Case-Based Panel Discussion on Dog Attack Injuries

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Dog fight wounds and trauma - this is a case-based discussion on the approach to cases from a surgeon’s and emergency clinician’s perspective. It will address soft tissue trauma as well as bite wounds involving the joints and fractures, as well as truncal penetration wounds. This treatise will also cover initial approach and triage of the patient, treating shock with stabilisation and assessment and management of wounds, as well as the risk of SIRS & sepsis, with antimicrobial coverage expansion. Some controversies will be explored – timing of medical & surgical intervention and anti-inflammation therapy (steroids and non-steroids), and the use of anti-fibrinolytics to name a few.

Dog bites wounds were implicated for 10% of admissions to an emergency centre in one study, even though the true incidence of dog bites has not been established.

Another study reviewed 185 dogs and 11 cats that suffered dog bite attacks and here, male dogs were more frequently bitten than females, and small dogs (< 10 kg) were more common victims and also were more likely to suffer multiple injuries. Mortality occurred only in cases with thoracic or abdominal injuries. Curiously, exploratory thoracotomy, did not prove to alter prognosis in the cases presented with penetrating thoracic injury.

A further study evaluating organ dysfunction and mortality risk factors in severe canine bite trauma wounds reported an enhanced risk of the development of complications of SIRS, DIC, & MODS. In this study, longer time to anaesthesia prolonged recovery and an increased mortality was associated with longer anaesthetic times. In this cohort of 94 cases admitted to the ICU with dog attack injuries, the respiratory system was the body system most commonly affected, and cardiovascular dysfunction was highly predictive of mortality.

A veterinary study of 87 untreated canine bite wounds somewhat surprisingly reported little correlation between the prevalence of pathogens in the mouth and their prevalence in wounds. Here, Staphlococcus intermedius & Escherichia coli predominated and antimicrobial resistance was common, with Cotrimoxazole showing the most in-vitro effectiveness.

Another study of 37 dogs cultured S. intermedius, Enterococcus and E. coli in decreasing order of frequency with a wide range of aerobic & anaerobic bacteria also cultured; there was no one antibiotic that was shown to be reliable and there was an inability to predict neither the bacterial isolates nor the likely antibiotic sensitivity could be predicted with any accuracy.

Dog bite wounds to dogs and cats range in intensity from simple lacerations to life-threatening injuries to the head and trunk, with the chest and abdominal cavities particularly at risk. These injuries may result in internal organ damage, SIRS (Systemic Inflammatory Response Syndrome), and sepsis. Lacerations of major vessels can result in severe haemorrhage. Our current understanding of inflammation, wound healing and SIRS highlights the key facts that healing will not advance past the inflammatory phase until dead, dying or infected tissue is removed, and that a wound containing devitalised +/- infected tissue can act as a continuous stimulus for SIRS +/- sepsis.

Dog bite wounds are familiar phenomena, and while bite trauma can occur anywhere on the body, the head and ventral neck are especially prone to attack.

The ABCDE’s OF Emergency Medicine provide the essentials of initial point-of-care dealing with dog bite wounds – treating shock, providing analgesia and antibiotic cover with stabilisation of major
problems (airways, breathing, circulation taking precedence) prior to most invasive procedures. Once life-threatening concerns have been addressed and the patient is stabilised, more detailed and advanced imaging +/- exploratory surgery may be undertaken more securely. Many times, the skin wounds are not the most important problem for the dog – puncture wounds can mask consequential deeper damage as the victim’s elastic skin typically moves with the teeth as well as the bitten dog’s tendency to pull away from the aggressor, not least of all the massive biting pressure that the dog’s jaws impose. Hence the skin wound often hides more ominous damage to crucial structures below the skin, the consequence of the teeth tearing through the deeper tissues during the scuffle – the so-called ‘iceberg’ effect – creating a dead space and inoculating the wound with bacteria and organic matter.

Where the wounds are assessed as superficial with no harm to vital structures, cleaning and leaving the wounds open is commonly employed to cater for ongoing tissue necrosis and exudation, with analgesia and appropriate antimicrobials prescribed; any necessary repair being postponed until any discharge has eased, often 1-3 days – an absorptive bandage aids in keeping the wounds clean. Wounds that are determined to have substantial dead space will have surgically placed drains applied. Any evidence of subcutaneous emphysema over the thorax could indicate intercostal muscle tearing or even fractures of ribs. Bulges over the abdomen may be indicative of breaching or herniation of the body wall.

Radiography +/- Ultrasound is contemplated if wounds are thought to penetrate the thorax or abdomen – the detection of effusions or free gas warrant exploration to evaluate internal organ injury and to lavage the affected body cavity. Also, tears in the body wall with or without herniation demand evaluation surgically with repair. Further radiography +/- contrast +/- advanced imaging (CT/MRI) is considered if skeletal and/or spinal injuries are seen or suspected.

Wounds have been defined as Clean-contaminated if <6 hours old, Contaminated if it looks grossly dirty +/- is >6 hours old, and Dirty if the wound contains necrotic tissue +/- purulence. Bacteria commonly isolated from dog bites include Pasteurella canis, Staphlococcus and Fusobacterium spp. These can manifest as rapidly progressing cellulitis. While research on antibiotic use in dog fight injuries is very scarce, evidence, although weak, suggests prophylactic antibiotics are not usually warranted in fresh superficial dog bite wounds. However, prophylactic antibiotics receive far less controversy in injuries with a high risk of infection – delayed presentation (>6 hours) wounds; wounds in immunocompromised patients; wounds involving deep tissues such as tendons, joints, bones; puncture wounds that cannot be adequately debrided.

The risk of infection can be reduced with proper wound care. Initial therapy for all bite injuries involves comprehensive cleaning, debridement, irrigation +/- immobilisation. Antimicrobial therapy should never be used as a substitute for good infection control, and good medical and surgical implementations.

Antimicrobial, pathogen, infection site and patient factors come under scrutiny when choosing as appropriate antimicrobial.

A narrow spectrum antimicrobial is preferred for as short a time as possible. In patients who present with bite wounds with an established infection, there is scant but compelling evidence that primary closure of bite wounds may be associated with higher rates of infection, and so consideration should be given to delaying primary wound closure.

Ideally, infected tissue is collected and tested for gram stain, aerobic and anaerobic cultures before starting antimicrobials. In short, antibiotics have a limited role in the prevention of infection but are an important adjunct to treatment of infected and at-risk dog bite wounds (necrotic tissue, circulatory compromise, and delays in proper medical/surgical management).
MANAGEMENT OF THE TRAUMA PATIENT - A BLUEPRINT FOR HANDLING ALL EMERGENCIES

In acute trauma, early effective treatment influences greatly the occurrences of secondary organ system involvement and hence the final outcome. The so called "Golden Period" is reported to be one hour ie., the time frame in which a good outcome is likely if appropriate treatment is begun. Hence, teamwork and readiness are essential to allow efficient and rapid resuscitation from expected and sometimes unexpected consequences of major trauma.

Early restoration of tissue perfusion and maintenance of tissue oxygenation is paramount to improving patient survival from trauma this is based around oxygen content of the blood and delivery of oxygen to cells in the body. With trauma, an accumulating tissue oxygen debt (from decreased tissue perfusion and/or hypoxemia) can trigger processes that lead to a systemic inflammatory response (SIRS) and multiple organ dysfunction syndrome (MODS). Hence, the initial approach and fluid resuscitation of all traumatically injured patients should be aimed at improving and restoring tissue perfusion and oxygenation.

Oxygen delivery (DO2) is dependent on cardiac output (CO), haemoglobin saturation with oxygen (SaHbO2), and total haemoglobin concentration ([Hb]):

$$\text{DO2} = \text{CO} \times \text{CaCO2}$$

Where CO = HR x SV (Contractility, Preload, Afterload)

$$\text{CaCO2} = (\text{Hb} \times \text{SaHbO2}) + (0.003 \times \text{PaO2})$$

Therefore, an initial approach to the patient with traumatic injury should be focused on:

1. **The respiratory system** - insuring adequate saturation of haemoglobin with oxygen by assessing breathing and correcting potential causes of hypoxaemia using GPE parameters like MM colour, RR rate & effort, HR, thoracic auscultation and measurable parameters such as SpO2 or more ideally PaO2. Pleural space compromisation (pneumothorax, haemothorax, diaphragmatic hernia) can be assessed by TFAST, Diagnostic thoracocentesis, and/or chest radiographs
   - Airway access +/- oxygen supplementation
   - Analgesia

2. **Improving cardiac output** - the most common cause of decreased cardiac output in traumatically injury patients is hypovolaemia secondary to haemorrhage. Initially, assessment of cardiac output and circulating blood volume includes evaluation of the patient’s mucous membrane colour, HR, CRT and pulse quality - pale or grey mucous membranes, prolonged CRT, tachycardia (HR > 120 bpm) and weak peripheral pulses indicate inadequate perfusion. Arterial blood pressure (indirect with Doppler or Oscillometric apparatus or direct via an Arterial catheter) is important as many animals with hypoperfusion will still have palpable peripheral pulses. ECG should be performed during the initial survey to assess heart rate and evaluate for the presence of cardiac arrhythmias (VPCs & VTach are the more common arrhythmias in trauma).

   SI (Shock Index), the ratio of heart rate to systolic blood pressure has been evaluated in dogs and an SI > 1.0 was found to be both sensitive and specific for diagnosing blood loss.

   Haemorrhage should be suspected in a patient with a low PCV and low TS but also may be occurring in a patient with a normal PCV with concurrent low total solids as a result of
splenic contraction – in fact, low total solids (< 55 g/L) may be more specific than the actual PCV for active or previous haemorrhage.

Blood lactate concentration increases with decreased oxygen delivery as cellular metabolism switches from aerobic to anaerobic metabolism. Increased lactate concentration greater than 2.0 mmol/L may suggest decreased tissue perfusion. A lactate >5.0 mmol/L was found to be associated with non-survival in a large canine study of trauma.

An increased base deficit and metabolic acidosis or decreased CO2 are also indicators of reduced tissue perfusion.

AFAST examination to assess for abdominal blood loss, which may be contributing to inadequate tissue perfusion, is probably as accurate as any of the monitors described. It can help guide fluid therapy and direct future additional diagnostic testing, eg. abdominocentesis. Repeat AFAST exams assess for worsening effusion or in cases in which the AFAST was initially negative but the patient was haemodynamically unstable.

- IV access with IVF administration

3. Hb concentration maximisation

   \[ \text{PCV} \times \frac{10}{3} = [\text{Hb}] \text{ in g/L} \]

   as PCV is used more commonly in veterinary medicine, however the optimum haemoglobin concentration in animals is not known and no specific PCV has been labelled as the ‘transfusion trigger’

   The decision to give blood products is largely based around:

   - Clinical parameters (HR, RR, Mentation, Pulse quality, heart arrhythmias, etc)
   - The rate at which the haematocrit changes

   A canine study showed a PCV of 39% (92% specific but only 43% sensitive) & TS of 45g/L (88% specific but only 55% sensitive) as predictors for blood transfusion.

   Another study of 52 dogs with blunt trauma revealed a base excess of -6.6 mmol/L was 73% specific & 88% sensitive for predicting the need for blood transfusion.

   Acute traumatic coagulopathy secondary to an imbalance of the equilibrium between procoagulant factors, anticoagulant factors, platelets, endothelium and fibrinolysis may contribute to ongoing haemorrhage and need for blood transfusion. The use of anti-fibrinolytics, eg. tranexamic acid & aminocaproic acid to prevent clot dissolution and additional haemorrhage is coming into vogue in veterinary medicine. This interest comes from compelling evidence in some large human studies finding that the administration of tranexamic acid to traumatically injured people who were bleeding or at risk of bleeding within 3 hours of injury reduced the risk of death from haemorrhage and decreased overall mortality as compared to placebo. In veterinary medicine, there have been some recent retrospective studies describing the use of tranexamic acid & aminocaproic acid in dogs. Although the evidence is not robust, the anti-fibrinolytics do seem to help control haemorrhage in the trauma patient, and it would seem do no harm at the very least.

TRIAGE AND EARLY PATIENT ASSESSMENT AND CARE

The Primary survey of the presented trauma patient may have to be very scant if a true emergency and the clinician may have to get a quick history as treatment is already underway eg. those presented with respiratory distress, head trauma (coma, seizuring, etc), overt bleeding, pallor/slow capillary refill time, multiple fractures, very weak pulses.

   The time honoured pneumonic for immediate action is:

   A  Airway maintenance with control of the cervical spine
B Breathing and ventilation
C Circulation with haemorrhage control
D Disability: rapid neurological examination
E Exposure/Environment control: prevent hypothermia

1) Level of Consciousness
   • bright, alert and responsive (B.A.R.) is the standard
   • if reduced, determine the cause eg. hypotension, head trauma, etc.

2) Airway Patency and Breathing Effort
   • resuscitation to restore the airway if not patent
   • check for subcutaneous oedema, blunt or penetrating wounds, crepitus, pain
   • if dyspnoeic, give oxygen by fly-by, catheter (nasal or nasopharyngeal or tracheal), or if breathing problems persist, then assisted ventilation by an Ambu bag may be necessary; intubation and IPPV if previous methods are not working and this often requires some chemical sedation (diazepam 0.1 mg/kg, thiopentone 3-5 mg/kg, or ketamine 2-5 mg/kg if no evidence of head injury)
   • thoracocentesis diagnostically and therapeutically as well as chest tube placement for pneumothorax may be employed.
   • chest x-rays will be necessary at some stage.

3) Circulation
   • pulse character, pulse rate, rhythm and strength, mucous membrane colour, capillary refill time
   • if poor pulses, begin resuscitation of the circulation; doppler blood flow detector for blood pressure measurement is handy here
   • fluid therapy
     i. Crystalloid fluid (eg. Lactated Ringers Solution) at shock rates initially (90 ml/kg/hour for dogs, 55 mls/kg/hour for cats) delivered warm and under pressure through a large bore catheter. Smaller increments of 1/4 – 1/3 of the shock dose is now recommended, with monitoring of the response before proceeding with the next increment.
     ii. (Colloid (eg. Voluven) up to 20 ml/kg in increments of 5 mg/kg over 5-10 minutes indicated in acute shock conditions, hypoproteinaemia, for interstitial protection, and as a blood substitute; reduce the amount of crystalloids needed by 40-60%, but crystalloids are needed if there is severe dehydration; doses may be repeated daily. The use of Colloids remains controversial.
     iii. Hypertonic Saline creates a hypertonic intravascular environment where there occurs a rapid shift of extravascular fluid into the vascular space and hence there is a rapid improvement in blood pressure and circulation with small volumes (4-5 mls/kg); however equilibration of intra and extra vascular fluid levels fail to maintain appropriate blood levels.
     iv. Hypertonic Saline (7.5%) in Dextran 70 (6%) greatly improves the longevity of the rapid response seen with hypertonic solutions; need to follow up with isotonic crystalloid solution, but the amount needed is reduced by 40-60%; good indications for closed head injury, burns shocked patients and hypovolaemic shock due to trauma or haemorrhage but is contraindicated where haemorrhage is uncontrolled, dehydration (especially hypernatraemic dehydration) and hypothermia.
     v. Provide hypotensive resuscitation initially where internal bleeding is suspected or proven (eg., in penetrating trauma to the thorax or abdomen) as the first priority here is to stop the source of haemorrhage before providing massive fluid or blood support as this risks restarting of the haemorrhage.
   • Tranexamic Acid loading dose (10-15mg/kg IV bolus) then CRI of 1/5mg/kg/hr
• If shock persists, other methods of resuscitation that may be employed include:
  (a) Abdominal counterpressure - controversial; Crowe claims that counterpressure decreases vascular diameter by external force on the blood vessels and a small reduction in diameter significantly reduces flow. Cotton towels could be used around the abdomen, pelvis and pelvic limbs and secured with tape. Being able to comfortably place a finger between the bandage and the skin confirms correct placement; alternatively a blood pressure cuff could be placed on the abdomen partially inflated and incorporated into the bandage - in this situation, 40-60 mm Hg measured on the sphygmomanometer is ideal. The rear limbs should always be included and should be bandaged first to prevent venous distension caudally. Monitor breathing carefully to avoid compromisation. As the animal's condition stabilises, the wrap may be gradually removed, starting from the cranial aspect. If stabilisation is not occurring, maintain counterpressure until surgery is undertaken. If surgery is not to be done, the counterpressure wrap should stay on up to 24 hours. The addition of 25-50 mls/kg of warmed saline/lactated ringer's solution can be infused rapidly into the abdomen to provide hydraulic pressure to the organs if surgery is not possible. Complications include respiratory compromise as well as continued haemorrhage requiring more transfusions than if surgery would have been performed earlier.
  (b) Pressor drugs:
    - eg. dopamine 3-20 mcg/kg/min; dobutamine 5-30 mcg/kg/min; adrenaline 0.05-20 mcg/kg/min
    - best to have an ECG monitor to look for adverse cardiac effects eg., arrhythmias.
  (c) Check for hypothermia.
  (d) Re-evaluate the patient as there is likely to be blood loss from an unidentified problem eg., the abdomen.

4. Neurologic Trauma

• Corticosteroid use is controversial but still in regular use – there is no evidence to support its use, and in fact, deleterious effects seem to outweigh any potential benefits
• Polyethlene glycol (PEG) has shown some promise – 30% solution (w/v) is given at 0.5-1.0 ml/kg IV and repeat in 6 hours.
• Mannitol (0.5 - 1.0 g/kg) can be given repeatedly but it is necessary to begin fluids first as it is essential to be sure of adequate blood volume.
• Oxygen is paramount.
• Frusemide (1 mg/kg) has been reported to help dull the initial rise in CSF pressure caused by Mannitol and has been used as a once only dose before employing low dose Mannitol (0.25 g/kg) therapy
• Anatomically localising the neurologic lesion is useful for prognosis initially:
  eg. cerebral - good prognosis
  eg. cerebellar - guarded
  eg. brain stem - poor prognosis

Injuries are addressed as they are detected, using the same basic order as before - the respiratory system is looked after firstly, rapidly followed by the cardiovascular system and then the central nervous system before the abdomen is attended to.

A more detailed history may provide more information eg., did anyone witness the trauma and if so, describe the events; prior medical problems; last meal; did the patient urinate, etc.

Radiography
Xrays of the chest and abdomen should be performed on all trauma patients; spinal survey films are indicated in non-ambulatory cases.

Although Xrays often provide invaluable information in patients with trauma, the old adage "Never risk a patient's life for the want of a diagnosis" holds true here, eg., evisceration, severe penetrating injuries, obvious gunshot wounds, severe peritonitis, don't require Xrays. But Xrays may be a good survey market in animals in too much pain to allow systematic evaluation of the chest or abdomen by palpation.

Abdominal survey films help identify masses, organomegaly, foreign bodies, intussusception, intestinal obstruction, calculi, fluid, intestinal or gastric gas, free gas (seen between the diaphragm and the liver), diaphragmatic herniation, abdominal wall herniation, organ torsions, pancreatitis, skeleton abnormalities, peritonitis (regional or generalised loss of abdominal detail).

Retroperitoneal haemorrhage or urine in suspected with streaking of the soft tissues ventral to the lumbar vertebrae or a depressed psoas line on a lateral view; retroperitoneal tumour or abscess can look similar.

Generalised loss of detail suggests abdominal effusion - fluid, inflammation.

Posterior rib fractures might indicate more significant trauma to the stomach, liver, pancreas, and/or biliary apparatus.

Ultrasonography

With the improving quality of portable ultrasound machines, this non-invasive and quick modality is becoming more frequently used in veterinary emergency and critical care medicine, and is very useful in the evaluation of the trauma patient eg., detecting intraabdominal haemorrhage, pericardial effusion, etc.

AFAST (Abdominal Focused Assessment with Sonography for Trauma)
TFAST (Thoracic Focused Assessment with Sonography for Trauma)

Lisciandro et al JVECCS 19 (5) 2009, pp 426-437

Abdominocentesis

Indications

- loss of serosal detail on abdominal Xrays
- penetrating abdominal injury without obvious peritoneal entry wounds
- CNS injury making abdominal examination unreliable
- possibility of abdominal haemorrhage
- persistent abdominal pain of unknown cause
- shock, multiple injuries, or signs of abdominal injury after blunt trauma
- postoperatively for investigations of complications of surgery eg., leaking from enterostomy site, monitoring of peritonitis, etc.
- detection of abdominal fluid (Xrays, ultrasound, physical examination) or free gas, or a generalised loss of radiographic abdominal detail
- may help therapeutically if effusion is large enough to be compromising breathing
- often narrows down the list of differential diagnoses and provides fluids for cytology, culture and sensitivity, and biochemical analysis.

Contra-indications
• suspect pyometra
• best to do after Xrays as it is possible to introduce air (or fluid in DPL) into the abdomen which may confuse diagnostics
• disadvantage is the 50% false negatives, as it is said that there has to be at least 5mls/kg and up to 25mls/kg of free fluid to be detected by needle paracentesis, cf, 40mls/kg must be present to detect distinct abdominal distension.

Techniques

1. Tapping the four quadrants with 22 gauge needles with the animal in standing or right lateral recumbency.
2. Tap the lower caudal segment (described by Guildford) in right lateral recumbency eg., male dogs, just to the right of the prepuce. The advantage is that it avoids the omentum; the disadvantage is the bladder.
3. Ultrasonic guidance to the site of fluid accumulation.

Evaluation

PCV, TP (to compare with peripheral blood), specific gravity, cellular count, and biochemistry (urea, creatinine, potassium, amylase, bilirubin) as well as gram stains may be performed.

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<th>TP</th>
<th>TNCC</th>
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<td>• usually due to hypoalbuminaemia</td>
<td>&lt; 1.017</td>
<td>&lt; 25 g/L</td>
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<th>Exudate</th>
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<td>• septic e.g. bowel perforation**</td>
<td>&lt; 1.017</td>
<td>&gt; 30</td>
<td>&gt; 3000/uL</td>
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<td>• sterile e.g. pancreatitis</td>
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<th>Modified Transudate</th>
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<td>• suggests, prehepatic protal hypertension (organ torsions, neoplasia)</td>
<td>&lt;= serum albumin concentration</td>
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<td>• suggests hepatic or posthepatic portal hypertension (cirrhosis, CHF)</td>
<td>TP about equal to serum albumin concentration</td>
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<td>• haemorrhage</td>
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** A Glucose reading of abdominocentesis fluid that is greater than 1.1 mmol/L less than peripheral Blood Glucose is highly suggestive of septic peritonitis.

** A Lactate reading of abdominocentesis fluid that is greater than 2.0 mmol/L more than peripheral Blood Lactate is also highly suggestive of septic peritonitis
**Gastric perforation should be considered a differential diagnosis in dogs with an increased peritoneal effusion to serum potassium ratio**

### Studies have shown there are no objective predictive indicators for post-operative septic peritonitis in dogs with closed-suction abdominal drains

- PCF/TP similar to blood suggests a recent haemorrhage (less than six hours) or iatrogenic blood vessel puncture.
- If PCV is greater than that of peripheral blood, highly indicative of splenic, hepatic, or renal parenchymal laceration.
- If PCV is less than blood, medical support may be adequate. If repeated samples show PCV increasing by 5% or more, there is significant ongoing haemorrhage.

REFERENCES
Available on request