Advances in Small Animal Care 6 (2025) 129–154
ADVANCES IN SMALL ANIMAL CARE

Use of Point-of-Care Ultrasound in the Emergency Room and Intensive Care Unit—Thorax Part II

Gregory Lisciandro, DVM, DiplABVP, DiplACVECC*
FASTVet.com and Hill Country Veterinary Specialists, Spicewood, TX, USA

KEYWORDS
• POCUS • AFAST • TFAST • Vet BLUE • Global FAST • Point-of-care ultrasound

KEY POINTS

- Traditionally difficult conditions that are often life-threatening may now be recognized by *seeing* the problem with evidence-based information using point-of-care ultrasound (POCUS).
- AFAST, TFAST, and Vet BLUE are easily achievable point-of-care ultrasound formats combined called Global FAST and used as an extension of the physical exam.
- Global FAST is always strived for to prevent imaging interpretation errors, ie, confirmation bias and satisfaction of search error, that may lead to patient mismanagement.
- TFAST fundamental echocardiography and use for pleural and pericardial effusions, pneumothorax, thorax-related soft tissue abnormalities, and Vet BLUE provide clear advantages over plain radiography.
- Global FAST should be part of the initial examination of all patients to decipher preexisting and acquired conditions.

INTRODUCTION

Diagnostic ultrasound is a safe, radiation sparing, imaging modality that is available to veterinary imaging specialists and many small animal practices worldwide. The point-of-care ultrasound (POCUS) is an effective low-risk and low-impact diagnostic tool that has been monumental in changing the approach to diagnosing and serially assessing emergent and critical small animal patients.

Use of POCUS began in the 1990s with the development of focused assessment with sonography for trauma (FAST) by human trauma surgeons [1–4]. The use of FAST ultrasound in people documented proficiency of nonradiologist physicians for recognizing cavitary, retroperitoneal and pericardial effusions [1–4]. In veterinary medicine, the initial FAST study was performed in dogs in 2004 [5]. The following year, the original veterinary FAST examination was modified to include an abdominal fluid scoring system and was named AFAST along with the addition of a thoracic FAST protocol named TFAST [6,7]. These 2 formats were combined for patient evaluation for a *global quad cavity* assessment of the abdominal and pleural cavities, the retroperitoneal and pericardial spaces named Combo FAST [8]. *T3* was applied to these acronyms indicating their use for trauma, triage (non-trauma), and tracking (monitoring) [8–11]. With the detection of lung pathology at the TFAST chest tube site (CTS), a more comprehensive lung ultrasound screening test evolved named veterinary brief lung ultrasound examination (Vet BLUE) [8,10,12–16]. These 3 formats when combined and used as a single ultrasound examination were called Global FAST and used

*Corresponding author. *E-mail address:* FastSavesLives@gmail.com

https://doi.org/10.1016/j.yasa.2025.06.016 www.advancesinsmallanimalcare.com
2666-450X/25/

ABBREVIATIONS

AFAST	abdominal FAST
Ao	aorta
AX	anaphylaxis
Cd	Vet BLUE caudodorsal region
CHF	congestive heart failure
CPE	cardiogenic pulmonary edema
Cr	Vet BLUE cranial region
CS-LUS	curtain sign of lung ultrasound
CS-PE	curtain sign of PE
CT	computed tomography
CTS	chest tube site
CVC	caudal vena cava
DH	diaphragmatico-hepatic view
ER	emergency room
FAST	focused assessment with sonography for trauma
GDTs	goal-directed tTemplates
GBWE	gallbladder wall edema
HR 5th bonus view	hepato-renal 5th bonus view
Hs of CPR	hypotension; hyperkalemia; hypertension, pulmonary; hypocontractility; hypoventilation, pleural space disease; heartworm, caval syndrome
HV	hepatic veins
ICS	intercostal space
ICU	intensive care unit
LA	left atrium
L-CHF	left-sided congestive heart failure
LUS	lung ultrasound
LV	left ventricle
Md	Vet BLUE middle region
NCPE	non-cardiogenic pulmonary edema
PA	pulmonary artery
PCE	pericardial effusion
PCS	TFAST pericardial site view
PE	pPleural eEffusion
Ph	Vet BLUE perihilar region
PHT	pulmonary hypertension
PTE	pulmonary thromboembolism
PTX	pneumothorax
RA	right atrium
R-CHF	right-sided congestive heart failure
RV	right ventricle
SAx	short axis
SIU	spleno-intestino umbilical view
SR	spleno-renal view
TFAST	The thoracic FAST consisting of bilaterally applied CTS, PCS, and single DH Views
Ts of CPR	tension, PTX; trauma, hemorrhage; thromboembolism, PTE; tamponade, PCE; toxin, AX; tear, left qtrial; tachypnea, aspiration pneumonia.
TXR	thoracic radiography
Vet BLUE	veterinary brief lung ultrasound examination
ZZC	zig-zag continuum

routinely in trauma and nontrauma as *an extension of the physical examination*. [8,17–24] Each of these formats is more than *flashing* or *targeting* and thus separates these Global FAST formats from POCUS, to avoid the danger of "asking the clinical question, followed by targeted POCUS imaging, to answer the specific clinical question(s) in binary fashion" that can lead to potentially serious imaging interpretation errors, that is, the "*cardiac*" and "*anaphylactic*" gallbladder [25]. Thus, this article will primarily focus on the 3 components of Global FAST, specific objectives and views, and describe an unbiased set of 15-data imaging points of the abdomen and thorax, including heart and lung.

The standardized formats of AFAST, TFAST, and Vet BLUE are combined as a single ultrasound format used as an *extension of the physical examination* and called Global FAST. Global FAST provides a vast amount of clinical imaging information that may be acquired within minutes [6–8,17,18,20,24–41].

Add-on POCUS imaging may be used for additional clinical information, such as a more detailed ultrasound approach to the heart or gastrointestinal tract, male and female reproductive tracts, volume estimation of the urinary bladder, locations of tubes and catheters, imaging soft tissue swellings, the eye, or long and flat bones for fractures [29,31,34–38,41–59]. Just like the stethoscope, ultrasound belongs in the hands of all veterinary professionals; however, responsible use should be advocated with standardized formats and clear objectives. This article will be unable to focus on the vast enormity of POCUS, and help avoid limitations of other formats described by others, and will hopefully pique the interest of the reader to explore unlimited creative POCUS uses in patient care [8,60].

The TFAST Examination

The TFAST consists of 5-views, including the bilaterally applied CTS Views (directly above the xiphoid to the upper 1/3 of the thoracic wall) and pericardial site (PCS) views (the 4–6th intercostal space [ICS]), and the singly applied diaphragmatico-hepatic (DH) view (subxiphoid) that is shared by TFAST, AFAST, and Vet BLUE [7,8,10,22–24,33,61,62]. TFAST and Vet BLUE are used to rapidly rule in and rule out pericardial and pleural effusion, pneumothorax, cardiac abnormalities using fundamental echocardiography, soft tissue abnormalities within the thorax (herniation, masses), upper and lower airway causes of respiratory distress [7,10,14,16,26,28,33,39–41,63–67].

The Chest Tube Site Views for Pneumothorax

The CTS view is the highest point on the thoracic wall over the pleural cavity where free air in the presence of pneumothorax (PTX) would rise to the least gravity-dependent location (Fig. 1) [7,8]. Thus, if *lung sliding* is observed (also called the *glide sign*) against the thoracic wall at the CTS view, or B-lines (also called *lung rockets*), then clinically relevant PTX is ruled out [7,8,18,19,24,62,67]. However, any evidence for lung being opposed to the intercostal space (ICS) qualifies [7,8,10,62,67,68]. The *lung point* is defined as the level along the chest in people, thorax in animals, were PTX is immediately dorsal, and evidence for lung recontacting the ICS is immediately ventral [7,8,10,17–19, 24,69,70]. A-lines *without lung sliding* plus a *lung point* confirms PTX [8,10,62,67,69–71]. When possible, the following should take place in any patient with suspected PTX: (1) move the patient to dorsal or sternal recumbency because air rises to the least gravity-dependent location (CTS view, upper 1/3), and the weight of collapsed lung falls into the gravity dependent pleural space, giving a true *lung point*, (2) use the *one-eyed gator sign* technique, placing the rib in the center of the screen, and (3) search for the *lung point* by moving along the "*Vet BLUE line*" at the middle one-third (perihilar Vet BLUE), and lower one-third of the thorax (middle Vet BLUE) [8,17,18,24,62,67]. In lateral recumbency, multiple *lung points* are possible because of gravity equal probe positioning, creating a confounding *double lung point* effect (see Fig. 1) [62,67,72–74]. Slower, deeper breathing patients make imaging *lung sliding* easier over the rapid, shallow breathing, or panting patient [7]. The *lung pulse* is additional evidence that lung (severely collapsed) is opposed to the thoracic wall but movement of the lung surface is in synchrony with heart beats [24,67,75]. The author likens *lung sliding* to an Etch-a sketch cursor moving *to and fro* in synchrony with inspiration and expiration [7,8,62,67].

The *curtain sign of lung ultrasound (CS-LUS)* is analogous to the *curtain sign of* pleural effusion (*PE*) *(CS-PE)* but in different circumstances (air vs free fluid, PE) (Fig. 2) [67,71,73]. Instead of the CS-PE covering and uncovering fluid (PE) like a curtain covering and uncovering with a linear border when moved back and forth, the CS-LUS is of the pleural cavity is with a linear border, covering and uncovering the abdominal cavity. This is the transition zone of pleural and abdominal cavities [67,71,73]. The CS-LUS is achieved by having the scanning plane in longitudinal, perpendicular to the long axis of the ribs with cranial to the left and caudal to the right on the ultrasound screen. By not identifying the CS-LUS and transition zone, abdominal structures may be mistaken for lung pathology (see Vet BLUE) [15,16] (Fig. 1).

Other strategies for detecting pneumothorax

The CS-LUS has been described as a means to detect/suspect PTX by imaging findings called reversed *A-lines* and the *asynchronous curtain sign*. [71,73,76]. This is again by starting the imaging at the highest point over the thorax where air would rise, that is, the TFAST CTS view (analogous to the Vet BLUE caudodorsal view). Simply, the *curtain sign* moves in synchrony with phases of respiration with the pleural side and abdominal side moving together in normalcy. When PTX is present the *dry artifacts (A-lines)* or the *CS-LUS* move toward and away from one another as *Reverse A-lines* by one, and an *Asynchronous CS-LUS* by the other [71,73,76] (Fig. 2). This phenomenon is not pathognomonic because paradoxical abdominal breathing from other non-PTX respiratory conditions also create CS-LUS asynchrony [77]. Thus, within the CS-LUS, only A-lines should be present because PTX is a dry, A-line condition followed by the search for the *lung point* (see Fig. 1). If *B-lines* or any other evidence for lung opposed to the ICS (Vet BLUE signs of consolidation, shred, tissue, nodule, and wedge signs), then clinically relevant PTX is not present [8,10,14,16,24,40,41,68,78,79]. A final LUS described finding is the *lung pulse*, defined as atelectic lung, that is, the Vet BLUE tissue sign, interposed between the ICS and the heart, and thus has *lung sliding* that moves in concert with heart beats rather than phases of respiration [75]. A clinical diagnostic algorithm has been created (Fig. 3).

Final Comments on Pneumothorax

PTX may be semiquantitated to its degree and tracked using *lung point* location using the author's *TFAST*

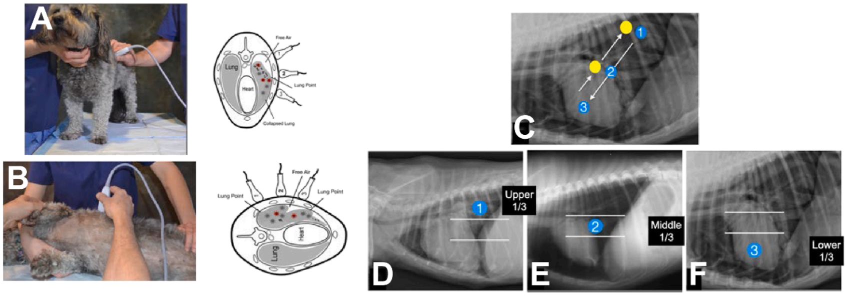


FIG. 1 (**A–F**) The TFAST CTS and detection of PTX. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

PTX 1/3s Rule of (1) upper 1/3, trivial to mild PTX, (2) middle 1/3, moderate PTX, and (3) lower 1/3, severe PTX, with the middle and lower thirds generally warranting timely thoracocentesis. In medical records, PTX should be recorded according to the location of the *lung point* as the TFAST *upper 1/3*, *middle 1/3*, and *lower 1/3* (see Fig. 1) [24,67]. B-mode over M-mode is preferred, as in a related equine study B-mode performed better diagnostically [80].

TFAST for detection of pleural and pericardial effusion

TFAST pericardial site views. Rules for detecting PCE and PE are important to prevent mistaking the only major fluid filled thoracic structure, your patient's heart, which could lead to a potentially catastrophic mistake of performing centesis on a heart chamber (Table 1).

PCE and PE are best detected at the gravity-dependent PCS view(s) and DH view. The major strategy for accurately diagnosing PCE is to image toward the sternum, toward the heart's solid muscular apex eliminating the confounding crescent-shaped right ventricle (RV) and left auricle (LAu) that are mistaken for PCE (or PE) [24,26,33,62,67]. Additional important imaging principles are (1) always image the heart in its entirety (use the bright white (hyperechoic) pericardium as a landmark), and (2) have enough depth to clearly have the bright pericardium in the far field clearly off the bottom of the screen (*never fight the bottom of the screen*), and (3)

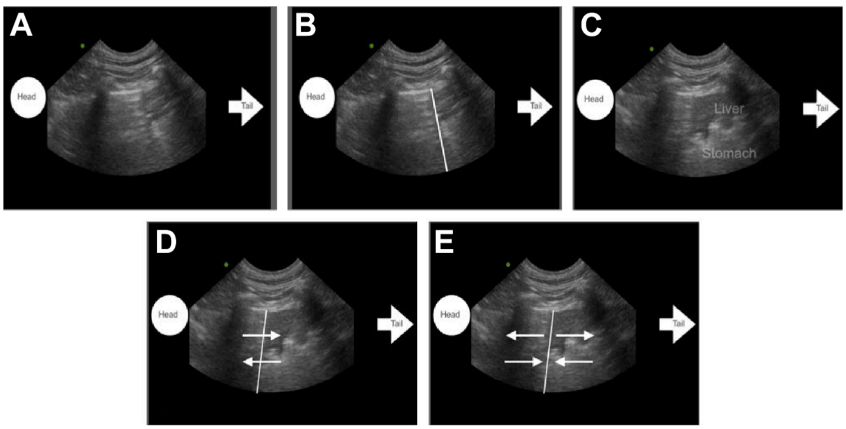


FIG. 2 (**A–E**) The *curtain sign* of lung ultrasound. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

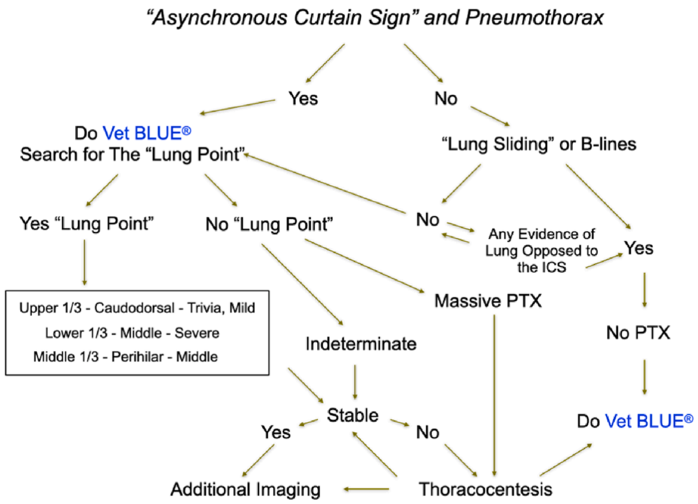


FIG. 3 The clinical diagnostic algorithm for PTX and the *asynchronous curtain sign*. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

opening, widening the scan area allows the sonographer to see more of the heart from side to side (Fig. 4) [24,26,33,67].

Right PCS short axis (SAx) views are especially problematic (higher [dorsal] levels called *Batman* to the *Mercedes Benz*) for mistaking heart chambers for PCE and PE versus fanning lower (ventral) at our *Bull's Eye View*, that is most gravity-dependent in standing or sternal patients, where PCE would round the heart as a *Bull's Eye Sign* (Fig. 5). [22–24,33,67] By imaging low (ventral) on the heart toward its apex, the confounding crescent-shaped RV and LAu are eliminated [33]. Acceptable traditional echocardiography views are limited to (1) the right PCS long axis (LAx 4)-chamber view in which all 4 chambers are identified, and fluid, PCE, and PE are clearly seen outside these 4 chambers (rounding PCE and triangulations PE); and (2) the left PCS *Hammerhead View* where the scanning plane is low (ventral) to have only the left and RVs in view, another strategy that minimizes mistaking heart chambers for PCE and PE [24,26,33,67]. PE in larger amounts that requires timely therapeutic thoracocentesis is readily seen surrounding the heart, and smaller diagnostic volumes, that is, fissure lines radiographically, appear as smaller volumes as the CS-PE by caudally sliding into the *cardiac-diaphragmatic pouch* and cranially to the heart into the *cardiac-cervical pouch*. [22–24,33,67,81].

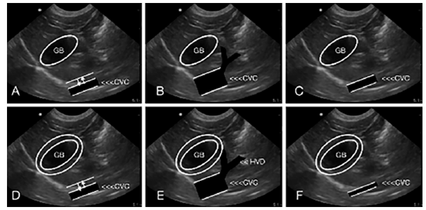
The diaphragmatico-hepatic view

The DH view using the acoustic windows of the soft tissues of liver and gallbladder has advantages over transthoracic TFAST PCS views for detecting PCE and PE by avoiding the transthoracic shadowing of air. *Rounding* of free fluid around the heart's muscular apex, referred to as the *racetrack sign* (see Table 1) is pathognomonic and likely 100% sensitive and specific for clinically relevant PCE because there are no confounding heart chambers and lung wafts away from the diaphragm in the presence of PE [22–24,26,33,82,83]. The *mirror image artifact* of abdominal structures into the thorax (requiring a strong soft-tissue air interface) immediately rules out PE along that specific scanning plane [24,33,67]. In contrast to *racetrack sign* of PCE needing no additional views, PE often requires the PCS views [33,67]. Moreover, a clearly seen *cardiac bump* (the heart's apex indenting/directly opposed to the diaphragm) with no *racetrack sign*, confidently rules out clinically relevant PCE [22–24,26,33,67].

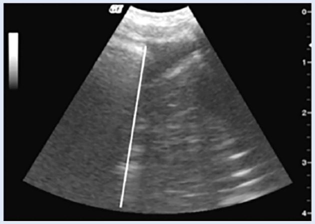
Fundamental echocardiography using TFAST

TFAST can be used as a screening test to assess (1) intravascular fluid volume status and systolic function by the short axis *mushroom view* and the left ventricle (LV), and (2) the presence of left-sided problems (left atrial [LA] size/enlargement) by the SAx *Mercedes Benz view*, and

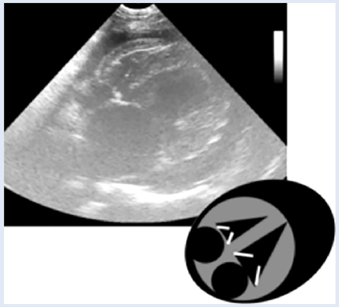
TABLE 1
TFAST STOP Placing This Spe Out OLD Outdated Acronym that is Inaccu Rules for the Accurate Detection of Pericardial Effusion and Pleural Effusion

TFAST Tenets for the Detection of Pleural Effusion	TFAST Tenets for Diagnosing Pericardial and Pleural Effusion	TFAST Tenets for Cardiac Tamponade
• TFAST DH View and dal Vena Cava: Triangulations of uncontained free fluid along the pulmonary-diaphragmatic interface 	• TFAST DH View and dal Vena Cava: Rounding of contained free fluid along the diaphragm referred to as the *racetrack sign* 	• TFAST DH View and dal Vena Cava: CVC and hepatic veins distended as a *FAT* CVC with hepatic venous distension (*tree trunk sign*), and in time ascites. • A *bounce* or *flat* CVC rules out cardiac tamponade 

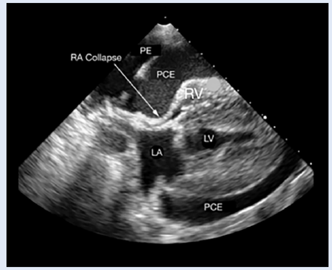
- Pericardial site views: *TFAST slide* caudal from the heart into the *cardiac-diaphragmatic pouch* and cranial from the heart into the *cardiac-cervical pouch* for the *curtain sign of PE*"



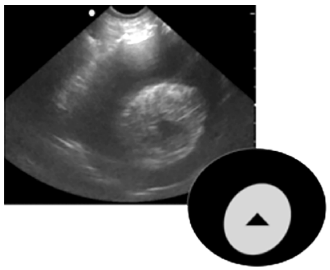
- Right pericardial site view: LAx 4-chamber view where all 4 chambers are identified, and free fluid is accurately identified outside these 4 chambers, rounded and contained within the pericardial sac



- Right pericardial site view: Cardiac tamponade as obstructive shock, results in dynamic collapse of the right atrium or both the right atrium and RV, as a *wave* or *rippling effect* along the outer walls of either or both right chambers
- TXR is unreliable for PCE and cardiac tamponade
- There are different degrees of cardiac tamponade so always look at the patient to decide if pericardiocentesis requires an emergent procedure vs can be delayed



- Right pericardial site view: the *bull's eye view* by directing the scanning plane toward the muscular apex of the heart eliminating the confounding crescent-shaped RV



(*continued on next page*)

TABLE 1
(continued)

TFAST Tenets for the Detection of Pleural Effusion	TFAST Tenets for Diagnosing Pericardial and Pleural Effusion	TFAST Tenets for Cardiac Tamponade
• Pericardial site views: Rotating the probe parallel to the long axis of the ribs in cardiac pouches for the curtain sign of PE	• Left pericardial site view: Left SAx *hammerhead view* with identification of both ventricles and free fluid completely surrounding the heart within the pericardial sac Note there should be more depth in this image. 	

Other General Pearls

- *Never fight the bottom of the screen* - Always have enough depth to see the heart in its entirety by observing the bright white (hyperechoic) pericardium, your landmark, in the far-field clearly off the bottom of the screen, at any and all PCS views. By doing so, heart chambers are less likely to be mistaken for pleural effusion (PE), pericardial effusion (PCE), or other pathology.
- Pericardial fat mimics both PE more so than PCE and is often visualized at the left Pericardial site *hammerhead view*, as a dark (anechoic or hypoechoic) *stripe* along the heart and thoracic wall, and a dark or gray echogenic triangulation at the *cardiac-diaphragmatic pouch* where the heart apex and the pericardial ligament, and diaphragm meet. Sweep immediately dorsal for proper interrogation to observe for the *curtain sign of PE* or ruling out by lung shadowing in absence of the curtain sign.
- *One view is no view* - Meaning combining thoracic focused assessment with sonography for trauma views, especially for PE.
- Pay careful attention to the centimeter scale on your ultrasound screen, because what looks like a large volume, may in fact be small volume.

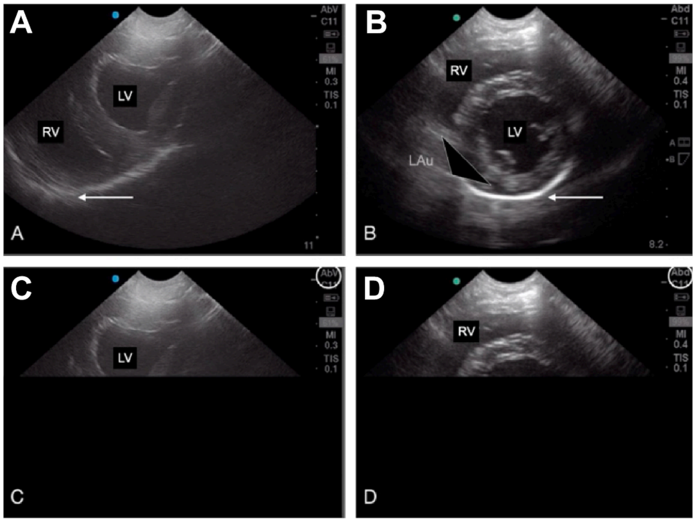


FIG. 4 (**A–D**) Images of the heart from the left and right short axis views of Hammerhead and Mushroom views showing how to image the heart in its entirety to prevent imaging interpretation errors. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

(3) the presence of right-sided problems (right ventricular [RV]/right atrial [RA] size/enlargement) by the LAx 4-chamber view [18,19,22–24,61,67]. A teaching TFAST echocardiography chart is provided (Fig. 5).

Filling and contractility assessment requires freezing the image and scrolling through frames in tachycardiac patients, or those difficult to assess real-time. The LA size is compared to the aorta (Ao) using the Sax, Mercedes Benz view. Obvious abnormal is an LA: Ao greater than 2. The RV size is compared to the LV on LAx 4-chamber view with obvious abnormal is an RV that is greater than 50% of the LV. The RA to LA size is close to 1:1. Being too low (ventral) on SAx, *batman sign view*, a patient can falsely appear volume contracted [24,61,67]. The author likes *double-checks* that include some echocardiography measurements, plus integrating *Global FAST nonecho fallback views* [9,18,19,24]. RV size may be double-checked by measuring on LAx immediately behind the tricuspid valves and comparing to the analogous measurement on same still image behind the mitral valves in diastole during maximal filling [84]. Other add-ons include estimating pulmonary artery size (PA), looking for heartworms (Dirofilaria), and *saddle thrombus*, just above (higher, dorsal) to the SAx Mercedes Benz view or on the LAx 4-chamber view (Fig. 5); and on LAx opening the left ventricular outflow tract (LVOT), that is, aortic valve lesions, heart-based tumors (5-chamber view) (Fig. 5) [43,61,67,83,85–91].

Global FAST nonechocardiography fallback views

Vet BLUE and its *wet versus dry lung* pattern-based approach serves as ruling in and ruling out left-sided congestive heart failure (L-CHF) and the DH View for characterization of the caudal vena cava (CVC [FAT, flat, or bounce]) and hepatic veins (*tree trunk sign*) for right-sided congestive heart failure/overload (R-CHF) are *Global FAST nonfallback views* (Fig. 6) [9,18,19,24,33,62,67]. These *fallback views* are integrated into cardiac assessment but also may be used to rule out L-CHF and R-CHF when echocardiography is not possible if a patient is too critical or requires chemical/physical restraint. Moreover, *dry lung all Vet BLUE views* rules out clinically relevant L-CHF; and a *bounce* or *flat* CVC and absent *tree trunk sign* rules out clinically relevant R-CHF [24,33 ,84,92–94].

The Vet BLUE

The Vet BLUE is a unique regional, pattern-based lung ultrasound (LUS) approach created by the author [12–16]. The fundamental *gator sign* orientation (called the *bat sign* in human medicine) is mandated for all lung ultrasound (Fig. 7) [12,95]. Vet BLUE has 4 bilaterally-applied, transthoracic regional LUS views named the caudodorsal (Cd) view (similar to the TFAST CTS view), perihilar (PH) view, middle (Md)

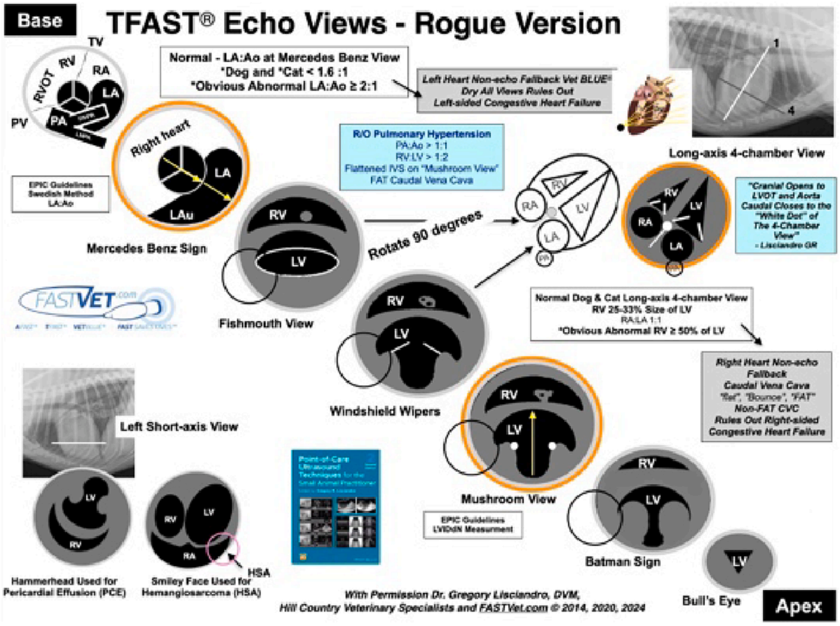


FIG. 5 TFAST fundamental echocardiography views are shown from the left and right pericardial site views using the FASTVet clockface technique and the SAx and LAx levels named for teaching purposes with normals, abnormals, and mantras for image acquisition. It is called the *rogue version*"because orientation is cranial to the left and caudal to the right, like all other imaging. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.) RV, right ventricle; LV, left ventricle; LA, left atrium; LAu, left auricle, RA, right atrium; RAu, right auricle; PA, pulmonary artery; RVOT, right ventricular outflow tract; LVOT, left ventricular outflow tract; PV, pulmonic valve; TV, tricuspid valve; MV, mitral valve.

view, and cranial (Cr) view [12–16]. Additionally, the AFAST-TFAST DH view provides a deep window of lung surface along the pulmonary-diaphragmatic interface; and the pulmonary-pericardial interface provides another deep window to lung surface inaccessible by transthoracic views [22,23]. Lung surface may also be imaged at its deeper surfaces along the pericardium at the TFAST PCS views [96,97]. A depth setting is generally between 4 to 8 cm dependent on patient size (smaller 4–6, medium 5–7, larger 7–8 cm, and sometimes 9–10 cm for larger dogs) and frequency is generally between 10–5 MHz, using a curvilinear or linear probe [15,16]. The cardiac probe should be avoided because it cannot accurately image the gator sign orientation or allow counting of B-lines [98,99]. Interpretation of LUS findings risks interpretation error(s) if the *gator sign orientation* is not clearly imaged and numbers of B-lines accurately counted because of incorrect technique. Moreover, A-lines, stomach wall, fascial planes, and the scapula can mimic the bright white (hyperechoic) *lung line* [15,16,68].

Vet BLUE and its Regional, Pattern-Based Approach for *Wet Versus Dry Lung* Conditions

Dry lung all Vet BLUE views is hugely impactful by ruling out quickly all *wet lung* conditions, the author's mantra being *water*, *blood*, or *pus*, including cardiogenic pulmonary edema (CPE), noncardiogenic pulmonary edema (NCPE), pneumonia, and lung hemorrhage including trauma-induced lung contusions (see Fig. 7) [12,13,16,39,40,68,92]. The Vet BLUE was designed to evaluate lung as we interpret thoracic radiography (TXR). A Figure is provided for examples of common respiratory conditions and their Vet BLUE pattern (Fig. 8).

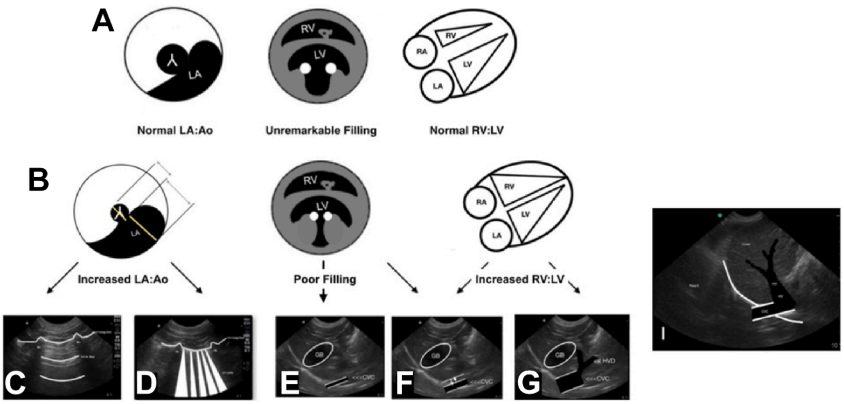


FIG. 6 (**A–G**) TFAST fundamental echocardiography views, Vet BLUE dry and wet lung, and the caudal vena cava, hepatic veins, and gallbladder at the DH view. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

Vet BLUE B-Line Scoring and its Inherent Severity Scoring System

The Vet BLUE B-line scoring system is defined as the highest numerical score over a single ICS at each respective Vet BLUE view and recorded as *Dry* with absent B-lines *0*, and then *Wet* as *1*, *2*, *3* (*weak positives*) and *greater than 3* and *infinity (∞)* (*strong positives*) (Fig. 9) [12,13]. The regional, pattern-based, B-line scoring B-line distribution of *wet lung* along with the presence or absence of other Vet BLUE findings, ie, shred, tissue, nodule, wedge signs, are placed in clinical context of the patient's history and clinical signs for a rapid working diagnosis (Figs. 8 and 9) [10,14,16,39–41,63,68,78,79,92]. Importantly, *wet lung* conditions such as NCPE, CPE, PHT, and PTE are sorted out by the patient's clinical data set of history, physical examination findings, vital signs, and TFAST fundamental echocardiography (Fig. 10) [17,18,24]. Moreover, knowing this information quickly along with considering all Global FAST findings are invaluable in helping guide additional

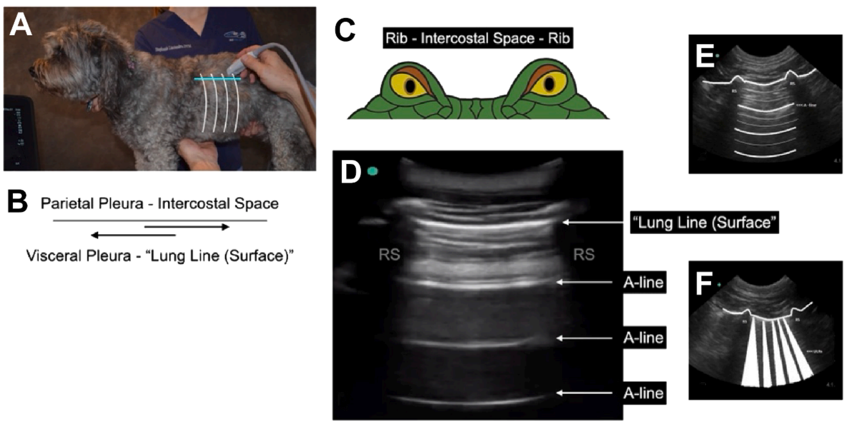


FIG. 7 (**A–F**) fundamentals of TFAST and Vet BLUE lung ultrasound. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.).)

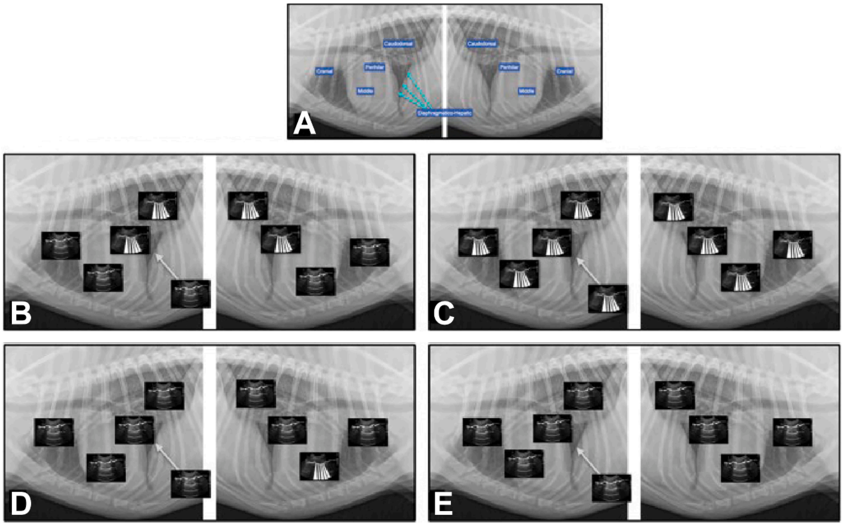


FIG. 8 (**A–E**) Vet BLUE and its novel, unique, regional, pattern-based approach and examples of common respiratory conditions using wet versus dry lung principles. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

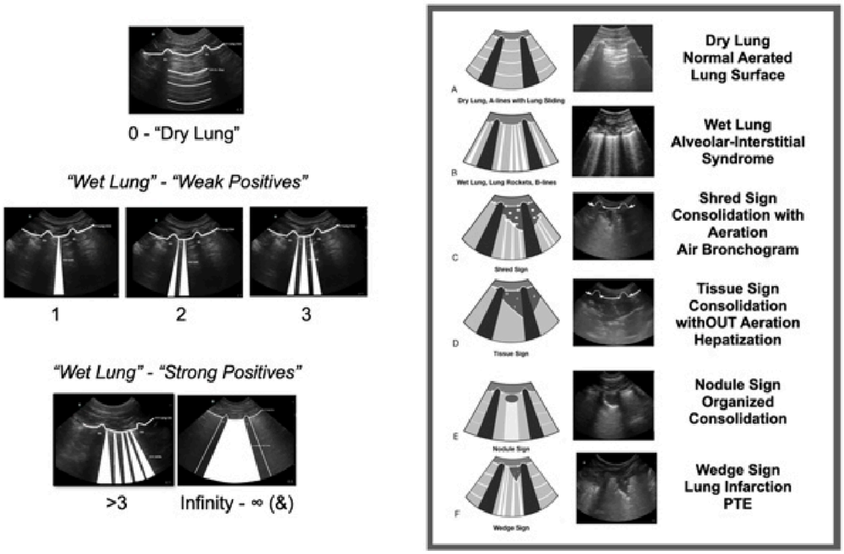


FIG. 9 The Vet BLUE B-line scoring system and its signs of consolidation. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

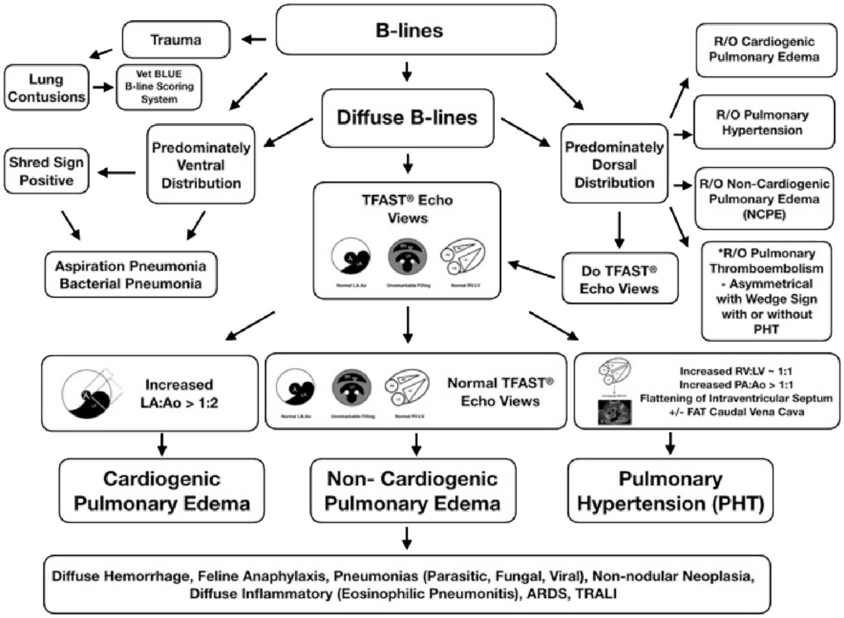


FIG. 10 Vet BLUE flow chart with its finding of B-lines and their distribution coupled with fundamental TFAST echocardiography. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

diagnostics and therapy [17–19,24]. Once the Vet BLUE paradigm is understood, Vet BLUE may be used literally for tracking all respiratory conditions with more sparingly used TXRs (Figs. 10 and 11) [16,68,100,102].

The Vet BLUE Signs of Consolidation —its Visual Lung Language

When pulmonary parenchyma is affected enough to where aerated lung is minimized, then ultrasound can penetrate and image into lung. These 4 types of consolidations are named as follows: (1) shred sign, air bronchograms, hallmarked by linear and punctate bright white (hyperechoic) areas, (2) tissue sign, hepatization of lung, looks like liver, hallmarked by no aeration, (3) nodule sign, hallmarked by a soft issue component that is darker (anechoic, hypoechoic) and oval or circular, while also casting a *pseudo B-line* (see pseudo B-lines), and (4) wedge sign, hallmarked by its wedge or pie piece/triangular shape, and when in upper Vet BLUE Cd and Ph views (where pneumonia is not expected), strongly supports lung infarction (pulmonary thromboembolism) (see Fig. 9) [16,39–41,68,78,79,99,100,102]. The shred sign in gravity-dependent Md and Cr Vet BLUE regions, strongly supports aspiration and bacterial bronchopneumonias and can be used to monitor the patient's clinical course during therapy [16,40,99,103–105] (see Figs. 8 and 11) [14,16,17,19,68,100,101]. As an example, pneumonia is progressively more severe moving from B-lines to shred sign to tissue sign and improving by moving in the opposite direction to complete resolution of *dry lung* all Vet BLUE views [16,68,101]. The shred sign may be further subdivided into *dynamic* and *static* air bronchograms, representing pneumonia and atelectasis, respectively, although patient history is often enough to place the shred sign into these 2 categories [106]. Finally, the nodule sign has rule outs that range from neoplasia to treatable fungal (coccidiomycosis, blastomycosis, aspergillosis, and histoplasmosis) and verminous pneumonias (Dirofilaria immitis, Aelurostrongylus abstrusus, and possibly others); and abscess from inhaled/aspirated/migrating foreign bodies or puncture wounds, and less likely bacterial pneumonias [16,40,78,79,99,107]. Thus, the sonographer should consider a through list of nodule sign differentials [16]. A clinical algorithm is provided (Fig. 12).

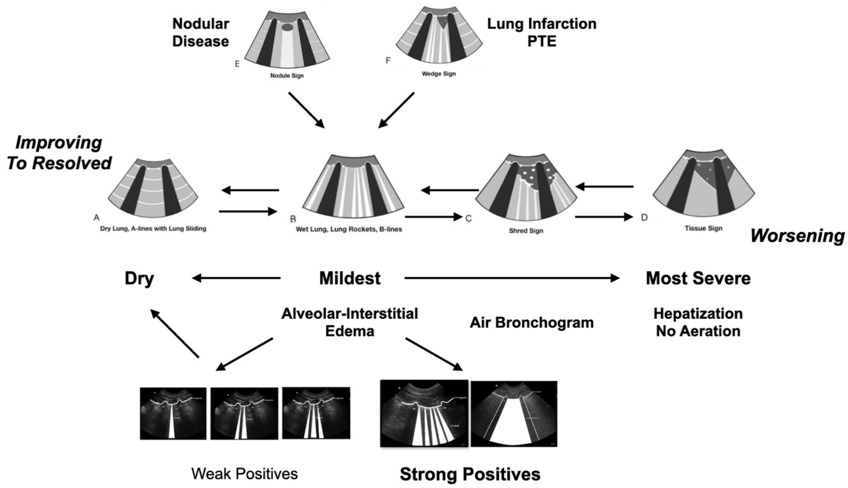


FIG. 11 Vet BLUE serves as a tracking tool using this paradigm for any visible Vet BLUE findings in respiratory patients, point-of-care, low impact and low risk, with real-time interpretation without delay. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

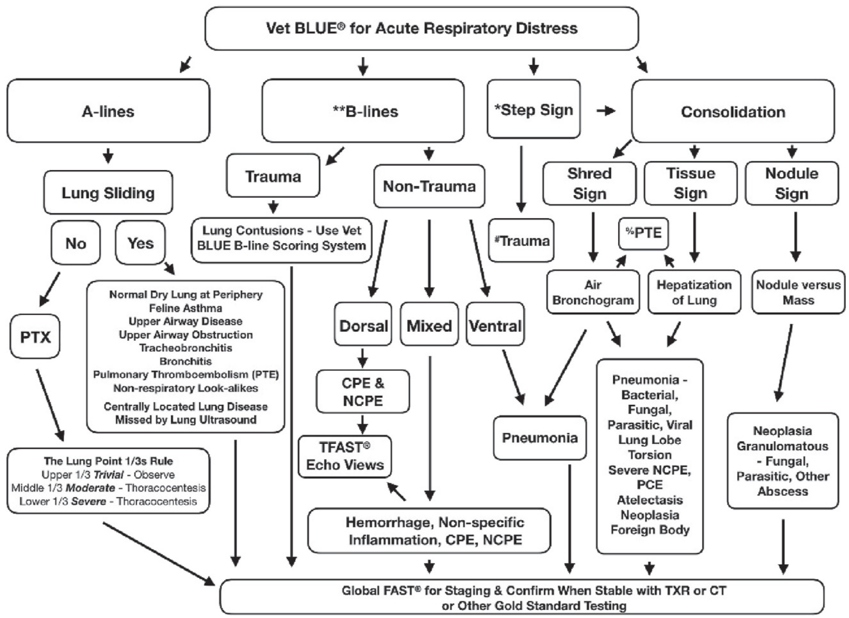


FIG. 12 Clinical flow chart for Vet BLUE wet lung findings and integrating TFAST echocardiography to arrive at a working diagnosis. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

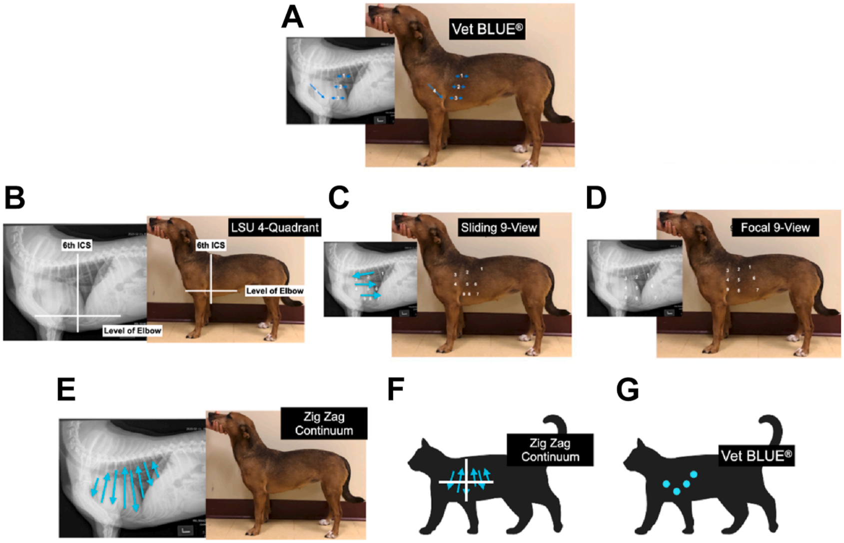


FIG. 13 (**A–G**) Comparison of Vet BLUE to other published lung ultrasound formats.

The Limitations and Advantages of Vet BLUE Lung Ultrasound

Although LUS is extremely sensitive for detecting lung surface pathology including *wet lung* and the Vet BLUE 4 types of consolidations, limitations exist. First, lung pathology must be present at or within millimeters of the *lung (surface) line* at a LUS acoustic window [108]. If pathology is more centrally located away from the *lung line*, then it will be missed, making the point that TXR is not replaced by LUS. Interestingly, Dr. Daniel Lichtenstein, the grandfather of LUS in people, claims that *additional* acoustic windows, like sliding protocols, gain little to nothing over his BLUE protocol, and moreover, sliding protocols or quadrant protocols lose the regional, pattern-based approach to formulate a working diagnosis [95,103]. One of the strengths of Vet BLUE is to record and track LUS findings [95].

Advantages of Vet BLUE and other veterinary LUS protocols are that they have been shown to correlate favorably or exceed TXR for *wet lung* conditions and have similar sensitivity to computed tomography (CT) to detect pulmonary contusions in dogs [100,102, 109–111]. In human medicine, studies support that LUS approaches the sensitivity and specificity of CT for *wet lung* conditions, pneumothorax, and lung consolidations [112–118]. Few comparative veterinary imaging studies exist; however, a pulmonary contusion study of 29 dogs with trauma that had a 3-view TXR followed by Vet BLUE followed by CT within 30 minutes with no interventions between imaging, showed that for pulmonary contusions, Vet BLUE (92%) performed closely to CT (100%) and outperformed TXR (67%) [102]. In another study, *Vet BLUE* was compared to CT; however, probe placement did not follow standard Vet BLUE methodology, and surveyed a single ICS rather than 3 at each view [16,39,40]; and its applications went beyond Vet BLUE's intended design, (ie, Vet BLUE is not designed for PTX and PE) [119] and was performed within a median of 19 hours. With these differences in mind, *Vet BLUE* performed less than previously reported for B-lines when compared to CT [39,40,100,102,109,111] During this time, patients are assumed to have been treated, and B-lines certainly could have resolved (or progressed dependent on the disease) before the reference standard of CT was performed. Interestingly, Z lines are mentioned as a confounder, but with proper training there is very low probability that a Z line would ever be mistaken for a B-line.

Other Protocols, Studies, and New Thoughts

In the author's opinion, the objectives of a LUS protocol, a screening test, should be to rapidly develop a working diagnosis through its views, have a B-line scoring system that can be recorded and followed, and a simple language to describe consolidations, while also minimizing confounders like peripheral LUS artifacts. Furthermore, the LUS views should in fact be over lung to prevent making an inaccurate diagnosis [110,111,120–122]. When evaluating different

TABLE 2
Hypotension; Hyperkalemia; Hypertension, Pulmonary; Hypocontractility; Hypoventilation, Pleural Space Disease; Heartworm, Caval Syndrome and Tension, Pneumothorax; Trauma, Hemorrhage; Thromboembolism, Pulmonary Thromboembolism; Tamponade, Pericardial Effusion*; Toxin*, Anaphylaxis*; Tear, Left Atrial; Tachypnea, Aspiration Pneumonia* of Treatable/Reversible Forms of Shock and CPR

Use of Global FAST for Rapid Detection of *Hypotension; Hyperkalemia; Hypertension, Pulmonary; Hypocontractility; Hypoventilation, Pleural Space Disease; Heartworm, Caval Syndrome* and *Tension, Pneumothorax; Trauma, Hemorrhage; Thromboembolism, Pulmonary Thromboembolism; Tamponade,* Pericardial Effusion*; Toxin,* Anaphylaxis; *Tear, Left Atrial; Tachypnea, Aspiration Pneumonia* of Treatable/Reversible Forms of Shock of treatable/Reversible Forms of Shock and CPR				
The *Hs*	AFAST	TFAST	Vet BLUE	Comments
Hypotension/hypovolemia	flat CVC	Poor LV Filling at Right PCS SAx "Mushroom View"		
Hyperkalemia/hypokalemia	Dilated renal pelvis, distended ureter(s), distended urinary bladder, ± calculi	Bradycardia		
Hypocontractility (DCM)	FAT CVC and *tree trunk sign*, ± GBWE as *Cardiac Gallbladder*, ± Ascites	Poor Contractility on SAx "Mushroom View"	"Wet Lung" Pattern Supportive of L-CHF	
Hypertension, pulmonary	FAT CVC and tree trunk sign, ± GBWE as *cardiac gallbladder*, ± Ascites	Enlarged RV on LAx, Flattened IVS at Right PCS SAx *mushroom view*, Enlarged PA on SAx/LAx	"Wet Lung" Pattern Supportive of L-CHF	See also thromboembolism and PTE
Heartworm, caval syndrome	CVC with Heartworms, FAT CVC and *tree trunk sign*, ± gallbladder wall edema (GBWE) as *cardiac gallbladder*, ± Ascites	PA with heartworms, enlarged RV with heartworms occluding the tricuspid valves	*wedge sign* at upper Cd and Ph regions	*Anemia *Hemoglobinuria *Death is imminent (<48 h)
The *Ts*	AFAST	TFAST	Vet BLUE	Comments
Tension pneumothorax		A-lines, Absent *lung sliding* and Presence of a *lung point* moving Through Vet BLUE	A-lines, Absent lung sliding and Presence of a lung point moving through Vet BLUE	See clinical algorithm for more detail

Trauma, hemorrhage	Abdominal fluid scoring and categorizing as *small volume (<3)* vs *large volume (≥3)* to predict expected degree of anemia and track clinical course; survey all potential cavities, spaces of hemorrhage - retroperitoneal space through SR and HR 5th bonus views, pleural cavity, pericardial sac through DH View	Survey all potential cavities, spaces of hemorrhage - pleural cavity, pericardial sac	Detect and score degree of lung contusions by its B-line scoring and their distribution over all the regional views	See clinical algorithm for more detail
Thromboembolism, pulmonary	FAT CVC and hepatic veins (tree trunk sign) and Ascites for R-CHF, GBWE as a *cardiac gallbladder*	Right PCS view, SAx enlarged PA, LAx RV enlargement, enlarged PA; SAx and LAx, thrombus, SAx saddle thrombus at bifurcation of right and left mainstem PA	*wedge sign* at upper Cd and Ph Regions	
Tamponade, PE	*racetrack sign* at DH View, FAT CVC and hepatic veins (*tree trunk sign*) and Ascites for R-CHF; GBWE as a *cardiac gallbladder*	Right PCS views - SAx *bull's eye sign*; LAx 4-chamber view Left PCS views - hammerhead view and *circling of heart*		A *bounce* of a *flat* CVC rules out cardiac tamponade
Tachypnea, aspiration pneumonia			shred sign in middle and cranial lung regions	
Toxin, AX	GBWE as an *anaphylactic gallbladder*; flat CVC; ± hemoperitoneum			see clinical algorithm for more detail

Global FAST® Goal-Directed Template – Right Lateral Recumbency

Sonographer _________ Patient Name__________ Date/Time_________ Sedation? Y ☐ N ☐ If yes, type of_______________

Patient Positioning: Sternal/standing ☐ Left Lateral ☐ or Right Lateral ☐ or Modified sternal ☐

AFAST® Right Lateral ☐

Diaphragmatico-Hepatic (DH) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Spleno-Renal (SR) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Cysto-Colic (CC) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Spleno-Intestino Umbilical (SIU) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Total Abdominal Fluid Score (AFS) 0-4:** ________ *If positive as patient status allows, move to either lateral recumbency and WAIT 3-minutes to allow fluid to redistribute before ***repeating AFAST® and ***assigning*** the AFS.

Focused Spleen: Unremarkable ☐ Abnormal ☐ Indeterm ☐ N/A ☐

Vet BLUE® LEFT **Lung Sliding** Yes ☐ or No ☐ or Indeterm ☐ or N/A ☐

If PTX, **Lung Point** located - Upper 1/3 ☐ Middle 1/3 ☐ Lower 1/3 ☐ Indeterm ☐ N/A ☐

Cd - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

Ph - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size__Wedge ☐ size___

Md - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size__Wedge ☐ size___

Cr - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

Move the Patient to Standing for the Rest of the Global FAST® Views...

Vet BLUE® RIGHT. **Lung Sliding** Yes ☐ or No ☐ or Indeterm ☐ or N/A ☐

If PTX, **Lung Point** located - Upper 1/3 ☐ Middle 1/3 ☐ Lower 1/3 ☐ Indeterm ☐ N/A ☐

Cd - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

Ph - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size__Wedge ☐ size___

Md - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size__Wedge ☐ size___

Cr - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

TFAST® LEFT Pericardial Site (Hammerhead [HH], Smiley Face[SF]):

Pericardial Eff. (HH View): Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

Right Auricular Mass (SF View): Absent ☐ Present ☐ Indeterm ☐ N/A ☐

Pleural Eff.: Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

TFAST® RIGHT Pericardial Site (Short axis [SAx), Long axis[LAx]):

Left Ventricular SAx (Mushroom View): Volume (Filling): Unremark☐ Poor☐ Indeterm☐ N/A☐

Contractility (FS%): Unremark☐ Poor☐ Indeterm☐ N/A☐

Flattened IVS? Yes☐ No☐ Indeterm☐ N/A☐

SAx LA:Ao (Mercedes Benz View): Unremark☐ Obvious Incr. (>2.0 cats/dogs)☐ Indeterm☐ N/A☐

SAx Pulmonary Artery, Mainstem RPM and LPM: Unremark☐ Incr. PA Size (PA>Ao)? Yes☐ No☐ Indeterm☐ N/A☐

Heartworms? Yes☐ No☐ Indeterm☐ N/A☐ Saddle Thrombus? Yes☐ No☐ Indeterm☐ N/A☐ Other_________

LAx RV:LV 4-Chamber: Unremark☐ Obvious Incr. (>1:2 dogs/cats)☐ Indeterm☐ N/A☐ Other_________

LAx LVOT/5-Chamber: Unrem☐ Abnormal Valves? Yes☐ No☐ Mass? Yes☐ No☐ Indeterm ☐ N/A☐ Other_________

Pericardial Eff. (LAx): Absent☐ Present☐ Mild <1 cm☐ Moderate >1 cm <3 cm☐ Severe >3 cm☐ Indeterm☐ N/A☐

Pleural Eff.: Absent☐ Present☐ Mild <1 cm☐ Moderate >1 cm <3 cm☐ Severe >3 cm ☐ Indeterm☐ N/A☐

Hepato-Renal 5th Bonus (also do Curtain Sign Right Vet BLUE®):** *0☐ 1/2☐ 1☐ Indeterm☐ N/A☐ ***Not part of AFS

Comments____

____

____

Qualifier: The Global FAST® is a combination ultrasound format that includes AFAST®, TFAST® and Vet BLUE®. Global FAST® is a screening test for free fluid and some soft tissue abnormalities that helps direct resuscitation and diagnostic efforts. Global FAST® is not meant to replace radiography, complete detailed abdominal ultrasound, complete echocardiography, CT or MRI.

FIG. 14 GDTs. Global FAST blend beginning with the patient beginning in right lateral recumbency. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

Global FAST® Goal-Directed Template – Standing Position

Sonographer ___________ Patient Name____________ Date/Time___________ Sedation? Y ☐ N ☐ If yes, type of_________________

Patient Positioning: Sternal/standing ☐

Vet BLUE® LEFT **Lung Sliding** Yes ☐ or No ☐ or Indeterm ☐ or N/A ☐

If PTX, **Lung Point** located **-** Upper 1/3 ☐ Middle 1/3 ☐ Lower 1/3 ☐ Indeterm ☐ N/A ☐

Cd - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

Ph - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size_Wedge ☐ size___

Md - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size_Wedge ☐ size___

Cr - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

TFAST® LEFT Pericardial Site (Hammerhead [HH], Smiley Face[SF]):

Pericardial Eff. (HH View): Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

Right Auricular Mass (SF View): Absent ☐ Present ☐ Indeterm ☐ N/A ☐

Pleural Eff.: Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

AFAST® Diaphragmatico-Hepatic (DH) View

Caudal Vena Cava: Bounce (fluid resp.) ☐ Flat (hypovolemic) ☐ FAT (fluid intolerant) ☐ Indeterm ☐ N/A ☐

Hepatic Venous Distension (Tree Trunk Sign): Absent ☐ Present ☐ Indeterm ☐ N/A ☐

Pleural Eff.: Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

Pericardial Eff.: Absent ☐ Present ☐ Mild <1 cm ☐ Moderate >1 cm <3 cm ☐ Severe >3 cm ☐ Indeterm ☐ N/A ☐

Vet BLUE®: B-lines 0☐ 1 -3☐ >3☐ ∞☐ Indeterm☐ N/A☐ Shred☐ size__Tissue☐ size_Nodule☐ size_Wedge☐ size___

AFAST® Sternal/standing ☐

Diaphragmatico-Hepatic (DH) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Spleno-Renal (SR) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Cysto-Colic (CC) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Spleno-Intestino Umbilical (SIU) 0 ☐ *1/2 ☐ 1 ☐ Indeterm ☐ N/A ☐

Total Abdominal Fluid Score (AFS) 0-4:** __________ *If positive as patient status allows, move to either lateral recumbency and WAIT 3-minutes to allow fluid to redistribute before ***repeating AFAST® and ***assigning*** the AFS.

Hepato-Renal 5th Bonus View:** *0 ☐ 1/2 ☐ 1 ☐ Indeterminate ☐ Not Assessed ☐ ****Not part of AFS

Focused Spleen: Unremarkable ☐ Abnormal ☐ Indeterm ☐ N/A ☐

Vet BLUE® RIGHT. **Lung Sliding** Yes ☐ or No ☐ or Indeterm ☐ or N/A ☐

If PTX, **Lung Point** located **-** Upper 1/3 ☐ Middle 1/3 ☐ Lower 1/3 ☐ Indeterm ☐ N/A ☐

Cd - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

Ph - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size_Wedge ☐ size___

Md - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size_Nodule ☐ size_Wedge ☐ size___

Cr - B-lines 0 ☐ 1 -3 ☐ >3 ☐ ∞ ☐ Indeterm ☐ N/A ☐ Shred ☐ size___ Tissue ☐ size__Nodule ☐ size__Wedge ☐ size___

TFAST® RIGHT Pericardial Site (Short axis [SAx), Long axis[LAx]):

Left Ventricular SAx (Mushroom View): Volume (Filling): Unremark☐ Poor☐ Indeterm☐ N/A☐

Contractility (FS%): Unremark☐ Poor☐ Indeterm☐ N/A☐

Flattened IVS? Yes☐ No☐ Indeterm☐ N/A☐

SAx LA:Ao "Mercedes Benz View": Unremark☐ Obvious Incr. (>2.0 cats/dogs)☐ Indeterm☐ N/A☐

SAx Pulmonary Artery, Mainstem RPM and LPM: Unremark☐ Incr. PA Size (PA>Ao)? Yes☐ No☐ Indeterm☐ N/A☐

Heartworms? Yes☐ No☐ Indeterm☐ N/A☐ Saddle Thrombus? Yes☐ No☐ Indeterm☐ N/A☐ Other___________

LAx RV:LV 4-Chamber: Unremark☐ Obvious Incr. (>1:2 dogs/cats)☐ Indeterm☐ N/A☐ Other___________

LAx LVOT/5-Chamber: Unrem☐ Abnormal Valves? Yes☐ No☐ Mass? Yes☐ No☐ Indeterm ☐ N/A☐ Other___________

Pericardial Eff. (LAx): Absent☐ Present☐ Mild <1 cm☐ Moderate >1 cm <3 cm☐ Severe >3 cm☐ Indeterm☐ N/A☐

Pleural Eff.: Absent☐ Present☐ Mild <1 cm☐ Moderate >1 cm <3 cm☐ Severe >3 cm ☐ Indeterm☐ N/A☐ **Renal 5th**

Hepato-Renal 5th Bonus (also do Curtain Sign Right Vet BLUE®):** *0☐ 1/2☐ 1☐ Indeterm☐ N/A☐ ****Not part of AFS

Comments____

____

____

Qualifier: The Global FAST® is a combination ultrasound format that includes AFAST®, TFAST® and Vet BLUE®. Global FAST® is a screening test for free fluid and some soft tissue abnormalities that helps direct resuscitation and diagnostic efforts. Global FAST® is not meant to replace radiography, complete detailed abdominal ultrasound, complete echocardiography, CT or MRI.

LUS protocols in current literature, the reader should consider whether (1) the views obtained are over accessible lung, (2) the sonographer can develop a working diagnosis with the respective protocol, (3) there is a B-line scoring system, (4) the B-line scoring system makes sense, (5) record findings can be tracked, and (6) how are consolidations characterized. In the author's opinion, imaging of more lung and the likelihood of finding more artifacts adds confounding variables that limits the use of LUS as a screening test [119,120,123,124]. The standard Vet BLUE methodology was not intended to screen for PTX; and PE as the depth of Vet BLUE is too shallow.

The author has reviewed and named other published studies to describe limitations compared with the Vet BLUE protocol. The LSU 4-quadrant protocol defined 4-quadrants with just 1 quadrant scanning over a significant lung area [111]. The same LSU 4-quadrant protocol was used as a B-line scoring repeatability study [125]. The LSU 4-quadrant protocol was followed by a midthoracic boxed (limited) sliding protocol referred to as the Armenise protocol [74,81], that then evolved to a sliding protocol to cover more thorax, called a 9-point POCUS protocol, with at least 3 of the points not scanning over accessible lung. The Armenise protocol was further modified with subdivisions dividing the intercostal spaces into upper, middle, and lower thirds of the 4th, 6th, and 8th ICS [121,122]. The Modified Armenise/PLUS protocol (sliding) has interestingly become a sliding protocol over all Vet BLUE views but does not promote recording findings [81,123] Lastly, the imaging of every ICS, known as the zig-zag continuum (ZZC), is similar to a LUS protocol that has previously been reported for use in large animals [111,120]. This ZZC is not a regional, pattern-based approach and scores findings per hemithorax versus 4-quadrants (Fig. 13).

Probe type has also been studied. The phased-array cardiac probe should be avoided because it cannot accurately image the *gator sign orientation* or count numbers of B-lines [98,99]. The linear probe may be used for lung, but it is not adequate for all Global FAST. More recently, the lung surface character and thickness have been evaluated; however, lung surface features may not outperform Vet BLUE combined with signalment, history, physical examination, and other patient data [123].

Global FAST for Patient Monitoring, Detecting Treatable Forms of Shock, CPR—*Hypotension; Hyperkalemia; Hypertension, Pulmonary; Hypocontractility; Hypoventilation, Pleural Space Disease; Heartworm, Caval Syndrome and Tension, Pneumothorax; Trauma, Hemorrhage; Thromboembolism, Pulmonary thromboembolism; Tamponade,* Pericardial Effusion*; Toxin,* Anaphylaxis*; Tear, Left Atrial; Tachypnea, Aspiration Pneumonia*

Global FAST can be used to determine whether treatable, reversible forms of shock, dubbed *hypotension; hyperkalemia; hypertension, pulmonary; hypocontractility; hypoventilation, pleural space disease; heartworm, caval syndrome* (Hs) *and* tension, PTX; trauma, hemorrhage; thromboembolism, PTE; tamponade, PCE; Toxin, AX; Tear, Left atrial; tachypnea, aspiration pneumonia (*Ts)"* of cardiopulmonary resuscitation (CPR) by the American Heart Association and created by the author for veterinary patients, are present in small animals with unexplained hypotension, or in those that appear questionably stable, appear to be in danger of imminent or have had cardiopulmonary arrest and are experiencing cardiopulmonary resuscitation [9,17,18,126] Global FAST rapidly surveys for treatable causes, helps better direct resources and resuscitation efforts with the potential to improve survival and outcome (see Table 2). Global FAST should be part of advanced life support.

Global FAST for Staging Localized Versus Disseminated Disease

Anytime a serious finding is detected, Global FAST should be performed to determine if the abnormality is *localized* or *disseminated*; Global FAST also can help locate potential diagnostic sampling sites, (ie, centesis, fine needle aspiration, and biopsy) [19].

Recording results on goal-directed templates and serial examinations

To have value, any finding during Vet BLUE and all the components of Global FAST must be recorded on

FIG. 15 GDTs. Global FAST blend with the patient standing. (*Reprinted with permission from* Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, Second Edition, edited by Gregory R. Lisciandro, published by John Wiley & Sons, Inc. And Dr. Gregory Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC, Hill Country Veterinary Specialists and FASTVet.com. Copyright 2012, 2014, 2019, 2021, 2025.)

standardized Goal-directed Templates (GDTs). GDTs are important for showing objective findings that may be tracked with future comparative Vet BLUE and Global FAST examinations with interobserver subjective variability (Figs. 14 and 15). Additional examples may be found in the Free Resources of FASTVet.com. Standard protocols with documentation of patient position are necessary to ensure accuracy.

SUMMARY

The Global FAST Approach as *an extension of the physical examination* is having a vital impact in small animal veterinary medicine. The mindset of Global FAST over POCUS *flashing* and *selective imaging* is important to prevent imaging interpretation errors. Documentation of baseline and serial findings on GDTs help track patients and can determine preexisting conditions. The greatest potential of Global FAST and its unbiased set of data imaging points of the abdomen and thorax including heart and lung, lies in its ability to capture conditions earlier in their course and conditions traditionally missed without use of ultrasound, with the potential for cure. The Global FAST examination is performed more expediently without the delay of traditional complete ultrasound studies and radiography including CT that may be delayed due to patient instability or resources. The use of Global FAST imaging allows the clinician to better pick the *next best* diagnostic test and more accurately treat patients by *seeing* their problems, thus carrying potential for keeping patients alive for gold standard testing and treatment. The Global FAST approach and POCUS have *awakened a sleepy giant* already contributing to widespread advancement in patient care and untold uses still exist on the horizon.

CLINICS CARE POINTS

- TFAST is a rapid point-of-care imaging test that can detect pneumothorax, pericardial and pleural effusion, cardiac abnormalities including chamber enlargement and abnormalities, cardiac-related masses and intracardiac parasites (Dirofilaria immitis), many of which are only suspected or missed on survey radiographs and avoids the inherent risk of transport and restraint of an unstable patient.
- TFAST can rapidly provide characterization of the caudal vena cava and hepatic veins for volume status, lung and cardiac pathology along the cardiac-diaphragmatic and pulmonary-diaphragmatic interface at the diaphragmatico-hepatic view.
- Vet BLUE has a regional, pattern-based approach of lung regions that help rapidly develop a working diagnosis. Moreover, using its B-line scoring system, there is an inherent severity scoring system that may be used to guide therapy and track patients.
- Vet BLUE has a visual lung language for consolidations and although not meant to replace plain radiography or computed tomography (CT), evidence is building on its performance being closer to CT than radiography.
- Global FAST should be used for rapidly surveying treatable forms of shock, hypotension; hyperkalemia; hypertension, pulmonary; hypocontractility; hypoventilation, pleural space disease; heartworm, caval syndrome and tension, pneumothorax; trauma, hemorrhage; thromboembolism, pulmonary thromboembolism; tamponade, pericardial effusion; toxin, anaphylaxis; tear, left atrial; tachypnea, aspiration pneumonia of CPR, as a means to better direct resources to increase the probability of saving a patient's life and also used for guiding resuscitation.

DISCLOSURES

Dr G. Lisciandro is the co-owner of Hill Country Veterinary Specialists and FASTVet.com, a private company that provides veterinary ultrasound training to veterinarians and veterinary professionals with loaned equipment from several ultrasound companies without sales commissions. The terms AFAST, TFAST, Vet BLUE, and Global FAST are service marked for educational purposes and are proprietary to FASTVet.com and Hill Country Veterinary Specialists through Lisciandro Enterprises, PLLC, Spicewood, Texas. His spouse, Dr. Stephanie Lisciandro, DVM, DACVIM (SAIM) is a co-owner of Hill Country Veterinary Specialists and FASTVet.com.

REFERENCES

[1] Rozycki GS. Surgeon-performed ultrasound: its use in clinical practice. Ann Surg 1998;228(1):16–28.
[2] Rozycki GS, Ochsner MG, Jaffin JH, et al. Prospective evaluation of surgeons' use of ultrasound in the evaluation of trauma patients. J Trauma 1993;34:516–27.
[3] Rozycki GS, Ballard RB, Feliciano DV, et al. Surgeon-performed ultrasound for the assessment of truncal injuries: lessons learned from 1540 patients. Ann Surg 1998;228(4):557–67.
[4] Boulanger BR, Brenneman FD, McLellan BA, et al. A prospective study of emergent abdominal sonography after blunt trauma. J Trauma 1995;39(2):325–30.

[5] Boysen SR, Rozanski EA, Tidwell AS, et al. Evaluation of a focused assessment with sonography for trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. J Am Vet Med Assoc 2004; 225(8):1198–204.
[6] Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of an abdominal fluid scoring system determined using abdominal focused assessment with sonography for trauma in 101 dogs with motor vehicle trauma. J Vet Emerg Crit Care 2009;19(5):426–37.
[7] Lisciandro GR, Lagutchik MS, Mann KA, et al. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. J Vet Emerg Crit Care 2008;18(3):258–69.
[8] Lisciandro GR. Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals. J Vet Emerg Crit Care 2011; 21(2):104–22.
[9] Lisciandro GR, Armenise A. Chapter 16: focused or COAST^3 – cardiopulmonary resuscitation (CPR), global FAST (GFAST^3) & the FAST-ABCDE exam. In: Lisciandro GR, editor. Focused ultrasound techniques for the small animal practitioner. Ames IA: Wiley Blackwell; 2014. p. 269–85.
[10] Bosyen SR, Lisciandro GR. The use of ultrasound for dogs and cats in the emergency room: AFAST and TFAST. Vet Clin North Am Small Anim Pract 2013; 43(4):773–97.
[11] Lisciandro GR. Evaluation of initial and serial combination focused assessment with sonography for trauma (CFAST) examinations of the thorax (TFAST) and abdomen (AFAST) with the application of an abdominal fluid scoring system in 49 traumatized cats. Abstract. J Vet Emerg Crit Care 2012;22(S2):S11.
[12] Lisciandro GR, Fosgate GT, Fulton RM. Frequency of ultrasound lung rockets using a regionally-based lung ultrasound examination named veterinary bedside lung ultrasound exam (Vet BLUE) in 98 dogs with normal thoracic radiographic lung findings. Vet Radiol Ultrasound 2014;55(3):315–22.
[13] Lisciandro GR, Fulton RM, Fosgate GT, et al. Frequency of B-lines using a regionally-based lung ultrasound examination (the Vet BLUE protocol) in 49 cats with normal thoracic radiographical lung findings. J Vet Emerg Crit Care 2017;27(3):267–77.
[14] Lisciandro GR. Chapter 10: the Vet BLUE lung scan. In: Lisciandro GR, editor. Focused ultrasound techniques for the small animal practitioner. Ames IA: Wiley Blackwell; 2014. p. 166–88.
[15] Lisciandro GR, Lisciandro SC. Chapter 22: POCUS: Vet BLUE-introduction and image acquisition. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 425–58.
[16] Lisciandro GR, Lisciandro SC. Chapter 23: POCUS: Vet BLUE-clinical integration. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 459–507.
[17] Lisciandro GR, Lisciandro SC. Global FAST for patient monitoring and staging in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1169–82.
[18] Lisciandro GR. Chapter 37: POCUS: global FAST-detecting treatable forms of shock, advanced life support, and cardiopulmonary resuscitation. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 729–56.
[19] Lisciandro GR. Chapter 36: POCUS: global FAST-patient monitoring and staging. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 685–728.
[20] McMurray J, Boysen S, Chalhoub S. Focused assessment with sonography in nontraumatized dogs and cats in the emergency and critical care setting. J Vet Emerg Crit Care 2016;26(1):64–73.
[21] Boysen SR, Chalhoub S. FAST ultrasound examinations. In: Cohn L, Cote E, editors. Clinical veterinary advisor. 3rd Edition. St. Louis MO: Elsevier; 2019. p. 1103–5.
[22] Lisciandro GR. Chapter 3: point-of-care ultrasound. In: Mattoon JS, Sellon R, Berry CR, editors. Small animal diagnostic ultrasound. 4th Edition. St. Louis (MO): Elsevier; 2021. p. 76–104.
[23] Lisciandro GR. Chapter 73: point-of-care ultrasound examination. In: Cote E, Ettinger SJ, Feldman EC, editors. Ettinger's textbook of veterinary internal medicine. 9th Edition. St. Louis (MO): Elsevier; 2021. p. 355–60.
[24] Lisciandro GR. Cageside ultrasonography in the emergency room and intensive care unit. Vet Clin North Am Small Anim Pract 2020;50(6):1445–67.
[25] Lisciandro GR, Gambino JM, Lisciandro SC. Case series of 13 dogs and 1 cat with ultrasonographically-detected gallbladder wall edema associated with cardiac disease. J Vet Intern Med 2021;35(3):1342–6.
[26] Lisciandro GR. The use of the diaphragmatico-hepatic (DH) views of the abdominal and thoracic focused assessment with sonography for triage (AFAST/TFAST) examinations for the detection of pericardial effusion in 24 dogs (2011-2012). J Vet Emerg Crit Care 2016; 26(1):125–31.
[27] Kim SY, Park KT, Yeon SC, et al. Accuracy of sonographic diagnosis of pneumoperitoneum using the enhanced peritoneal stripe sign in beagle dogs. J Vet Sci 2014;15(2):195–8.
[28] Spattini G, Rossi F, Vignoli M, et al. Use of ultrasound to diagnose diaphragmatic rupture in dogs and cats. Vet Radiol Ultrasound 2003;44(2):226–30.
[29] Fulton RM. Focused ultrasound of the fetus, female and male reproductive tracts, pregnancy, and dystocia in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1249–65.

[30] Cole L, Humm K, Dirrig H. Focused ultrasound examination of the canine and feline emergency urinary tract disorders. Vet Clin North Am Small Anim Pract 2021;51(6):1233–48.
[31] Sanderson JJ, Boysen SR, McMurray JM, et al. The effect of fasting on gastrointestinal motility in healthy dogs as assessed by sonography. J Vet Emerg Crit Care 2017;27(6):645–50.
[32] Boysen SR, Gambino JM. POCUS: gastrointestinal tract & pancreas. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 225–44.
[33] Lisciandro GR. TFAST accurate diagnosis of pleural and pericardial effusion, caudal vena cava in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6): 1169–82.
[34] Matthews AR, Penninck DG, Webster CRL. Postoperative ultrasonographic appearance of uncomplicated enterotomy or enterectomy sites in dogs. Vet Radiol Ultrasound 2008;49(5):477–83.
[35] Ramesh M, Brooks AC, Thomovsky E, et al. Comparison of 4-point techniques to detect correct positioning of nasogastric tubes in dogs (2020-2021). J Vet Emerg Crit Care 2023;33(5):501–8.
[36] Nobles IJ, Johnson CB, Lisciandro GR. Gastric POCUS protocol for the evaluation of gastric size and contents in dogs. Abstract. J Vet Emerg Crit Care 2023;S1(33): S2–42.
[37] Siena G, Romagnoli S, Drigo M, et al. Ultrasonographic changes in fetal gastrointestinal motility during the last 10 days before parturition in dogs. Front Vet Sci 2022; 9:1000975.
[38] Mays E, Phillips K. Focused ultrasound of the vascular system in dogs and cats-thromboembolic disease. Vet Clin North Am Small Anim Pract 2021;51(6):1267–82.
[39] Ward JL, Lisciandro GR, Tou SP, et al. Accuracy of point-of-care lung ultrasound (Vet BLUE protocol) for the diagnosis of cardiogenic pulmonary edema in dogs and cats with acute dyspnea. J Am Vet Assoc 2017;250(6):666–75.
[40] Ward JL, Lisciandro GR, Ware WA, et al. Lung ultrasound findings in 100 dogs with various etiologies of cough. J Am Vet Med Assoc 2019;255(5):574–83.
[41] Lisciandro GR, Puchot ML, Gambino JM, et al. The wedge sign: a possible lung ultrasound sign for pulmonary thromboembolism. J Vet Emerg Crit Care 2022; 32(5):663–9.
[42] DeFrancesco TC, Ward JL. Focused canine cardiac ultrasound. Vet Clin North Am Small Anim Pract 2021; 51(6):1203–16.
[43] Loughran K. Focused cardiac ultrasonography in cats. Vet Clin North Am Small Anim Pract 2021;51(6): 1183–202.
[44] Penninck D. Gastrointestinal tract. In: Penninck D, d'Anjou MA, editors. Atlas of small animal ultrasonography. Ames IA: Blackwell Publishing; 2008. p. 281–318.
[45] Penninck D, Nyland T, Fisher P, et al. Ultrasonography of the normal canine gastrointestinal tract. Vet Radiol Ultrasound 1989;31(3):272–6.
[46] Sharma AJ, Thompson MS, Scriviani PV, et al. Comparison of radiography and ultrasonography for diagnosing small intestinal mechanical obstruction in vomiting dogs. Vet Radiol Ultrasound 2011;52(3): 248–55.
[47] Picandet JD, Macieira S, Beauregard G, et al. Detection of rib trauma in newborn foals in equine critical care unit: a comparison ultrasonography, radiography, and physical examination. Equine Vet J 2007;39(2): 158–63.
[48] Ramirez-Schrempp D, Vinci RJ, Liteplo AS. Bedside ultrasound in the diagnosis of skull fractures in the pediatric emergency department. Pediatr Emerg Care 2011; 27(4):312–4.
[49] Todd-Donato AB, VanDeventer GM, Porter IR, et al. Ultrasound is an accurate imaging modality for diagnosing hip luxations in dogs presenting with hind limb lameness. J Am Vet Med Assoc 2024;262(10): 1379–87.
[50] Stieger-Vanegas S. Focused ultrasound of superficial-soft tissue swelling, masses, and fluid collections in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1283–93.
[51] Stieger-Vanegas SM. Chapter 34: POCUS: musculoskeletal - soft tissue. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 647–61.
[52] Stieger-Vanegas SM. Chapter 35: POCUS: musculoskeletal - bones and joints. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 662–82.
[53] Cho J. Chapter 27: POCUS: eye. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 553–78.
[54] Cho J. Ocular ultrasound abnormalities and optic nerve sheath diameter in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1295–314.
[55] Ilie LA, Thomovsky EJ, Johnson PA, et al. Relationship between intracranial pressure as measured by an epidural intracranial pressure monitoring system and optic nerve sheath diameter in healthy dogs. Am J Vet Res 2015;76:724–31.
[56] Smith JJ, Fletcher DJ, Cooley SD, et al. Transpalpebral ultrasonographic measurement of the optic nerve sheath diameter in healthy dogs. J Vet Emerg Crit Care 2018;28(1):31–8.
[57] Evangilisti MA, Carta G, Burral GP, et al. Repeatability of ultrasound examination of the optic nerve sheath diameter in the adult cat: comparison between healthy cats and cats suffering from presumed intracranial hypertension. J Fel Med Surg 2020;22(10):959–65.

[58] Rong AJ, Fan KC, Golshani B, et al. Multimodal imaging features of intraocular foreign bodies. Semin Ophthalmol 2019;34(7–8):518–32.

[59] Carvalho CF. Chapter 29: POCUS: brain - clinical integration. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 595–608.

[60] Lisciandro GR, Gambino JM. Point-of-Care ultrasound -the awakening of a sleeping giant. Vet Clin North Am Small Anim Pract 2021;51(6):xi–xiii.

[61] Lisciandro GR. Chapter 17: POCUS: TFAST-introduction and image acquisition. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 297–387.

[62] Lisciandro GR. Chapter 9: the thoracic FAST^3 (TFAST^3) examination. In: Lisciandro GR, editor. Focused ultrasound techniques for the small animal practitioner. Ames IA: Wiley Blackwell; 2014. p. 140–65.

[63] Ward JL, Lisciandro GR, Ware WA, et al. Evaluation of point-of-care thoracic ultrasound and NT-proBNP for the diagnosis of congestive heart failure in cats with respiratory distress. J Vet Intern Med 2018;32(5):1530–40.

[64] Nevins JR, Mai W, Thomas E. Association between ultrasound and clinical findings in 87 cats with urethral obstruction. Vet Radiol Ultrasound 2015;56(4): 439–47.

[65] Cole LP, Mantis P, Humm K. Ultrasonographic findings in cats with acute kidney injury: a retrospective study. J Fel Med Surg 2019;21(6):475–80.

[66] Lisciandro GR, Fosgate GT. Use of AFAST cysto-colic view urinary bladder measurements to estimate urinary bladder volume in dogs and cats. J Vet Emerg Crit Care 2017;27(6):713–7.

[67] Lisciandro GR. Chapter 18: POCUS: TFAST-clinical integration. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Wiley Blackwell: Ames IA; 2021. p. 337–88.

[68] Lisciandro GR, Lisciandro SC. Lung ultrasound fundamentals, "wet versus dry" lung, signs of consolidation in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1169–82.

[69] Lichtenstein DA, Meziere G, Biderman P, et al. The "lung point": an ultrasound sign specific to pneumothorax. Intensive Care Med 2000;26(10):1434–40.

[70] Santos-Silva J, Lichtenstein DA, Tuinman PR, et al. The "lung point": an ultrasound sign specific to pneumothorax. Intensive Care Med 2019;45(9):1327–8.

[71] Boysen SR. Lung ultrasonography for pneumothorax in dogs and cats. Vet Clin North Am Small Anim Pract 2021;51(6):1153–68.

[72] Volpicelli G, Audino B. The double lung point: an unusual sonographic sign of juvenile spontaneous pneumothorax. Am J Emerg Med 2011;29(3):355.

[73] Boysen S, McMurray J, Gommeren K. Abnormal curtain signs identified with a novel lung ultrasound protocol in 6 dogs with pneumothorax. Front Vet Sci 2019;6:291.

[74] Armenise A, Boysen RS, Rudloff E, et al. Veterinary-focused assessment with sonography for trauma-airway, breathing, circulation, disability and exposure: a prospective observational study in 64 canine trauma patients. J Small Anim Pract 2019;60:173–82.

[75] Lichtenstein DA, Lascols N, Prin S, et al. The "lung pulse" and early ultrasound sign in complete atelectasis. Intensive Care Med 2003;29:2187–92.

[76] Hwang TS, Yoon YM, Jung DI, et al. Usefulness of transthoracic lung ultrasound for the diagnosis of mild pneumothorax. J Vet Sci 2018;19(5):660–6.

[77] Lisciandro GR. The “Asynchronous Curtain Sign” occurs in respiratory conditions other than pneumothorax. Abstract. J Vet Emerg Crit Care 2025 In Press.

[78] Kulhavy DA, Lisciandro GR. Use of a lung ultrasound examination called Vet BLUE to screen for metastatic lung nodules in the emergency room. Abstract. J Vet Emerg Crit Care 2015;25(S1):S14.

[79] Pacholec C, Lisciandro GR, Masseau I, et al. Lung ultrasound nodule sign for detection of pulmonary nodule lesions in dogs: comparison to thoracic radiography using computed tomography as the criterion standard. Vet J 2012;275:105727.

[80] Partlow J, David F, Hunt ML, et al. Comparison of thoracic ultrasonography and radiography for the detection of induced small volume pneumothorax in the horse. Vet Radiol Ultrasound 2017;58(3): 354–60.

[81] Armenise A. Point-of-care lung ultrasound in small animal emergency and critical care medicine: a clinical review. Animals 2015;15:106.

[82] Candotti C, Arntfield R. Pericardial effusion. In: Soni NJ, Arntfield R, Kory P, editors. Point-of-Care ultrasound. Philadelphia: Elsevier; 2015. p. 130–4.

[83] DeFrancesco TD. Chapter 21: POCUS: heart-pericardial effusion and pericardiocentesis. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 417–24.

[84] Chou Y, Ward JL, Baron LZ, et al. Focused ultrasound of the caudal vena cava in dogs with cavitary effusions or congestive heart failure: a prospective observational study. PLoS One 2021;16(5):e0252544. https://doi.org/10.1371/journal.pone.0252544.

[85] DeFrancesco TD. Chapter 19: POCUS: heart-introduction and image acquisition. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 389–402.

[86] DeFrancesco TD. Chapter 20: POCUS: heart-abnormalities of valves, myocardium, and great vessels. In: Lisciandro GR, editor. Point-of-care ultrasound techniques for the small animal practitioner. 2nd Edition. Ames IA: Wiley Blackwell; 2021. p. 403–16.

[87] DeFrancesco TC, Ward JM. Focused canine cardiac ultrasound. Vet Clin North Am Small Anim Pract 2021; 51(6):1203–16.
[88] Visser LC, Wood JE, Johnson LR. Survival characteristics and prognostic importance of echocardiographic measurements of right heart size and function in dogs with pulmonary hypertension. J Vet Intern Med 2020;34:1379–88.
[89] Reinero C, Visser LC, Kellihan HB, et al. ACVIM Consensus statement guidelines for the diagnosis, classification, treatment, and monitoring of pulmonary hypertension in dogs. J Vet Intern Med 2020;34:549–73.
[90] Lyssens A, Lekane M, Gommeren K, et al. Focused cardiac ultrasound to detect pre-capillary pulmonary hypertension. Frontiers Vet Sci 2022;9:830275.
[91] Vientós-Plotts AI, Wiggen KE, Lisciandro GR, et al. The utility of point-of-care ultrasound non-echo right-sided cardiac markers as a screening test for moderate to severe pulmonary hypertension in dogs. Vet J 2019;250: 6–13.
[92] Lisciandro GR, Ward JL, DeFrancesco TC, et al. Absence of B-lines on lung ultrasound (Vet BLUE protocol) to rule out left-sided congestive heart failure in 368 cats and dogs. J Vet Emerg Crit Care 2016;26(S1):S8.
[93] Tchernodrinski S, Arntfield R. Inferior vena cava. In: Soni NJ, Arntfield R, Kory P, editors. Point-of-Care ultrasound. Philadelphia: Elsevier; 2015. p. 135–41.
[94] Baron LZ, DeFrancesco TD, Chou YY, et al. Echocardiographic caudal vena cava measurements in healthy cats and in cats with congestive heart failure and non-cardiac causes of cavitary effusions. J Vet Cardiol 2023;48:7–18.
[95] Lichtenstein DA. Current misconceptions in lung ultrasound. Chest 2019;156(1):21–5.
[96] Hori Y, Yamashita Y, Sakakibara K, et al. Usefulness of pericardial lung ultrasonography for the diagnosis of cardiogenic pulmonary edema in dogs. Am Jr Vet Res 2020;81(3):227–32.
[97] Lisciandro GR, Gambino JM, Lisciandro SC. Letter to the Editor "Pericardial lung ultrasonography for diagnosis of cardiogenic pulmonary edema". Am J Vet Research 2020;81(7):538–9.
[98] Ward JL, Murphy SD, Lisciandro GR, et al. Comparison of curvilinear-array (microconvex) and phased-array transducers for ultrasonography of the lungs in dogs. Am J Vet Res 2021;82(8):619–28.
[99] Lobaczewski A, Czopowicz M, Moroz A, et al. Lung ultrasound for imaging of B-lines in dogs and cats-a prospective study investigating agreement between three types of transducers and the accuracy of diagnosis of cardiogenic pulmonary edema, pneumonia and lung nodules. Animals 2021;11:3279.
[100] Murphy SD, Ward JL, Viall AK, et al. Utility of point-of-care lung ultrasound for monitoring cardiogenic pulmonary edema in dogs. J Vet Intern Med 2021;35(1): 68–77.
[101] Smith MJ, Hayward SA, Innes SM, et al. Point-of-care lung ultrasound in patients with COVID-19-a narrative review. Anesthesia 2020;75(8):109–1104.
[102] Dicker SA, Lisciandro GR, Newell SM, et al. Diagnosis of pulmonary contusions with point-of-care lung ultrasonography and thoracic radiography compared to thoracic computed tomography in dogs with motor vehicle trauma: 29 cases (2017-2018). J Vet Emerg Crit Care 2020;30(6):638–46.
[103] Lichtenstein DA, Meziere GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure - the BLUE Protocol. Chest 2008;134:117–25.
[104] Lichtenstein D, van Hooland S, Elbers P, et al. Ten good reasons to practice ultrasound in the critically ill. Anaesthesiol Intensive Ther 2014;46(5): 323–35.
[105] Lichtenstein DA, Meziere G, Seitz J. The dynamic air bronchogram. A lung ultrasound sign of alveolar consolidation ruling out atelectasis. Chest 2009;135(6): 1421–5.
[106] Shah A, Oliva C, Stem C, et al. Application of dynamic air bronchograms on lung ultrasound to diagnose pneumonia in undifferentiated respiratory distress. Respir Med Case Rep 2022;39:101706.
[107] Gambino J, Hiebert E, Johnson M, et al. Diagnosis of *Aelurostrongylus abstrusus* verminous pneumonia via sonography - guided fine-needle pulmonary parenchymal aspiration in a cat. J Fel Med Surg 2016;2(1): 2055116916646584.
[108] Volpicelli G, Mussa A, Garofalo G, et al. Bedside lung ultrasound in the assessment of alveolar-interstitial syndrome. Am J Emerg Med 2006;24:689–96.
[109] Ward JL, Lisciandro GR, DeFrancesco TD. Distribution of alveolar-interstitial syndrome in dogs and cats with respiratory distress assessed with lung ultrasound versus thoracic radiographs. J Vet Emerg Crit Care 2018;28(5):415–28.
[110] Vezzosi T, Mannucci T, Pistores A, et al. Assessment of lung ultrasound B-lines in dogs with different stages of chronic valvular heart disease. J Vet Intern Med 2017; 31(3):700–4.
[111] Rademacher N, Pariaut R, Pate J, et al. Transthoracic lung ultrasound in normal dogs and dogs with cardiogenic pulmonary edema: a pilot study. Vet Radiol Ultrasound 2014;55(4):447–52.
[112] Lichtenstein DA. Lung ultrasound (in the critically ill) superior to CT: the example of lung sliding. Korean J Crit Care Med 2017;32(1):1–8.
[113] Zietkiewicz M, Buda N, Wiesik-Szewczyk E, et al. Comparison of pulmonary lesions using lung ultrasound and high-resolution computed tomography in adult patients with primary humoral immunodeficiency. Front Immunol 2022;13:1031258.
[114] Colombi D, Petrini M, Maffi G, et al. Comparison of admission chest computed tomography and lung ultrasound performance for the diagnosis of COVID-19

pneumonia in populations with different disease prevalence. Euro J Radiol 2020;133:109344.
[115] Watanabe S, Yomono K, Yamamoto S, et al. Lung ultrasound in the assessment of interstitial lung disease in patients with connective tissue disease: performance in comparison with high resolution computed tomography. Mod Rheumatol 2024;35(1):79–87.
[116] Nazerian P, Volpicelli G, Vanni S, et al. Accuracy of lung ultrasound for the diagnosis of consolidations when compared to chest computed tomography. Crit Ultrasound J 2015;7(Suppl):A13.
[117] Fochi O, Bronoc A, Nacoti M, et al. Modified pediatric lung ultrasound score compared with computed tomography for assessment of lung aeration in children. Minerva Anestesiol 2021;87(6):675–83.
[118] Biancolin SE, Dos Santos Fernandes H, Sawamura MV, et al. Lung ultrasound versus chest computed tomography for pregnant inpatients with COVID-19. J Clin Ultrasound 2023;51(1):54–63.
[119] Cole L, Pivetta M, Humm K. Diagnostic accuracy of a lung ultrasound protocol (Vet BLUE) for detection of pleural fluid, pneumothorax, and lung pathology in dogs and cats. J Small Anima Pract 2021;62:178–86.
[120] Rigot M, Boysen SR, Masseau I, et al. Evaluation of B-lines with 2 point-of-care lung ultrasound protocols in cats with radiographically normal lungs. J Vet Emerg Crit Care 2024;1–10.
[121] Rodriguez F, Giraud L, Bolen G, et al. Comparison of lung ultrasound, chest radiographs, C-reactive protein, and clinical findings in dogs treated for aspiration pneumonia. J Vet Intern Med 2024;38(1):336–45.
[122] Lisciandro GR. Letter to the Editor "Comparison of lung ultrasound, chest radiographs, C-reactive protein, and clinical findings in dogs treated for aspiration pneumonia". J Vet Intern Med 2024;36(6):743–52.
[123] Granger KL, Guieu L, Boysen SR. Inter-rater agreement and characterization of pleural line and subpleural fields in canine lung ultrasound: a comparative pilot study between high contrast linear and curvilinear transducers using B-mode and M-mode ultrasonographic profiles. Ultrasound J 2025;17(1):3.
[124] Vidal P, Boysen SR, Fordellone J, et al. Retrospective evaluation of the agreement between thoracic point-of-care ultrasound and thoracic radiographs in cats with recent trauma. Front Vet Sci 2024;11:1376004.
[125] Oricco S, Medico D, Tommasi I, et al. Lung ultrasound score in dogs and cats: a reliability study. J Vet Intern Med 2024;38(1):336–45.
[126] Lichtenstein DA, Malbrain M. Critical care ultrasound in cardiac arrest. Technological requirements for performing the SESAME-protocol - a holistic approach. Anaesthesiol Intensive Ther 2015;47(5):471–81.