**TFAST® FOR PLEURAL AND PERICARDIAL EFFUSION**

Gregory R. Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC

Hill Country Veterinary Specialists & FASTVet.com, Spicewood, Texas USA

Email LearnGlobalFAST@gmail.com

Cell 210.260.5576

Website FASTVet.com

Text [Point-of-care Ultrasound Techniques for the Small Animal Practitioner, 2nd Edition](https://www.amazon.com/Point-Ultrasound-Techniques-Animal-Practitioner/dp/1119460980/ref%3Dsr_1_1?crid=2W3RO79YXBLKT&keywords=Lisciandro+ultrasound&qid=1674252243&sprefix=lisciandro+ultrasoun%2Caps%2C203&sr=8-1), Wiley ©2021

**What is TFAST®?**

FAST is an acronym that stands for Focused Assessment with Sonography for Trauma developed by trauma surgeons (yes trauma surgeons) in the 1990s and used in people as a screening test for the detection of free fluid in the abdominal and pleural cavity and pericardial sac. In 2004, the translational study from humans to dogs was published by Boysen and colleagues out of Tufts. The next year TFAST® was developed (and AFAST® with its fluid scoring system and target-organ approach) as part of the author's clinical research requirement for his emergency and critical care residency training focusing the publication on its use for pneumothorax (PTX). This was the first FAST protocol developed for the thorax in veterinary medicine, called TFAST®. In fact, the TFAST® protocol exceeded the human format called EFAST ("E" for "extended) by having the TFAST® bilaterally applied Pericardial Site views. These unique veterinary TFAST® Pericardial Site views were used for pleural and pericardial effusion, pleural space abnormalities, and fundamental echocardiography.

The EFAST protocol uses the subxiphoid view of human FAST protocols (our Diaphragmatico-Hepatic [DH] view of AFAST® and TFAST®) for pleural and pericardial effusion (PE, PCE) with add-on of anterior chest views for pneumothorax, and more recently long-axis and short-axis echocardiography evaluation. Both EFAST (protocol for people) and TFAST® use the least gravity dependent views for the detection of pneumothorax because free air in the pleural space rises; and the subxiphoid-DH view for pleural and pericardial effusion by taking advantage of the acoustic window of the liver and gallbladder without the air interference from lung at transthoracic views. Thus, TFAST® is best performed in standing or sternal patients taking advantage of the principle that "air rises" and "fluid falls" into gravity dependent regions called "pouches." TFAST® has the following views - the single DH view and the bilaterally applied Chest Tube Site (CTS) and the Pericardial Site (PCS) views. The mindset is to use TFAST**®** as "an extension of the physical exam." In other words, every day ultrasound for nearly every patient. A TFAST**®** with proper training and experience is a < 3-minute screening imaging test that is achievable for the non-imaging specialist with minimal ultrasound training.



**Figure 1.** TFAST® shown in a standing dog. CTS, Chest Tube Site view; PCS, Pericardial Site view; DH, Diaphragmatico-Hepatic view. *This material is reproduced with permission of John Wiley & Sons, Inc.,* [*Point-of-Care Ultrasound Techniques for the Small Animal Practitioner*](https://www.amazon.com/Point-Ultrasound-Techniques-Animal-Practitioner/dp/1119460980/ref%3Dsr_1_1?crid=2W3RO79YXBLKT&keywords=Lisciandro+ultrasound&qid=1674252243&sprefix=lisciandro+ultrasoun%2Caps%2C203&sr=8-1)*, 2nd Edition, Wiley ©2021 and Greg Lisciandro, Hill Country Veterinary Specialists, FASTVet.com.*

**Advantages of TFAST® and What It Can Do for You**

* TFAST**®** is rapid, radiation sparing, low impact (minimal restraint), and real-time information (no delay) at your patient's side especially when transport and patient status make radiography too risky. With proper training and minimal experience, a TFAST**®** exam should take < 3-minutes.
* \*TFAST**®** is arguably the gold standard test for pericardial effusion (PCE) and radiography has been shown in our peer-reviewed literature to be unreliable.
* \*TFAST**®** is an effective imaging modality for the detection of even small volume pleural effusion (PE) and may exceed that of radiography in some cases; however, PE is much different than PCE because PE is uncontained and unrestrained and can be compartmentalized into different regions within the pleural cavity.
* The TFAST**®** Diaphragmatico-Hepatic (DH) view not only rapidly screens for PE and PCE but also provides trans-diaphragmatic echocardiographic information and screens for lung, liver, and gallbladder abnormalities, ascites, and is used to characterize the caudal vena cava and hepatic veins for patient volume status.
* TFAST**®** fundamental echocardiography can screen for volume and contractility abnormalities, left- and right-sided cardiac problems, pulmonary artery and left ventricular outflow abnormalities, and cardiac associated masses.
* TFAST**®** can rapidly detect pneumothorax and by finding the "Lung Point", may be used to assess degree of pneumothorax (PTX) and be used as a tracking tool.

\*By following the TFAST**®** tenets for the accurate diagnosis of PCE and PE, mistaking heart chambers and normal cardiac anatomy for pathology are avoided.

**TFAST® and Its Use for Pleural and Pericardial Effusion**

There are fundamental tenets to accurately diagnose PCE that is contained and rounded within the pericardial sac and PE that is uncontained and unrestrained within the pleural cavity that are imperative for the non-cardiologist sonographer to learn, understand and follow. From experience, TFAST**®** data collection, and a clinical study published several years ago, we developed these FASTVetTM TFAST**®** tenets for the accurate diagnosis of pericardial and pleural effusion (PCE, PE):

1. Image the heart toward its muscular apex where chambers are difficult to confuse for PCE at the DH view, called the “Racetrack Sign”, and from the right PCS view, called the “Bull’s Eye Sign” (Figure 2 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)); and PE as anechoic (black) triangulations with wafting lung and the "curtain sign" of PE.
2. Image first caudally into the cardiac- diaphragmatic pouch and then cranially into the cardiac-cervical pouch away from heart chambers by using the “TFAST® Slide” for the “Curtain Sign” of PE (Figure 3 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).
3. Use only the long-axis 4-chamber view from the *right* Pericardial Site view, where all 4 chambers may be identified, and fluid clearly determined to be *outside* the heart and contained within the pericardial sac for PCE or outside the pericardial sac for PE (Figure 4 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).
4. Use only the short-axis Hammerhead view from the *left* Pericardial Site view, where both ventricles may be identified, and fluid clearly determined to be *outside* the heart and contained within the pericardial sac for PCE or outside the pericardial sac for PE (Figure 4 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)). Note: The Hammerhead view is the most ventral view with both ventricles from the *left* hemithorax.
5. Always image the heart in its entirety using the bright white (hyperechoic) pericardium as a landmark in the far field (Figure 5 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)). The author likes to say "never fight the bottom of the screen" when imaging.
6. Avoid using the *right* Pericardial Site *short-axis* views as a sole view for the diagnosis of both pleural and pericardial effusion because it is too easy to mistake the crescent-shaped right ventricle, and the pooching of the *left* auricle, for either PE or PCE (Figure 5 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).
7. If you can clearly identify all 4-chambers of the mammalian heart, and there is clearly fluid outside these 4 chambers, then default to PE if it is not clearly PCE because PCE is much easier to diagnose (Figure 4 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).

***Pitfalls***

The right ventricle (RV) on short-axis is probably the most important structure to pay respect. The RV is crescent-shaped and has echogenic papillary muscles with associated chordae tendinea along this scanning plane. Moreover, the RV can image quite variably by the non-cardiologist sonographer with the RV appearing falsely enlarged, and its normal anatomical structures such as its papillary muscles mistaken for masses, thrombi, fibrin, lung and its chordae tendinae for heartworms. Its crescent-shape mimics PCE and PE (Figure 5 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).

***Methods to Avoid Pitfalls***

* Respect the “Danger Zone” on right Pericardial Site short-axis and avoid diagnosing PCE and PE solely on this view. The axiom in human point-of-care ultrasound is “one view is no view.” In other words, other than the single diagnostic views of 1) the DH view and the "Racetrack Sign”, 2) the long-axis 4-chamber view, and 3) the Hammerhead view, you must see the abnormality on 2 different views.
* Memorize the FASTVetTM TFAST**®** Echocardiography Chart and double-check yourself at its short-axis levels by fanning a level ventral and a level dorsal to where you think you are located on the “cardiac (short-axis) ladder" (Figure 7 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).
* Primarily assess RV chamber size at the right Pericardial Site view on the long-axis 4-chamber view because the scanning plane is more reliable using the author’s FASTVetTM “white dot method” over right Pericardial Site short-axis views (Figure 6 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)).
* Learn to fan on the short-axis and long-axis lines using the author’s FASTVetTM clockface methodology to image the heart and learn its expected appearance (Figure 7 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)) most consistently.
* Keep the direction of the head (cranial) to the left and the tail (caudal) to the right of the screen like all other imaging. Note that this contrasts with traditional echocardiography in which the orientation was reversed for some odd reason. This will not only help you spatially orient yourself as to the anatomy, which is like a lateral radiograph, but also help you center the heart on the screen identical to how you would center any other structure, i.e., gallbladder, kidney, urinary bladder, etc.
* Everyone looks at the screen. This includes the sonographer, restrainer, and patient because it is safer in case the patient is showing aggression, turns to bite or scratch, or is decompensating. Also, the sightline to the screen should be comfortable for the sonographer (avoid looking over your shoulder) and allows for the sonographer to physically see the external location of the probe and its scanning plane.
* Part the hair with minimal alcohol and then apply alcohol-based hand sanitizer gel so that the probe's footprint is as directly opposed to skin as possible to avoid "air trapping" which reduces image quality.
* Use your non-probe hand on the standing patient’s sternum as your "V-trough" to stabilize the patient or knuckling the probe if under the patient to help reduce probe pressure on the intercostal spaces when patients are in lateral recumbency.
* Follow the FASTVetTM TFAST**®** tenets for the accurate diagnosis of PCE and PE and avoid the trap of “it just looks like PCE or PE” and potentially mistaking a heart chamber for PE or PCE.

**TFAST**® **and the Caudal Vena Cava**

*Volume Status*

Characterizing the caudal vena cava (CVC) in its longitudinal plane as it courses through the diaphragm and its associated hepatic veins estimates patient volume status by its respirophasic height change as follows: fluid responsive ("bounce"), a change of 35-50%; fluid intolerant ("FAT"), little change (<10%) and an increased maximum height; and fluid starved/hypovolemic ("flat"), little change (<10%) and a decreased maximum height (Figure 2). Hepatic venous distension, called the “Tree Trunk Sign”, is close to 100% specific for severely increased right-sided filling pressures in dogs and cats positioned in lateral, standing or sternal. In other words, the patient has right-sided congestive heart failure until proven otherwise. The "Tree Trunk Sign" plus a "FAT" CVC is easily recognized by properly trained non-radiologist sonographers.Absolute measurements of the maximum CVC height have also been created; however, dynamic CVC characterization, i.e., FAT, flat and bounce, as a rule trumps maximum height measurements unless there is a "Tree Trunk Sign" of hepatic venous distension (Table 2 [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/)). More recently the maximum height of the feline CVC has been evaluated. The rule for maximum heights in dogs, small dogs, and larger dogs should be no more than 0.5 cm, 1.0 cm, and 1.5 cm, respectively which is easy to remember (0.5-1.0-1.5 cm).



**Figure 2.** Characterization of the caudal vena (CVC) cava and hepatic veins. Shown is a "bounce" or fluid responsive CVC in A); a "FAT" and distended or fluid intolerant CVC in B); and "flat" or hypovolemic or fluid starved CVC in C). CVC, caudal vena cava; GB, gallbladder; HVD, hepatic venous distension ("Tree Trunk Sign"). *This material is reproduced with permission of John Wiley & Sons, Inc.,* [*Point-of-Care Ultrasound Techniques for the Small Animal Practitioner*](https://www.amazon.com/Point-Ultrasound-Techniques-Animal-Practitioner/dp/1119460980/ref%3Dsr_1_1?crid=2W3RO79YXBLKT&keywords=Lisciandro+ultrasound&qid=1674252243&sprefix=lisciandro+ultrasoun%2Caps%2C203&sr=8-1)*, 2nd Edition, Wiley ©2021 and Greg Lisciandro, Hill Country Veterinary Specialists, FASTVet.com.*

**Table 2.** Reference Values for the Maximum Height of the Caudal Vena Cava (CVC) Measured in Longitudinal at the Subxiphoida view in 126 Healthy Dogs grouped into \*3 Body Weight Classes.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size** | **Body weight (kg)** | **Expected CVC height measurement (cm) and range** |  | **Suggested CVC maximum height** **(cm)** for a **"flat" or hypovolemic, fluid-starved CVC** | **Suggested CVC maximum height (cm)** for a **"FAT" or fluid-intolerant CVC** (high central venous pressure) |
| Small/Toy | >9.0 | 0.55 (0.40-0.70) |  | <0.25 | >1.0 |
| Medium | >9–15kg | 0.85 (0.50-1.10) |  | <0.35 | >1.5 |
| Large/Giant | >15kg | 0.95 (0.80-1.20) |  | <0.50 | >1.5 |
| \*Data from the study by Darnis et al. (JVIM 2018) with their weight classes. Measurements listed created with permission by Lisciandro GR and Vientós-Plotts AI. These values are unproven but give some guidelines for veterinary clinicians to combine with the eyeball method – "Bounce", "FAT," and "flat."aThe subxiphoid view is analogous to the FAST DH view and the CVC imaged in its longitudinal plane.First published in Lisciandro GR. Cageside Ultrasonography in the Emergency Room and the Intensive Care Unit. *Vet Clin North Am* 2020;50(6):1445-1467. |

**TFAST**® **and Fundamental Echocardiography Views**

TFAST® echocardiography views are from the right PCS view and include the left ventricular (LV) short-axis “mushroom” view for volume status and contractility, the LV short-axis Mercedes Benz view for left atrial (LA) to aortic (Ao) assessment for left-sided problems (increased LA filling pressures), the long-axis 4-chamber view for right-sided problems (increased RV filling pressures), and the long-axis LV outflow tract (LVOT) and aortic valves (Figure 3). The "eyeball method" in properly trained non-cardiologists has been shown to be effective as a screening test in people. These views also serve as a screening test for cardiac-related soft tissue abnormalities because the radiographic cardiac silhouette is unreliable. Importantly, when the sonographer is unable to obtain its echocardiography views, the absence of "Wet Lung" during Vet BLUE® rules out clinically relevant left-sided *congestive* heart failure; and absence of a "FAT" or fluid intolerant CVC rules out clinically relevant right-sided *congestive* heart failure.These Global FAST® Non-echo "Fallback" Views allow an approach that often is easier (and faster) than echocardiography in the unstable patient.

******

**Figure 3.** Global FAST® Fallback Views to help better interpret TFAST® echocardiography findings or when echocardiography is not possible at that point in time. *This material is reproduced with permission of John Wiley & Sons, Inc., Point-of-Care Ultrasound Techniques for the Small Animal Practitioner, 2nd Edition, Wiley ©2021 and Greg Lisciandro, Hill Country Veterinary Specialists, FASTVet.com.*

***Recognizing Cardiac Abnormalities***

The radiographic cardiac silhouette is an unreliable screening test for many cardiac-related conditions that are likely under reported regarding prevalence because historically pre-TFAST® without complete echocardiography (or computed tomography), the condition would be missed. These conditions include intra- and extra-cardiac masses, intracardiac thrombi and echogenic smoke, dilated cardiomyopathy, pulmonary hypertension, and intracardiac heartworms and caval syndrome, all of which can be suspected/detected and directly seen using the TFAST® approach. The caveat is that TFAST® serves as a screening test, and that artifacts and cardiac anatomy can mimic pathology, and that not finding these conditions does not definitively rule them out because more advanced imaging is necessary. However, there is tremendous value in using the TFAST® approach over, or in combination with, physical examination and radiography, then considering the patient’s clinical profile for interpretation of findings.

**Final Comments**

TFAST® is low impact, cost effective, real-time information, rapid, radiation-sparing, point-of-care imaging that allows the veterinarian to “see” their problem list and thus better direct resuscitation, treatment, and streamline the diagnostic plan. TFAST® should be considered a screening test used for detecting obvious abnormal; however, its use has clear advantages in the acute triage setting and during patient rounds and rechecks over physical examination, laboratory test results, and radiography for many conditions. Global FAST® and its 15-views provide an unbiased set of data imaging points that prevent the common imaging mistakes of “satisfaction of search” and “confirmation bias” errors through TFAST® alone or selective POCUS imaging. Global FAST® should be used as an "extension of the physical exam" daily for nearly all patients in the clinical setting and preempt add-on POCUS examinations. How to Perform Global FAST® Efficiently may be seen in a webinar short [here](https://fastvet.com/global-fast-blend-how-to-do-global-fast-in-standing-and-most-efficiently/).

**TFAST® and Recording Findings on Goal-directed Templates**

Goal-directed templates (GDTs) for recording your findings are a must for success. GDTs keep you disciplined and on task. TFAST® is performed the same order every time just like a cardiologist and a radiologist perform their ultrasound examinations the same way every time. GDTs also give you value for comparison to future exams for you and for your colleagues and show your TFAST® objectives. Examples of GDTs may be found at our website FASTVet.com on our Free Resources page and by clicking [here](https://fastvet.com/most-updated-global-fast-goal-directed-templates/).

**References & Further Reading**

1. **Figures** and **Tables** for these **TFAST®** **Proceedings** are [here](https://fastvet.com/fastvet-table-for-the-accurate-diagnosis-of-pericardial-and-pleural-effusion/).
2. **FASTVetTM** Free Resources [here](https://fastvet.com/category/free-resources/); Goal-directed Templates [here](https://fastvet.com/most-updated-global-fast-goal-directed-templates/); Webinars [here](https://fastvet.com/category/archived-webinars/); Global FAST® Training [here](https://fastvet.com/learn-in-person/); Video How to Perform Global FAST® Efficiently [here](https://fastvet.com/global-fast-blend-how-to-do-global-fast-in-standing-and-most-efficiently/); Anaphylactic Hemoabdomen Webinar in Dogs [here](https://fastvet.com/fastvet-monthly-webinar-july-2022-updated-information-on-medically-treated-canine-anaphylactic-hemoabdomen-presented-at-the-acvim-forum-2022/); other Free Resources [here](https://fastvet.com/category/free-resources/).
3. Point-of-care Ultrasound Techniques for the Small Animal Practitioner, 2nd edition, Ed. Lisciandro GR, Wiley ©2021. Click [here](https://www.amazon.com/Point-Ultrasound-Techniques-Animal-Practitioner/dp/1119460980/ref%3Dsr_1_1?crid=2W3RO79YXBLKT&keywords=Lisciandro+ultrasound&qid=1674252243&sprefix=lisciandro+ultrasoun%2Caps%2C203&sr=8-1).
4. **Lisciandro GR**. Focused abdominal (AFAST) and thoracic (TFAST) focused assessment with sonography for trauma, triage and monitoring in small animals. *J Vet Emerg Crit Care* 2011;20(2):104-122.
5. **Lisciandro GR**. Lisciandro GR. The use of the diaphragmatico-hepatic (DH) view of the abdominal and thoracic focused ultrasound techniques 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.
6. 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.
7. **Lisciandro GR**. Chapter 17: POCUS: TFAST-Introduction and Image Acquisition. *In* Point-of-care Ultrasound Techniques for the Small Animal Practitioner, 2nd Edition, Ed. Lisciandro GR. Wiley Blackwell: Ames IA 2021.
8. **Lisciandro GR**. Chapter 18: POCUS: TFAST-Clinical Integration, Point-of-care Ultrasound Techniques for the Small Animal Practitioner, 2nd Edition, Wiley-Blackwell: St. Louis, ©2021.
9. **Lisciandro GR.** Cageside Ultrasonography in the Emergency Room and Intensive Care Unit. *Vet Clin North Am Small Anim Pract* 2020;50(6):1445-1467.
10. **Lisciandro GR**. Chapter 3: Point-of-Care Ultrasound. *In* Small Animal Diagnostic Ultrasound, 4th Edition, Eds. Mattoon JS, Sellon R, Berry CR. Elsevier: St. Louis MO, 2021.
11. Chou Y, Ward JL, Baron LZ, Murphy SD, Topf MA, **Lisciandro GR**, 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. doi:10.1371/journal.pone.0252544
12. **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):1342-1346.
13. Lisciandro GR. TFAST Accurate Diagnosis of Pleural and Pericardial Effusion in Dogs and Cats. *Vet Clin North Am Small Anim Pract* 2021; 51(6):1169-1182.
14. Darnis E, Boysen S, Merville A, et al. Establishment of reference values of the caudal vena cava by fast ultrasonography through different views in healthy dogs. *J Vet Intern Med* 2018;32(4):1308-1318.

\*A summary of all our 20+ peer-reviewed clinical studies may be found [here](https://fastvet.com/publications-references-validating-fastvet-techniques/).