Abdominal FAST (AFAST®) and Its Fluid Scoring System for Trauma, Triage, and Tracking - Parts I and II

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INTRODUCTION

The clinical utility of AFAST and the applied fluid scoring system for trauma, triage (nontrauma) and tracking (monitoring) cases in the emergent and critical care settings will be reviewed. The T^3 designation encompasses these 3 subsets and avoids the onslaught of confusing acronyms in human medicine in which similar abbreviated formats are given different acronyms when applied to different subsets of human patients. Thus, $AFAST^3$ becomes a universal term that has exact clarity of the 4-acoustic windows used by the veterinary sonographer.

The $AFAST^3$ ultrasound format has greater potential to positively guide clinical course and improve patient outcome by detecting conditions and complications otherwise occult based on traditional means of physical examination, laboratory and radiographic findings, and avoiding the delay associated with more advanced imaging (jeopardizing patient care). Finally, $AFAST^3$ findings are made more clinically relevant for the clinician, client, and referring veterinarian by using a standardized ultrasound format ($AFAST^3$), and standardized goal-directed templates for medical records (see below). The mindset for those using $AFAST^3$ is one of a ruling out test for the presence or absence of free fluid, and a ruling in of target-organ pathology; and that $AFAST^3$ is a means to better survey veterinary patients, keeping them alive for gold standard testing; and that $AFAST^3$ helps better decision-making regarding medical vs. surgical cases. Finally, the Global FAST approach, AFAST, TFAST and Vet BLUE combined as a single exam, better ensures that more traditional complete studies are ordered for the correct cavity.

TERMINOLOGY

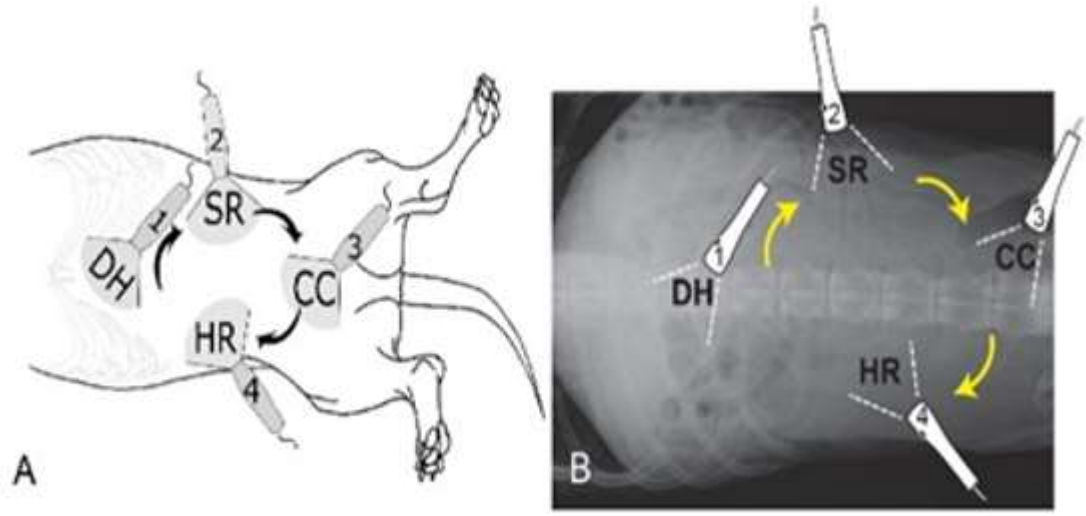
In the human literature, there has been a confusing onslaught of multiple acronyms for similar ultrasound examinations by non-radiologists. Veterinarians would be best served by using $AFAST^3$, $TFAST^3$ (thoracic) and Vet BLUE (lung exam). When all 3 formats are used together the exam is referred to a Global FAST. Because Global FAST and any of the three AFAST, TFAST and Vet BLUE ultrasound formats may be diagnostic, the author suggests that comprehensive exams of the abdomen and thorax be designated as "complete or formal abdominal ultrasound" and "complete or formal echocardiography" respectively, similar to the human literature. Finally, terms such as "focused" and "targeted" and "$COAST^3$" have been used for specific sonographic interrogation of organs in both human and veterinary medicine. However, focused organ exams and traditional complete exams may not be ordered for the correct system or cavity, thus we strongly advocate for Global FAST as a first-line screening soft tissue and free fluid exam to better pick the next best test and avoid missing potentially serious conditions.

PATIENT POSITIONING AND PREPARATION

Right lateral recumbency is recommended because right lateral recumbency is the standard positioning for electrocardiographic and echocardiography evaluation; the left kidney at the SR view is more easily and reliably imaged (vs. the more cranially located right kidney often under the rib cage); and the gallbladder via the DH view is readily imaged by directing the probe slightly toward the table top. Lastly, the spleen located predominantly left of midline is arguably less apt to incur iatrogenic puncture via abdominocentesis. $AFAST^3$ should not be performed in dorsal recumbency because it not only invalidates the fluid scoring system, but also

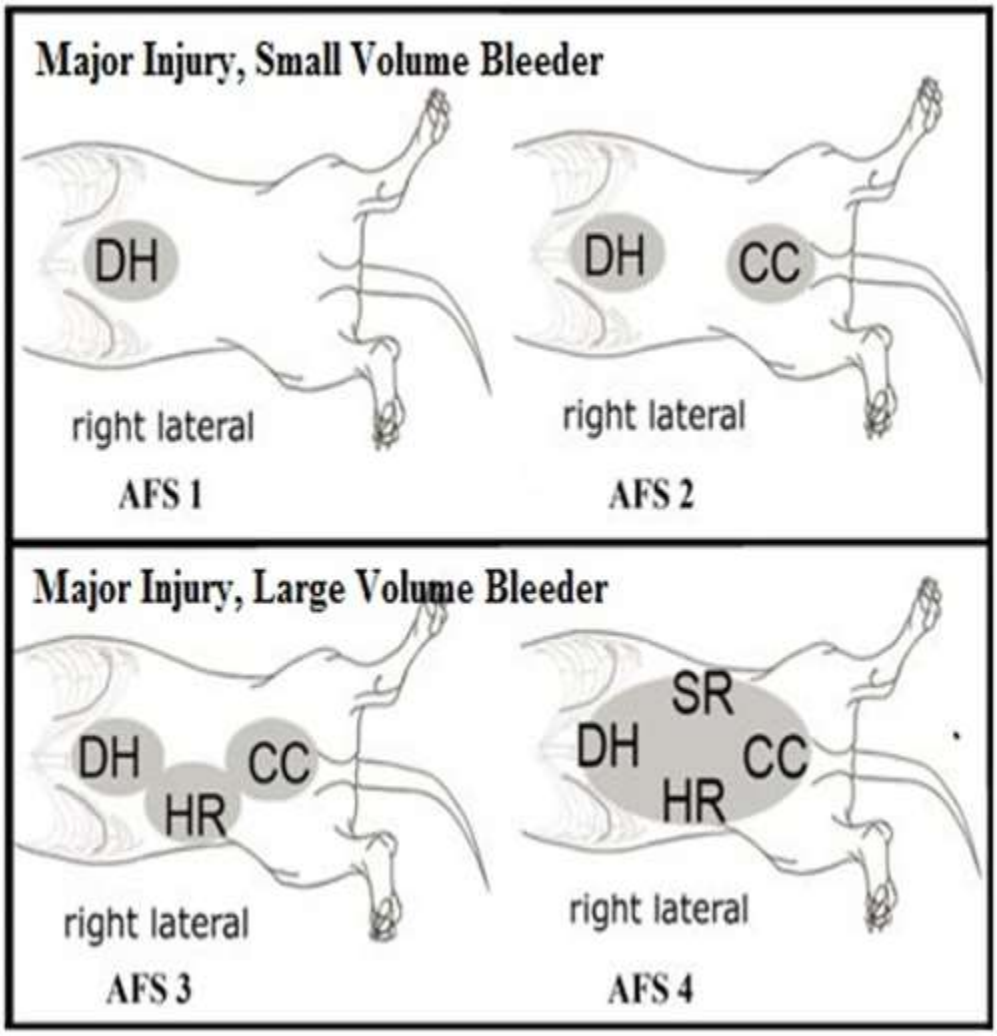
jeopardizes injured and critically ill patients by compromising their respiratory status and venous return. In respiratory compromised patients, TFAST[3] and Vet BLUE are performed in sternal or standing prior to AFAST and a cursory or delayed AFAST is then performed. The AFAST[3] target-organs may still be imaged in standing or sternal; however, the abdominal fluid scoring system will not be valid. Fur is **not** shaved but rather parted and alcohol and/or gel applied. Alcohol should not be used if electrical defibrillation is anticipated.

THE AFAST EXAM



The AFAST[3] sites are shown in right lateral recumbency. To the right of the pictorial labeled A) is a translational depiction on an abdominal radiograph of a dog. The AFAST[3] should always be performed in a standardized counter-clockwise manner as follows: 1) Diaphragmatic-hepatic (DH) view also used to image the pleural and pericardial spaces; 2) Spleno-renal (SR) view also used as a window into the retroperitoneal space; 3) Cysto-colic (CC) view; and 4) Hepato-renal (HR) umbilical view which completes the AFAST[3] exam. The HR umbilical view in higher-scoring dogs and cats is often a favorable site for abdominocentesis. All AFAST[3] views are performed in the longitudinal (sagittal) orientation because it is easier to appreciate the anatomy of the respective target-organs and less confusing especially for the novice sonographer. Importantly, Boysen *et al*. showed that when comparing longitudinal (sagittal) to transverse views, they matched 397/400 times. Thus, keeping it simple with fanning through only longitudinal expedites the learning process.

AFAST-Applied Fluid Scoring System



The AFAST[3]-applied fluid scoring system is defined as follows (4-point scale): abdominal fluid score (AFS) of 0 (AFS 0) means negative at all 4 views to a maximum score of AFS 4 means positive at all 4 views. Low-scoring AFS1 and 2 are considered major injury, small volume bleeders. High-scoring AFS 3 and 4 are considered major injury, large volume bleeders. Reproduced with permission. Lisciandro, *et al. JVECC* 2009;19(5):426–437. *JVECC* 2011;20(2):104–122.

Use of Serial AFAST and Determining the AFS

The use of serial AFAST[3] and serial application of the abdominal fluid score is imperative to maximize information and improve sensitivity of the exam including searching for fluid, assessing the abdominal fluid score (0–4), and evaluating the presence or absence of the urinary bladder. The author performs 4-hour post-admission serial AFAST and AFS in all stable patients (sooner if unstable); and serial FAST exams are standard of care in human medicine since 2001 by the American College of Emergency Physicians Guidelines.

Traumatic Hemoabdomen

The clinical utility of the AFAST[3]-applied fluid scoring system as predictor of anticipated degree of anemia and need for blood transfusion was shown in dogs with traumatic hemoabdomen (Lisciandro *et al*., *JVECC* 2009).

Dogs with negative fluid scores (AFS 0), and as low-scorers (AFS 1 and AFS 2) that had no other sources of blood loss apparent on physical exam and AFAST[3] and TFAST[3] imaging (no free fluid in retroperitoneal, pleural and pericardial spaces), predictably did not develop anemia. For example, in dogs with normal admission packed cell volume, low-scoring AFS 1 and 2 dogs that remained AFS 1 and 2 during their hospitalization, rarely became anemic from their intra-abdominal hemorrhage; and if anemia did occur it was mild >30%. Therefore, a general guideline used by the author is that if the PCV <30% in an AFS 1 or 2 dog or cat, the attending should look elsewhere for the source of bleeding (i.e., retroperitoneal and pleural spaces, fracture sites) and only then consider the possibility of hemodilution. Although not determined in the AFAST[3] study, clinicians should keep in mind that AFAST[3] does not interrogate the intra-pelvic region effectively and that significant bleeding in dogs and cats through pelvic fractures and femoral fractures is possible, which could lead to anemia and be missed by AFAST[3] and TFAST[3].

On the other hand, high-scoring AFS 3 and 4 dogs are more likely to develop anemia and predictably an ~25% decrease in PCV from baseline admission PCV; and with ~25% of these high-scoring dogs becoming severely anemic defined as a PCV <25% requiring blood transfusion in the manner the author fluid resuscitates. Bluntly traumatized dogs uncommonly require emergent laparotomy and should be treated initially with titrated fluid therapy to conservative endpoints and blood transfusion(s).

In summary, the AFAST-applied fluid scoring system is simple and easy to remember and provides a semi-quantification of the degree of hemorrhage; and analogous hemorrhage scoring systems have been shown to also helpful in clinical decision-making regarding blood transfusion and need for surgery or advanced imaging in human patients. To reiterate, bluntly traumatized dogs (i.e., hit-by-car, kicked, stepped on, falls from rooftops) uncommonly require emergent laparotomy to control their hemorrhage and often are successfully managed with judicious fluid therapy and blood transfusion(s). Cats as a species typically do not survive large volume bleeds; and thus trauma-related large-volume effusions in felines are more likely to be due to uroabdomen. Moreover, by using the abdominal fluid score and recording locations of positive sites, not only is the volume semi-quantified but the source is potentially localized.

NONTRAUMATIC HEMOABDOMEN AND POST-INTERVENTIONAL BLEEDING

The same concept may be applied to nontraumatic hemoabdomen (i.e., bleeding tumor and coagulopathic cases) and to at-risk post-interventional cases (i.e., post-surgical, percutaneous biopsy/aspirate, laparoscopy, interventional radiology, etc.). The abdominal fluid scoring system applied in serial manner allows for the detection of ongoing (increasing scores), static, and resolving hemorrhage (decreasing scores). Whereas bluntly traumatized dogs and cats rarely need surgical intervention, post-interventional large volume bleeding (AFS 3 and 4) **commonly** requires exploratory laparotomy and surgical ligation of the bleeding source.

Summary* of abdominal fluid score (AFS 1, 2 [small volume] vs. AFS 3, 4 [large volume]) and medical vs. surgical decision-making in bleeding dogs
****Same concepts may be applied to cats***

Type of trauma	Major injury, small volume bleeder (AFS 1,2)	Major injury, large volume bleeder (AFS 3,4)
Blunt trauma - Think medical 1st *Blood rapidly defibrinates thus is seen acutely as anechoic black triangles.	- If stays AFS 1,2 no blood transfusion necessary if only bleeding intra-abdominally because do **not** expect anemia (PCV>35%) if only bleeding intra-abdominally - If stays AFS 1,2 and anemic <30% rule out another site of bleeding (retro-peritoneal, pleural cavity, fracture site, externally)	- If is an AFS 3,4 or becomes AFS 3,4 then expect anemia (<35%) to develop and use graduated fluid therapy (1/3 shock dose and repeat as fluid challenge needed) - If becomes severely anemic <25% generally need a blood transfusion **first** because most bleeding will stop with 1 or 2 rounds of blood transfusion +/- fresh frozen plasma; and rarely need exploratory surgery
Penetrating trauma - Think surgical for **any** positive AFS *Blood from ripping, tearing, crushing, is often clotted and thus often missed acutely during AFAST because clotted blood looks like adjacent soft tissue; however, in time blood clots will defibrinate and become visible during AFAST, thus serial exams are key in cases unsure if medical vs. surgical. *Generally best to err that is surgical with **any** positive	- Think surgical for any positive - Combine with other clinical findings and surgical indications (hernia, free air, septic abdomen, refractory pain, etc.) - Serial exams are key! - Sample fluid when accessible!	- Think surgical even for any positive - Combine with other clinical findings and surgical indications (hernia, free air, septic abdomen, refractory pain, etc.) - Serial exams are key! - Sample fluid when accessible!
Post-interventional trauma - think medical for AFS 1,2 and surgical for AFS 3,4 *Large volume bleeding (AFS 3,4) is generally not going to stop without surgical ligation of the bleeding. *Correct coagulopathy if present	- If stays AFS 1,2 on serial exams, then generally **not** surgical - Do serial exams to make sure does not change score and become a large volume bleeder (AFS 3,4) - Sample fluid when accessible!	- If is an AFS 3,4 and not anemic, then generally it is still best to explore emergently and **not** wait (if you wait you will likely have to transfuse your patient with its added extra cost and risk) - If is an AFS 3,4 and already anemic, transfuse as per patient assessment and explore emergently! - Sample fluid when accessible!

OTHER ABDOMINAL EFFUSIONS

The use of the AFAST-abdominal fluid scoring system also provides a means to detect and monitor response to therapy of other nonhemorrhagic effusive conditions including, for example, transudates (liver/GI disease), modified-transudates (right-sided heart failure, liver disease, splenic disease) and exudates (peritonitis). The use of the AFAST-applied abdominal fluid scoring system also is helpful for the surveillance of postoperative patients at risk for hemorrhage and peritonitis since ultrasound is superior in sensitivity to physical examination and abdominal radiography.

HIGHLIGHTS OF THE AFAST VIEWS

The Diaphragmatico-hepatic (DH) view is loaded with information that is readily appreciated during the minutes it takes to perform the AFAST[3]. The highlights of the DH view are as follows: 1) The DH view is nicknamed the "designated hitter" because it is part of **both** the abdominal FAST (AFAST[3]) and thoracic FAST (TFAST[3]) formats; 2) The DH view is used for the rapid and confirmatory sonographic diagnosis of pleural and pericardial effusion (racetrack sign); 3) Patient volume status can be appreciated by observing the dynamics during respiratory cycles of the caudal vena cava (CVC) as it passes through the diaphragm (FAT, flat or bounce) for evidence of right-sided volume overload and right cardiac insufficiency/failure; along with hepatic venous distension (tree trunk sign). A FAT CVC is defined as marked distension and having less than 10% change in its diameter during respiratory cycles. Concurrently, there should be easily appreciated hepatic venous congestion referred to as the "tree trunk sign" by the author. The FAT CVC represents a high central venous pressure (>10 cm water) in humans. Conversely, a flat CVC is defined as being markedly attenuated with little change in its diameter thus representing a low central venous pressure due to hypovolemia. A CVC with a bounce is somewhere in the ballpark of a normal central venous pressure. If clinically the patient needs a fluid challenge, it should be performed; however, the endpoint of fluid resuscitation is a FAT CVC. If the patient remains hypotensive with a FAT CVC, then vasopressors are logically the next step for resuscitation (see Global FAST for more detail); 4) The gallbladder should be immediately against the diaphragm when starting the DH view in most dogs. When the sonographer is unable to get this orientation, then liver enlargement should be suspected and when the gallbladder cannot be located then its displacement (hernia) or its rupture or sonographically obscuring pathology (calculi/mineralization, emphysema) should be suspected. In cats, this orientation is less reliable but should be attempted; 5) The "gallbladder halo sign" representing gallbladder wall edema can be supportive evidence for canine anaphylaxis; however, there are several causes of gallbladder wall edema including right-sided heart failure/dilated cardiomyopathy, pericardial effusion/tamponade (Lisciandro, unpublished), right-sided volume overload, 3rd spacing/hypoalbuminemia, primary gallbladder disease, and pancreatitis; 6) Liver masses can often be appreciated.

Causes of gallbladder wall edema (the gallbladder halo sign)

Canine anaphylaxis (acute collapse, flat caudal vena cava) - massive histamine release results in hepatic venous congestion
Right-sided heart failure/dysfunction (collapse, weakness, FAT caudal vena cava) - backflow of blood flow from the right heart results in hepatic venous congestion
Pericardial effusion (acute collapse, weakness, FAT caudal vena cava) - obstruction of blood flow to the right heart results in hepatic venous congestion
Cholecystitis
Pancreatitis
Hypoalbuminemia, 3rd spacing
Right-sided volume fluid overload (iatrogenic)
Immune-mediated hemolytic anemia (IMHA), unknown cause, speculate immune-mediated
Post-blood transfusion, unknown pathogenesis, speculate both immune-mediated and volume overload

The Spleno-renal (SR) view is unique since it interrogates both the abdominal cavity and retroperitoneal space. The left kidney is longitudinally fanned until it is lost in both directions. Linear stripes are generally not free fluid but rather small intestine or the great vessels. The transverse colon banks to become the descending colon at the SR view and an air-filled colon when present whites out everything through the far-field because ultrasound does not transmit through air. Hydronephrosis, mineralization and calculi, and masses and cystic structures are often readily suspected by performing the AFAST^3 SR view in this repetitive manner. In smaller dogs and in many cats, **both** left and right kidneys may be imaged through the SR view, not a mirror-image artifact.

The Cysto-colic (CC) view is the most common AFS-positive site in low-scoring AFS 1 and AFS 2 dogs and cats. The CC view is properly imaged by directing the probe toward the tabletop into the "CC pouch" where the urinary bladder is immediately against the far abdominal wall. The CC view screens for urinary bladder pathology similar to the gallbladder at the DH view since both structures are often fluid-filled and ultrasound images best through fluid. The colon, the colic part of the site's name, is a tricky structure that lead to mistakes when the air-filled colon slips under the urinary bladder and thus appears like bladder stones, mineralized sediment, or the fecal-filled colon like masses. However, by directing the probe into the CC pouch, these pitfalls are often avoided. Care should be taken because blood clots, intraluminal thrombus, may also appear like, and be mistaken for, urinary bladder neoplasia; and the thigh through the far-field is often image and should be appreciated as an extra-abdominal structure and not intra-abdominal pathology.

The Hepato-renal (HR) umbilical view completes the AFAST^3 format. In high-scoring dogs and cats the view will likely have abundant fluid amenable to abdominocentesis. Since ultrasound cannot sonographically characterize free fluid, sampling is necessary with fluid analysis, including cytology and chemistry analysis. The HR umbilical view is nicknamed by the author the "big lie" since routinely the right kidney and liver are not directly imaged but rather the probe is placed in the mid-section umbilical region and directed into the most gravity-dependent "HR pouch" for the detection of free fluid. In cases in which the right retroperitoneal space is of interest, then the author will interrogate the target-organs as a 5th AFAST^3 view called the HR5th or HR bonus view. This 5th or bonus view is **not** part of the abdominal fluid scoring system. It has not been determined what clinical importance of routinely performing the additional AFAST^3 HR5th view is when compared to findings at the SR view. In other words, is interrogation of the retroperitoneal space adequate through just the SR view or will right retroperitoneal pathology be missed without the HR5th or HR bonus view? In cases that have urinary tract pathology/conditions suspected, the HR5th view is always attempted by the author.

Clinical Indications for AFAST^3

The use of AFAST^3 should be simply stated as an "extension of the physical exam" for all dogs and cats that are abnormal or suspect. Global FAST should be adopted as first-line "free fluid and soft tissue screening test" just as we have been trained to perform basic blood tests. There is a long list of effusive and soft-tissue conditions missed by radiography, which are potentially picked up by the AFAST target-organ approach.

Clinical indications include:

1. Blunt trauma
2. Penetrating trauma
3. Collapse, apparent collapse
4. Undifferentiated hypotension

5. Anemia

6. Respiratory distress (since there are nonrespiratory lookalikes [hemoabdomen, cardiac tamponade, anaphylaxis, high fever, and others])

7. Post-interventional at-risk bleeding (surgery, percutaneous procedures, laparoscopy)

8. Post-interventional at-risk peritonitis (surgery, percutaneous procedures, laparoscopy)

9. Patient monitoring during fluid resuscitation and during hospitalized care

10. Preanesthetic screening test

Goal-Directed Template for AFAST[3]

Patient positioning:	right or left lateral recumbency (right preferred)
Gallbladder:	present or absent, contour, wall, content, unremarkable or abnormal
Urinary bladder:	present or absent, contour, wall, content, unremarkable or abnormal

Positive or negative at the 4 views (0 negative, 1 positive)

Diaphragmatico-hepatic site:	0 or 1
Spleno-renal site:	0 or 1
Cysto-colic site:	0 or 1
Hepato-renal site:	0 or 1

Abdominal fluid score: 0-4 (0 negative all quadrants to a maximum score of 4 positive all quadrants)

HR5th bonus view: _____

Focused spleen (add-on after AFAST[3] HR umbilical view): _____

DH view:
Pleural effusion: absent, present (mild, moderate, severe) or indeterminate
Pericardial effusion: absent, present (mild, moderate, severe) or indeterminate
Hepatic venous distension: present, absent or indeterminate
Caudal vena cava characterization: FAT, flat or bounce or indeterminate

Comments:_____

Note: The AFAST[3] exam is a rapid ultrasound procedure used to detect the presence of free abdominal fluid (which is generally abnormal) as a screening test in order to better direct resuscitation efforts, detect complications, and manage critically ill patients. AFAST[3] allows rapid but indirect assessment for evidence of major internal abdominal organ injury or disease. The AFAST[3] exam is not intended to replace a complete abdominal ultrasound exam of the abdomen.

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