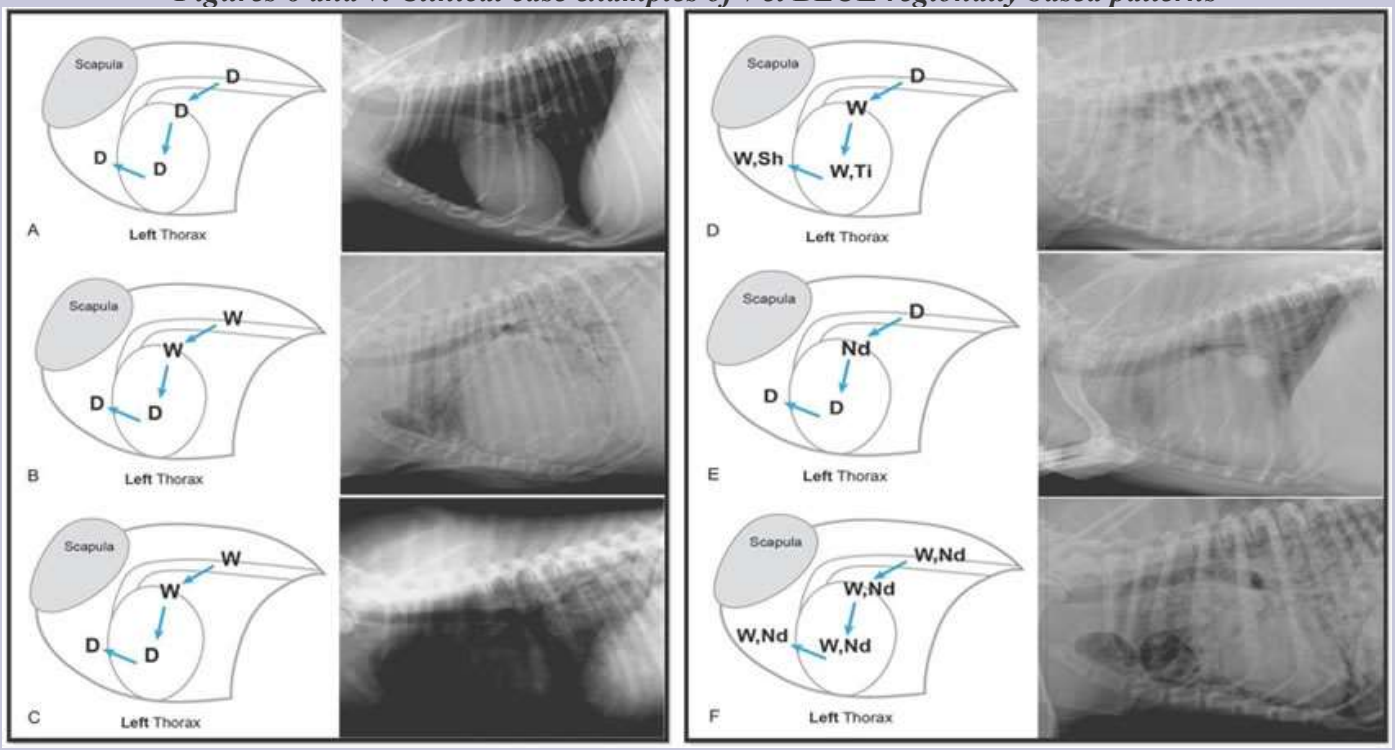
Figure 5



A) No ULRs B) A single ULR (also called B-lines) scored as "1" or 2 or 3 not shown C) >3 ULRs where there are more than 3 but ULRs are still recognized as individual ULRs and D) ∞ or infinity ULRs. The maximum number of ULRs over a single representative intercostal space at each respective Vet BLUE view is recorded. The counting system is as follows: 0; 1; 2; 3; >3, when ULRs are still recognized as individuals; and ∞ or infinity, when the ULRs blend into one another becoming confluent. ULRs also called B-lines are vertical hyper-echoic lines that do not fade extending from the lung line to the far field and swing in synchrony with the phases or respiration. ULRs also called B-lines and must be placed in clinical context with a Vet BLUE pattern-based approach. FASTVet.com

REGIONAL PATTERN-BASED APPROACH OF VET BLUE®

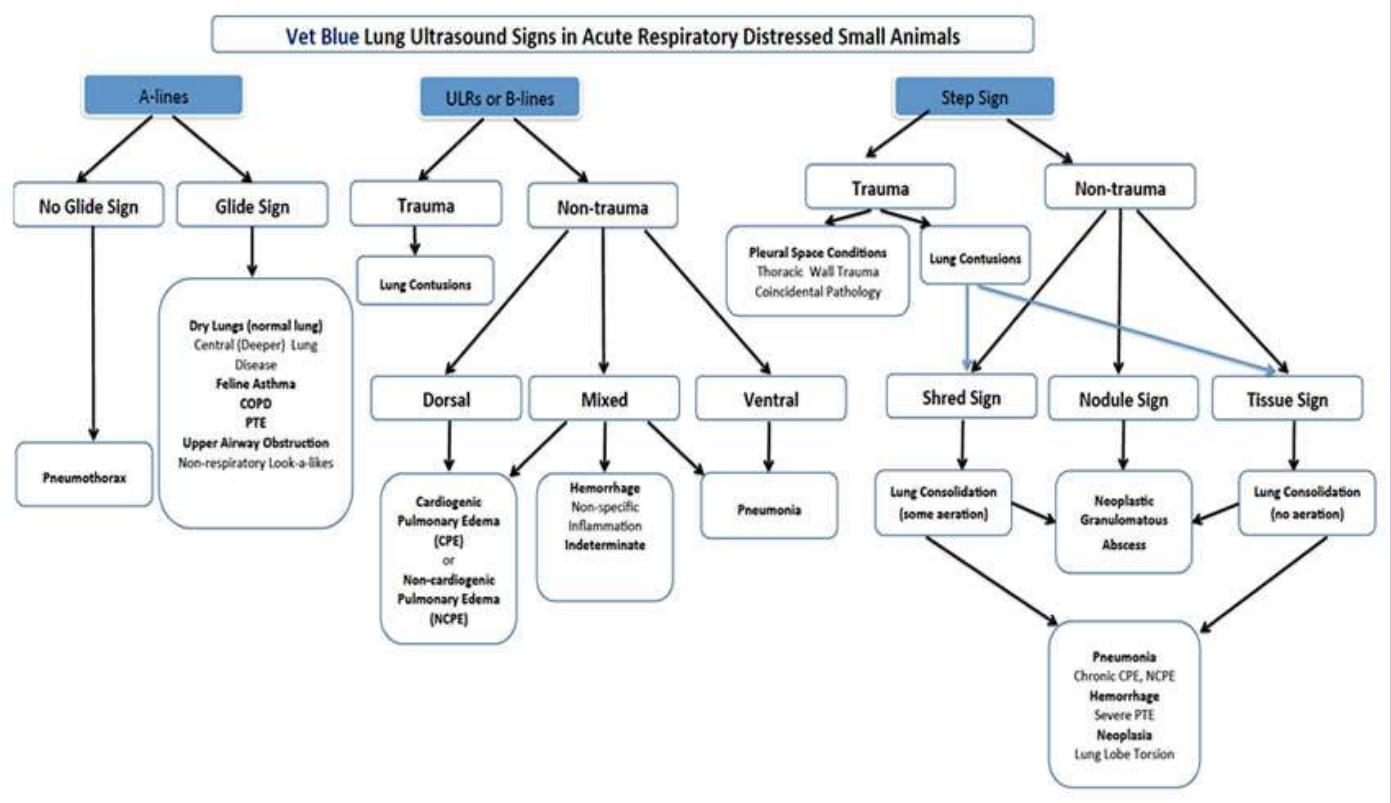
Figures 6 and 7. Clinical case examples of Vet BLUE regionally based patterns



A) Dry Lung all fields rules out clinically relevant Left-sided Congestive Heart Failure (L-CHF), suggests upper airway obstruction, Feline Asthma, COPD, PTE and non-respiratory look-a-likes. B) Wet Lung or ULRs in dorsal, perihilar, and middle lung regions (plus an increased LA:Ao on TFAST) suggests Cardiogenic Lung Edema (left-sided congestive heart failure, volume overload from intravenous fluids). C) Wet Lung in dorsal lung regions suggests forms of Non-cardiogenic Lung Edema (plus unremarkable TFAST echo views) making TFAST echo views helpful to distinguish from Cardiogenic Lung Edema. D) Wet Lungs in ventral fields with or without signs of consolidation (Shred Sign/Tissue Sign), suggest Pneumonia. E) Solitary nodule. F) Multiple nodules suggest Metastatic Disease or Granulomatous Disease (fungal, bacterial, parasitic, idiopathic). **Key**: D=Dry lung; W=Wet lung; Sh=Shred Sign; Ti=Tissue Sign; Nd=Nodule Sign. Wedge Sign (PTE) not shown. This material is reproduced and modified with permission of John Wiley & Sons, Inc. Lisciandro GR. Chapter 10: The Vet BLUE Scan. In: *Focused Ultrasound Techniques for the Small Animal Practitioner*. Wiley © 2014 and FASTVet.com © 2014.

VET BLUE® DIAGNOSTIC ALGORITHM FOR FINDINGS AND PATTERNS

Figure 8



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Rule outs for DRY All Fields on Vet BLUE®
Respiratory
Pulmonary thromboembolism (PTE)
Dynamic upper airway conditions (e.g., collapsing trachea, laryngeal paralysis)
Upper airway obstruction (e.g., mass, oropharyngeal swelling)
Chronic obstructive pulmonary disease (COPD), bronchitis
Feline asthma
Tracheobronchitis (e.g., infectious, inflammatory, irritant)
Pleural effusion
Centrally located lung pathology away from the lung line (missed by Vet BLUE)

Cardiac
Pericardial effusion/cardiac tamponade
Cardiac arrhythmia
Dilated cardiomyopathy (DCM)
Right-sided congestive heart failure (CHF)
Pulmonary hypertension
Undifferentiated hypotension
Canine anaphylaxis
Hemoabdomen
Hemothorax
Hemoretroperitoneum
Cavitary (or spacial) effusion
GDV/bloat
Sepsis
Other non-respiratory
Pyrexia/heat stroke
High fever
Severe metabolic acidosis
Severe anemia
Note: Dry Lungs ALL Fields also called Absent B-lines ALL Views (ABAV) is Rapid (<90 sec), Point-of-care, Minimal Restraint - Highly Sensitive Test Ruling Out Left-sided CHF (Dogs 88–96%, Cats 96%)
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ADVANTAGE OF VET BLUE® OVER THORACIC RADIOGRAPHY

Ultimately proactive Vet BLUE lung ultrasound will prove itself as a more sensitive test than radiography for lung surface pathology (and diagnosing pneumothorax), alveolar-interstitial edema (Ultrasound Lung Rockets, also called B-lines), lung consolidation (Shred Sign, Tissue Sign, Wedge Sign for PTE) and nodules (Nodule Sign). We have several clinical studies accepted, in the process of being written, that support this statement.

ALWAYS STRIVE FOR THE GLOBAL FAST® APPROACH

We have been advocating for Vet BLUE as both a screening test and a complementary test to better interpret pulmonary radiography and refer to the latter as "RADBLUE"; however, the Global FAST® avoids mistakes, for example, a dog with a dry cough from mainstem bronchial compression from dilated cardiomyopathy (DCM) may very well have absent B-lines on all Vet BLUE views, and an unremarkable cardiac silhouette on thoracic radiographs, but have easily detected DCM by TFAST recognizing an enlarged left ventricle and very poor contractility at the TFAST right pericardial short-axis view. Without the Global FAST® Approach (you miss it through satisfaction of search error), serious disease would have been missed and the dry cough misdiagnosed.

Moreover, the dog may have abdominal co-morbidities like right-sided congestive heart failure (FAT caudal vena cava and ascites), or a splenic mass that is missed, by only performing POCUS or targeted ultrasound examinations or focused ultrasound and again falling into the trap of "satisfaction of search error." The author advocates for the Global FAST Approach® on all patients having through experience seen the danger of not doing so to the patient's detriment.

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SPEAKER INFORMATION

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