Initial triage, diagnosis, and stabilisation of the acutely collapsed dog

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Collapse is defined as a pathological process leading to unintentional prostration or the inability to remain standing.[1,2] There are numerous underlying causes of collapse associated with almost any organ system, which may vary from benign and self-limiting to fatal. In most cases, the underlying cause often dictates the clinical signs associated with collapse. Patients that are ambulatory at the time of presentation with a history of episodic collapse may have unremarkable exam findings and require a thorough medical work up to identify the underlying cause.[2] Despite a thorough work-up, it is not always possible to determine the cause of collapse in every patient, and having the owner capture any recurrent events on video, may be helpful in narrowing the differential diagnosis.[3] Fortunately, with the exception of intermittent seizures or arrhythmias that may become acutely fatal, patients that are ambulatory at the time of presentation with a normal physical exam, electrocardiogram, blood pressure, complete blood count, serum chemistry panel, and urinalysis, are likely to remain stable for some time, which allows more comprehensive and advanced diagnostic testing to be performed when indicated.[2] The above tests are recommended in all patients presenting with a history of collapse for which an underlying cause is not evident on initial examination.

On the other hand, patients presenting acutely collapsed and non-ambulatory should be considered emergencies with a high risk of deterioration until proven otherwise. Many of these patients will present with significant neurologic impairment, life-threatening hypoperfusion and shock, and/or respiratory distress. Even with advanced life-threatening signs, an underlying cause of collapse may not be immediately evident on the initial exam. Furthermore, many dogs presenting for collapse have a dynamic and progressive condition, which may lead to irreversible injury if not rapidly treated. Immediate assessment and stabilisation of these cases is essential to decrease the risk of serious complications.

This article focuses on dogs presenting for acute collapse that are assessed as unstable based on the triage exam and emphasises the initial stabilisation and emergency cage-side diagnostics (the first 30 seconds to 30 minutes) that should be considered in these patients. For patients with a history of episodic collapse and/or assessed as stable on initial triage examination, readers are referred to more comprehensive reviews at the end of this article.

Physical exam parameters	Indicators of instability
Cardiovascular parameters	
Heart rate	>120-140bpm
Pulse quality	Weak, irregular, deficits Compare peripheral and proximal pulses – dorsal pedal vs femoral. Recent evidence suggests pulse quality of the dorsal pedalpulse is decreased prior to the femoral pulse quality
Capillary refill time	>2 sec
Mucous membranes	Pale, white
Temperature: Rectal Extremities	< 37.5°C Cool
Evidence of hyperdynamic shock	Brick-red mucous membranes, capillary refill time (CRT) <1 sec, bounding pulses
Respiratory parameters	
Respiratory effort	Dyspnoea (signs such as abducted elbows, flared nostrils, open-mouth breathing, excessive chest excursions, increased abdominal effort)
Mucous membranes	Grey, blue
Neurological system	
Mentation	Decreased level of consciousness (stupor or coma)
Trauma	Spinal or skull fracture
Ambulation	Severe paresis or paralysis
Miscellaneous	Seizures

Table 1: Criteria used to classify collapsed dogs as unstable.

HOW TO IDENTIFY AND MANAGE THE UNSTABLE ACUTELY COLLAPSED DOG

There are several key objectives that should be addressed in a dog presenting for acute collapse: perform an immediate triage exam to assess the cardiovascular, pulmonary, and neurological status of the dog and decide if the patient is stable or not (see Tables 1 and

Parameter assessed	Most common/significant causes	Key clinical considerations
Rectal temperature		
Hyperthermia	Fever	Often a history or clinical signs supportive of a concurrent underlying inflammatory or infectious cause
	Heat stroke	History of exercise in hot environment or enclosure in a hot confined space (a vehicle)
	Increased work of breathing	Increased respiratory effort, stridor often noted
Hypothermia	Vasoconstriction Hypoperfusion/shock Thromboembolism	Often concurrent with other clinical findings of hypoperfusion (eg. prolonged CRT, poor pulses, etc.) or thromboembolism (eg. weak to absent pulses, a predisposing cause such as immune mediated haemolytic anemia, cancer, etc.)
	Extreme cold/hypothermia	History of environmental exposure to environmental temperatures below freezing for prolonged periods of time
Capillary refill time (CRT)		
Prolonged (>2 seconds)	Most likely decreased perfusion	Assess other parameters of perfusion(eg. blood pressure, lactate, etc.)
Rapid (<1 second)	Vasodilation/capillary engorgement	Consider vasodilatory shock including systemic inflammatory response syndrome (SIRS), sepsis, anaphylaxis
Mucous membrane colour		
Pale/white	Vasoconstriction/anemia	Check packed cell volume (PCV) and assess other parameters of hypoperfusion/shock
Blue/grey	Cyanosis/hypoxaemia	Assess pulmonary function and oxygenation or the blood (eg. pulse oximetry and/or arterial blood gas)
Brick-red	Vasodilation/capillary engorgement	Consider vasodilatory shock including SIRS, sepsis, anaphylaxis
Dry mucous membranes/ prolonged skin tent	Suggests dehydration	Consider causes of increased fluid losses (eg. vomiting, diarrhoea, polyuria, haemorrhage, etc.)
Pulmonary auscultation		
Crackles	Small airway/alveolar inflammation/ oedema	Provide oxygen if dyspnoeic +/-anxiolytics. Consider emergency lung ultrasound to look for interstitial alveolar disease and to assess the heart (or chest radiographs when stable)
Wheezes	Bronchoconstriction	Asthma, allergic bronchitis. Provide oxygen if dyspnoeic and consider anxiolytics. Radiograph when stable.
Stridor	Laryngeal paralysis, upper airway obstruction	Anxiolytics are often key in reducing work of breathing and decreasing upper airway resistance. Upper airway exam often diagnostic
Absent breath sounds	*Dorsally*: Most often pneumothorax *Ventrally*: Pleural effusion, diaphragmatic hernia, mass	Perform emergency lung ultrasound during stabilisation or thoracic radiographs when stable
Muffled heart sounds	Pleural or pericardial effusion	Consider emergency sonography or radiographs (when stable)
Pulse quality Weak Bounding Irregular	Hypoperfusion/vasoconstriction/ thrombus Anaemia, hyperdynamic shock Arrhythmia	Assess other parameters of perfusion Check PCV and look for supporting evidence of hyperdynamic shock ECG recommended
Pulses paradoxes	Most often pericardial effusion	Assess for muffled heart sounds and consider emergency sonography or radiographs (when stable)

Table 2: Assessment of triage exam findings in unstable dogs presenting for acute collapse.

Diagnostic parameter assessed	Most common causes in acutely collapsed dogs
Packed cell volume (PCV) Both increased	and total solids (TS) Suggestive of dehydration
TS relatively low (<60g/dl) compared to PCV (>37%)	Rule out acute haemorrhage (PCV often initially preserved through splenic contraction)
Decreased PCV relative to TS	Decreased red cell production Anemia of inflammation Immune mediated Myeloproliferative disease
	Destruction Immune mediated Toxin Infection
	Loss
Low blood glucose	Sepsis
	Xylitol toxicity
	Insulin overdose
	Insulinoma
	Hepatic failure
Elevated blood glucose	Diabetic ketoacidosis
Elevated blood urea nitrogen (BUN) Evaluate in conjunction with urine specific gravity (USG)	Pre-renal: Any cause of decreased renal perfusion
	Renal: Toxin Infection - Pyelonephritis - Leptospirosis - Lyme nephrosis
	Postrenal: - Ureteral obstruction/rupture - Urethral obstruction/rupture - Urinary bladder rupture
ECG irregular rhythm	Hypoperfusion
	Ischaemia
	Electrolyte imbalances
	Pain
	Myocardial contusion/trauma
	Cardiomyopathies Valvular disease
	Pericardial disease
	Splenic/other masses
Decreased blood pressure	Shock (any cause of) Anaphylaxis
Hypoxaemia/dyspnoea	Airway obstruction Laryngeal paralysis Tracheal collapse Asthma Interstitial/alveolar pathology: - Oedema - Pneumonia - Haemorrhage - Contusions
Hyperkalaemia	Hypoadrenocorticism/Addison's Ureteral obstruction/rupture Urinary bladder rupture Urethral obstruction/rupture Acute renal failure
Hypocalcaemia	Relatively rare cause of collapse, consider toxins, parturition

Table 3: Emergency cage-side diagnostics in unstable dogs presenting for acute collapse.

Hypernatraemia	**Uncommon cause of acute collapse, consider salt ingestion (salt water, play dough, etc.)**
Hyponatraemia	**Often seen with other causes of acute collapse, consider hypoadrenocorticism or third space losses**
Hyperlactatemia	**Decreased oxygen delivery/utilisation at the tissues (any cause of)**
AFAST	**Free abdominal fluid: see text for more details**
TFAST/Vet BLUE	**Pleural effusion, pericardial effusion, pneumothorax, B-lines suggestive of interstitial/alveolar pathology: see text for more details**

Table 3: (cont'd).

2); if unstable institute emergency stabilisation; of the cardiovascular, pulmonary, and neurological systems; perform cage-side emergency diagnostic testing to identify and correct immediate life-threatening conditions (see Table 3 and algorithms 1-3, and Table 4); and determine and treat the specific underlying cause. It should be noted that patient status can change rapidly and some patients initially assessed as stable on triage require close observation and frequent re-assessment (for example, patients with rib fractures, flail chest, penetrating wounds, etc, who may otherwise be stable on presentation). Similarly, some patients with abnormal breath sounds, (eg. decreased to absent; increased/harsh, crackles, wheezes, stridor, etc.) may not present with dyspnoea but should be closely observed and reassessed often until the underlying cause can be identified and corrected.

EMERGENCY CAGE-SIDE DIAGNOSTICS

Clinical exam findings in dogs presenting with acute collapse are often non-specific and may be associated with many underlying conditions (eg. hypoadrenocorticism, anaphylaxis, acute hemorrhage, pericardial effusion, etc.), so emergency cageside diagnostic laboratory and imaging is recommended, particularly in unstable patients (see Table 3). These emergency diagnostics should be initiated concurrent with attempts to stabilise the patient. If limited personnel are available, stabilisation takes priority and emergency cageside tests should not supersede stabilisation efforts. Although emergency cageside testing will vary depending on the suspected underlying cause and initial triage exam findings, common general emergency diagnostics to consider in all patients include packed cell volume (PCV), total solids (TS), blood glucose, blood urea nitrogen (BUN), lactate, electrolytes, arterial blood gas (ABG) and/or pulse oximetry, urine specific gravity (USG), electrocardiogram (ECG), and arterial blood pressure.[4] Blood samples and urine should ideally be collected prior to starting fluid therapy. Collect enough blood for emergency blood tests as well as a complete blood count and serum chemistry profile, if possible. Other valuable emergency diagnostics include emergency cage-side sonography, including abdominal and thoracic-focused assessment with sonography (AFAST and TFAST) and emergency cageside lung ultrasound Vet BLUE (see algorithms 1, 2 and 3 for emergency sonographic evaluation and therapy for patients presenting unstable, with dyspnea or with signs of acute abdomen and acute collapse).[4]

Centesis of any sonographically detected-free fluid is recommended. It is also important to assess the patient's mental status and spinal cord function as these conditions may require emergency stabilisation and/or surgery. Dogs with acute collapse that have a change in mentation and/or seizures should prompt consideration of intracranial diseases, extracranial diseases, and toxins while spinal cord lesions leading to acute collapse may include disc disease, fibrocarilagenous embolism, traumatic contusions/fractures, acute hemorrhage, and acute spinal cord edema. Depending on the suspected underlying cause, additional emergency testing may be indicated (ie. blood typing, diagnostic peritoneal lavage, adrenocorticotropic hormone (ACTH) stimulation testing, etc.). If the history, physical examination, and emergency cageside tests fail to identify an underlying cause of acute collapse, referral and/or more advanced diagnostic tests should be considered when the patient is stable (eg. magnetic resonance imaging [MRI], computed tomography [CT], etc.).

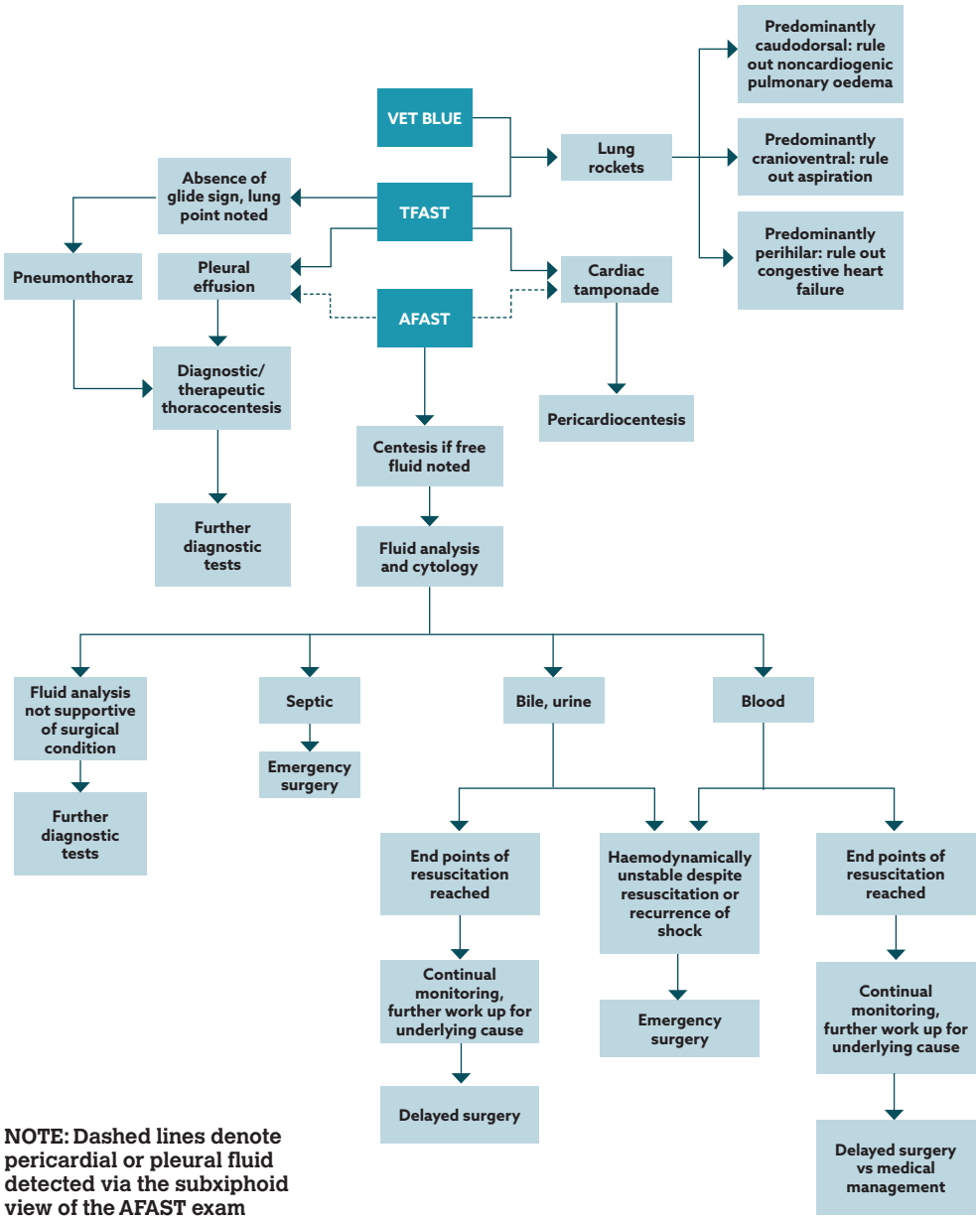
Interpretation of common emergency cage-side diagnostic tests for unstable dogs presenting with collapse are listed in Table 3. See references at the end of this article regarding interpretation of diagnostic tests in stable dogs presenting with collapse and more advanced diagnostic testing.

EMERGENCY CAGE-SIDE ULTRASOUND AND CENTESIS

The detection of body cavity fluids (with fluid analysis and cytology) can be critical in directing further diagnostic tests and therapy in the collapsed dog, particularly in determining the need for surgery. A recent study investigating dogs and cats presenting to an emergency service or hospitalised in the ICU, identified free fluid (abdominal, pleural, and/or pericardial) on AFAST and TFAST exams in 74% of dogs assessed as unstable on triage compared to only 6% of dogs assessed as stable.[6] It is therefore recommended that emergency cageside sonography be performed in any unstable patient presenting for acute collapse (see Figure 1).[5-7]

The advantages of AFAST and TFAST scans are that they can be completed in under five minutes, require minimal ultrasound training, can be repeated as necessary, and can be done cageside while unstable patients are receiving emergency therapy (see Figures 2 and 3 regarding the technique for AFAST and TFAST).[5-7]

Emergency sonography is more sensitive than radiographs for detecting effusion, and with



Algorithm 1: Focused assessment with sonography in cardiovascularly and/or respiratory unstable dog presenting acute collapse. ***Veterinary Emergency and Crucial Care, 3rd ed, Matthews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission).***

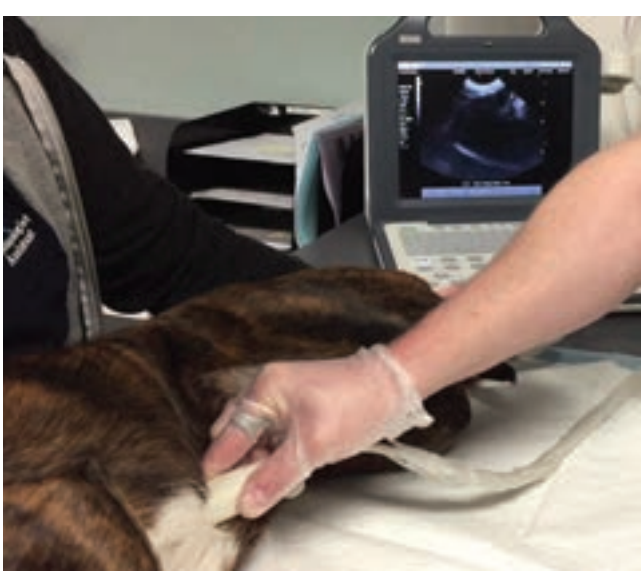
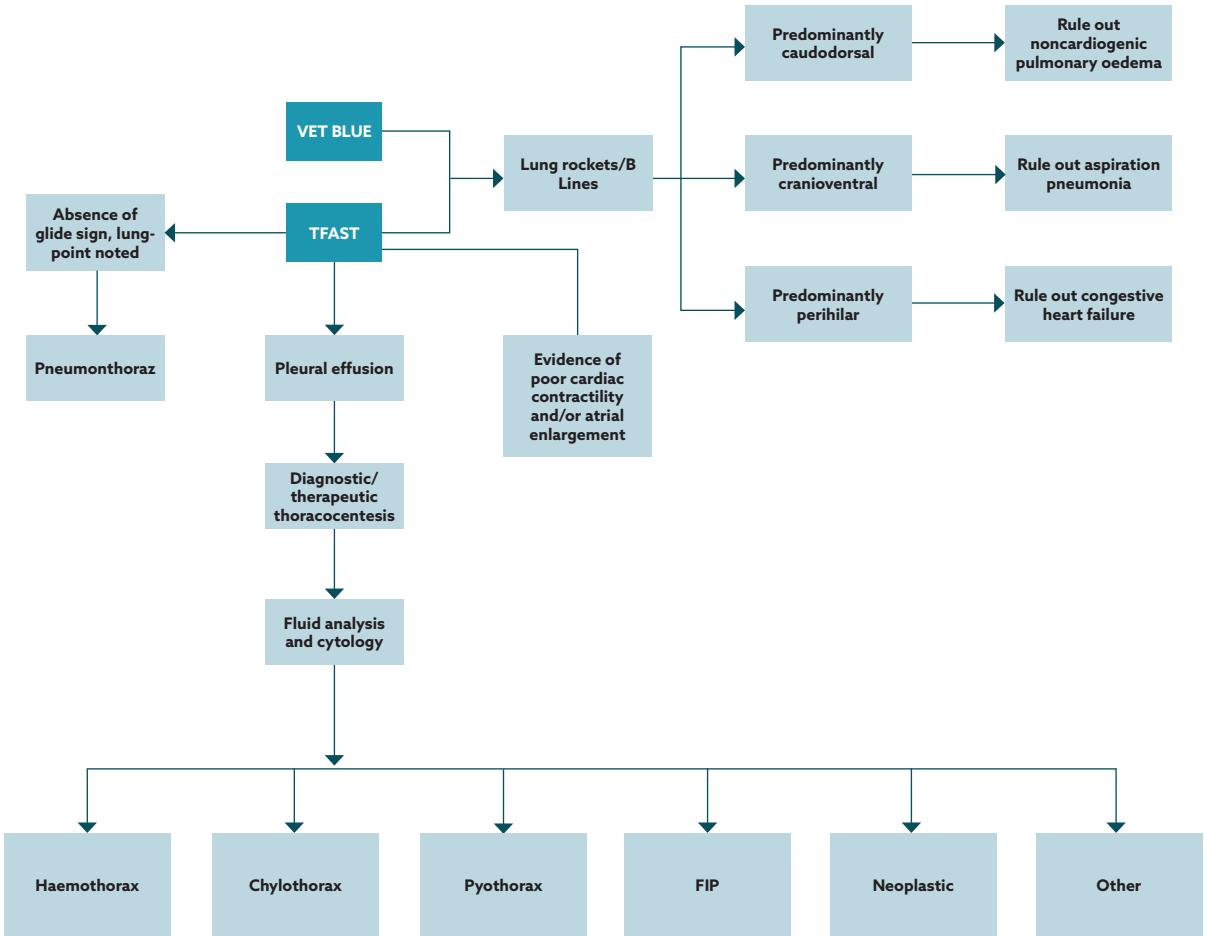


Figure 1: Emergency AFAST examination of a dog presenting for acute collapse. The dog is placed in right lateral recumbency with the head in the near field in this image. The subxiphoid site is being evaluated. The liver and diaphragm are visible on the ultrasound screen. In larger dogs, it is often necessary to angle the head of the ultrasound probe under the xiphoid process by applying firm but gentle pressure. Also, the angle of the probe is about 45° to the patient, which allows the liver, located cranial to the stomach, to be evaluated.

practice emergency sonography is very sensitive at detecting pneumothorax and interstitial/alveolar pathology,[9] all of which have been identified in patients presenting for acute collapse. Patients do not need to be shaved to perform these emergency scans (just part the fur and apply alcohol). The ultrasound machine should be brought to unstable patients; do not move unstable patients away from the emergency treatment area to perform ultrasonography. The types of free



Algorithm 2: Focused assessment with sonography in thedog with acute collapse and respiratory distress. *Veterinary Emergency and Crucial Care, 3rd ed, Matthews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission).*

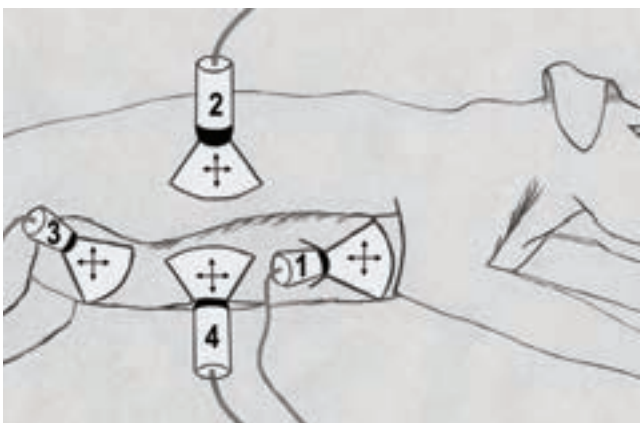


Figure 2: Technique for AFAST exam. The patient is placed in right or left lateral recumbency (left shown here). Four sites of the abdomen are evaluated; 1. Subxiphoid or diaphragmatico-hepatic (DH) site; 2. The right paralumbar or hepato-renal (HR) site; 3. Off-midline over the bladder or cysto-colic (CC) site and; 4. The left paralumbar or spleno-renal (SR) site. A quick 'umbilical flash' can be used by placing the probe on midline over the umbilicus and directing it laterally towards the gravity dependent flank to assess free fluid (site 4 with the dog in left lateral recumbency or site 3 with the dog in right lateral recumbency) if the objective is to identify free fluid and kidney assessment is not vital. At each site, the ultrasound probe is initially placed longitudinally to the underlying organs and fanned through an angle of 45° and moved 2.5cm in cranial, caudal, left, and right directions. *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission).*

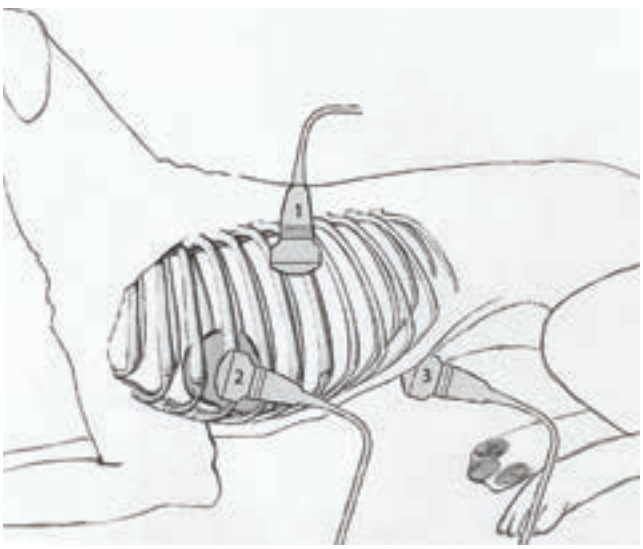
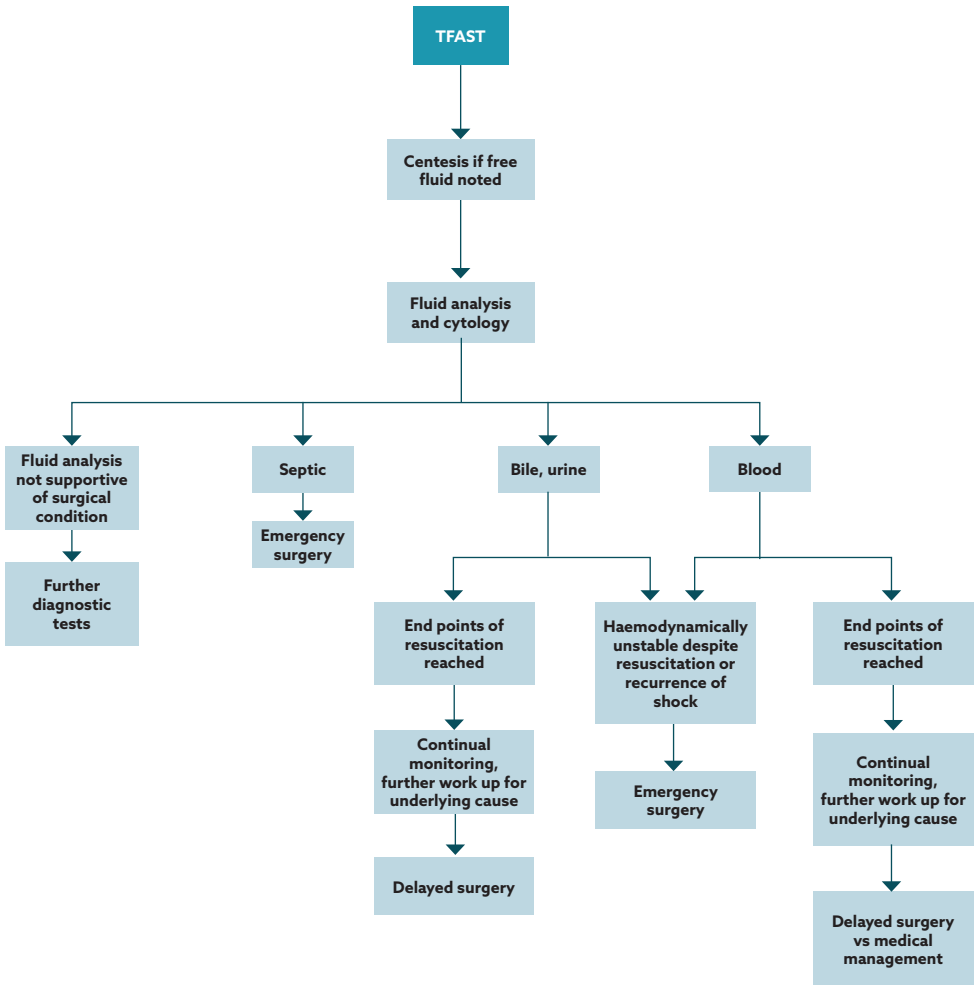


Figure 3: Technique for TFAST exam. Five sites are examined; 1. The chest tube site (CTS) with the probe placed perpendicular to the ribs at the left and right side of the thorax; 2. The left and right pericardial sites (PCS) with the probe in both longitudinal and transverse orientation to the heart, and; 3. The subxiphoid site with the probe initially placed in a longitudinal orientation. In Figure 3, the dog is in sternal recumbency with the hind end shifted into a more right lateral position. This allows both side of the chest to be evaluated while still leaving access to the subxiphoid site. *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission).*



Algorithm 3: Abdominal focused assessment with sonography for dogs with acute collapse and and signs of acute abdomen. ***Veterinary Emergency and Crucial Care, 3rd ed, Matthews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission).***

fluid found in acutely collapsed patients are variable (blood, bile, urine, septic exudate, chylous effusion, etc.) and difficult to predict, so ultrasound-guided centesis should be considered to allow rapid determination of the nature of the fluid, which may help guide management decisions during initial stabilisation and treatment (see algorithms 1-3).[4,5] Fluid cytology consistent with sepsis (bacteria, particularly intracellular) and/or fluid analysis supportive of sepsis (fluid lactate more than 2.0mmol/L greater than a concurrent peripheral blood sample or a peripheral blood glucose more than 2.0mmol/L greater than fluid glucose concentrations in fluid other than haemorrhage) may indicate a need for exploratory surgery (see stabilisation below) and/or further diagnostics to confirm the cause. The presence of degenerate neutrophils, even in the absence of bacteria warrants further analysis, including culture. In some cases, free fluid may not be initially detectable but can accumulate in third spaces following fluid resuscitation, so serial emergency sonography exams (repeated two-four hours after initiation of fluid therapy) may prove valuable in detecting delayed free fluid accumulations, which can subsequently be aspirated and evaluated.[8] When combined with bedside lung ultrasound evaluation (VetBLUE) protocols (see Figure 4 for technique), TFAST may also detect B lines. These are also known as lung rockets, vertical white lines originating at the parietal/pleural interface extending vertically through the ultrasound image that move back and forth with respirations, (see Figures 5a and 5b).[8,10] Healthy dogs normally have very few lung rockets found on thoracic ultrasound, and typically not more than one per probe site.[10] An increase in the frequency of B lines (which can even coalesce to form sheets) is suggestive of significant interstitial/alveolar pathology.[8-10]

INITIAL STABILISATION

Immediate stabilisation focuses on supporting the cardiovascular, pulmonary, and neurological systems concurrent with diagnostics to identify the underlying cause.

CARDIOVASCULAR SYSTEM

Cardiovascular compromise is probably the most common reason for an acutely collapsed dog to be unstable. The most common form of shock in dogs is hypovolemic (fluid losses, haemorrhage, etc.), but other forms of shock including cardiogenic (pericardial effusion with tamponade, cardiac arrhythmias, congestive heart failure), distributive (sepsis, anaphylaxis, SIRS), obstructive (gastric dilation [GDV], thrombosis, heartworm), metabolic

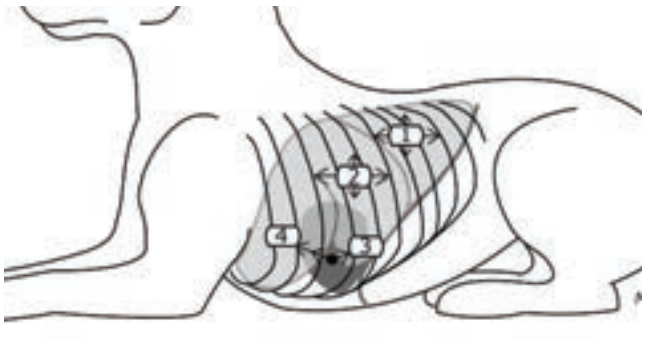


Figure 4: Technique for VET BLUE. Four sites on each haemithorax are evaluated; 1. Upper third of the thorax at the 9th intercostal space, or dorsal caudal lung region; 2. Sixth intercostal space in the middle third of the thorax or perihilar region; 3. Lower third of the thorax near the costochondral junction at the sixth to the eighth intercostal space or middle lung region; and 4. The lower third of the thorax near the costochondral junction at the third to fifth intercostal space or cranial lung region. The probe is placed in longitudinal orientation at each site and initially moved one to two rib spaces, cranially and caudally to rapidly look for B lines. In larger dogs, the probe can also be moved 1-2cm dorsally and ventrally. At the middle lung site (3), the probe is initially placed over the fourth to sixth intercostal space just above the level of the costochondral junction; if the heart obscures the field of view and prevents visualisation of the lung field, the probe is moved caudally one to two rib spaces until the heart is no longer visible and the lung can be evaluated. At the cranial lung site (4), the probe is initially placed over the fourth to sixth intercostal space 1-3cm (depending on the size of the patient) above the costochondral junction so that the heart is visible; the probe is then moved cranially one rib space at a time, until the heart is no longer visible and the lung can be evaluated. The patient's forelimb may need to be pulled cranially to facilitate probe positioning at this site. *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada* (with permission).[14]

(hypoglycemia, hypoadrenocorticism, mitochondrial dysfunction), and hypoxemic (anaemia, severe pulmonary disease, dyshaemoglobinaemias) can also occur.[11] Regardless of the cause, all haemodynamically unstable patients should have vascular access secured (either via the intravenous or intraosseous route).[4] In the absence of congestive heart failure and cerebral or pulmonary edema, resuscitative fluid therapy is recommended.[11] Studies have not shown a clear benefit of one fluid type over another in patients with shock, making isotonic crystalloids a good starting point as they are relatively inexpensive. Of great importance is administering the fluid chosen at an appropriate quantity and rate, as failure to provide sufficient fluids in a timely fashion, or giving too much fluid, can contribute to mortality.[11] It is therefore, essential that unstable collapsed dogs in shock have fluid therapy tailored via continual monitoring until normal homeostasis is re-established. Continual or serial monitoring should include heart rate, capillary refill time, mucous membrane colour, mentation, pulse quality, blood pressure, and blood lactate. In essence, the cardiovascular parameters assessed in Table 1 to determine if the patient is unstable should be monitored during fluid resuscitation with the goal of returning these parameters to normal values. With the exception of certain conditions (congestive heart failure, cerebral Oedema, internal hemorrhage) isotonic

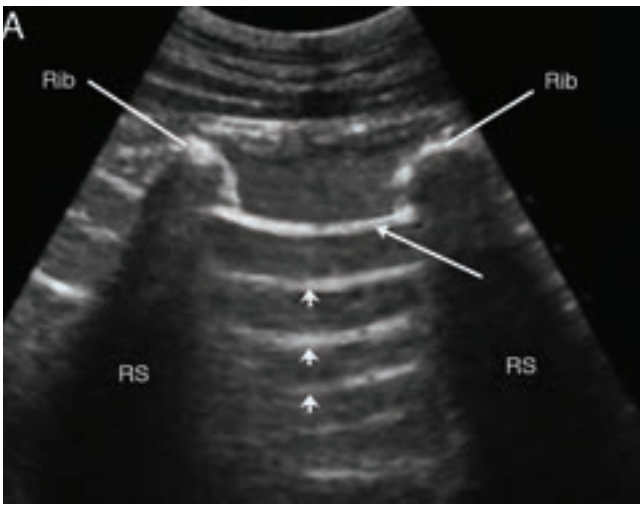


Figure 5a: Sonographic image obtained when the ultrasound probe is placed perpendicular to the ribs at the chest tube site (CTS). The ribs appear as the curvilinear white lines to either side of the image with rib shadowing (RS). The first white line that appears distal to the rib, connecting the two ribs, is the pleural line (identified by the long white arrow). This is the area that is assessed for the back and forth shimmering or glide sign. The reverberation artifact that cause the pleural line to be repeated in the far field of the image are known as A lines (short arrows). Note that the pleural line and A lines are both present in healthy patients and patients with pneumothorax. It is the back and forth motion along the pleural line that differentiates healthy animals (glide sign present) from patients with a pneumothorax (glide sign absent). *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission)*.[14]

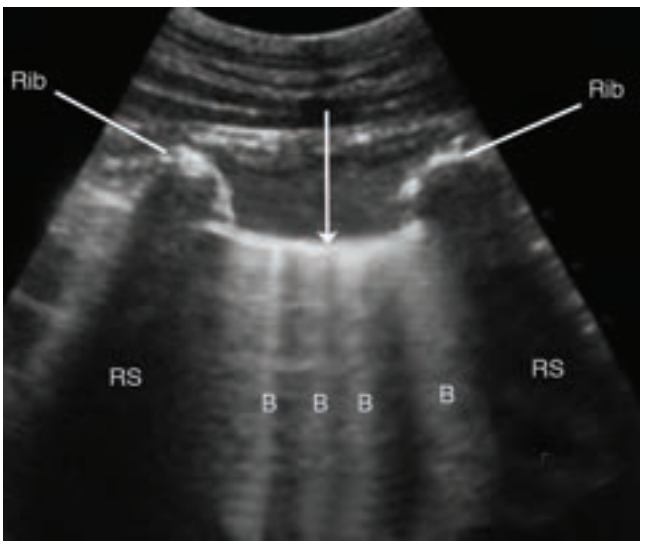


Figure 5b: Sonographic image obtained when the ultrasound probe is placed perpendicular to the ribs at the chest tube site (CTS) in a patient in respiratory distress with crackles noted on auscultation. The ribs appear as the curvilinear white lines to either side of the image with rib shadowing (RS). The first white line that appears distal to the rib, connecting the two ribs, is the pleural line (long white arrow). In patients with interstitial/alveolar disease (eg. pulmonary oedema, contusions, etc.) vertical white lines known as B lines (B) may be noted. These originate at the pleural line, extend to the far field of the image, obliterating A lines, and will move back and forth with respirations similarly to the glide sign. *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (with permission)*.[1]

Figure 6: The distal (male end) of an IV extension set can be connected to a large bore IV catheter that is passed into the trachea. The proximal end of the IV extension set can be connected to an oxygen source to allow transtracheal oxygen delivery in cases of severe upper airway obstruction where it is not possible to pass an endotracheal tube. In this image the oxygen line (blue rubber connector) is connected to the proximal end of the IV extension set using a 3ml syringe that has had the plunger removed and the wing tips cut away with bandage scissors. Caution to avoid overinflation of the lungs must be used when delivering transtracheal oxygen to patients with upper airway obstruction. If the patient cannot expire the oxygen source will need to be disconnected intermittently to prevent over-inflation of the lungs. *Veterinary Emergency and Critical Care, 3rd ed, Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (for more details).*[14]

Figure 7: An Ambu bag has been connected to IV extension tubing using an adaptor from a 3.5 endotracheal tube. The other end of the IV extension has been connected to an IV catheter, which is placed transtracheally, below the obstruction site for temporary emergency relief in patients with complete upper airway obstruction. In this image the IV catheter has been placed into the injection port of an empty IV fluid bag to simulate the lungs and to allow positive pressure ventilation to be practised using the equipment. Caution must be used to prevent over-inflation of the lungs if complete upper airway obstruction is present and positive pressure ventilation is initiated via a transtracheal catheter. *Veterinary Emergency and Critical Care, 3rd ed Mathews, 2016, Lifelearn, Guelph, Ontario, Canada (for more details).*

crystalloids can be given rapidly at repeated doses (15-20ml/kg over 10-15 minutes) until the desired endpoints are achieved. Blood products may be required following (or in place of) isotonic crystalloids in patients that have life threatening anemia, ongoing haemorrhage (continually falling hematocrit), or an obvious clotting factor deficiency (vitamin K antagonist toxicity). Cardiac arrhythmias causing clinical symptoms (pulse deficits, pale mucous membranes, weak peripheral pulses) or having a high risk of progressing to a fatal arrhythmia should be treated. Intravenous lidocaine is often a good initial anti-arrhythmic medication for ventricular arrhythmias, which are probably the most common arrhythmia noted in dogs with acute collapse. Patients found to have cardiac tamponade secondary to pericardial effusion ,should have pericardiocentesis performed. Patients with congestive heart failure should be stabilised with oxygen therapy and furosemide, and positive inotropes should be considered depending on the underlying cause (dilated cardiomyopathy versus endocardiosis). Patients identified as septic (based on fluid analysis or the finding of cavitary free air in the absence of another source of free air) should have broad spectrum intravenous antibiotic therapy started as soon as possible (ideally within an hour) following collection of samples for culture and sensitivity. Evidence in people suggests delaying the administration of antibiotics to patients with sepsis, even by one to two hours, is associated with increased morbidity and mortality.[12] The underlying source of infections should be identified and managed surgically if indicated. Surgery should be delayed until the cardiovascular system is stable or efforts to stabilise the cardiovascular system have been exhausted.

RESPIRATORY SYSTEM

The focus in acutely collapsed patients with signs of respiratory disease (cough, stridor, stertor, dyspnoea, tachypnoea, crackles and wheezes, harsh breath sounds, or decreased/absent breath sounds) should include stabilisation of the respiratory system. All patients with dsypnoea should have supplemental oxygen administered, regardless of the underlying cause. If the equipment is available, an objective assessment of the pulmonary system should be undertaken as soon as possible. This often includes pulse oximetry, arterial blood gasses, TFAST/VET BLUE emergency sonographic evaluation, and, when the patient is stable, radiographs. Stress, including physical restraint, may cause dogs to decompensate with worsening respiratory distress and should be avoided. Oxygen supplementation and anxiolytics may provide sufficient relaxation and decrease the work of breathing to allow gentle restraint, intravenous catheter placement and emergency cageside diagnostics to be performed. Short- acting reversible sedative regimens are preferred (eg. opioid and benzodiazepine combinations), and drugs and dosages that will cause significant respiratory depression should be avoided. Intramuscular injections should be considered if the patient is assessed to be too dyspnoeic to allow placement of an intravenous catheter (butorphanol 0.05-0.2mg/kg IM, morphine 0.2-1.0mg/kgIM or meperidine 3-5mg/kgIM followed by midazolam 0.2-0.4mg/kgIM if further sedation is required). Patients in respiratory arrest (not breathing) should have the upper airway assessed for obstruction followed by intubation and positive pressure ventilation. The presence of stridor or increased upper airway sounds

may indicate upper airway obstruction, which if left untreated could lead to further inflammation, swelling, oedema, and progression of the obstruction.[4,13,14] If upper airway patients are at imminent risk of respiratory arrest or fail to improve with oxygen therapy and anxiolytics, emergency endotracheal or tracheostomy tube placement may be required.[13,14] In these cases, due to stress and the work of breathing, heavy sedation (such as opioids combined with benzodiazepines) or general anaesthesia (such as alfaxalone or propofol titrated to effect) may be required to allow passage of an oral or endotracheal tube. If tracheostomy or endotracheal intubation is not possible (severe upper airway swelling/obstruction), passage of a longer (3-4.5 inch) large bore (12-14 gauge) intravenous catheter (or the largest bore intravenous catheter available) through the skin into the trachea between adjacent tracheal rings or via the cricothyroid distal to the suspected obstruction may allow stabilisation until tracheostomy or other lifesaving interventions can be performed.[14] If a transtracheal catheter is placed it can be connected to an IV extension set which is then connected to an oxygen line (see Figure 6) and/or an Ambu bag if positive pressure ventilation (PPV) is needed (the latter is achieved by using an adaptor from a 3.5-inch endotracheal tube, see Figure 7).[14] It may be necessary to intermittently discontinue supplemental oxygen or PPV to allow exhalation via the transtracheal tube, particularly in cases of complete upper airway obstruction where expiration via the normal oro-tracheal route cannot occur. If the cause of respiratory distress is unknown and ultrasonography is available, patients may benefit from TFAST and/or VET BLUE evaluations by the emergency clinician (which can be performed with the patient in sternal or standing while receiving oxygen therapy). Thoracic radiographs can be very valuable in determining the underlying cause of respiratory distress in the collapsed dog. However, radiography should not be performed until the patient is sufficiently stable to allow radiographs to be safely taken without causing respiratory compromise.

NEUROLOGICAL SYSTEM

Haemodynamically stable patients presenting in a state of collapse and comatose with or without a history of seizures should have intracranial disease (particularly trauma and tumor), infectious disease (rabies, distemper, fungal, and parasitic), metabolic disease (hypoglycaemia, hyper- or hyponatraemia, diabetic ketoacidosis, hyperosmolar diabetes mellitus, hepatic encephalopathy, myxedema

coma) and toxin exposure ruled out.[13] Anti-seizure medication should be administered to the seizing patient (diazepam 0.5-1mg/kgIV; can repeat twice in 15 minutes, if ineffective then use constant rate infusion or different drug); or phenobarbital 2-15mg/kg slow IV bolus (monitor respiration); or propofol (if severe hepatopathy/hepatic coma) 1-6mg/kg IV bolus, can repeat or switch to constant rate infusion (monitor respiration).[4]

Patients with evidence of increased intracranial pressure may benefit from mannitol (0.5-2mg/kgIV over 20-30 minutes) or hypertonic saline (5-7.5% at 4-6ml/kg), particularly in cases of traumatic brain injury. If stupor or coma is present, intubation may be required to protect the airways (assess presence or absence of a gag reflex) and ventilation should be monitored closely, ideally using capnography or blood gases aimed at maintaining the EtCo2/PCo_2 between 35-45mmHg.

If life-threatening, deterioration occurs before the diagnosis is confirmed, rapid-acting intravenous glucocorticoids (dexamethasone, 0.1mg/kg IV) can be administered for suspected neoplasia or encephalitis.[15] Many of these patients will require advanced diagnostic testing such as cerebrospinal fluid collection and analysis CT or MRI to determine the underlying cause if their state of collapse is not trauma, idiopathic epilepsy, metabolic, or toxin-related, and they do not show neurological improvement within 24-48 hours.

SUMMARY

Collapse in the canine patient can result from numerous underlying causes. Unstable patients require emergency cageside diagnostics concurrent with immediate stabilisation efforts to rapidly identify the underlying cause and help direct further diagnostic and therapeutic decisions.

It is critical that practitioners who might have to manage acutely collapsed patients become familiar with performing and interpreting these tests, and know how to implement immediate stabilisation procedures within minutes of patient arrival.

REFERENCES

Available on request

READER QUESTIONS AND ANSWERS

1. APPROXIMATELY WHAT PERCENTAGE OF UNSTABLE DOGS PRESENTING WITH ACUTE COLLAPSE WILL LIKELY HAVE FREE FLUID IDENTIFIED ON EMERGENCY CAGESIDE ULTRASOUND EXAMS?

A 75%
B 100%
C 50%
D 25%
E 5%

2. MINIMUM EMERGENCY CAGESIDE DIAGNOSTIC TESTS IN THE ACUTELY COLLAPSED PATIENTS ARE USED TO:

A Establish base-line prognosis but should not be repeated to determine serial prognosis
B Assess stability of the respiratory system and should not be used to assess cardiovascular stability
C Assess patient stability but should only be performed after the patient is completely stable
D Establish prognosis prior to resuscitation efforts as resuscitation can confound interpretation of the results
E Establish base line parameters which help guide therapy, and help identify the underlying cause

3. GENERAL THERAPY FOR THE ACUTELY COLLAPSED UNSTABLE CANINE PATIENT SHOULD FOCUS ON:

A Aggressive fluid boluses in all patients, regardless of the underlying cause
B Stabilisation of vital organs until the underlying cause can be identified and addressed
C High-dose glucocorticoids as no patient should die without the benefit of steroids
D Antibiotics as there is sufficient indication for antibiotics in any collapsed patient
E Identifying the cause before providing analgesia as analgesia can confound results

4. RECOMMENDED IMMEDIATE THERAPY AND EMERGENCY CAGESIDE TESTING FOR DOGS PRESENTING WITH ACUTE COLLAPSE AND RESPIRATORY DISTRESS SHOULD INCLUDE:

A Thoracic radiographs, an intravenous catheter and blood gas analysis
B An intraosseous catheter, minimising stress and antibiotics
C Oxygen therapy, anxiolytics and TFAST/Vet BLUE cageside sonography
D Glucocorticoids, pulse oximetry and positive pressure ventilation
E Furosemide, endotracheal intubation and an emergency venous cutdown

5. A REASONABLE INTRAVENOUS FLUID CHOICE AND DOSE TO ADMINISTER TO AN ACUTELY COLLAPSED CANINE PATIENT WITH HYPOVOLEMIA AND SIGNS OF SHOCK WOULD BE:

A Hypertonic saline (5%) at a dose of 20ml/kg over 10 minutes
B Isotonic saline at a dose of 15ml/kg over 10 minutes
C Hypotonic saline at a dose of 20ml/kg over 20 minutes
D Synthetic colloids at a dose of 15ml/kg over 10 minutes

ANSWERS: 1:A, 2:E, 3:B, 4:C, 5:B