Proactive Vet BLUE® Lung Ultrasound in Feline Respiratory Distress ACVIM 2017 Gregory R. Lisciandro, DVM, DABVP, DACVECC

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INTRODUCTION

The reluctance to pro-actively apply lung ultrasound (LUS) to small animals with respiratory signs or distress is irrational in many respects. The overriding belief that air-filled lung creates insurmountable sonographic obstacles, and that sonographic imaging of lung is difficult, perpetuates these myths, and delays the widespread acceptance of what is true and reality, that the ultrasound probe is your new stethoscope. TFAST (thoracic FAST) was the first standardized abbreviated veterinary ultrasound exam of the thorax and the proactive survey of lung via the TFAST chest tube site (CTS) view for the diagnosis of pneumothorax.

However, because of the finding of lung pathology during TFAST, extended lung surveillance from the TFAST CTS with the addition of 6 more lung views and its applications beyond trauma to non-trauma subsets of small animal patients was logically the next step. The name of this novel pattern-based, regional LUS exam is Vet BLUE (veterinary **b**edside **l**ung **u**ltrasound **e**xam); and BLUE also for cyanosis implying respiratory conditions. The Vet BLUE's 8 regional sites applied bilaterally include the caudo-dorsal (Cd) lung region, the peri-hilar (Ph) lung region, the middle (Md) lung region, and the cranial (Cr) lung region. It is important to recognize that the views are not anatomical per se, and that different parts or different lobes may dynamically enter and exit the intercostal spaces of each of these 8 views. The regional concept is important to appreciate because 2 parts of a lung lobe or 2 different lung lobes may be coming into view over the same intercostal space during Vet BLUE. As an example, dry lung, then wet lung, then dry lung, then wet lung may interchange during phases of respiration; or dry lung, and a shred sign, and dry lung then a shred sign, as the patient inspires and expires, This phenomenon in fairly common.

The next logical step is developing a lung language that is easy to understand. We have sided with the visual and explanative terms of dry lung, wet lung, shred sign, wedge sign, tissue sign, and nodule sign, while also acknowledging the lung ultrasound consensus statement of 2012. The terms have been adopted and modified primarily from Volpicelli and Lichtenstein. In 2017, many medical doctors default to these easily understandable terms over less descriptive B-lines, A, B, and C profiles. Having an easily understandable lung language allows for easy communication regarding findings, and thus, LUS use can accelerate over the next several years bucking the lag time between human and veterinary medicine. Finally, having an easily understandable standardized method of recording findings is mandatory for interpreting LUS, and establishing patient profiles that may be compared on serial exams. Having applied Vet BLUE to >1,000 small animal patients since 2010, with >400 cases compared to thoracic radiography, we have learned expected patterns, perfected a lung language, and a perfected a simple procedure for recording findings. Most recently, we have been determined to define the Vet BLUE acoustic windows more accurately by embracing the pitfalls and peritoracic anatomy to locate the Vet BLUE sites more consistently for better inter-observer performance.

HOW TO PERFORM VET BLUE

Patient Positioning & Preparation

Although Vet BLUE may be performed in lateral recumbency, Vet BLUE is generally performed in standing or sternal recumbency, which is safer for dogs and cats in respiratory distress, or those that are hemo-dynamically or respiratory fragile. For ventral views, a roll of towels or paper towels under the forelegs of a sternally

recumbent feline or canine is an easy tolerated maneuver to gain access to the lower ventral Vet BLUE and TFAST pericardial site views.

Generally no Vet BLUE sites are shaved. All images in the lecture were from unshaved sites. The fur is parted and alcohol is applied to the skin with or without a small amount of acoustic coupling gel or alcohol-based hand sanitizer on the probe head. Keep in mind that most ultrasound manufacturers warn against placing alcohol directly on the probe head because of alcohol's potentially damaging effects. To maximize the image quality, the probe head should be applied as directly as possible to the skin surface without fur in between the probe head and the patient's skin.

BASIC VET BLUE ORIENTATION

The Gator Sign

The gator sign typically gets some chuckles, however, the concept is important to understand to ensure that the pulmonary-pleural interface, also referred to as the lung line, is properly imaged. By mistaking air reverberation artifacts or another structure for the lung line, makes your LUS ineffective. The probe is held stationary perpendicular to the long-axis of the ribs.





The probe is positioned over lung perpendicular to the long-axis of the ribs. The rounded rib heads are likened to the eyes, and the pulmonary-pleural (PP-line) interface, also called the lung line, to the bridge of its nose, as a partially submerged gator (alligator) peers at the sonographer (middle image, B). The proximal PP-line white line is the focus of all LUS. The major orientation error is looking beyond the PP-line and mistaking A-line artifacts for the PP-line, or being over the abdomen and mistaking liver, stomach (especially when air-filled), or the gallbladder for lung pathology, or being over peri-

thoracic soft tissue such as the thoracic inlet, the pectoral or scapular muscles. This material is reproduced with permission of John Wiley & Sons, Inc, Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley &2014. Reproduced with permission. Lisciandro, JVECC 2011;20(2):1104–122.

Probe Orientation, Type, and Depth Settings

LUS orientation always begins with establishing the gator sign so that the sonographer has properly identified the pulmonary-pleural interface or lung line for confident imaging and assessment of the surface of the lung. The depth is generally set between 4–8 cm depending on the size of the patient. In felines, depth is generally set between 4–6 cm. Being in closer than 4 cm lends itself to missing pathology that extends from the lung surface deeper than your depth setting. Frequency is generally set between 5–10 MHz. A microconvex probe is preferred over a linear probe because the microconvex probe is acceptable for Global FAST - combining AFAST, TFAST, and Vet BLUE - as a whole body surveillance of the patient, a concept and strategy gaining momentum on the human side. A phase-array or sector probe is generally not recommended because its focal point is too small, although usefulness of a phase array probe is unknown. A linear probe will provide superior imaging of the lung surface, however, how much is gained over a microconvex probe is unknown, and the linear probe is not ideal for the AFAST and TFAST portions of Global FAST. Either the abdominal preset or cardiac preset may be used for Vet BLUE. The preference is machine and user dependent. We prefer the abdominal preset for the entire Global FAST exam in the great majority of cases.

FELINE VET BLUE EXAM

How to Perform



Figure 2

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: caudo-dorsal lung region (Cd - same as the TFAST CTS view, upper third, 8–9th intercostal space), peri-hilar 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). This material is reproduced with permission of John Wiley & Sons, Inc, Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley **2**014 and FASTVet.com **2**014.

The Best Way to Perform Vet BLUE Accurately

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, finding the transition zone of lung and abdominal cavity, and then moving 1 or 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 view which is the same as the Vet BLUE caudo-dorsal (Cd) view, draw an imaginary line or an actual line with your alcohol or acoustic coupling gel to the elbow. Halfway to the elbow is the Vet BLUE peri-hilar (Ph) view, and near the elbow is the Vet BLUE middle (Md) view. If the heart is in view at the Vet BLUE Md view, slide above the heart until you see the lung line. In most cats and dogs, sliding caudally at the Md view often images the transition zone of lung and abdominal cavity, confounding those unfamiliar or inexperienced with the pitfall. The final site is the Vet BLUE cranial (Cr) view, which requires gently extending the foreleg cranially to get the probe placed in the 2nd–3rd intercostal space. If too ventral at the Cr view, you will see the striations of the pectoral muscles; and if too high and cranial at the Cr view, you will be in the thoracic inlet with soft tissue and vessels. We use the thoracic inlet as a landmark for then sliding over the first 2 intercostal spaces for the Cr view. Our preference is to start high (dorsal) on the left hemithorax moving from Cd to Cr, and then performing the same routine on the right hemithorax. By always performing Vet BLUE in the same manner, findings are better remembered.

THE 5 BASIC VET BLUE FINDINGS

Wet vs. Dry Lung - Basic Lung Ultrasound

Basic easily recognizable LUS findings are categorized 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). 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 without fading to the far field obliterating A-lines.

Shred Sign, Tissue Sign, & Nodule Sign (plus Wedge Sign) - Advanced Lung Ultrasound

These are the 3 more advanced LUS signs we have described in progressive order of increasing consolidation/infiltration. The shred sign is similar to 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 with**out** aeration; and the nodule sign or rather consolidation/infiltration in discreet nodules. The wedge sign is a subset of the shred sign and represents pulmonary thrombo-embolism (PTE) or rather infarcts at the lung periphery.

Regionally-Based Respiratory Pattern Approach Using Vet BLUE

The clinical relevancy of Vet BLUE's patterned-based regional approach includes the following:

- 1. Dry lung all fields rules out clinically relevant left-sided congestive heart failure, and suggests upper airway obstruction, feline asthma, COPD, PTE, and non-respiratory look-a-likes.
- 2. Wet lung or ULRs in high numbers (>3 or infinity) in > than 2 sites bilaterally is good evidence for the likely diagnosis of cardiogenic lung edema in non-trauma even more reliably in felines than canines, especially when involving upper Vet BLUE views.
- 3. Wet lung in ventral fields with or without signs of consolidation (shred sign/tissue sign) suggest pneumonia.
- 4. Multiple nodules suggest metastatic disease or granulomatous disease.
- 5. Wedge sign suggests PTE.

THE TALE OF 4 FELINES

The use of thoracic auscultation and breathing patterns for respiratory distress is insensitive and prone to error, coupled with the dangers of transport and restraint in radiology and thoracic radiographic interpretation, making the proactive use of Vet BLUE lung ultrasound incredibly powerful for differentiating respiratory distress in cats. Vet BLUE is a pattern-based regional approach of using our 5 described basic lung ultrasound findings - dry lung (glide with A-lines), wet lung (ultrasound lung rockets also called B-lines), shred sign (wedge sign, PTE), tissue sign and nodule sign.

A Veterinary Cardiologist Once Said - "I Can't Tell the Difference Between Feline Asthma and CHF" -However, You Can Using Point-of-Care Vet BLUE in <60–90 Seconds

In the Tale of 4 Cats, we have Cat #1 with left-sided CHF that is wet all fields; Cat #2 with feline asthma that is dry all fields; Cat #3 with pleural effusion, but don't stop at the pleural effusion, look through the lung line; and Cat #4 with metastatic disease that has the nodule sign with various-sized nodules at nearly every Vet BLUE view. On physical examination, considering auscultation and breathing patterns, all 4 cats look exactly the same with nostril flaring, abdominal breathing, and harsh lung sounds. We will work through these 4 cats emphasizing the evidence-based power of Vet BLUE that better directs care and diagnostic testing.

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SPEAKER INFORMATION

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