Global FAST℠: AFAST®, TFAST®, and Vet BLUE® for Patient Monitoring

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INTRODUCTION

The evolution of veterinary abbreviated ultrasound formats has extended beyond the abdominal format as a simple "flash exam" of fluid positive or fluid negative since the landmark publication by Boysen *et al*. in 2004. In 2008, the thoracic FAST format was developed by Lisciandro *et al*. and referred to as TFAST for the rapid diagnosis of pneumothorax and other thorax-related injury. In 2009, the abdominal FAST referred to as AFAST was a modification from the original FAST study. AFAST renamed the views with a target-organ approach rather than naming of external sites so that sonographer would be more aware anatomically about the actual organs and structures at each of the AFAST views; and AFAST directed the probe more strategically into the gravity-dependent regions of each view; and AFAST has its applied fluid scoring system to make more sense of a positive scan; and the same study advocated for 4-hour serial exams with repeat scoring for all hospitalized patients. In 2014, a 3rd abbreviated lung ultrasound format was published by Lisciandro *et al*. named Vet BLUE to complement AFAST and TFAST. In combination, these 3 formats are called Global FAST. Global FAST provides a huge amount of clinical information (<6–8 minutes) regarding your patient by taking advantage of basic echo views of the heart, and non-echo views that reflect left- and right-sided cardiac status; and determining if your patient is losing volume internally because the abdominal cavity, retroperitoneal space, pleural cavity, pericardial sac, and lung are also surveyed for free fluid and edema, respectively; and urinary bladder volume may be estimated and serial exams using our AFAST cysto-colic formula can non-invasively estimate urine output. A similar strategy has evolved referred to as the **r**apid **u**ltrasound in **sh**ock exam (RUSh) in emergent patients, although the RUSh exam does not have a fluid scoring system, lacks a lung screening component other than ruling in or out pneumothorax, and does not evaluate urinary bladder volume. Most recently, the analogous global approach as a screening test is gaining some momentum on the human side because focused exams are dangerous, and traditional complete abdominal ultrasound and complete echocardiography are often not in the right cavity. We advocate for a baseline Global FAST recorded on goal-directed templates for all admitted patients prior to intervention; and with proper training Global FAST takes <6–8 minutes with no shaving, minimal restraint.

GLOBAL FAST FOR PATIENT MONITORING

The Abdominal Fluid Scoring System

Small animals are placed in preferably right lateral recumbency because it facilitates the right TFAST pericardial views for TFAST basic echo views; however, either lateral recumbency is validated for the AFAST abdominal fluid scoring system. The abdominal fluid score (AFS) of 1 is given to any positive AFAST views so the scoring system ranges from 0–4. The use of the abdominal fluid scoring system gives more value to effusions over mild, moderate and severe, and allows for better tracking of resolution or worsening or effusions. In cases of hemorrhage, the fluid scoring system helps categorize intra-abdominal bleeding as small volume bleeding, AFS 1 and 2, and large volume bleeding, AFS 3 and 4. Small volume AFS 1 and 2 dogs and cats do not have enough intra-abdominal hemorrhage for anemia, so if they are or become anemic then pre-existing anemia existed or they are losing blood somewhere else (i.e., retroperitoneal, pleural, pericardial, lung, intrapelvic, fracture sites, gastro-intestinal tract, or externally, respectively). On the other hand, large volume bleeders of AFS 3 and 4, considered life-threatening, have enough intra-abdominal hemorrhage to become anemic and many require blood transfusions dependent on the subset of patient and the degree of fluid resuscitation. The use of the AFAST-applied AFS is also a monitoring tool for all at-risk for bleeding, post-interventional cases, including those with percutaneous needle and Tru-cut biopsies. Patient AFS helps better

make decisions regarding ongoing bleeding, resolving bleeding, and need for blood transfusion and/or exploratory laparotomy.

TFAST Right Pericardial Echo Views

Left Ventricular Short-Axis View for Volume and Contractility

The left ventricular short-axis view (LVSA) is acquired just below the mitral valves at the level where the chordae tendinae come off the left papillary muscles referred to as the LV short-axis "mushroom" view. The filling and size of the "mushroom" is a reflection of patient volume status as long as the sonographer is aware of how to locate the proper level on short-axis. Contractility is also assessed subjectively using the eyeball approach. It does not take a whole lot of training to be able to screen for poor filling and poor contractility. Poor filling indicating poor volume can be supported or refuted by assessing the caudal vena cava; and contractility by triggering a complete echocardiography. In the meantime though, a patient thought to have poor contractility (i.e., dilated cardiomyopathy) may be treated and better stabilized during the delay of acquiring complete echocardiography.

Long-Axis 4-Chamber View for the Right Ventricular to Left Ventricular Ratio (RV:LV)

The normal RV:LV ratio is 1:3–4 with the RV being a small triangle when compared to the LV. When the RV is nearly the same size of the LV then right heart problems and pulmonary hypertension should be suspected, and complete echocardiography is indicated until proven otherwise. However, by recognizing the abnormality, patient therapy may be adjusted to better head off complications. In an acutely respiratory distressed cat or dog that develops acute RV dilation, massive PTE has likely occurred. Your non-echo fallback view for right-sided heart problems is the caudal vena cava at the FAST DH View (see below).

Left Ventricular Short-Axis View for the Left Atrial to Aortic Ratio (LA:Ao)

The normal LA:Ao ratio is <1.3 in dogs and <1.6 in cats. This is the most challenging view to obtain. Your non-echo fallback strategy is performing the easier, less stressful, Vet BLUE lung exam. Absent B-lines in all views (ABAV) is an effective means to rapidly rule out left-sided congestive heart failure (see below).

Figure 1

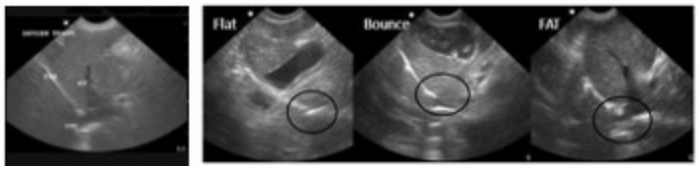
The Non-Echo Fallback Views for Left- and Right-Sided Cardiac Problems

Characterizing the Caudal Vena Cava and Hepatic Veins

The caudal vena cava (CVC) where it traverses the diaphragm rapidly reflects preload and is your new non-invasive central venous pressure (CVP). In fact, central lines have been debunked in human medicine since 2013; and it is common practice to use the analogous view of the inferior vena cava (IVC). We simply eyeball

and characterize the CVC as being 1) FAT or distended with <10% change in diameter (high CVP), or 2) flat (collapsed with <10% change in diameter, low CVP), or 3) having a bounce (~50% change in diameter, in the ballpark of normal). The normal "bounce" reflects the dynamic changes in CVC diameter during inspiration and expiration as blood is drawn/squeezed into the heart in spontaneously ventilating dogs and cats. Measuring the CVC using M-mode can be challenging and difficult with a lot of patient movement. However, by visually characterizing the CVC at the FAST DH view, called the "eyeball approach," and correlating with clinical impression and other findings (blood pressure, physical exam findings, blood lactate), the clinician has a much better idea of patient preload (CVP) and right-sided cardiac status. Moreover, if the sonographer wants a numeric value, then imaging the CVC in B-mode and freezing and rolling the cine ball to get minimal and maximal diameter is another approach. These measurements can then be used to calculate its distensibility index. Because of the great differences in sizes in dogs absolute measurements are less likely to be as reliable. The hepatic veins are not normally seen in lateral or sternal/standing, so their distension is another clue that CVP is high.

Figure 2

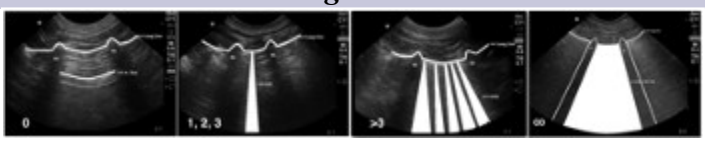


Far left image shows the classic FAT or distended CVC as it traverses the diaphragm with associated hepatic venous distension likened to tree trunks and branching referred to as the "Tree Trunk Sign." The 3 images labeled FAT, Bounce, and Flat represent a high CVP, a ballpark normal CVP, and a low CVP, respectively. This material is reproduced with permission of John Wiley & Sons, Inc, Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley © 2014.

Use of Vet BLUE - "Wet Lung" vs. "Dry Lung"

Because the "wet lung" vs. "dry lung" concept is easily recognized during Vet BLUE, the presence or absence of ultrasound lung rockets (ULRs), also called B-lines, provides important clinical information regarding left-sided cardiac status and left-sided volume overload. Moreover, Volpicelli *et al*. showed that numbers of ULRs correlate with the degree of alveolar-interstitial edema when compared to CT; and Vet BLUE requires minimal patient restraint, is rapid (<60–90 seconds), safe and point-of-care. Thus, acquire a baseline Vet BLUE prior to fluid therapy on all hospitalized dogs and cats. ULRs have been shown to correlate with extravascular lung water, and thus are sentinels for worsening respiratory status and pulmonary failure. If treatment strategy is not adjusted, then alveolar-interstitial edema may progress to alveolar flooding, which is much more difficult to treat. Using the regionally-based Vet BLUE patterned approach, other causes of wet lung artifacts, such as pneumonia, can often be discriminated. Moreover, the use of Vet BLUE potentially triggers additional testing and imaging.

Figure 3



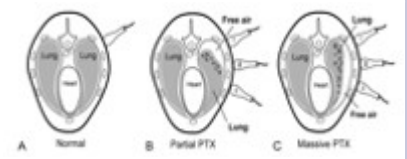
Showing the counting scheme published by the author for counting ULRs as 1, 2, 3 or >3 and infinity ∞.

The Urinary Bladder Volume Formula

At the AFAST cysto-colic view the urinary bladder is imaged in longitudinal (sagittal) and the best oval is acquired in this plane and measured followed by transverse orientation and acquiring the largest oval and measured. Measurements in cm will give you an estimation of urinary bladder volume in ml by using Length x Width x Height x 0.625. With measurements over time, urine output can be non-invasively estimated.

Use of the Lung Point for Monitoring Pneumothorax (PTX)

Figure 4



The use of the lung point, the transition zone of where there is pneumothorax (PTX) and lung re-contacting the thoracic wall, is a means to increase the sensitivity for the diagnosis of PTX and to track worsening, or resolving, PTX. Post lung lobe aspirate, chest tube placement/removal, or other invasive thoracic procedures, the lung point qualifies the PTX, point-of-care with minimal patient restraint and stress, as follows: 1) upper 1/3 of the thorax, trivial or 2) middle 1/3 of thorax moderate and concerning warranting thoracocentesis or 3) lower 1/3 of thorax as severe/massive warranting thoracocentesis (author's experience). Clinical judgment is required to maximize decision-making.

Baseline Admission Global FAST and Serial Exams are Key

The repeating of Global FAST exams, serial exams, cannot be overemphasized. Minimally a 4-hour post-admission Global FAST exam should be performed in all admitted patients; and the author incorporates Global FAST as part of daily rounds immediately after a complete physical exam.

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SPEAKER INFORMATION

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