Abdominal FAST (AFAST^{SM}) – The Technique and Practical Everyday Case-based Applications Part I and II

Gregory R. Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC
Hill Country Veterinary Specialists & FASTVet.com, San Antonio, Texas USA
***FAST*Vet^{SM}** and ***FAST Saves Lives!*^{TM}**
Email FastSavesLives@gmail.com; Website www.FASTvet.com; Phone 210.260.5576
Text Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley © 2014

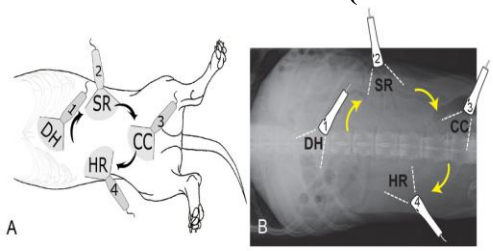
Introduction:
The clinical utility of AFAST^3 and the applied fluid scoring system trauma, triage (non-trauma) and tracking (monitoring) cases in the emergent and critical care settings will be reviewed. The T^3 designation encompasses these 3 subsets and avoids the onslaught of confusing acronyms in 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 in 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 modes of 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).*

Terminology:
In the human literature, there has been a confusing onslaught of multiple acronyms for similar ultrasound examinations by non-radiologists, i.e. FFAST, EFAST, HHFAST, BOAST, INBU, FEEL, FALLS, FATE, RUSH, etc. 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 or GFAST. Because any of the three GFAST ultrasound format (AFAST, TFAST and Vet BLUE) may be diagnostic, the author suggests that comprehensive exams of the abdomen and thorax be designated as "complete abdominal ultrasound" and "complete echocardiography" respectively, similar to the human literature. Finally, terms such as "Focused" and "Targeted" and "COAST" (cage-side organ assessment with sonography for trauma, triage and tracking) have been used for specific sonographic interrogation of organs in both human and veterinary medicine. For absolute clarity we recommend the use of "Focused X" with X being the system being evaluated (e.g., "Liver and Gallbladder", "Spleen", "Kidney", "Urinary Bladder", "Gastro-intestinal", "Reproductive", "Echo or Heart", "Eye", etc.).

Patient Positioning and Preparation:
Right lateral recumbency is recommended for AFAST^3 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

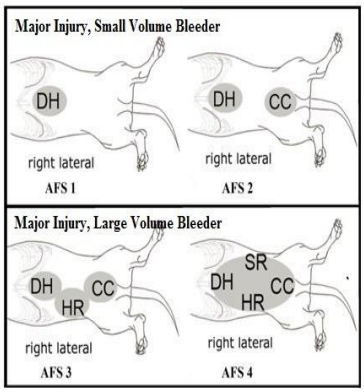
in dorsal recumbency because it not only invalidates the fluid scoring system, but jeopardizes injured and critically ill patients by compromising their respiratory status and venous return. Fur is NOT shaved but rather parted and alcohol and/or gel applied. Alcohol should not be used if electrical defibrillation is anticipated.

Schematic of the AFAST (Abdominal) Ultrasound Exam:



The AFAST[3] sites (right lateral recumbency is preferred but left lateral is acceptable. 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) View which completes the AFAST[3] exam. The HR 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, when comparing longitudinal (sagittal) to transverse views, they matched 399/400 times; thus, ONLY fanning longitudinally (sagittal) is necessary expediting 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, considered major injury, big or large volume bleeders.

Use of Serial AFAST Exams 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 (American College of Emergency Physicians Guidelines [2001]).

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. 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 or AFAST[3] and TFAST[3] imaging (no free fluid in retroperitoneal, pleural and pericardial spaces), predictably did not develop anemia (no dogs were anemic on their admission packed cell volume [PCV]). 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 intraabdominal 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 (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 that could lead to anemia and missed by AFAST[3] and TFAST[3].

On the other hand, high-scoring AFS 3 and 4 dogs are more likely to develop anemia (~ 25% decrease in PCV from baseline [admission PCV]) with ~25% of high-scoring dogs becoming severely anemic (PCV < 25%); thus, are more likely to require blood transfusions and rarely emergent laparotomy. The AFAST[3]-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. Importantly, bluntly traumatized (hit-by-car, kicked, stepped on, falls) dogs RARELY need emergent laparotomy to control the 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 large volume effusions are more likely to be due to uroabdomen. Moreover, by using the abdominal fluid score and recording locations of positive sites, the volume may be semi-quantified, and source potentially localized (guiding surgical exploration), respectively. See Table below with decision-making.

Non-traumatic Hemoabdomen and Post-interventional Bleeding Dogs and Cats

The same concept may be applied to non-traumatic hemoabdomen (bleeding tumor, coagulopathic) and to at-risk post-interventional cases (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 rarely need surgical intervention, post-interventional large volume bleeding OFTEN requires exploratory laparotomy and surgical ligation of the bleeding source. See Table below with decision-making.

Other Abdominal Effusions

The use of the AFAST[3]- abdominal fluid scoring system also provides a means to detect and monitor response to therapy of other non-hemorrhagic effusive conditions including for example transudates (liver/GI disease), modified-transudates (right-sided heart failure) and exudates (peritonitis). The use of the AFAST[3]- applied abdominal fluid scoring system also is helpful for the surveillance of post-operative patients at-risk for hemorrhage and peritonitis since ultrasound is superior in sensitivity to physical examination and abdominal radiography.

AFAST is a Cerebral Exam, Not just Fluid-positive, Fluid-negative:
The Diaphragmatico-Hepatic (DH) View is loaded with information that is readily appreciated during the minutes it takes to perform the AFAST[3].

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 of the caudal vena cava at 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). See Global FAST[3] for more detail.
4) The gallbladder should be immediately against the diaphragm when starting the DH view in dogs. When the sonographer is unable to get this orientation in dogs, then liver enlargement should be suspected and when the gallbladder cannot be located than 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" can be supportive evidence for anaphylaxis; however, there are several causes of gallbladder wall thickening (the halo) including right-sided heart failure, pericardial effusion/tamponade, volume overload, 3rd spacing, primary gallbladder disease, and pancreatitis.
6) Liver masses can often be appreciated.

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 (ultrasound does not transmit through air) everything through the far field. 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.

The Cysto-Colic (CC) View lends itself to suspecting urinary bladder pathology similarly to the gallbladder at the DH view since both structures are often fluid-filled and ultrasound images best through fluid. The colon is a tricky structure that can cause mistakes by the air-filled colon appearing like bladder stones, the fluid-filled or fecal-filled colon like masses. Care should be taken because blood clots may also appear like, and be mistaken for, urinary bladder neoplasia. The CC View is the most common AFS-positive site in low-scoring AFS 1 and AFS 2 dogs (and

cats) by directing the probe toward the table top into the "CC pouch" where the urinary bladder is immediately against the ventral abdominal wall.

The Hepato-Renal (HR) View is completes the AFAST[3] format and is this called the "Home Run Site" because 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 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 place in the mid-section umbilical region and directed in 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. It has not been determined what clinical importance of routinely performing the AFAST[3] 5th view is (low yield or high yield or if the left retroperitoneal space is adequate without the right retroperitoneal space since they are in such close proximity).

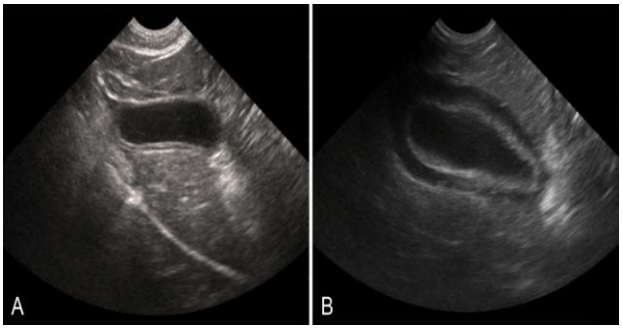
The Gallbladder Halo Sign: More than Anaphylaxis:
The gallbladder is fluid-filled and thus easily recognized by the non-radiologist since ultrasound images best through fluid; and is reliably imaged in dogs and cats at their FAST[3] DH view when placed in right lateral recumbency. There are 3 major features to consider when viewing the gallbladder including its shape, lumen contents and its wall. In normalcy, the gallbladder sonographically is generally oval in longitudinal (sagittal) orientation with a lumen that is homogeneously anechoic (black); however, exceptions exist, and dogs and more commonly cats may have bi-lobed (oddly-shaped) gallbladders; and in dogs the gallbladder lumen may have echogenic (gray) material, referred to as sludge, that may also be considered normal when placed into clinical context. On the other hand, the gallbladder wall is quite reliably a thin hyperechoic (white) line in both the canine and the feline species (despite being reported to be considered as normal to a thickness of 2-3 mm). Lastly, the hepatic veins in normalcy are not readily apparent. In summary, the sonographic features of the canine and feline gallbladder are easy to appreciate by non-radiologist sonographers during both AFAST[3] and TFAST[3] at the DH view.

Image showing the normal gallbladder wall as a thin hyperechoic (white) line at the FAST[3] DH View.

Compare to gallbladder wall edema referred to as the "Gallbladder Halo Sign" in subsequent images.

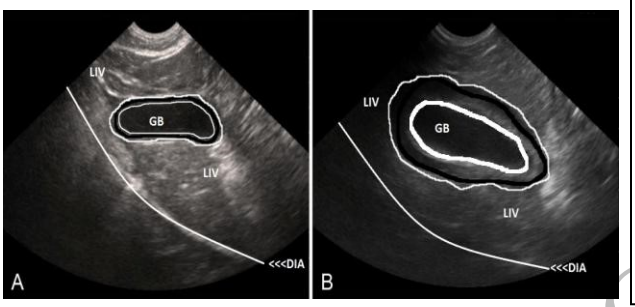
In 2009, Quantz et al. performed a landmark study that correlated the presence of a thickened gallbladder wall, referred to as the gallbladder halo sign, with anaphylaxis (AX) in dogs because their shock organ, is the gastro-intestinal tract and liver. In contrast, the shock organ of cats and humans is the lung (thus neither humans nor cats get an AX-induced gallbladder halo sign). The massive release of histamine during AX causes the hepatic sphincters to tighten resulting in massive hepatic venous congestion resulting in gallbladder wall edema within minutes. The gallbladder wall edema is easily recognized sonographically by its hyperechoic (white) inner and outer walls with a sonolucent line (typically anechoic [black]) in between. In other words, the

gallbladder wall becomes layered as white, black, and white; and thus dubbed the "gallbladder halo sign." Moreover, Quantz et al. found that the gallbladder halo sign was not only sensitive and specific for AX, but also an immediate finding, in contrast to the delay of the spike of the historical marker of serum alanine transaminase (ALT), which may take 2-4 hours.



Varying degrees of gallbladder wall edema referred to as the "Gallbladder Halo Sign" in different dogs with anaphylaxis at the FAST[3] DH View. A) mild B) severe. We have found the degree of gallbladder wall edema inconsistently correlates with severity of AX.

Note the sonographic layering of white, black and white of lumen wall, its sonolucent center, and outer wall respectively.



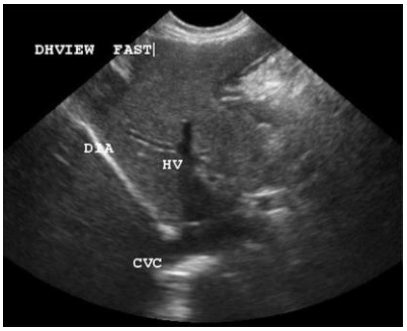
Modified from Focused Ultrasound Techniques for the Small Animal Practitioner, Wiley ©2014 with the sonographic layering placed as white, black and white. Compare to previous unlabeled image. GB:gallbladder; LIV: liver; DIA: diaphragm

Causes of Gallbladder Wall Edema (the Gallbladder Halo Sign)
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 immune-mediated
FASTVet.com Copyright 2015, 2016 - Greg Lisciandro, FASTSavesLives@gmail.com

Veterinarians should be made aware of the use of the gallbladder halo sign as supportive evidence for the diagnosis of AX in dogs but also be aware of the other causes for gallbladder wall edema (see chart). Hasty diagnosis of AX and treatment with EPI, large volumes of crystalloids, and histamine (H1 and H2) blockers and gluococorticoids may not be in the best interest of the patient if misdiagnosed as AX when has pericardial effusion or right-sided heart failure. Regarding right-sided heart failure/conditions/pulmonary hypertension, resultant backflow causes venous congestion of the caudal vena cava (CVC), referred to as FAT CVC, and the hepatic venous system as the "Tree Trunk Sign." The venous congestion of both the caudal vena cava and the hepatic venous system is obvious sonographically; and gallbladder wall

edema is a secondary consequence. The phenomenon occurs in humans, dogs, and rarely cats, and has been termed the "cardiac gallbladder."

Use of the Caudal Vena Cava and Hepatic Veins. Moreover, the use of the dynamic characterization of caudal vena cava (FAT, flat or Bounce) is invaluable for sorting out dogs with weakness and collapse. Consider a dog (or cat) with AX, the caudal vena cava will be "flat" due to lack of venous return from profound hypovolemic/distributive shock. In contrast, consider a dog collapsed from pericardial effusion and tamponade, right-sided heart dysfunction/ failure/pulmonary hypertension/ generalized heart failure, the CVC will be "FAT" from the obstruction of blood flow from the liver to the right atrium. The CVC characterization provides a clue as to cause since it is diametrically opposed in these to conditions that can have very similar clinical presentations (the collapsed or weak dog).



Showing the FAT (distended) caudal vena cava (CVC) as it passes through the diaphragm (DIA) and the distended hepatic veins appearing as tree trunks thus referred to as the Tree trunk Sign. The character of the CVC is completely different in AX (flat) and PCE (FAT) or right-sided heart failure.

Complication of AX-induced Hemoabdomen. Lastly, dogs with anaphylaxis not uncommonly develop degrees of coagulopathic hemoabdomen, typically abdominal fluid scores (AFS) of 1 or 2, but may have higher scores of AFS 3 and 4. Treatment consists of correcting the coagulopathy, if present, with transfusion, e.g., fresh frozen plasma (FFP) and very rarely red blood cells. Monitoring of the degree of hemorrhage, its worsening, and its resolution, can be done with serial AFS. Most lower-scoring AFS 1 and 2 dogs have normal clotting times and their AFS will return to 0 (negative) within 24-hours without FFP. Even dogs with high-scoring AFS 3 and 4 can self-resolve without fresh frozen plasma. It's important to recognize the complication, and not over-react in stable patients with normal to relatively normal clotting times (<25% over baseline) since many will self resolve (and even some with abnormal coagulation profiles will still resolve without transfusion products); and not unknowingly take an AX-coagulopathic hemoabdomen to surgery, which could be catastrophic for the dog resulting in death. These cases are difficult to sort out because many dogs have minimal changes in traditional coagulation times (PT, aPTT < 25% above baseline), yet have a high AFS (3,4). The author speculates that the pathogenesis is a combination of mast cell release of heparin and tryptase (some dogs do indeed have discordant PT and aPTT with the aPTT much higher as would occur with heparinization; however, other dogs do not), and the acute hepatic venous congestion resulting in the diapedesis of blood and plasma. Findings on exploratory surgery will involve a large swollen (rounded, blunted hepatic lobe edges), oozing, liver and a hemorrhagic effusion (***and the dog will unlikely survive*** [approx 100% death] ***the surgery***).

Clinical Indications/Applications of AFAST:

****The use of AFAST should be simply stated as an "extension of the physical exam" for nearly ALL dogs and cats that are abnormal. FAST^3 formats (AFAST and its applied fluid scoring***

system [AFS], TFAST and Vet BLUE) should be adopted as BASIC "screening tests" just as we have been trained to perform minimally basic blood tests (so-called Quick Assessment Tests [PCV/TS, serum character, BUN, Creatinine, Blood Glucose, and ALT]). *Indications include: Blunt trauma, Penetrating trauma, Collapse, apparent collapse, Undifferentiated hypotension Respiratory distress (since there are non-respiratory look-a-likes [hemoabdomen, cardiac tamponade, anaphylaxis, high fever, and others]), Post-interventional at-risk bleeding (surgery, percutaneous procedures, laparoscopy), Post-interventional at-risk peritonitis (surgery, percutaneous procedures, laparoscopy), Patient monitoring during fluid resuscitation and during hospitalized care.*

Use Goal-directed Templates to Give Value, Recording Findings, Ensure Quality Control!

Goal-directed Template for AFAST[SM]

Patient positioning: right or left lateral recumbency (right preferred)

Gallbladder: present or absent, contour, wall, content, unremarkable or abnormal?
gallbladder wall edema (halo sign) present or absent?

Urinary bladder: present or absent, contour, wall, content, unremarkable or abnormal?

Positive of 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)

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.)

Summary of Abdominal Fluid Score (AFS 1,2 (small volume) **vs. AFS 3,4** (large volume)**) and Medical vs. Surgical Decisions in Bleeding Dogs**		
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 so 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!***	***– 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!***
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)***	***– 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!***

References:

1. Quantz JE, Miles MS, Reed AL, et al. 2009. Elevation of alanine transaminase and gallbladder wall abnormalities as biomarkers of anaphylaxis in canine hypersensitivity patients. *J Vet Emerg Crit Care* 2009;19(6):536–544.
2. Lisciandro GR. Abdominal FAST (AFAST)-detected Hemorrhagic Abdominal Effusion in 11 Dogs with Acute Collapse and Gallbladder Wall Edema (Halo Sign) with Presumed Anaphylaxis. *In review*, 2016.
3. Lisciandro GR. Case Series of Dogs with the Gallbladder Halo Sign Associated with Pericardial Effusion and Right-sided Heart Failure during FAST Exams. *Unpublished,* 2014.
4. Lisciandro GR. Chapters 2: The Abdominal (AFAST) Exam. *In* Focused Ultrasound for the Small Animal Practitioner, Editor, Lisciandro GR. Wiley Blackwell: Ames IA 2014.
5. Nelson NC, Drost WT, Lerche P, et al. Noninvasive estimation of central venous pressure in anesthetized dogs by measurement of hepatic venous blood flow velocity and abdominal venous diameter. *Vet Radiol & Ultrasound* 2010; 51(3):313–323.
6. World Allergy Organization Anaphylaxis Guidelines, http://www.worldallergy.org/anaphylaxis/.