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Best practice recommendations for prehospital veterinary care of dogs and cats

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Abstract

Objective – To examine available evidence on prehospital care in human and veterinary trauma and emergency medicine and develop best practice guidelines for use by both paramedical and nonparamedical personnel in the approach to the prehospital care of dogs and cats.
Design – Systematic evaluation of the literature gathered via medical databases searches of Medline, CAB abstracts, and Google Scholar.
Synthesis – From a review and systematic evaluation of the available evidence, consensus guidelines on the approach to prehospital care of dogs and cats in 18 scenarios were developed.
Conclusions – Due to the lack of current evidence in the veterinary prehospital arena, best practice guidelines were developed as an initial platform. Recommendations were based on a review of pertinent human and available veterinary literature as well as a consensus of the authors' professional opinions. It is anticipated that evidence-based additions will be made in the future.

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Keywords: cat, dog, first response, trauma, VetCOT

Abbreviations

ALS	advanced life support
ATLS	advanced trauma and life support
BLS	basic life support
BSI	body substance isolation
BVM	Bag Valve Mask
CNS	central nervous system
CPA	cardiopulmonary arrest
CRI	continuous rate infusion
C-TCCC	canine tactical combat and casualty care
CV	cardiovascular
EMS	emergency medical services
EMT	emergency medical technician
ET	endotracheal
ETT	endotracheal tube
FB	foreign body
GDV	gastric dilatation and volvulus
GI	gastrointestinal
GSW	gunshot wound
HTS	hypertonic saline
IO	intraosseous
K9	canine
K9 TECC	canine tactical emergency casualty care
LRS	lactated ringers solution

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LOC/LOR	level of consciousness/responsiveness
MDI	metered dose inhaler
MOI	mechanism of injury
MTA	medical threat assessment
MWD	military working dog
NOI	nature of illness
NS	normal saline
OpK9	operational canine
PHTLS	prehospital trauma life support
PPE	personal protective equipment
PPV	positive pressure ventilation
SACS	small animal coma score
SAR	search and rescue
SCI	spinal cord injury
TBI	traumatic brain injury
TBSA	total body surface area
TCCC	tactical combat and casualty care
TQ	tourniquet
TXA	tranexamic acid
VetCOT	veterinary committee on trauma

Background

The American College of Veterinary Emergency and Critical Care's Veterinary Committee on Trauma (VetCOT) has recognized the need for the development of prehospital care in veterinary trauma medicine. To address this void, the Prehospital Committee was formed, incorporating members interested or currently involved in veterinary prehospital training of human responders. The goal of the committee is to improve the availability and quality of prehospital care to injured small animals, which may incorporate individuals trained in either or both human and veterinary medical trauma care. The first step identified by the committee was the development of guidelines, similar to those present in human trauma care, to be utilized by responders. The following paragraphs outline historical and organizational concepts taken into consideration by the committee.

Unintentional injuries remain one of the leading causes of death worldwide in people 1–44 years of age. Many (40–70%) posttraumatic fatalities occur before the patient ever reaches a medical treatment facility (ie, the prehospital period). These prehospital fatalities often occur within minutes of the injury as a result of massive exsanguination or severe brain injury. Expedient recognition of life-threatening conditions and provision of timely first aid at the point of injury can often be lifesaving. It is estimated that 20–25% of all prehospital fatalities are preventable simply by implementing early and appropriate basic first aid techniques. The three most commonly observed trauma-related preventable deaths in people are: (1) hemorrhage from extremity wounds, (2) tension pneumothorax, and (3) airway obstruction. Unfortunately, these statistics are not yet available in veterinary medicine, but the mechanisms of injury, such as blunt trauma from a moving vehicle, are similar.

Brief history of human trauma care

The need for adequate prehospital trauma care and rapid transport to a definitive trauma care facility led in the 1970s to the widespread development of formalized Emergency Medical Systems (EMS) that provide the following 6 key functions: *detection, reporting, response, on-scene care, care in transit, and transfer to definitive care*.[a] Development of robust EMS programs required that EMS personnel[b] receive formal training in prehospital trauma care. This training was initially based off the principles taught in the American College of Surgeons' Advanced Trauma Life Support (ATLS) course for physicians. Because the prehospital setting is a different situational and logistical environment where ATLS principles may not be applicable, in 1981, the American College of Surgeons Committee on Trauma in cooperation with the National Association of Emergency Medical Technicians developed the *Prehospital Trauma Life Support (PHTLS)* course for emergency medical responders. The PHTLS course has the main goals of: (a) gaining access to the patient, (b) rapidly identifying and rendering aid for life-threatening injuries until the patient can be evacuated to a higher level of definitive care, and then (c) packaging and transporting the patient to a designated trauma care center in the shortest amount of time possible. The principles of PHTLS focus on early, simple, and well-conducted medical interventions that will eliminate or mitigate preventable deaths and contribute most to improving survival and overall outcome. Considering each situation is unique, PHTLS incorporates flexibility allowing first responders the ability to adapt their principles to the scenario at hand. In addition, PHTLS does not require advanced medical knowledge. Skills must be easily learned and implemented by a wide range of paramedical personnel with varying degrees of medical knowledge and experience. PHTLS remains one of the leading training programs for prehospital emergency trauma care throughout the world. In low-income countries that do not have adequately established EMS services, the implementation of even basic PHTLS principles (eg, direct pressure hemostasis, simple airway techniques) provides a beneficial effect in reducing trauma-related mortalities.

Initial management ("*Stay and Play*" versus "*Scoop and Run*")

In recognition of the need to highlight timely response, the critical periods postinjury have been coined the

"Platinum 10 minutes" and the "Golden Hour." Once on scene, the "Platinum 10 minutes" is the time it takes for an emergency medical responder to assess the situation, initiate treatment, and prepare the patient for transport. The PHTLS and most other guidelines advise limiting scene time to as short as possible. Therefore, during these "Platinum 10 minutes" responders should only pursue those interventions necessary to abate life-threatening complications associated with exsanguination, airway, and breathing.

Once the patient arrives at the trauma center, the trauma team identifies all major trauma injuries and initiates definitive resuscitative and care interventions. These measures need to begin as soon as possible; within the so-called "Golden Hour" that refers to the initial 60 minutes posttrauma, including prehospital care and transport. Traditionally, it has been considered the most important period of time for saving lives. If definitive care is not provided within these 60 minutes, injury severity and rate of nonsurvival significantly increases.

In human trauma care, there is still lack of evidence regarding the most effective strategy for prehospital interventions. A major point of debate is the value of performing advanced life support (eg, endotracheal intubation, tube thoracostomy, intravenous catheterization) versus basic life support (eg, oxygen supplementation, cardiopulmonary resuscitation, hemorrhage control, fracture stabilization) procedures at the scene. This debate has led to two different approaches ("*Stay and Play*" versus "*Scoop and Run*") in the initial management of a patient at the scene. With "*Stay and Play*," the technology is brought to the patient in order to facilitate stabilization at the point of injury. Advanced life support (ALS) techniques (ie, securing the airway by endotracheal intubation, performing tube thoracostomy in patients with recurring tension pneumothorax, or establishing intravenous access and initiating fluid resuscitative therapy) are often pursued with the "*Stay and Play*" approach. Once stabilized, the patient is then transported to the hospital. "*Stay and Play*" generally works best for patients from rural areas and other situations having prolonged transport times from the scene to definitive treatment. Despite ALS having the theoretical advantage for improving patient outcome, the evidence for any benefit is limited.

"*Scoop and Run*" is where the patient is rapidly transported to the trauma center without implementing any stabilization procedures at the scene. The "*Scoop and Run*" approach is more applicable to urban areas with short transport times (eg, <20–30 minutes) to the trauma center. If any action at the scene is required, it should only be for time-sensitive EMS interventions necessary to survive preventable injuries (eg, correcting airway obstruction, respiratory arrest, or external hemorrhage at a compressible site). Any procedure (eg, intravenous catheterization or intubation) that delays timely evacuation should not be performed at the scene. Instead, these "advanced" procedures should be pursued during transportation, or left to be performed at the trauma center. This delayed resuscitative approach was first shown to be beneficial by Bickell et al with their landmark study in 1994 evaluating urban trauma casualties with penetrating injuries. Support for *"Scoop and Run"* comes from the fact that ALS procedures are technically demanding and not all EMS personnel have the proficiency to rapidly and correctly perform these skills in the field. Furthermore, proponents of the "*Scoop and Run"* also argue that patient outcome is improved if they are transported to definitive care within an hour of injury (ie, the "Golden Hour"). Although sound in theory, Newgard et al showed no association between EMS intervals times (eg, activation, response, on-scene, transport, and total time) and mortality among injured patients with physiologic abnormalities in the field.

No difference with regard to patient outcome has been shown when *"Stay and Play" and "Scoop and Run"* have been compared. Many factors unique to each situation (eg, mechanism of injury, level of provider experience, geographical location, transport times, available resources) likely influence outcome and may affect the degree of recommended prehospital interventions. For instance, basic life support (BLS) may be the better approach for patients with penetrating injuries whereas some studies indicate a beneficial effect of ALS among patients with blunt head injuries or multiple injuries. A more appropriate strategy may be to use a combined approach of *"Stay and Play"* and *"Scoop and Run"* to balance the pros and cons of each strategy. In the end, the goal of prehospital care should be to limit scene time, and only provide those interventions necessary to secure airway patency, abate massive hemorrhage, and immobilize the cervical spine.

The development of tactical combat casualty care and tactical emergency casualty care

In PHTLS, the main focus is placed on the patient without overt concern for the surrounding operational situation. However, managing prehospital trauma care in high threat situations such as battlefield trauma or urban tactical environments has led to the development of Tactical Combat Casualty Care (TCCC) guidelines that consider tactical constraints. In 2001, the Committee on TCCC (CoTCCC), a joint United States (US) Armed services service committee, was developed to ensure that TCCC guidelines are kept up to date with the best-practice, leading edge medical technology. The TCCC guidelines are the only trauma care guidelines to have received triple endorsement by the

Department or Defense, the American College of Surgeons' Committee on Trauma, and the National Association of EMTs. Current and updated TCCC guidelines are published in the Journal of Special Operations Medicine (*https://www.jsomonline.org/TCCC.html#TCCCGuidelines*) and as a military edition of the Prehospital Trauma Life Support Manual. Since its implementation, TCCC has been credited with a significant reduction in battlefield fatalities and is taught and used by all US Military services. It has also been recommended as the standard of care for combat first-aid training by the British, Canadian, Australian, and New Zealand armies.

The increasing frequency in active shooter mass casualty events led to a paradigm shift in the law enforcement tactical response, whereby a rapid emergency deployment model is now used. This new shift to a rapid tactical deployment also brought about a need for a faster emergency medical response to care for and evacuate the wounded. However, this need would inherently increase the threat risk to the medical provider. The proven success of TCCC on the battlefield led to an interest in incorporating these principles into the civilian tactical medical community. However, TCCC principles were devised for the military combat medic and medical provider deploying in support of combat operations. They did not take into account the differences in situational environment, variances in patient populations, availability of resources, or scope of practice under which civilian tactical medics are typically operating. In noncombat situations, the threat at the scene may not be hostile fire but instead involve explosive hazards, downed power lines, fire or flames or other environmental hazards (eg, avalanche risk) that may make the scene unsafe. Realizing that a different set of principles were needed for the civilian tactical medic, a Committee on Tactical Emergency Casualty Care was convened in 2010 with the goal of modifying the lessons learned from battlefield TCCC to accommodate for law enforcement and other civilian emergency response teams. These new civilian tactical medic principles became known as *Tactical Emergency Casualty Care [TECC* (*http://c-tecc.org/news/28-2014-tecc-guidelines-update*)]. Similar to TCCC, TECC principles are developed to provide the best-practice recommendations for casualty management during high-threat civilian tactical and rescue operations.

Trauma care for "Operational K9s"

The "operational K9" (OpK9) encompasses a special population of dogs that are specifically trained to assist society in a variety of settings and circumstances such as federal and civilian law enforcement, military, and search and rescue (SAR) operations. The utility of these OpK9s has become paramount in the success of many civilian and military operations, where these dogs have proven to be a force multiplier that saves human lives. True to the words inscribed on the US Military Working Dog Team Monument, these "Guardians of Freedom" selflessly dedicate their lives to protect us from danger and defend our way of life.

The Global War on Terror has led to a significant upsurge in the call for duty of both military working dogs (MWDs) and civilian OpK9s. Similar to their human tactical counterparts, OpK9s deployed in a tactical environment or high threat situation are at high risk for suffering preventable deaths (eg, airway obstruction, pneumothorax, severe hemorrhage). Unfortunately, timely access to veterinary care is not available for most injured OpK9s in a tactical environment. This responsibility often falls to the handler, combat medic, or other nearby medical providers; many of which have not received training in basic canine first aid. During Operation Iraqi Freedom, over 600 OpK9s were often scattered over 100 different locations with fewer than 30 total veterinary personnel available to provide care. Furthermore, logistical allocations such as evacuation assets for the OpK9 operating in an austere environment may be severely limited. The combined lack of readily available veterinary care and high-risk for traumatic injuries is a recipe for high mortality rates. In the United States, OpK9s tasked to federal, law enforcement or search and rescue agencies are similarly vulnerable to severe traumatic injuries as well as lack of immediate veterinary care and evacuation assets. Active shooter events and terrorist bombings are two high threat scenarios where OpK9s may play a vital role and be at risk for severe trauma. Civilian EMS systems do not currently exist for injured veterinary patients, nor are most civilian EMTs trained to perform emergency procedures or basic first aid on dogs. Once again, this places these dogs at high risk for succumbing to their injuries.

The operational canine and canine tactical combat casualty care (C-TCCC)

Until recently, prehospital trauma care standards did not exist for the OpK9. In 2009, a United States Special Operations Command subcommittee was formed to develop canine-specific TCCC principles (C-TCCC) for MWDs. C-TCCC is modeled from the same principles as human TCCC with adaptation to canine-specific anatomical and physiological differences. Since C-TCCC principles align with current TCCC doctrine, C-TCCC can be easily taught to various paramedical and nonparamedical personnel. The Department of Defense Military Working Dog Veterinary Services (DODMWDVS) represents the Army Veterinary Services for all Military Working Dog medical issues. In 2012, the DODMWDVS

adopted C-TCCC into their medical care training and published guidelines for MWDs handlers.

Canine tactical emergency casualty care (K9 TECC)

Despite their usefulness for providing care to MWDs in a combat environment, Canine-TCCC principles have limitations when attempting to apply them to the civilian OpK9, similar to the aforementioned TCCC compared to TECC guidelines. In addition, Canine-TCCC only addresses interventions for mitigating the 3 major preventable causes of death for human battlefield casualties (ie, massive hemorrhage, upper airway obstruction, and tension pneumothorax). Canine-TCCC principles do not address other life-threatening conditions unique to all OpK9s such as heat-related injuries, gastric dilatation and volvulus, and illicit drug or explosive compound exposures. Finally, the original subcommittee that was formed to develop Canine-TCCC principles has disbanded; therefore, no process currently exists to review and update the C-TCCC principles in accordance with new available literature.

In 2014, the K9 Tactical Emergency Casualty Care (K9 TECC) working group was developed under the oversight of the human Committee for Tactical Emergency Casualty Care (www.c-tecc.org). The K9 TECC working group's primary goal is to develop best practice prehospital care guidelines for civilian OpK9s injured under high threat situations. A diverse group of subject matter experts consisting of emergency physicians, veterinarians, EMS paraprofessionals, military professionals, tactical medics, law enforcement officers, K9 Handlers (law enforcement and SAR), and fire fighters make up the working group. The K9 TECC guidelines are written primarily for use by civilian EMS/Fire, Tactical EMS, law enforcement officers, and K9 Handlers. Information about the K9 TECC working group may be found at www.k9tecc.org.

Veterinary prehospital care

In veterinary medicine, the lack of EMS systems for veterinary patients has precluded the gathering of prehospital trauma-related data. Therefore, there is currently insufficient data to indicate what proportion of animals actually succumbs to prehospital injuries and what types of prehospital injuries are most prevalent. It seems feasible that similar or even higher numbers of prehospital fatalities may occur relative to that of human casualties. However, considering the inherent differences between people and animals (eg, anatomy, conformation, locomotion), we may expect a different prevalence in the type of injury-related fatalities that animals may experience.

When a companion animal is injured it is typically the owner or by-stander (neither of which are usually medically trained) that witness the trauma and then drive the animal to the veterinary clinic. The lack of a veterinary EMS system was perceived to obviate the need for veterinary-specific PHTLS guidelines. However, situations (eg, house fires) exist where first responders trained in human PHTLS or ATLS may be first on the scene and in a position to provide life-saving care to an injured animal. As previously described for OpK9s (eg, military, law enforcement, search, and rescue), it is typically the handler that is the first responder. Many of these handlers are trained in human BLS and sometimes ALS techniques. In these situations, where medically trained first responders are available to assist, it is prudent to have a set of prehospital veterinary care guidelines that paramedical and nonparamedical personnel could utilize to decrease the incidence of prehospital veterinary fatalities.

The American College of Veterinary Emergency and Critical Care Veterinary Committee on Trauma (VetCOT) has the mission of advancing trauma care through establishing a veterinary trauma system, providing trauma education, and developing and maintaining a veterinary trauma registry (*https://sites.google.com/a/umn.edu/vetcot/).* The goal of the VetCOT's Prehospital Committee is to advance veterinary prehospital care and develop best practice guidelines that can be used to train veterinary and nonveterinary paramedical and nonparamedical (eg, OpK9 handlers) personnel. Due to the lack of current evidence in the veterinary prehospital arena, best practice guidelines were chosen as an initial platform, with the anticipation that evidence-based additions will be made in the future. These guidelines may also serve as a bridge between the veterinary community and initiatives such as the K9 TECC.

Development of prehospital care best practice guidelines

The VetCOT Prehospital Committee agreed on 17 core topics, and each topic was assigned a primary author. The guidelines for each topic then underwent at least 2 subsequent reviews by the Committee Chair (RH) and at least one other member of the committee. The complete set of guidelines were then posted to the VetCOT website for commentary, with announcements sent to members of the Veterinary Emergency and Critical Care Society and the American College of Veterinary Emergency and Critical Care. Final revisions were made based upon this commentary and sent back to the committee for review. The guidelines are not intended to provide a comprehensive review of the subject. Each author was tasked with providing limited relevant background information followed by a stepwise logical approach to each scenario dependent upon the skill of the responder and transport time (Table 1). Each section may also include a short discussion of any items deemed controversial or in need of

Table 1: Organization of section/scenario guidelines

Category	Time to transport to veterinarian	Skill level
First response	< 20 minutes	Independent of skill level
Delayed veterinary care	> 20 minutes	Minimal or no medical training
Delayed veterinary care	> 20 minutes	Medically trained responder and/or individual with some canine or feline training

further explanation as well as references the reader can consider for additional information. It is strongly recommended to read the first section, general approach, before using these guidelines.

The 18 core topics (sections) are listed below, in order of publication:

1. General approach to prehospital trauma
   a. Introduction/Overview to Guidelines and their intended application.
2. External/compressible hemorrhage
3. Management of acute respiratory distress
4. Fluid therapy and resuscitation
5. Basic life support
6. Advanced life support
7. Analgesia/sedation/anesthesia
8. Neurological trauma
9. Management of penetrating trauma
10. Blast injury
11. Fracture/luxation stabilization
12. Gastric dilatation with volvulus (GDV or bloat)
13. Heat exhaustion
14. Burn injury
15. Smoke inhalation
16. Allergic reactions and anaphylaxis
17. Poisonings
18. Ocular injury

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Footnotes

[a] These six key functions are represented on the EMS "Star of Life" symbol created by the National Highway Traffic Safety Administration (http://www.ems.gov/star.htm).

[b] EMS personnel include paramedics, military combat medics, law enforcement tactical medics, emergency medical technicians, and other emergency medical responders.

Further Reading

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Section 1: General Approach to Canine/Feline Prehospital Trauma

Background

The following set of guidelines provides best practice interventions applicable to animal handlers, veterinary personnel, and first responders for the evaluation and treatment of injured small animal(s) in a prehospital setting. These resources are intended to be utilized **ONLY** for rendering emergency lifesaving preveterinary care to companion animals or OpK9s when licensed veterinary professionals are not readily available to render care. Moreover, the delayed response guidelines for medical providers are intended for use **ONLY** by qualified veterinary personnel and licensed or certified EMS paraprofessionals (eg, EMTs, AEMTs, paramedics), law enforcement officers, and OpK9 handlers that have received

additional hands on training.[c] It is imperative that first responders receive adequate training and skills testing to ensure that they do not incite further harm to the injured animal(s). Responders should not perform any skill that they are not proficient in performing (ie, Do No Harm).

Scope of practice

Most US state EMS statutes, veterinary practice acts, and so called "Good Samaritan Laws" do not provide provisions for emergency responders to render services to injured animals. To date, only Colorado and Ohio have taken legislative action to allow EMS personnel to provide emergency services to injured animals. Colorado has adopted a Senate bill (SB 14-039) granting limited authority to state EMS personnel for voluntarily rendering emergency preveterinary care to OpK9s and other dogs and cats. Similar legislation (House Bill 187) allowing EMS providers the ability to render prehospital emergency care to animals has been passed by the Ohio House of Representatives. It is anticipated that other states will consider similar legislation in the near future. Therefore, this resource is also intended to be used as a reference to assist EMS, fire, and law enforcement agencies in developing protocols and standing orders for rendering emergency lifesaving care to companion animals and OpK9s.

Because of the general lack of legislation, the authors are compelled to advise the reader of the following:

1. The emergency treatment of animals by emergency medical responders and other nonveterinary personnel is not legislatively approved at this time by most jurisdictions, thus leaving the nonveterinary provider at risk for legal reprisal.
2. The information and resources made available in this publication do not provide authorization for **nonveterinary** personnel to practice veterinary medicine.
3. Each nonveterinary organization's protocols and standing orders related to animal care should be developed in collaboration and partnership with a veterinarian that is licensed in that state or region.
   a. EMS Medical Directors should establish a liaison and partnership with a local/regional veterinarian to support implementing these guidelines into their program's standing orders and protocols.
   b. The EMS Medical Director should approve and define their provider's scope of practice (eg, medication and equipment requirements) and training based on the provider's competencies and capabilities and by the laws of their respective state's:
      i. Veterinary practice act or statutes regulating veterinary medicine, AND
      ii. Practice acts or statutes of their respective profession (eg, state EMS statutes)
   c. Certain operational circumstances (eg, working in an "austere" or "wilderness" environment when delivery of the traditional framework of EMS care is impossible due to the unavailability of personnel and equipment resources) may allow the Medical Director to extend the scope of practice of their EMS providers.
   d. Consideration for implementing an extended scope of practice protocol must take into account the:
      i. Providers' previous training and experience.
      ii. Assumption that patients will be transferred to the appropriate level of veterinary medical care as expeditiously as possible.
4. Prior to rendering any services to an injured animal, first responders should have approval from their medical director. Approval may be obtained through the form of:
   a. Direct orders (requires contact with Medical Control prior to initiation of services), OR
   b. Standing orders (skill or treatment may be initiated prior to contact with Medical Control based on preapproved protocols)
      i. When no standing orders for care are in-place, then (if possible) direct consultation with the unit's Medical Director or a veterinarian is highly recommended prior to administering care.

Medical threat assessment

1. Whenever possible, a medical threat assessment (MTA) is a key component of planning for any prehospital emergency response. An MTA identifies those things that represent factors the team must account for when planning to execute an operation.
2. The components of an MTA are unique to the unit's scope of practice, the operational situation, and the unit's mission objectives. Developing an MTA may include knowing the required equipment, logistical resources, weather conditions at the site, closest available medical, and veterinary facilities that have the resources to provide definitive medical care, quickest routes to those medical facilities, available means of transport (to include aeromedical assets), risk of hazardous materials or waste, tactical environment (eg, active shooter), and environmental hazards (eg, fire, flooded areas). An effective communications plan is also vital to success and should include at minimum contact information for key personnel, medical assets, and other responding agencies (eg, local veterinary hospitals, aeromedical assets, EMS providers, fire, and rescue services) and a strategy for backup communications for primary communication asset failures.

3. Preparedness and prevention are vital components of any successful operation. Knowing the hazards and how to mitigate their risks while on scene not only keeps first responders safe, but also allows them to remain engaged in providing early and vital medical care to the patient. As a result, patients are afforded a greater opportunity of survival.

Considerations for general patient care

1. Consider that when rendering aid to an injured animal that any given patient may require the use of a single protocol, a portion of a protocol, or a combination of several protocols.
2. Although the Guidelines have a numerical order, it may be necessary to change the sequence order or even omit a procedure based on the patient's condition, the availability of personnel or equipment.
3. Several sections/tables attempt to include all possible scenarios, but may be more "user friendly" if tailored to meet the needs of each user with respect to supplies and situations encountered.
4. These guidelines were written with the intent of being applicable to both dogs and cats. Since dogs are more likely to be encountered in certain scenarios, some guidelines are written only for dogs [eg, gastric dilatation and volvulus (GDV)]. It is recommended to work with your consulting veterinarian to tailor these guidelines, if needed, to fit scenarios frequently encountered by the end user.

Approach to the injured operational K9 (OpK9)

1. Do not attempt to handle or treat a conscious OpK9 without the handler available to restrain the OpK9. If the original handler is not available, all attempts should be made to find an alternate handler to restrain the OpK9.
2. Keep your movements slow, smooth, and purposeful.
3. Avoid approaching the dog in a standing or looming position. Looming may make an already anxious, fearful dog even more anxious and fearful.
4. Approach in a crouched-like stance or consider sitting down and scooting slowly along the ground slowly toward the dog.
5. Do not approach from behind or in the dog's blind spot to avoid startling the dog and making it more fearful or aggressive. Consider approaching from the side or at a 45-degree angle from the front to ensure the dog can see you at all times.
6. Talk to the dog as you approach; use the name if you know it. Keep a positive attitude; reassure the dog by speaking calmly, clearly. Do not shout.
7. Restrain using the LEAST STRESSFUL technique with the least amount of physical force.
8. Restrain the dog in a "position of comfort." Allow the dog to remain in a position that does not interfere with breathing and where the dog appears most comfortable.
9. Muzzle and properly restrain injured animals before handling. Do not muzzle any dog that:
   a. is unconsciousness,
   b. has an upper airway obstruction,
   c. is vomiting,
   d. has severe facial trauma, and
   e. is at risk for heat-related injury (allow evaporative cooling via panting).

The basic concepts of approach to prehospital trauma care

1. Scene size-up
2. Patient assessment
   a. Primary assessment
   b. Vital parameters
   c. Secondary ("Head-to-Tail") assessment
   d. Complete history
3. On-scene medical care
4. Packaging, transport, and care en-route
5. Reassessment
6. Communication and documentation

Scene size up

1. STAY CALM and ASSESS the scene.
2. When approaching any hazardous situation priority for safety is always directed to yourself, followed by your teammates, then finally to the patient. You are no good to the patient, and only make the situation worse, if you become injured or incapacitated.
3. Ensure the scene is safe. Do not approach any casualty if the scene is not deemed safe to enter. Scan the area for the following potential hazards:
   a. Electricity from downed lines or lightning
   b. Water hazards, fires, explosions
   c. Hazardous Materials (HAZMAT) and other chemicals (eg, toxic gases/fumes, fuel spills)
   d. Oncoming traffic at a motor vehicle collision scene
   e. Biological hazards, including other animals
4. Practice **Body Substance Isolation (BSI**) and don personal protective equipment (PPE) where applicable (eg, gloves, eye protection, masks, and gowns).
   a. **BSI** – refers to those precautions taken to isolate the medical provider from all of the patient's body substances (eg, blood, urine, feces, saliva) in attempts to reduce the risk of infectious disease transmission from the patient to the medical provider. With respect to canines and felines that are not wild/free-roaming and vaccinated for rabies, zoonotic concerns are minimal.

5. Determine the number of patients involved (both human and veterinary)
   a. Determine additional resources needed.
   b. Multiple patients or a large events warrant establishment of an Incident Command System
      i. *Refer to: http://training.fema.gov/emiweb/is/icsresource/index.htm*
6. Attempt to determine the **mechanism of injury (MOI)** and/or **nature of illness (NOI).**
   a. Scan the scene for indicators such of falls, vehicular trauma, HAZMAT, environmental, chemical, or electrical hazards, etc.
   b. Scan the patient for evidence of penetrating or blunt injury, head trauma, external hemorrhage, open fractures, hives, rashes, etc.
   c. Consider a toxic hazard (eg, chlorine gas or other toxic fumes and gases) with multiple patients showing similar signs.
7. Determine specialized or additional resources that may be needed at the scene.
   a. More EMS providers for a mass casualty event.
   b. Fire and rescue.
   c. Search and rescue.
   d. Aeromedical evacuation assets.
   e. Law enforcement during hostile events (eg, active shooter).

Primary patient assessment

1. Keep scene time as short as possible (ideally less than 10 minutes for trauma-induced injuries)
2. Form a general impression of the patient (eg, what do you *see, hear,* or *smell?*). While approaching the patient attempt to determine:
   a. Age, anxiety level, and body positioning.
   b. Level of consciousness; consider using AVPU scale provided below:
      i. Alert – does the animal appear conscious and aware of it is surroundings
      ii. Verbal stimuli response
      iii. Pain responsive
      iv. Unresponsive
      v. Proceed through each letter until a positive response is observed. A patient that is responsive to a painful stimulus only may be reported as A&V – negative, P – positive.
   c. Determine priority of medical care based on the known or suspected MOI/NOI
      i. Despite outward appearances, certain MOI/NOI portend a worse prognosis in people due to associated severity of injury and can be similarly considered for animals. In these instances, rapid transport to a facility skilled in the management of trauma patients is recommended. These situations include:
         1. All penetrating injuries to the head, neck, torso, and extremities proximal to the elbow or knee.
         2. Chest wall instability or deformity (eg, flail chest).
         3. Two or more proximal long-bone fractures.
         4. Crushed, degloved, mangled, or pulseless extremity.
         5. Amputation proximal to the carpus or tarsus.
         6. Pelvic fractures.
         7. Open or depressed skull fractures.
         8. Falls from greater than 2-3 times the height of the patient.
         9. Automobile accidents that include intrusion > 12 inches into the car, ejection, or automobile versus patient.
3. Rapidly assess and treat any life-threatening conditions affecting **Airway**, **Breathing**, **Circulation**, and **Disability (ABCD or CABD)**. Immediate life threats include, in order of approach:
   a. External hemorrhage
   b. Problems with the airway
   c. Inhibitions of normal breathing
   d. Issues preventing normal circulation (eg, shock)
   e. Consider precautions for spinal injury and head trauma
   f. NOTE: The environment/situation as well as the problem that most threatens life dictates what order and how best to conduct the primary assessment.
4. **Operational environment**:
   a. Tactical and high-threat situations: when under a direct, imminent threat (eg, active shooter, structural fire, collapse), then consider implementing the principles as described in the K9 Tactical Emergency Casualty Care (K9 TECC) guidelines (available at www.k9tecc.org).
      i. In K9 TECC, the primary assessment follows the order described by the mnemonic M^3ARCH^2 (*Massive hemorrhage, Move, Muzzle, Airway, Respiration, Circulation, Head trauma, Hypothermia*).
   b. Nontactical, low-threat situations: the M^3ARCH^2 approach or the traditional EMS ABCD approach may be used to conduct the primary assessment.
5. **Most important life-threat**:
   a. The problem that threatens the patient's life the most dictates the order in which you perform your primary assessment.
      i. *Example*: applying direct pressure to a spurting femoral artery bleed takes precedence over

ensuring a patent airway; therefore, the order of *ABCD* changes to *CABD*.

6. Assess **circulation**
   a. Evaluate for **shock** and **bleeding** (*see Guidelines for Hemorrhage or Fluid Therapy and Resuscitation*)
      i. Evaluate for and control external hemorrhage
      ii. Assess for palpable femoral pulses
      iii. Implement passive warming techniques
7. Assess **airway** and **breathing** (see *Guidelines for Respiratory Distress)*.
   a. Establish patent airway
   b. Consider an animal to have a patent airway if it is:
      i. Barking (dog) or meowing (cat).
      ii. Alert and breathing comfortably.
      iii. Panting, but does not appear in respiratory distress.
   c. For **unconscious** animals:
      i. Extend the head and neck into a neutral in-line position.
      i. Manually open the mouth (use a leash or piece of gauze to keep fingers out of the mouth).
      ii. Grasp the tongue and extend it out over the bottom jaw.
      iii. Look inside for and remove any foreign material that is readily accessible.
      iv. Do not perform a blind finger sweep as this may push foreign material further into the airway.
      v. Refer to *Guidelines for Respiratory Distress* for more detailed information regarding establishing a patent airway.
      vi. Listen and feel for breath sounds. Determine whether breath sounds are normal whether breath and lung sounds are normal or decreased, absent, or abnormal (adventitious breath sounds).
      vii. Assess the rate, rhythm, and quality of respirations.
8. Determine level of consciousness (LOC) and potential for spinal injuries. If a spinal injury is suspected, consider immobilizing the spine (*see Guidelines for Neurological Trauma*).
   a. Check pupil size, symmetry, and reaction to light.
   b. If mental status is altered consider things that cause the brain "To STOP."
      i. **To**xicants
      ii. **S**eizure or Sugar (*hypoglycemia or low blood sugar*)
      iii. **T**emperature (*hyperthermia or hypothermia*)
      iv. **O**xygen (*low blood or tissue oxygen content*)
      v. **P**ressure (*increased intracranial pressure* – eg, *fluid, mass*)
   c. Suspect head trauma or spinal cord injury based on major traumatic MOI to include:
      i. Falls associated with loss of consciousness or altered mental status
      ii. Falls from a height in which the animal has fallen on their head or back or falls that are greater than 2-3 times their height or >15 feet (4.6 m)
      iii. High velocity impacts (eg, vehicular trauma)
      iv. Distraction injury (eg, hanging, tail pull injury in cats)
   d. Clinical signs associated with spinal cord injury:
      i. Obvious injuries to the area of the back/spinal column
      ii. Pain/tenderness palpated along the vertebral column
      iii. Weakness or paralysis in limbs
      iv. Lack of recognition to stimulus/pain in limbs
      v. Loss of bladder control
9. Primary assessment interventions may include:
   a. Applying direct pressure and pressure dressing to control external hemorrhage
   b. Clearing and establishing a patent airway
      i. Perform advanced airway techniques
   c. Providing supplemental oxygen
   d. Sealing an open chest wound
   e. Spine immobilization
   f. Administering epinephrine if the patient is suspected to be in anaphylactic shock
10. After addressing life-threatening injuries consider calling for assistance if needed.
11. Transport decision
   a. Any conditions that compromise the ABCDs should result in prompt transportation.
   b. Determine conditions that are life threatening.
   c. Treat to the best of your ability and with available resources.
   d. Provide rapid transport to PRIORITY patients, typified by the following:
      i. Poor general impression
      ii. Airway or breathing problems
      iii. Acute altered level of consciousness
      iv. Shock
      v. Severe pain
      vi. Uncontrolled bleeding
      vii. MOI associated with a poor prognosis

Vital parameters

Whenever possible, monitor, and record the following variables. Refer to Table 2 in the *Guidelines to Fluid Therapy and Resuscitation* for normal ranges.

1. Heart rate and femoral pulse rate/quality
   a. Beats per minute
   b. Rhythm: regular/irregular
   c. Quality: strong/weak/bounding

2. Capillary refill time in seconds: ≥ 2/1–2/< 1
3. Mucous membrane color: pink/pale-pink/red/white/blue-gray/yellow
4. Respiratory:
   a. Rate (breaths per minute)
   b. Rhythm: regular/irregular
   c. Quality: shallow/deep/labored/easy
5. Rectal or axillary temperature
6. Pupil size, symmetry, and response to light
7. As available (ranges for the following are similar in humans and animals):
   a. Blood pressure
      i. Human blood pressure cuffs are too big for most dogs
         1. Desired width of cuff is 40% of the circumference of extremity used for measurement.
   b. Pulse oximetry
      i. Acquire from tongue, lip, pinna, prepuce, or vulva.
      ii. Ear lobe probes can be used.
   c. Blood glucose
      i. Human point-of-care analyzers may be used.
   d. Lactate
      i. Human point-of-care analyzers may be used.

Secondary patient assessment

1. If time on scene permits (eg, delayed evacuation and transport), conduct a systematic full-body "Head-to-Tail" assessment on-site.
   a. If time on scene does not permit, then as feasible, conduct a secondary assessment en route.
2. Do not abandon management of life-threatening conditions for the sole reason of performing a secondary assessment.
   a. In cases that require continual management of life-threatening conditions found during the primary assessment (eg, *tension pneumothorax*), a secondary reassessment may not be possible to perform until definitive care is reached.
3. Consider using the following pneumonic for performing a secondary assessment "**A CRASH PLAN.**"

A = Airway
C = Cardiovascular/circulatory
R = Respiratory
A = Abdomen
S = Spine
H = Head (EENT: eyes, ears, nose, throat)
P = Pelvis
L = Limbs
A = Arteries
N = Nerves (Cranial Nerves, Spinal Reflexes, Pain)

History

1. Signalment: Age, gender, weight (in kilograms or "kg")
2. Chief complaint or MOI:
   a. Consider using pneumonic "**OPQRST**":
      i. ***O**nset – Does the incident seem to be acute or gradual in nature?*
      ii. ***P**rovokes/**P**alliates – What makes the pain or signs worse or better?*
      iii. ***Q**uality – Does the pain appear constant or intermittent?*
      iv. ***R**adiation/Region/Referred – Is the pain or signs localized or diffuse?*
      v. ***S**everity –Rate the animal's pain (scale 1–10, with 10 being severe)*
      vi. ***T**ime/Trend – How long have the signs been going on?*
   b. Other considerations include:
      i. "**SAMPLE**"–***S**igns, **A**llergies, **M**edications, **P**ertinent medical history, **L**ast intake and output, **E**vents leading up to incident*

Reassessment

1. Repeat the primary assessment.
2. Reassess the vital signs.
3. Reassess the patient's injuries.
4. Recheck interventions.
5. Identify and treat changes in the patient's condition.
6. Document all of the above.

Prepare and initiate immediate transport

1. When moving the injured animal from the point of injury, the animal should be extracted utilizing the method that is the least stressful and minimizes further injury.
2. Extraction methods may include:
   a. Walking the patient if stable.
   b. Carrying the patient; works well for cats and small dogs.
   c. Securing the animal to a movement assist device such as a commercial or homemade harness system, a litter, an emergency drag sled, or even dragging the patient out on a tarp or blanket.
   d. Vertical extraction such as hoisting the animal out of a ravine or large body of water or onto a transport helicopter may be required.
3. Ensure the patient is properly secured within the appropriate harness system and that personnel are familiar with the operation of the extraction harness device.
4. If neurologic injury is known or suspected, the patient should be immobilized on a stretcher/litter (see *Guidelines for Neurological Trauma*).

5. Definitive location transport decisions are based on:
   a. Patient's condition
   b. Distance of transport:
      i. The **closest facility** should be sought. However, priority and high-risk patients should be taken to a facility equipped for trauma patients; even if the distance is increased within reason (within 60 minutes of injury).
         1. Resources for emergency facilities include:
            a. Veccs.org under "Certified Facilities" at the following url: http://www.veccs.org/index.php?option=com_certifiedhospitals&nationid=1&Itemid=193
            b. Veterinary Committee on Trauma (VetCOT) at the following url: https://sites.google.com/a/umn.edu/vetcot/
   c. Provider's experience level and scope of practice
   d. Available on-scene resources
6. Do not delay transport to manage nonlife-threatening injuries. Treat these conditions en route to the veterinary hospital
   a. The time from sustaining an injury to reaching definitive veterinary care should ideally be kept to less than 1 hour (eg, "Golden Hour")
7. Record trends during transport in patient's LOC, vitals, and overall condition every 5–15 minutes to monitor for signs of deterioration requiring immediate intervention.
   a. Repeat the primary assessment.
   b. Determine if there have been changes in the patient's condition.
   c. Confirm the adequacy of interventions and patient status.
   d. If the patient's condition is stable and no life threats exist, reassess vital signs at least every 15 minutes.
   e. If the patient's condition remains unstable or is at high risk of deteriorating rapidly, reassess vital signs at least every 5 minutes.
   f. If available electronically monitor:
      i. Hemoglobin saturation (pulse oximetry)
      ii. Blood pressure (oscillometric)
      iii. ECG
      iv. $EtCO_2$ (if intubated)
8. Prevent hypothermia
   a. Minimize patient's exposure to the elements.
   b. If not performed already, remove any wet over garments and dry the patient.
   c. Place the patient onto an insulated surface as soon as possible.
   d. Cover the patient with commercial warming devices, dry blankets, poncho liners, sleeping bags, or anything that will retain heat and keep the patient dry.
   e. EXCEPTION: For suspected neurologic trauma patients, consider not actively warming and allowing mild permissive hypothermia (rectal temperature: 35–37°C or 95–98.6°F)
9. Rotary Wing Evacuation (most applicable to OpK9s):
   a. Whenever possible, the handler should accompany the OpK9. If the original handler is not available then an alternate K9 handler (preferred) or other designee (eg, medic) from the unit should accompany the K9.
      i. Consider that although most air medical transports have medical personnel on board (eg, flight nurse or paramedics), these personnel will most likely not be trained in K9 first aid. Handlers, with training, may be able to administer the care themselves or guide and assist the flight medic to provide the appropriate care.
   b. STRICTLY FOLLOW any and ALL special instructions provided by the flight crew for loading, securing, or unloading casualties.
   c. Keep head down and walk in a crouched position when approaching aircraft.
   d. Carry equipment below your waist.
   e. Do not allow unauthorized personnel to approach the aircraft.
   f. Secure all loose items (remove ball caps and other unsecured hats).
   g. Wear personal protective equipment when available to include:
      i. Eye wear (eg, goggles, sun glasses) or shield eyes to protect dirt or debris from blowing into the eyes
      ii. Hearing protection
      iii. Fire resistant or nonsynthetic materials
      iv. Gloves
      v. Head protection (eg, helmet)
   h. NO SMOKING or RUNNING within 100 ft. Do not chase loose items.
   i. **ALWAYS**:
      i. Approach a rotary-wing aircraft 90° from the side (three or nine-o'clock).
      ii. Approach from the down slope.
      iii. Exit in the same direction that you approached the helicopter.
   j. **NEVER**:
      i. Walk near the tail rotor.
      ii. Approach the aircraft unless directed to do so by the flight crew.
      iii. Approach from an uphill slope (eg, aircraft is below you).
      iv. Shine bright lights at the pilot, flight crew, or aircraft.

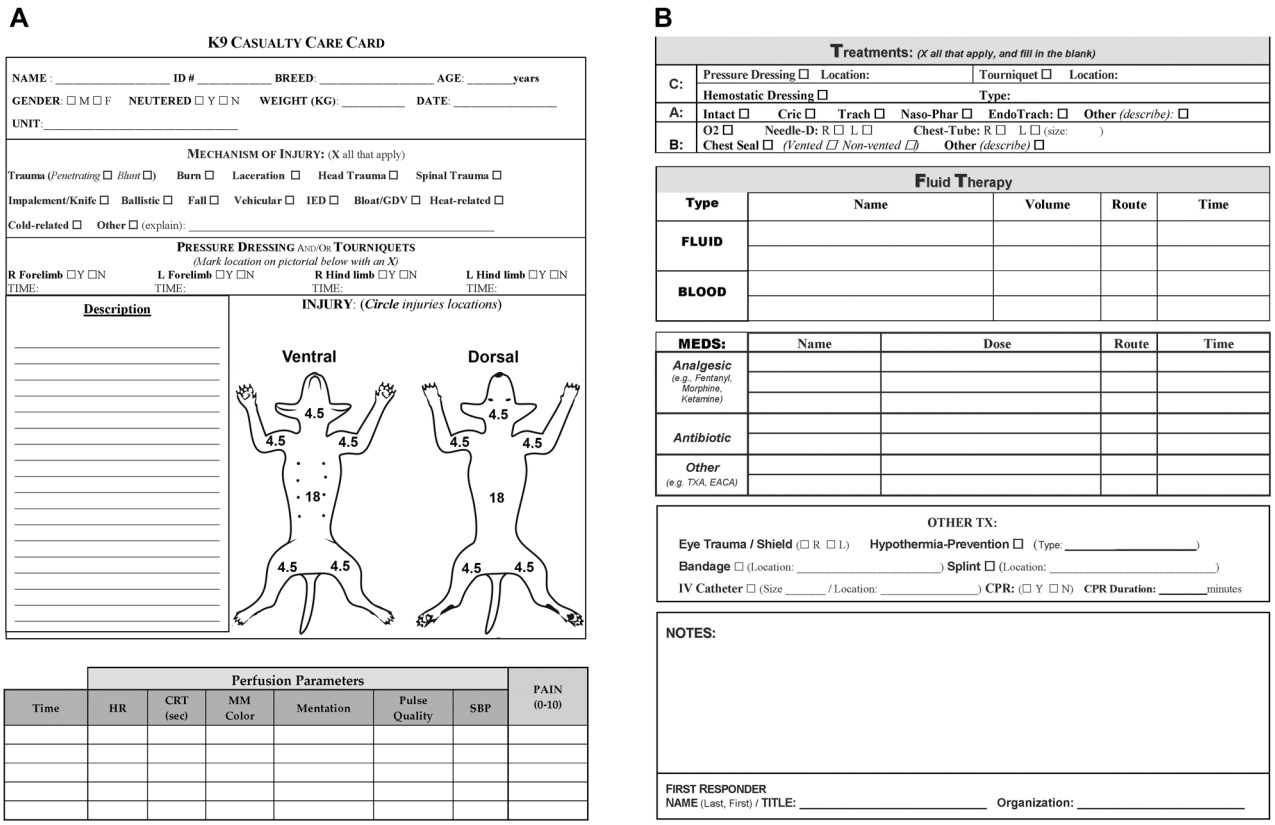

Figure 1: (A and B) Example of a canine casualty care card that can be used for documenting observations and interventions.

Communication and documentation

1. Identify and establish communications with a veterinary care facility before leaving the scene or en route:
   a. Not all veterinary facilities are capable of providing definitive trauma care support.
   b. Failure to identify a veterinary care facility that can provide the appropriate trauma care may delay time to definitive care and decrease the patient's chance of survival.
2. Relay estimated time of arrival and number of patients
3. Provide the following information about the patient to the receiving facility:
   a. Name/Identifying # if available
   b. Gender (male/female)
   c. Weight
   d. Suspected or known mechanism of injury
   e. Vitals and temperament
   f. Ambulatory or nonambulatory
      i. Secure to a litter (yes/no)
   g. Treatments performed and patient's response
4. Responder can also consider the "MIST" approach:
   a. Mechanism of injury
   b. Injuries incurred
   c. Signs/Symptoms
   d. Treatment already provided
      i. For example: This is SGT Jones from the Riverbend Police Department. We are en route by service vehicle with a police dog with gunshot wounds to the chest. He is conscious, with labored breathing. We have placed a chest seal over his wound and are giving him oxygen by mask. We are about ten minutes out from your clinic.
5. Provide the following information on the Responder
   a. Name of responder.
   b. Call back information in the case of a disconnection or in the event the facility requires further information during transport.
6. Be sure to document any changes in patient status and the time these occurred.
7. Document the reasoning for your treatment and the patient's response.
8. Transfer information with the patient to the next level of care either verbally or in writing.
9. Consider implementing a **K9 CASUALTY CARE CARD** (Figure 1A and B).

Discussion

One of the unique populations of animals that may require prehospital care is the working dog population. There are several categories of working dogs, whether they are assistance dogs providing important services for an individual or they are detection or patrol dogs that keep our communities safe. One of the first rules with any of these dogs is to keep the handler with the dog whenever possible. The second consideration is the impact of treatment on the dog's work. Clearly, a critically ill dog will not be returning to work immediately, but in some situations (eg, a laceration repair), a return to work may be required. In these situations, the impact of any treatment on the dog's ability to perform should be considered. There is little data defining drugs that may impair olfaction or performance in dogs. The drugs that have been shown to impair olfaction in dogs include steroids (7 days at doses of 2 mg/kg/day of dexamethasone or 18 days after 0.25 mg/kg/day of hydrocortisone with 0.25 mL/kg/day deoxycorticosterone acetate)[29] (Ezeh 1992) and metronidazole (at 5 days after 50 mg/kg/day).[30] There are numerous drugs in the human literature that have reported effects on olfaction.[28] However, the majority have not been evaluated in dogs. Anesthetics may impair performance, but there are no systematic studies. In general, the clinician should be attentive to the potential impact of medications prescribed in this population of dogs, and as long as the treatment of the patient is not compromised, minimize the use of medications.

Footnote

[a] Such training should be provided under the direction of a licensed veterinary professional or a professional veterinary training organization that employs a licensed veterinarian as their medical director to oversee their training curriculum.

Further Reading

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Section 2: External Hemorrhage

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes):

1. Assess airway and breathing. If needed refer to *Guidelines for Respiratory Distress or Basic Life Support* (BLS).
2. If bleeding is severe and shock is present or imminent, follow *Guidelines for Fluid Resuscitation* once bleeding is controlled.
3. Direct pressure, wound packing, and application of a circumferential pressure dressing remain the primary tenets of controlling external hemorrhage in small animals.
4. Immediately apply direct, **firm** pressure using standard gauze, impregnated hemostatic dressing, or any other suitable absorbent material to the area of external hemorrhage for at least 3–5 minutes. Refer to Step 7 for hemostatic dressings.
   a. Apply direct pressure with your hand until dressing/packing material is obtained.
   b. When anatomically feasible, place a circumferential pressure dressing around the bleeding area to maintain constant pressure directly on the wound. A noncircumferential dressing will not provide adequate pressure to maintain hemostasis.

   i. Do not be afraid to tightly wrap, control of bleeding using adequate pressure is paramount.
   ii. If bleeding is on the head or neck, ensure bandage does not restrict the patient's airway and breathing.
   iii. Consider applying an occlusive dressing for wounds to the neck.
c. If direct pressure/pressure wrap is successful, the area should be overwrapped firmly with self-adherent bandage material (eg, Vet Wrap or Coban, if available), elastic bandaging tape, or medical tape. Improvisation with common duct tape or other adherent tape material may be considered if needed.
d. Monitor for strikethrough (hemorrhage through the bandage).
e. If strikethrough occurs:
   i. DO NOT remove original dressing as this may remove formed clots and exacerbate bleeding.
   ii. Apply additional bandage material OVER the already present material.
5. If an extremity is involved, immobilize (eg, splint) and elevate (~ 6 inches) the injured area to slow blood loss.
6. If the above procedures are NOT successful, the source of hemorrhage involves an extremity (distal limb or tail), and the bleeding is considered life threatening, consider placing a tourniquet (TQ).
   a. Please see the discussion for further notes on the use of a TQ.
   b. Commercially available TQs used for people do not remain in place or provide adequate pressure to stop blood flow to the extremities in dogs.
   c. If used, the TQ should ideally be a pneumatic, or ratcheting device that has been demonstrated to occlude arterial flow, at least in people.
   d. In the absence of a commercial TQ, other materials that can be used to stop arterial blood include inflated pediatric blood pressure cuffs, Penrose drains, or cloth strips. Ensure that the material is > 2 inches in width to avoid crush injury to the tissues.
   e. General guidelines for placement of a TQ:
      i. Apply above the elbow and or stifle (knee) for distal extremity wounds or at least 2–3 inches above the wound.
      ii. Do not apply directly over a joint.
      iii. Make sure the TQ is securely tightened; demonstrated by cessation of arterial blood flow and loss of palpable distal pulse.
      iv. Never use wire, rope, a belt, or any other narrow material because it could cut into the skin and cause more tissue damage.
      v. Never cover a TQ with a bandage.
      vi. Do not loosen the TQ after you have applied it.
      vii. If a distal pulse or visual hemorrhage is still present, consider additional tightening of the TQ or the use of a second TQ, proximal and juxtaposed to the first, to eliminate the distal pulse and observable hemorrhage.
7. If the hemorrhage involves a junction (nonextremity) or area not amenable to TQ placement, a topical hemostatic agent should be packed into the area with direct firm pressure for 3–5 minutes (or in accordance with manufacturer directions).
   a. A nonexothermic agent amenable to packing into the area should be utilized. Gauze is best suited for this purpose (eg, QuickClot Combat Gauze).
   b. Avoid granular or zeolite-based hemostatic agents:
      i. Zeolite is exothermic and may cause significant tissue damage or complicate wound repair.
      ii. Under high arterial flow granular agents tend to wash away before allowing a clot to form
8. For an object protruding from the wound:
   a. Apply bulky dressings to stabilize the object in place, and apply pressure as best you can.
   b. Never remove an impaled object from a wound.
9. Place the animal in a position of comfort and that allows adequate respirations (eg, sternal recumbency).
10. Keep the animal quiet to prevent elevation in blood pressure and exacerbation of bleeding.
11. Use blankets to keep patient from becoming hypothermic.
12. Transport.

Recommendations for Responders in the Setting of Delayed Veterinary Care (assumes minimal to no medical training):

1. Follow guidelines as described above for First Response with the addition of the following recommendations.
2. If available, provide supplemental oxygen either via flow by or oxygen mask.
3. Regarding TQ usage and delayed care, it is NOT recommended to release a properly applied TQ in a prehospital setting without consultation with a veterinarian. Phone consultation in transit is recommended, as this action is scenario-dependent.
4. For Uncontrolled/Internal Abdominal Hemorrhage:
   a. Pending medical training consider applying abdominal external counter pressure (eg, "Belly Wrap").
   b. Incorporate the hind legs when applying abdominal counter pressure.

   c. DO NOT lift underneath the abdomen after trauma.
   d. Follow *Guidelines for Fluid Resuscitation.*
5. For patients not in shock, water per os can be offered.

Recommendations for medics in the setting of delayed veterinary care

1. Follow all recommendations as listed above for First Response.
2. If a TQ has been placed:
   a. Reassess need for TQ if evacuation time to definitive care is anticipated to be > 2 hours.
   b. Consider removing TQ if bleeding can be controlled by other methods such as with *direct pressure* and *pressure dressing*
   c. Expose the wound fully
   d. Identify an appropriate location above the original TQ and apply a new TQ.
   e. Once properly applied, loosen the initial TQ and observe for bleeding.
   f. If bleeding is not observed, loosen the newly applied TQ slowly (but leave in place).
      i. Apply direct pressure on the wound w/hemostatic impregnated gauze or gauze padding followed by a circumferential pressure dressing.
      ii. If bleeding remains controlled, TQ is not needed and may be completely removed.
      iii. If bleeding is not controlled without the TQ, retighten the TQ and leave in place.
   g. Reasons NOT to remove TQ include:
      i. The distal extremity or tail is a complete amputation.
      ii. The patient is in shock or is suffering traumatic brain injury (TBI).
      iii. The TQ has been on for > 6 hours .
      iv. Medical treatment facility is within 2 hours after time of application.
      v. It is considered inadvisable to transition to other hemorrhage control methods based on tactical or medical situation.
3. If the aforementioned fail and continued uncontrolled arterial or venous bleeding is noted, application of vascular clamps and ligation of major vessels may be attempted.
   a. Arterial bleeding is typically recognized as spurting or "hose-like" and should be ligated first.
   b. Venous bleeding is much lower pressure and will generally have a slower "oozing" or trickling quality to it.
4. Consider fluid resuscitation if bleeding is significant or prolonged and the animal has signs consistent with shock (increased heart rate, pale mucous membranes, altered mentation).
   a. Place an intravenous or intraosseous catheter and provide fluid resuscitation per *Guidelines for Shock/Resuscitation.*
5. Consider administration of antifibrinolytic agents such as tranexamic acid (TXA) or epsilon aminocaproic acid (EACA):
   a. If the patient presents with hemorrhagic shock, one or more amputations, penetrating torso trauma, or evidence of severe bleeding consider administration of one of the following as soon as possible and NO LATER than 3 hours postinjury:
      i. 10–15 mg/kg TXA in 100 mL NS (normal saline) or LRS IV slowly over 15 minutes
         1. If bleeding continues, a continuous rate infusion (CRI) of additional TXA at 10 mg/kg/h for 3 hours OR 10-15 mg/kg over 8 hours can be given.
      ii. 100–150 mg/kg EACA in 100 mL NS or LRS slowly over 15 minutes
         1. If bleeding continues, a continuous rate infusion of additional EACA at 15 mg/kg/h for 8 hours can be administered.
6. Use blankets to keep patient from becoming hypothermic.
7. Transport.

Discussion

While the use of TQs has made resurgence in human trauma care, their use in dogs is controversial and evidence to support their use is lacking. The placement of TQs in companion animals and working dogs is limited to injuries located on the distal limbs and tail. However, in a study of military working dogs that suffered gunshot wounds, none of the dogs with wounds to the extremities died and none of those were treated with a TQ (Baker et al., 2013). Although this suggests that TQs have little to no role in extremity hemorrhage control, the number of affected dogs in that study was low (29 total; 6 of those with wounds to only the extremities). As such, a complete condemnation of the use of TQs is not warranted. Rather, these guidelines have provided specific guidelines for their judicious use if other measures fail to provide hemostatic control.

Evidence supporting the effective dosage of TXA or EACA in dogs is currently limited but suggests higher doses of TXA may be needed in comparison to people. However, IV bolus administration of doses exceeding 10 mg/kg have been shown to induce vomiting in dogs; nevertheless a study of healthy dogs found that an initial bolus of 10 mg/kg followed by a constant rate infusion of 10 mg/kg/h for 3 hours was well tolerated. Thus, if the patient continues to hemorrhage after initial administration, a CRI of TXA should be considered.

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Section 3: Management of Acute Respiratory Distress

Background

In all of the following situations, there will be 3 main steps applicable to every patient. These include patient position, temperature, and the administration of oxygen. As such, consider the guidelines below in every scenario. In most situations, oxygen is not harmful and should be administered, when available, for any form of respiratory difficulty.

1. Place the animal in a position that favors air movement, with the least energy, and is not stressful. For most animals, this is sternal recumbency.
2. Monitor the rectal temperature in dogs.
   a. The work of breathing generates a lot of heat and dogs can become heat stressed when labored.
   b. Consider active cooling if patient temperature exceeds 105ºF. See *Guidelines for Heat Exhaustion*.
3. Oxygen administration, when available, should be considered for every patient.
   a. Humidified oxygen is preferred but not mandatory for short-term administration.
   b. Flow-by oxygen may be administered by:
      i. An oxygen tube positioned at least 2 cm from the patient's nostril
         1. At a flow rate of 2–3 L/min to provide 25–40% inspired oxygen.
         2. Flow rate may be increased up to 8–10 L/min if needed, but a conscious dog does sometimes not tolerate high rates.
      ii. A fitted face mask
         1. Compliance may be difficult; Consider removing diaphragm to increase tolerance to mask.
         2. Tight fitting mask with O_2 flows of 8–12 L/min provide 50–60% inspired O_2.
         3. Monitor for excess heat, humidity, and CO_2 buildup.
         4. Carbon dioxide will build-up in a non-vented mask; therefore, it is ideal to use a vented mask or a looser fitting mask to prevent rebreathing of CO_2 and or build-up of condensation.
         5. A vented Bag-Valve-Mask (BVM) is a viable option in dogs and cats.
      iii. A loose fitting mask with O_2 flows of 2–5 L/min will provide 25–40% inspired oxygen
         1. Consider removing diaphragm to increase tolerance to mask.
      iv. An oxygen hood
         1. Flow rates of 0.5 to 1 L/min typically will deliver 30–40% inspired O_2 and higher rates of 5–8 L/min can deliver 50–80% inspired oxygen.
         2. Monitor for excess heat, humidity, and CO_2 buildup.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Consider position, temperature, and oxygen administration (see above).
2. Is there **stridor**–a high pitched increase in noise of breathing
   a. **No**; continue to Step 3.
   b. **Yes**
      i. Evaluate for causes of partial airway obstruction, swelling of the face, oral, or neck tissues.
      ii. Trauma to the head or neck
         1. Apply gentle pressure with hemostatic gauze (preferred), standard gauze pads, or any clean absorbent material to stop bleeding.
      iii. Foreign body in the mouth, nose, or airway
         1. Clinical Signs may include: pawing at mouth, gagging, excessive drooling, frequent swallowing motions, and or extended head and neck.

2. If present monitor for complete obstruction during transport–see Step 3.

iv. Transport

3. Is the airway **patent**; in other words, can air pass into and out of the lungs
   a. **Yes**; continue to Step 4.
   b. **No**
      i. Perform an oral examination to look for a cause of airway obstruction – use caution not to insert fingers into the mouth:
         1. Palpate throat and trachea
         2. Tilt head slightly up/back and extend neck
         3. Open the mouth and examine mouth and pharynx. Can use a leash or gauze behind the upper and lower canine teeth to hold the mouth open.
         4. With caution and if able (eg, unconscious), pull tongue forward to help open the airway
         5. Consider using a roll of tape as a mouth gag to keep the mouth open if aides in air passage.
      ii. **Visible foreign material** lodged in airway?
         1. YES
            a. Perform a lateral Heimlich maneuver with the dog in lateral recumbency. Apply a thrusting force to the ribs, extend the head and neck.
            b. Or an abdominal Heimlich maneuver (for dogs only) standing behind the dog. Lean over top and "bear hug" the dog. Place your fist just below xiphoid process of the sternum and compress the abdomen with 3 quick upward thrusts. Repeat 1–2 times if not successful.
            c. NOTE: Do not attempt a Heimlich maneuver if sharp objects such as sticks, glass shards, or bones are present. ONLY attempt if obstruction is complete and preventing safe transport.
         2. NO obvious foreign material but no observed air flow, consider one or more of the following:
            a. Prop the mouth open and use two fingers to SWIPE AND CLEAR the mouth and pharynx. Ensure the mouth is secured open and the object(s) is now visible to prevent pushing it further into the airway.
            b. Perform a Heimlich maneuver (as described above).
            c. Needle tracheotomy (midtrachea between rings) or cricothyrotomy can be considered; if skills and scope of practice allow.
               i. Lidocaine regional block may be used to facilitate needle/catheter placement.
      ii. If not breathing, provide mouth to snout rescue breaths at 10 breaths per minute (See *BLS guidelines*).
      iii. Check for heart beat—if absent start CPR (See *BLS and ALS guidelines*).
4. Is the animal breathing at a normal rate?
   a. YES; Continue to Step 5
   b. NO
      i. Increased rate (> 30 breaths per minute)
         1. Evaluate mucous membrane color
            a. Blue-gray (cyanotic) mucous membranes (MM) indicate a need for oxygen.
            b. Bright red MM may be associated with heat stress, infection (sepsis), or cyanide or carbon monoxide exposure. See *Guidelines for Heat Exhaustion and/or Smoke Inhalation,* respectively.
            c. Pale (white) MM indicates blood loss or shock and a need for resuscitation/fluid administration. See *Guidelines for Fluid Resuscitation*.
         2. May be secondary to painful stimulus or anxiety
         3. Provide oxygen, if available, and place in a comfortable position.
         4. Transport
      ii. Decreased rate (<10/min)
         1. Evaluate neurologic status – is the animal aware?
            a. If not see *Guidelines for Neurological Trauma*. Consider elevation of head 15–30 degrees on a flat board. Keep neck extended and straight.
         2. Monitor for apnea (stopped breathing; see *Guidelines for BLS*)
         3. Provide oxygen, if available, and place in a comfortable position.
         4. Transport
5. Is the animal breathing with normal **effort?**
   a. **YES**; Consider oxygen, position, and transport.
   b. **NO**
      i. Evaluate mucous membrane color (see 4bi).
      ii. Evaluate for wounds of the head or neck
         1. If wounds are present over the chest cover them with a light occlusive dressing such as "Saran Wrap" (see *Guidelines for Penetrating Wounds*)

iii. Provide oxygen if available and consider position
iv. Minimize activity and stress
v. Transport

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

Consider position, temperature, and oxygen administration.

1. Is there **stridor** – a high-pitched increase in noise of breathing
   a. **NO**; Continue to step 3.
   b. **YES;** Follow recommendations for First Response
      i. If a known bee sting or allergic reaction is suspected, consider the administration of epinephrine. (See *Guidelines for Allergic reaction/Anaphylaxis*).
2. Is the **airway patent;** in other words, can air pass into and out of the lungs
   a. **YES;** Continue to Step 4.
   b. **NO;** Follow recommendations for First Response
3. Is the animal breathing at a normal **rate or effort?**
   a. **YES;** Transport immediately
   b. **NO;** Follow recommendations for First Response
      i. Evaluate mucous membrane color
         1. Blue (cyanotic) mucous membranes indicate a need for oxygen.
         2. Red MM may be associated with heat stress, infection (sepsis), or cyanide or carbon monoxide exposure. See *Guidelines for Heat Exhaustion or Smoke Inhalation*, respectively.
         3. Pale MM may be associated with shock from loss of blood or fluids. See *Guidelines for Fluid Resuscitation/Shock*.
      ii. Evaluate for source of pain or anxiety
         1. Stabilize fractures if present (See *Guidelines for Fracture Management*)
         2. Provide wound care
         3. DO NOT give aspirin or other over the counter pain-relieving medication
      iii. Minimize activity and stress
      iv. Transport

Recommendations for medics in the setting of delayed veterinary care

1. Consider position, temperature, and oxygen administration.
   a. Additional more invasive oxygen administration techniques can be considered:
      i. Nasal prongs or nasal catheter
         1. Flow rates of 50–150 mL/kg/min can provide 30–70% inspired O_2
      ii. Transtracheal oxygen (placed between tracheal rings or in cricothryoid ligament)
         1. Flow rates of 50 mL/kg/min can achieve 40–60% inspired O_2. CAUTION: Higher flow rates can cause damage to the tracheal mucosa.
2. Is there **stridor** – a high-pitched increase in noise of breathing
   a. **NO**; Continue to step 3.
   b. **YES;** Follow recommendations for First Response
      i. Evaluate for causes of partial airway obstruction
         1. Swelling of the face, oral or neck tissues
            a. If a known bee sting or allergic reaction is suspected, consider the administration of epinephrine. Refer to *Guidelines for Allergic Reaction/Anaphylaxis* for dosages and routes.
         2. Trauma to the head or neck
            a. Stop bleeding with careful pressure using hemostatic gauze or standard gauze pads.
         3. Foreign body in the mouth, nose, or airway
            a. If present attempt careful removal. Use caution not to insert fingers into the mouth, and use a leash or gauze behind the upper and lower canine teeth to pry the mouth open.
            b. Monitor for complete or worsening obstruction during transport – see below
            c. If necessary, to improve airflow or facilitate removal of foreign body, consider mild sedation. Refer to *Guidelines for Sedation/Analgesia*.
      ii. Minimize activity and stress
      iii. Monitor rectal temperature if > 40.6°C [>105°F], cool as necessary to 39.4°C [103°F] using tepid water or ice packs in the neck and groin (see *Guidelines for Heat Exhaustion*).
      iv. Transport
3. Is the airway **patent**; in other words, can air pass into and out of the lungs
   a. **YES;** Continue to Step 4.
   b. **NO;** Follow recommendations for First Response
      i. Perform an oral examination to look for a cause of airway obstruction and follow recommendations above (First Response) regarding suspected foreign material.

ii. If no obvious foreign material is observed then consider:
    1. Mouth to nose/snout resuscitation or a tight fitting mask for ventilation.
    2. Orotracheal or endotracheal (ET) intubation
        a. To facilitate ET tube (ETT) placement, ensure head, and neck are aligned and extended (not flexed), with the animal in sternal recumbency. This will allow a direct "line of site" or path from the oral cavity, through the oropharynx into the trachea. If sedation is needed, see *Guidelines for Analgesia/Sedation.*
        b. Secure ETT in place and inflate cuff. NOTE: the canine trachea is proportionally much larger than the human. The appropriate ETT for the average 35 kg police dog is a 10 or 11 mm tube, whereas a cat will generally require a 3–5 mm endotracheal tube.
    3. If the difficulty is on inspiration or there is trauma to the laryngeal/pharyngeal region, consider:
        a. Needle tracheotomy (midtrachea between rings) or cricothyrotomy.
            i. Lidocaine regional block may be used to facilitate needle/catheter placement.
        b. A "slash" or surgical tracheostomy/cricothyrotomy can also be considered if the responder has been trained to do so in canines and it is in their scope of practice.
            i. A surgical airway is needed if the intent is to secure the airway to ventilate the patient.
    4. Monitor oxygen saturation (SpO_2) and end-tidal carbon dioxide ($ETCO_2$); same parameters apply as in human medicine.
    5. If not breathing, provide rescue breaths at 10 breaths per minute (See *Guidelines for BLS*).
    6. Check for heart beat and if absent start CPR (See *Guidelines for BLS and ALS*).

4. Is the animal breathing at a normal **rate and effort?**
    a. **YES;** immediately transport.
    b. **NO;** Follow recommendations for First Response
        i. Increased rate
            1. Consider MM color, pain, anxiety, and patient position and address as indicated.
            2. Evaluate for wounds of the thorax
                a. If wounds present, clip and clean them, but do not delay transport or further evaluation.
                b. Cover any thoracic wounds with light occlusive dressing and apply a chest seal to any penetrating chest wound (See *Guidelines for Penetrating Wounds*).
        3. Auscult lungs
            a. Increased/Abnormal sounds
                i. Crackles (Rhonchi or Rales)?
                    1. Consider contusions, pneumonia, noncardiogenic or cardiogenic edema; provide oxygen
                    2. Auscult heart; if irregular rhythm or murmur consider furosemide (2 mg/kg IM or IV once)
                ii. Wheezes on expiration?
                    1. Asthma is uncommon in dogs, although bronchoconstriction may occur with inhaled chemicals. Cats do acquire inflammatory airway disease. For either, consider bronchodilator; Albuterol (1–2 puffs MDI (metered dose inhaler), every 15 min; max 3 doses).
            b. Decreased lung sounds are typical of pleural space disease.
                i. Lung sounds decreased dorsal (toward spine); consider pneumothorax
                ii. Lung sounds decrease ventral (toward sternum); consider hemothorax or diaphragmatic hernia
                iii. Evaluate for tension pneumothorax physiology
                    1. Progressive respiratory distress with history of trauma
                    2. Hypoxemia
                    3. Barrel chest
                    4. Decreased chest wall movement
                    5. Signs of shock—increased HR, weak pulses, pale mm, decreased awareness
                iv. Thoracocentesis (needle decompression) IF respiratory effort is increased with orthopnea (elbows abducted and neck extended) or tension physiology is suspected. Insertion site is between 7th and 9th ribs (count backward from 13) off the cranial (orad) side of rib.

4. Consider obtaining vascular access (cephalic or saphenous vein) or IO access, if unconscious (see *Guidelines for Fluid Resuscitation*).
5. Transport as soon as possible

ii. Decreased rate
1. Follow recommendations for First Response
2. Monitor for apnea (stopped breathing) and cardiac arrest; start CPR and follow *Guidelines for BLS/ALS*.
3. Consider intubation and monitoring (see 3b.ii above).
4. Consider vascular access
5. Transport

Discussion

Securing the airway

Oral tracheal intubation (endotracheal intubation) of cats can be challenging. Cats are prone to laryngospasm. The anatomy of most dogs allows for ready visualization of the airway and intubation. If either a dog or a cat is intubated, the subsequent management of that patient is critical, albeit similar to people. First the ETT placement should be confirmed with a combination of direct visualization of the ETT entering the larynx, digital palpation of the ETT within the larynx, end tidal CO_2 monitoring, and observing for the rise of the chest during positive pressure ventilation (PPV). The ETT must be secured and the cuff appropriately inflated, especially if smaller than ideal endotracheal tubes are being utilized. Once intubated, PPV may be required and should be initiated at a rate of 10 breaths per minute. If the animal is hypercapnic (assuming $ETCO_2$ is in place), an increased rate of ventilation to maintain a normal CO_2 (eg, 35–40 mm Hg) should be instituted. The appropriate tidal volume is a maximum of 10 mL/kg and peak inspiratory pressure should not exceed 20 cm H_2O in normal lungs or 30 cm H_2O in diseased lungs. Maintaining an animal intubated generally requires sedation or anesthesia, which may be outside the scope of prehospital care, dependent upon the expertise and resources of the responder. See *Guidelines on Analgesia/Sedation* for further discussion.

Although potentially life-saving, temporary tracheostomies have been associated with a high rate of complications (86%), even when managed in a veterinary hospital. In cats, tracheostomies are thought to be associated with a higher incidence of complications and poor outcome. In 10/23 cats with temporary tracheostomies (using 3.0–4.0 mm tubes) major complications (dislodgement or obstruction) occurred, and minor complications (partial occlusion) occurred in 14/23 cases. Needle tracheostomy may be a viable alternative in dogs and is currently the preferred approach for obtaining an airway in military working dogs as defined by the canine tactical combat casualty care guidelines. The advantages include the ability to maintain the airway without ongoing sedation and the ability to keep the dog muzzled. In cats, some success has been documented with providing ventilation via a tight fitting nasal mask; however, limited compliance and leaks around the nose are common disadvantage. A study of continuous positive airway pressure delivered via a Boussingnac continuous positive airway pressure (CPAP) mask in sedated dogs, demonstrated feasibility but practical prehospital use may be complicated by the need for sedation and need to maintain a tight seal. The use of a helmet CPAP system (MiniOx, MSA, Gurnee, IL) that seals around the neck was well tolerated by sedated healthy dogs. The inevitable leak at the neck and the potential for CO_2 rebreathing was compensated by increasing gas flows to 50 L/min. In one study of 30 healthy dogs, laryngeal mask airways were able to successfully maintain a seal in 63% of deeply sedated dogs; however, their use has not been investigated in a prehospital setting. Similarly, in a study involving cadavers and then 25 healthy dogs, James et al successfully used a blind insertion airway device (Combitube) during sedation and elective procedures in a nonemergent hospital setting. A specially designed supraglottic airway device (v-gel) has been developed for cats. This device has shown promise in a hospital setting of anesthetized cats, but has not been evaluated in a prehospital setting and requires the specialized device to conform to the anatomy of cats' oropharynx. The use of vented bag-valve masks has not been reported in dogs but can be considered if one is available, although a seal may be difficult to obtain.

In a 2008 Cochrane review, there was insufficient evidence for benefit of prehospital airway management, although only 3 randomized controlled trials were included and only one (in children) was relevant to the veterinary patient. A 2014 review of out of hospital airway management in approximately 300,000 cases reported an overall 85% success rate with endotracheal intubation, 80% success with alternate noninvasive airways and only 34% success with cricothyrotomy. In a recent review, the potential advantages of a cricothyrotomy over a surgical tracheotomy in dogs and cats were described. However, no data on complications or success in either a hospital or prehospital setting are available. One indication for a cricothyrotomy would be a complete airway obstruction; an alternative first approach would be to employ a Heimlich maneuver to dislodge any obstructing material, as described above. This methodology has been described in a research study, but no case reports or reviews are available in the literature.

In summary, although intubation may be successful, management of the intubated dog and cat can lead to additional complications. Insufficient evidence and lack of available equipment to successfully utilize noninvasive ventilation strategies precludes recommending these approaches. Securing the airway in the prehospital setting is most critical in the case of complete airway obstruction. Although evidence is not available, an attempt to dislodge any obstructing foreign material should be made with a manual assessment or Heimlich maneuver. If this approach fails, a needle cricothyrotomy or tracheostomy can provide oxygen whereas a surgical tracheotomy is needed to provide positive pressure ventilation, either of which may be life-saving, although evidence is not available.

Chest decompression

In a report of military working dogs injured by gunshot wounds, thoracic wounds were the most common injury location affecting 13/26 cases. Tension pneumothorax was diagnosed in all 4 dogs that were not immediately killed in action, and the 3 dogs that had needle decompression in the field survived. Other field management included occlusive bandages applied to all chest wounds and flow by oxygen. These findings are in contrast to the report of urban gunshot wounds in dogs, and rural gunshot wounds in which no dog had reported tension pneumothorax. In a series of 9 dogs with thoracic impalements (most commonly sticks), despite presence of pleural effusion and pneumothorax or pneumomediastinum, no report of emergency thoracocentesis was described. A systematic review of the human literature suggested that prehospital thoracocentesis had support in cases of tension pneumothorax due to the life-threatening nature of the pathophysiology, but still was only classed as a Grade C recommendation.

In summary, recognition of a tension pneumothorax requires accurate assessment of decreased breath sounds, tachypnea, and evidence of cardiovascular compromise; based on limited data, needle decompression may be lifesaving.

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Section 4: Fluid Therapy and Resuscitation

Background

The administration of fluids should be goal oriented to maximize efficacy. In the prehospital setting, 2 main scenarios exist: dehydration and hypovolemic shock, or a combination of these two states.

There are several physical examination findings that will direct one toward the correct fluid plan. When evaluating a patient, always consider the situation and environment. Factors such as stress or exercise may cause

Table 2: Resting vital parameters for dogs and cats and changes consistent with shock

Variable	Normal resting range	With hypovolemic shock
Temperature (°F/°C)	100–102.5/37.8–39	Initially normal, then progressive decline. Increases in temperature may be characteristic of sepsis or heat related illness (*see Guidelines for Heat Exhaustion*).
Heart/pulse rate (beats per minute)	Dog: < 20 kg: 100–160 20–40 kg: 60–120 > 40 kg: 50–80 Cat: 180–240	In medium to large breed dogs, tachycardia will prevail. In cats and sometimes small dogs (< 10 kg), a relative bradycardia may accompany hypothermia
Respiratory rate (breaths per minute)	6–30	Will typically increase with shock or exertion
Capillary refill time (CRT) and color	1–2 s/pink	Will prolong (> 2 s). Brisk refill (< 1 s) may be characteristic of sepsis or heat exhaustion.
Arterial pulse pressure	Systolic: 105–145 mm Hg Mean: 90–110 mm Hg Diastolic: 60–85 mm Hg	The two most easily palpable arterial pulses are the femoral and dorsal pedal. If you lose both, marked hypotension is present. The femoral is stronger and maintained with moderate hypotension. Hypotension is typically characterized by a systolic blood pressure of < 90 and a mean of < 70 mm Hg.
Mentation/attitude	Alert and interactive	Progressively dull

Exercise/activity will result in higher values for heart/pulse rate. OpK9s may have rectal temperatures as high as 108°F (42°C) during work and training events and be considered "normal" as long as they are not displaying clinical signs of heat-related illnesses.

significant, but appropriate, changes in the typical resting values listed below. The table below (Table 2) lists typical **resting** values for vital signs in dogs and cats based on varying body weights. The table also denotes expected clinical manifestations for animals experiencing hypovolemic shock.

This is in contrast to dehydration, which is characterized by the clinical signs listed in the table below (Table 3).

In order to tailor fluid therapy to the needs of the patient, the type of fluid deficit must be identified and addressed. These guidelines break fluid deficits into **5 main categories/scenarios**. Table 4 is a chart outlining a stepwise fluid plan for each scenario, which is also described below:

Table 3: Estimated percentage of dehydration based on clinical signs in dogs and cats

Percent dehydration	Clinical signs
< 5%	Not able to be detected on physical exam; history of fluid loss (vomiting/diarrhea) or no fluid intake
5-10%	Loss of skin elasticity, presence of turgor in subcutaneous tissues, dry mucous membranes, sinking of eyes into orbits
> 10%	Signs consistent with hypovolemic shock due to dehydration: lowered temperature, tachycardia, prolonged CRT, poor pulse pressure

1. **Dehydration only without clinical signs**
   a. This represents a patient with a history of losses (vomiting/diarrhea/exertion) and a lack of sufficient fluid intake, without any clinically detectable signs. This is less than 5% dehydration as outlined in Table 3.
2. **Dehydration with clinical signs, but NO signs of shock**
   a. This patient has a history of losses, insufficient intake and clinical signs that fit the 5–10% dehydration category
3. **Controlled hemorrhage or dehydration with signs of shock**
   a. This patient has a history of fluid losses, insufficient intake, and clinical signs consistent with hypovolemic shock (Table 2).
   b. The losses in this patient may also be due to hemorrhage that is controlled (able to be stopped/ligated and not ongoing).
      i. NOTE: Polytrauma, cavitary (abdominal or thoracic) bleeding, or unknown should be placed into scenario 3 or 4.
4. **Uncontrolled hemorrhage with signs of shock and no historical or physical evidence of traumatic brain injury (TBI) or thoracic trauma**
   a. This patient suffered a traumatic incident and has detectable signs of shock; typically at least 3 abnormalities are present from Table 2 above.

Table 4: Fluid plan for 5 common scenarios in the canine
Fluid Therapy Algorithm for: _____Body Weight in kg (Divide weight in lb/2.2) = _____kg.

Category/ condition	Fluid therapy steps	Type of fluid/route of administration	Dosage formula (use body wt in kg)	Notes Note: multiply by 1000 to convert L to mL
1. Dehydration; no clinical signs	1. Take steps to encourage drinking	Water/PO		Encourage oral consumption
	2. Precondition working dogs with SQ fluids in periods of high stress w/o environmental conditioning	LRS or NS/SQ	0.025 X B wt* = _____L X 1000 = _____mL	Do not exceed 1 L total volume or 500 mL per site in dogs (> 15 kg)
2. Dehydration; clinical signs present but no signs of shock	1. Encourage to drink	Water/PO		Encourage oral water consumption for exertion. Electrolyte solutions can be considered if source of loss is gastrointestinal (vomiting/diarrhea).
	2. If work is ongoing and /or oral administration is not possible; can consider SQ fluid therapy listed above	LRS or NS/SQ	0.05 X B wt* = _____L X 1000 = _____mL	Do not exceed 2 L total volume or 500 mL per site in dogs (> 15 kg)
	3. Consider IV crystalloid fluid therapy if PO is not feasible (vomiting, reluctance . . .)	LRS or NS/IV	0.08 X B wt* = _____L X 1000 = _____mL Divide volume by # of hours over which to deliver = dosage in mL/h.	Ideally delivered over 4–6 hours.
3. Controlled hemorrhage or dehydration with signs of shock	1. Administer IV crystalloid fluid therapy	LRS or NS/IV	(a) MAX amount of fluids to be infused in one hour = 0.08 X B wt* = _____L X 1000 = _____mL	Note: This is maximum dosage in one hour representing 8% dehydration. Delivery is via steps b through d.
			(b) Bolus in increments of 20 mL/kg = _____mL until vital signs have stabilized. Once stable, proceed to (c). If still unstable proceed to (d).	Average amount of IV bolus for a working dog (25 kg) is 500 mL.
			(c) Give remainder of fluids over the next 6 hours or (a–b)/6 = _____mL/h for next 6 hours	Note: This is to be used when dehydration is source of shock. If blood loss is source and vital signs are stable, no further fluid therapy is needed.
			(d) If unstable after reaching maximum goal in step (a), another process such as sepsis or ongoing hemorrhage is likely present. Veterinary assistance is mandatory. Continue with hemorrhagic shock algorithm (4) below, beginning at step 2.	
4. Uncontrolled hemorrhage with signs of shock; no traumatic brain or thoracic injury *Note: for this category rapid veterinary assistance is mandatory.*	1. Administer IV crystalloid fluid therapy	LRS or NS/IV	(a) Maximum volume of fluids to be infused = 40 X B wt* = _____mL	Note: If available, blood products should be administered in lieu of crystalloids as soon as possible.

(*Continued*)

Table 4: Continued

Category/ condition	Fluid therapy steps	Type of fluid/route of administration	Dosage formula (use body wt in kg)	Notes Note: multiply by 1000 to convert L to mL
			(b) Bolus in increments of 20 mL/kg = _____mL until pulses are palpable. HR and pressure need not normalize; target MAP of 60 or systolic of 70–90 mm Hg if able to measure. Still unstable, go to step 2.	Note: This relatively hypotensive goal is intended for transport. Organ injury may result if supported in this state for several hours.
	2. Administer blood (if available). Veterinary assistance is mandatory.	FWB/IV, or pRBC and FFP/IV	(a) FWB dosage = 20 X B Wt* = _____mL (b) pRBC dosage = 10 X B Wt* = _____mLs (c) FFP dosage = 10–20 X B Wt* = _____mLs. If still unstable, repeat dosage of blood product. If not available, proceed to step 3.	Give fresh whole blood whenever available. First time administration does not require a cross-match in dogs. If components are used, a pRBC:FFP ratio of 1:1 or 1:2 is recommended. Do not delay transport to veterinary care.
	3. Consider colloids; VOL would be preferable to HES. Hemorrhage is likely significant. Veterinary assistance is mandatory.	VOL or HES/IV	(a) VOL or HES bolus = 5 mL X B wt* = _____mLs until vital signs have stabilized. If still unstable proceed to (b).	HES: Do not exceed 10 mL/kg VOL: Do not exceed 50 mL/kg
			(b) Blood products or vasopressors are needed. Veterinary assistance is mandatory.	
5. Hemorrhage with signs of shock AND traumatic brain injury or significant thoracic trauma is present. *Note: for this category rapid veterinary assistance is mandatory.*	1. Small volume resuscitative IV fluid therapy with a colloidal or hypertonic solution.	HTS/IV	(a) TOTAL volume of HTS to be infused = 4 mL X B wt* = _____mL until vitals are stabilized. If unstable after 2 doses, go to step 2.	NOTE: to give slowly over 5–10 minutes to effect. NOTE: With neurologic injury, target normotension with MAP ≥ 70 or systolic ≥ 90 mm Hg if able to measure
	2. Consider colloid administration; VOL would be preferable to HES.	VOL or HES/IV	(a) HES or VOL bolus = 5 mL X B wt* = _____mL until vital signs have stabilized. If still unstable proceed to (b).	HES: Do not exceed 10 mL/kg VOL: Do not exceed 50 mL/kg
			(b) Blood products or vasopressors are needed. Veterinary assistance is mandatory. Can utilize crystalloid therapy for signs of shock (D.1.a & b) above, while en route to veterinary care.	

It is recommended to abbreviate this table by matching the contents to the supplies and scenarios encountered by each responder.
Reference Table 2 for signs of shock, and Table 3 for signs consistent with dehydration in dogs and cats. Abbreviations: B wt = body weight, NS = normal saline, LRS = Lactated Ringers Solution, FWB = fresh whole blood, pRBC = packed red blood cells, FFP = fresh frozen plasma, HTS = 7% hypertonic saline, HES = Hextend, VOL = Voluven or VetStarch, PO = oral route, SQ = subcutaneous route, IV = intravenous route (IO can be used instead of IV)
***Insert body weight in kg.**

b. Uncontrolled hemorrhage is assumed with polytrauma or signs of shock without another obvious cause.
c. Hemostatic resuscitation is desired with permissive hypotension as an endpoint.

5. **Hemorrhage with signs of shock and a history of TBI or thoracic trauma (small volume resuscitation).**
   a. This patient suffered a traumatic incident and has detectable signs of shock, as in number 4 above, but also has historical or physical signs of TBI or thoracic trauma, as evidenced by increased respiratory effort or sounds.
   b. In this scenario, normotension is preferred and using smaller volumes of fluids to attain this is recommended.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes; see Table 4 for dosages and choice of fluids)

1. **Dehydration only without clinical signs**
   a. This does not mandate transport.
   b. Move to cool, shaded, low-humidity, or air-conditioned environment
   c. Encourage rest and water per os (PO).
      i. For the Operational K9 (OpK9), stop training or working
      ii. If OpK9 fails to voluntarily drink water, consider administering subcutaneous fluids; especially if they need to continue the mission.
2. **Dehydration with clinical signs, but NO signs of shock**
   a. Seek veterinary consultation to determine if intravenous or subcutaneous fluid therapy is necessary.
   b. Move to cool, shaded, low-humidity, or air-conditioned environment
   c. Encourage to rest and take water PO.
3. **Controlled hemorrhage or dehydration with signs of shock**
   a. If heat related illness is suspected, refer to *Guidelines for Heat Exhaustion.*
   b. *Scoop and run* to nearest veterinary emergency facility.
4. **Hemorrhage with signs of shock and no historical or physical evidence of TBI or thoracic trauma**
   a. This is a HIGH risk patient.
   b. See Guidelines for *General Approach and Transport.*

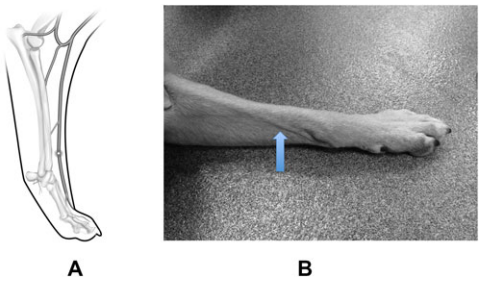

Figure 2: (A and B) Schematic (A) and photo (B) of the cephalic vein in the forelimb of a dog.

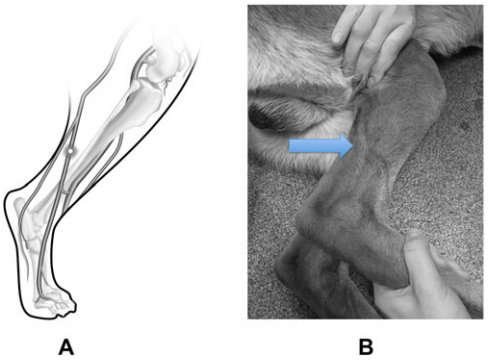

Figure 3: (A and B) Schematic (A) and photo (B) of the lateral saphenous vein on the lateral aspect of the rear limb in a dog.

   c. Refer to *Guidelines for controlling External Hemorrhage,* if needed.
   d. *Scoop and run* to nearest emergency veterinary facility; preferably skilled in the management of trauma patients (See *Guidelines for Transport*).
5. **Hemorrhage with signs of shock and a history of TBI or thoracic trauma**
   a. This is a VERY HIGH risk patient.
   b. See Guidelines for *"General Approach and Transport."*
   c. Refer to *"Guidelines for controlling External Hemorrhage,"* if needed.
   d. "*Scoop and Run*"; transport to a facility skilled in the management of trauma patients with high-risk injuries is a priority (See *Guidelines for Transport*).

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training; see Table 4 for dosages and choice of fluids)

1. **Dehydration only without clinical signs**
   a. Follow steps for scenario listed under first response above (number 1)
2. **Dehydration with clinical signs, but no signs of shock**

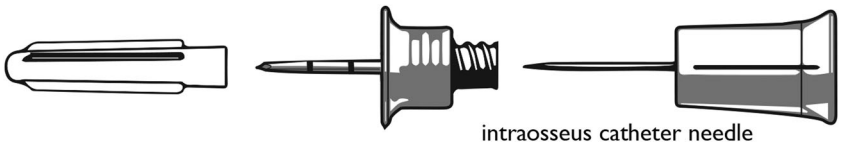

Figure 4: Schematic of the components of an intraosseous needle.

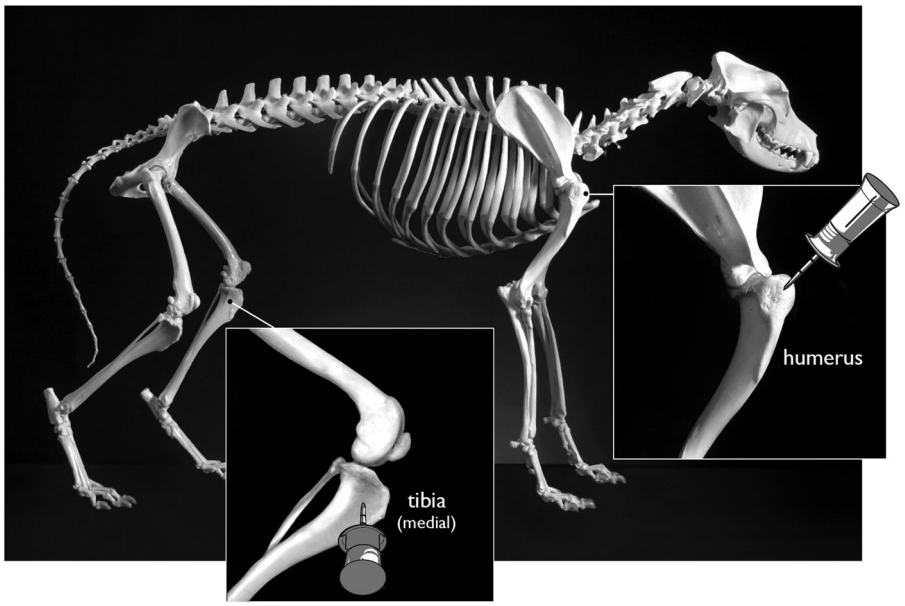

Figure 5: Schematic of the insertion sites for an intraosseous catheter; depicted are the medial aspect of the proximal tibia and the craniolateral aspect of the humeral head on a dog skeleton.

a. Follow steps for scenario listed under first response above (number 2)
b. If the situation is high-stress or rest and water intake are unlikely, subcutaneous fluids can be administered.
c. Alternatively, and especially if losses are ongoing (ie, continued vomiting), intravenous fluid therapy can be considered.
d. See Table 4 for dosages.
    i. **Intravenous (IV) catheter placement**
        1. Clip and clean an area of fur approximately 1 inch above the carpus (wrist) to access the cephalic vein (Figure 2A). An accessory branch extends medially, which can also be cannulated (Figure 2B). The lateral saphenous can be utilized as it courses across the lateral aspect of the back leg 1 inch above the hock (ankle). See Figures 3A and B.
        2. A standard over the needle 1–2 inch catheter can be placed ranging in size from a 22 Ga (< 5 kg) to a 16 Ga for dogs over 20 kg. Examples of catheter size relative to body weight are provided below:
            a. 24 Ga for neonates
            b. 22–20 Ga for small dogs/cats (< 7 kg)
            c. 20–18 Ga for medium patients (7–30 kg)
            d. 18–16 Ga for large dogs (> 30 kg)
    ii. Intraosseous (IO) catheter placement
        1. For ease and efficiency, a handheld automatic gun, such as the EZ-IO Intraosseous Vascular Access System, is recommended.
        2. Time permitting, clip, and clean the site for placement.
        3. To prevent the skin from winding around the catheter, time permitting, a small stab incision can be made at the placement site with a #11 blade.
        4. IO catheter needle sets (Figure 4):
            a. 15 Ga x 15 mm: use for small dogs/cats (< 7 kg)
            b. 15 Ga x 25 mm: use for medium and larger dogs (> 7 kg)
        5. There are 2 recommended sites for IO placement:
            a. The medial aspect of the tibial plateau, 0.5–1 inch below the stifle (knee) to avoid the joint. See Figure 5.

i. Placement is technically easier
ii. The cortex can be thick in large dogs and hard to penetrate

b. The craniolateral surface of the humeral head. See Figure 5.
i. Landmarks are more challenging
ii. This site is closer to central circulation and the cortex is slightly thinner and easier to penetrate

3. **Controlled hemorrhage or dehydration with signs of shock**
   a. In the setting of delayed transport, IV or IO access should be obtained if skills and scope of practice allow.
   b. Administer a 20 mL/kg bolus of an isotonic crystalloid over 5 minutes; repeat until signs of shock (See Table 5 below) are ameliorated or a total of 80 mL/kg has been reached.
      i. Repeat up to 4 times.
         1. Example: a 25 kg dog may receive a 500 mL bolus of LRS up to a maximum of 2000 mL (2.0 L).
         2. See fluid administrations worksheet (Table 4) for continued fluid administration rates once hemodynamically stable.
      ii. Endpoints of resuscitation are listed in Table 5 below. Normotension should be pursued.
      iii. Preferred isotonic crystalloids include: lactated Ringer's Solution, Plasmalyte-A, or Normosol-R
         1. A balanced electrolyte solution is generally preferred over 0.9% NaCl (Normal saline), although this fluid choice is also acceptable.
4. **Uncontrolled hemorrhage with signs of shock and no historical or physical evidence of TBI or thoracic trauma**
   a. Control any external hemorrhage. See *Guidelines for External Hemorrhage*.
      i. Note: patients in this category typically have concurrent uncontrolled cavitary (abdominal or thoracic) hemorrhage.
   b. Obtain IV or IO access as described above.
   c. Replacement crystalloids should be given incrementally as a bolus of 20 mL/kg over 5 minutes. Permissive hypotension is the goal until definitive care is reached (See Table 5 below).
      i. Repeat to a maximum of 40 mL/kg (see Table 4).
         1. As an example, a 25 kg dog would need boluses of 500 mL of LRS up to a maximum of 1000 mL (1.0 L).
         2. NOTE: If all of the steps below are unsuccessful, this step can be repeated as a last resort.
      ii. If unsuccessful, the administration of blood and advanced medic support are desired.
      iii. If the aforementioned is unavailable, administer a synthetic colloid or hypertonic saline (HTS). See Table 4 or Step 5c below for dosages.
      iv. If still unstable, immediate veterinary assistance or advanced medic support is mandated.
      v. Do not delay transport.
5. **Hemorrhage with signs of shock and a history of TBI or thoracic trauma.**
   a. Obtain IV or IO access as described above.
   b. The administration of blood and advanced medic support are critical.
   c. If blood/advanced medic support is not available, small volume resuscitation should be attempted in the following order:
      i. Synthetic colloid: 5 mL/kg IV bolus. Repeat up to total volume of 10 mL/kg for hextend/hetastarch or 50 mL/kg with Voluven /Vetstarch.
      ii. Hypertonic saline (7%): 4 mL/kg IV over 5–10 min. Repeat once if needed.
   d. If colloids or HTS are not available, consider replacement crystalloid bolus of 20 mL/kg over 5 minutes. Repeat once if needed.
   e. If still unstable, immediate veterinary assistance or advanced medic support is mandated.
   f. Do not delay transport.

Recommendations for medics in the setting of delayed veterinary care (see Table 4 for dosages and choice of fluids)

Follow recommendations listed above for Responders in the Setting of Delayed Veterinary Care with the following noted additions.

1. **Dehydration only without clinical signs**
   a. Follow recommendations for delayed response above.
2. **Dehydration with clinical signs, but no signs of shock**
   a. Follow recommendations for delayed response above.
3. **Controlled hemorrhage or dehydration with signs of shock**
   a. Follow recommendations for delayed response above.
   b. If unstable after reaching maximum goal (80-90 mL/kg), another process such as sepsis or uncontrolled hemorrhage is likely present.

c. If blood loss is suspected, administer blood (see Scenario 4 below).
d. If blood is not available, administer a synthetic colloid at a dosage of 5 mL/kg. Limits are dependent upon colloid used (see Table 4).
e. If bleeding is unlikely and goals are not met, consider the addition of a vasopressor:
   i. Begin epinephrine or norepinephrine at 0.2 μg/kg/min; increase in increments of 0.2–0.5 μg/kg/min every 2–5 minutes until maximum rate of 3 μg/kg/min
f. NOTE: Veterinary assistance is mandatory. Vasopressor usage should only be undertaken after consultation with a veterinarian, if immediate transport to definitive care is not possible.

4. **Uncontrolled hemorrhage with signs of shock and no historical or physical evidence of TBI or thoracic trauma**
   a. Obtain IV or IO access as described.
   b. If possible, fresh whole canine blood should be administered at an initial dosage of 10–20 mL/kg (see goals in Table 5). *NOTE: Brief notes are included below as a reminder with regard to canine transfusions. Due to the complexity of obtaining and administering blood, prior veterinary training is required and is beyond the scope of these guidelines.*
      i. If a dog has never received a blood transfusion, cross-matching, or blood typing is not mandated as there is a low risk of reaction for first time administration.
         1. Note: This is not the case in cats and transfusion should not be attempted without blood typing or a cross-match.
      ii. Standard drip sets with in line filters for administration of blood products are recommended.
      iii. When a human blood collection system is used for dogs, 450 ± 45 mL of canine blood is collected and combined with 63 mL of anticoagulant.
         1. Recommended anticoagulant ratios for immediate administration include:
            a. 3.8% sodium citrate–1 mL sodium citrate/9 mL of collected whole blood
            b. Unfractionated heparin–625 U heparin/50 mL of collected whole blood
      iv. Rate and volume of administration: administer as fast as possible to restore hemodynamic stability (eg, restoration of heart rate, pulse quality, mucous membrane color, CRT). See Table 5 for endpoints of resuscitation.
   c. If blood is not available, small volume resuscitation should be attempted in the following order:
      i. Synthetic colloid: 5 mL/kg IV bolus. Repeat up to total volume of 10 mL/kg for hextend/hetastarch or 50 mL/kg with Voluven/Vetstarch
      ii. Hypertonic saline (7%): 4 mL/kg IV over 5–10 min. Repeat once if needed.
   d. If colloids or HTS are not available, consider replacement crystalloid bolus of 20 mL/kg over 5 min. Repeat once if needed.
   e. Antifibrinolytics should be administered if available (eg, tranexamic or aminocaproic acid). See *Guidelines for External Hemorrhage* for dosages.
   f. If the aforementioned are unsuccessful, and canine/feline blood specific to the species of the patient is not available, human blood can be considered at the dosages described above.
      i. Xenotransfusion (the transfusion of blood from another species) of human blood to dogs or cats has not been reported. However, as a last resort it should be considered/administered.
         1. The likelihood of an anaphylactic reaction with repeat administration is high. Thus, this should be thoroughly documented in the patient's record.

5. **Hemorrhage with signs of shock and a history of TBI or thoracic trauma**
   a. Follow recommendations for delayed response above with normotension as endpoint (see Table 5), as opposed to permissive hypotension.

Discussion

Resuscitation in veterinary medicine follows the same principals put forth in human medicine, with the ultimate goals being arrest of hemorrhage and restoration of effective circulating volume. In the prehospital setting, resources, including transportation, can be limited. Therefore, immediate goals are to control bleeding (if possible), acidemia, hypothermia, and manage or prevent acute traumatic coagulopathy, while working to maintain effective circulating volume. In the setting of compressible hemorrhage, such as an extremity wound, bleeding can be arrested and guidelines for this scenario are provided (see *Guidelines for External Hemorrhage*). Patients with controlled hemorrhage or hypovolemia secondary to dehydration can be resuscitated to normotension, and crystalloids may be employed. In the setting of uncontrolled hemorrhage, large volume crystalloid therapy should be avoided and hemostatic resuscitation, using blood products, and permissive hypotension should be employed. Acute traumatic coagulopathy has been observed in dogs, and the administration of tranexamic acid, preferably, or aminocaproic acid is also recommended (see *Guidelines for External Hemorrhage*). The reader is referred to reviews on this topic,

Table 5: Targeted endpoints of resuscitation in canine or feline casualties with hypovolemic shock

Endpoint	Desired range	Comments
HR; < 20 kg dog	<180–200/min	Note: Increase in HR with normalization of other parameters should prompt investigation of other causes to include: pain, anxiety, anemia, respiratory complications, or arrhythmia.
HR; dog 20–40 kg	<140–160/min	
HR; dog >40 kg	<100/min	
HR; cat	<240/min	
Systolic blood pressure (or Doppler)	80–100 mm Hg	Note: Target the low end with uncontrolled hemorrhage (permissive hypotension; scenario 4) and upper with controlled losses or head trauma (scenarios 3 and 5)
Mean arterial blood pressure	60–80 mm Hg	Note: Target the low end with uncontrolled hemorrhage (permissive hypotension; scenario 4) and upper with controlled losses or head trauma (scenarios 3 and 5)
Capillary refill time	< 2 s	
Lactate	2 ± 0.5 mmol/L	
Base deficit	–4 to 4 mEq/L	

such as Palmer et al., listed below for a more in depth discussion. In the setting of trauma including the brain and thorax, minimizing the volume used in resuscitation and targeting normotension as an endpoint are recommended. See *Guidelines for Neurologic Trauma* for further discussion. Overall, similar debates persist regarding the use of crystalloids and colloids in veterinary medicine as in human medicine.

The main benefits of crystalloid usage in the aforementioned scenarios are minimal expense and widespread availability with no reported allergic reactions or direct effect on coagulation. The downside of their administration is that the amount necessary to achieve the desired effect may contribute to dilutional effects on oncotic pressure and hemostasis as well as interstitial edema. This makes it harder for oxygen to be delivered to cells in need, which can have deleterious consequences in the form of ileus, bacterial translocation, decreased pulmonary gas exchange and impaired wound healing. In a study performed by Muir et al. (2004), a hypovolemic hypotensive model was utilized in 12 anesthetized Beagles. Resuscitation was initiated with either hetastarch (HES) or LRS at 90 mL/kg/h. The HES group returned to baseline blood pressure more rapidly (6 ± 3 minutes versus 18.8 ± 3 minutes) and required less volume (194 ± 53 mls versus 749 ± 115 mls). The primary advantage of colloids, as demonstrated above, is their purported ability to assist in the maintenance of intravascular volume via their contribution to oncotic pressure. In a study published in 2005 by Silverstein and colleagues, they described the efficiency ratio (ie, the ratio of the increase in blood volume to the amount infused) of various crystalloids and colloids administered to beagles in a randomized cross-over design. Both HES and dextrans had an efficiency ratio of approximately 1.0 immediately postinfusion and increased to approximately 1.4 at 30 minutes postinfusion. By comparison, 0.9% saline had an immediate efficiency ratio of 0.8, which decreased to 0.4 by 30 minutes postinfusion. Despite this noted advantage, systematic reviews in humans have failed to demonstrate a significant benefit of crystalloids or colloids with respect to outcome. Unfortunately, large-scale studies or a meta-analysis on this topic do not exist in veterinary medicine at this time.

Two major concerns exist with respect to starch solutions in both people and animals. They can have an impact on coagulation and potentially renal function. Starches have been shown to decrease levels of von Willebrand's factor and factor VIII beyond those expected by dilution alone. They are also believed to bind to the surface of platelets blocking receptor sites and interfering with fibrin clot stabilization. This effect is most pronounced in HES preparations of higher molecular weights with greater degrees of substitution. This is reflected in the maximum daily dosages listed in Table 4 and is the rationale for the recommendation of Voluven over Hextend/hetastarch in traumatic situations. The concern with respect to renal function has primarily been documented in humans and animal models. One of the first studies to document this adverse outcome is the Volume Substitution and Insulin Therapy in Severe Sepsis (VISEP) Trial published in 2008. Patients were resuscitated with either a pentastarch solution or lactated Ringer's, and those administered pentastarch had statistically significant higher rates of renal failure and need for renal replacement therapy. Critics of this study note that dosages exceeded recommended limits, and multiple studies with appropriate dosages since that time have yielded conflicting results. Recently, a retrospective cohort study was published (Hayes et al) on the incidence of acute kidney injury and death following hydroxyethyl starch (HES 10% 250/0.5/5:1) administration in 180 dogs in an intensive care unit compared to control population. Hetastarch therapy was found to be associated with an increased risk of an adverse outcome including death or acute kidney injury. As such, in

accordance with recommendations in people, it is prudent to start with crystalloids for resuscitation. Colloids can be considered in patients without preexisting renal injury, current sepsis, and in which smaller volume resuscitation is recommended.

Further Reading

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Section 5: Basic Life Support

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

Untreated cardiopulmonary arrest (CPA) has a near 100% fatality rate

1. Basic life support (BLS) includes chest compressions and ventilation
2. Crucial steps are:
   a. Identify collapsed/unresponsive (to any stimulus) animal
   b. Immediately:
      i. Check for respiration.
      ii. If absent, begin BLS as outlined below.
      iii. If breathing is questionable or agonal (gasping), begin BLS as outlined below.
      iv. If clear evidence of breathing is present, check pulse rate (using femoral pulse or apical heart beat). If absent or less than 1 beat per second, begin BLS. If the heartbeat is fast, follow *Guidelines for Fluid/Shock resuscitation*.
      v. Call out for help and assistance to determine if transport is possible.
   c. Basic life support procedures
      i. Chest compressions:
         1. Place dog or cat on a rigid, flat surface in lateral recumbency; begin chest compression at a rate of 100–120 compressions per minute. Compressions should depress the chest cavity by 1/3 to ½ depth.
            a. In large dogs (>6.8 kg [>15 lb]), use hand over hand technique overlying the highest point on the chest wall (excluding the last 3 ribs).
            b. In small dogs or cats (<6.8 kg [<15 lb]), squeeze the ribcage overlying the heart with a one-handed approach from the sternum or by encircling the chest with your hands and compressing with the pads of your thumbs. The heart lies at the point of the elbow when the forelimb is flexed toward the thorax.
      ii. Perform "*Mouth-to-Snout*" ventilation at a rate of ~10 breaths per minute (or 1 breath every 6 seconds). If unsuccessful, check airway for obstruction.
      iii. To check and clear the airway:
         1. Gently tilt the head slightly back and extend the neck.
         2. Look inside the mouth and identify anything that is blocking the airway.
         3. Use a cloth or rag to grasp the dog's tongue and pull it forward to improve visualizing the mouth.
         4. If an object is visible, use the "2 finger sweep" technique to remove fixed objects such as a bone, stick, blood, or tissue.
         5. Take care to ensure the animal cannot harm you and have a second responder, if available, hold the mouth open by looping a leash, rope, or long pieces of roll gauze behind the upper canine teeth.
         6. Run your index and middle fingers into the dog's mouth along the cheek and across the back of the throat.
         7. Remove any foreign objects that are visualized or felt.

8. If unable to dislodge an identified foreign object, immediately transport to the nearest veterinary facility.

3. Basic life support recommendations
   a. If you are alone, initiate at least a 2-minute cycle of chest compressions and ventilation to determine if arrest is easily reversible (as outlined above).
      i. If single rescuer, perform 30 compressions, then deliver 2 breaths, and resume compressions.
      ii. Continue the 30 compressions: 2 breaths cycle without interruption for at least 2 minutes before reassessing the patient for return of spontaneous circulation (femoral pulse/apical heart beat).
   b. If a second rescuer is present:
      i. Rotate chest compressors every 2 minutes is to reduce compromise of compression efficacy due to fatigue.
      ii. Perform *"Mouth-to-Snout"* ventilation at a rate of ~10 breaths per minute (or 1 breath every 6 seconds).
4. When needed and if possible, continue BLS during transport to the definitive care facility.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. No further recommendations are possible. Compressions and ventilation should be continued for 15–20 minutes (in 2 minute cycles), particularly if associated with airway obstruction or in otherwise healthy animals.
2. Blunt trauma (eg, "hit by car" [HBC]) patients that are in CPA without signs of life are very rarely, if ever, resuscitated successfully. Discontinuing or not starting CPR in these cases should be considered.
3. Dying trauma patients may be markedly bradycardic and hypotensive; thereby compromising the rescuers ability to appropriately detect a preterminal condition. Before making the decision to withhold or sustain from CPR, the rescuer should palpate for an apex beat and femoral pulse for at least 45–60 continuous seconds. Palpating for pulses in multiple locations may increase the rescuers chance of finding a pulse.

Recommendations for medics in the setting of delayed veterinary care

1. Endotracheal intubation should be performed, in lieu of "mouth-to-snout" ventilation, with a rate of 10 breaths per minute.
   a. Ventilation can be provided with an Ambu bag (or Bag Mask Valve) and supplemental oxygen, if available.
   b. An inspiratory time of 1 second is recommended with a tidal volume of 10 mL/kg.
   c. An $ETCO_2$ concentration, if available, of > 15 mm Hg should be targeted.
2. If the arrest is not easily reversed or ventilation is difficult, consider bilateral needle decompression to rule out tension pneumothorax. See *Guidelines for Respiratory Distress*.
3. If an airway cannot be obtained due to an obstruction or trauma, consider needle or surgical/slash tracheotomy or cricothyrotomy. See *Guidelines for Respiratory Distress.*
4. If gastric dilatation with volvulus (GDV) is consider possible, consider trocarization of the stomach to improve the likelihood of resuscitation. Trocarization may be provided by placing a large gauge (ie,14–16 Ga) needle or catheter, typically 3.25 inches, into the most distended section of the cranial abdomen (just behind the last rib). See *Guidelines for GDV/Bloat*.
5. If a pulse is obtained it is not uncommon for the return of spontaneous respirations to be delayed. Continue breathing for the dog at a rate of ~10 breaths per minute until veterinary assistance is obtained. An acupuncture point to stimulate respirations is located at the base of the midline of the nose. A 25 Ga or 22 Ga needle can be used and placed at junction of the nose and haired skin down to the bone, although assisted ventilation is likely much more effective.
6. If advanced medical care is possible, consider placement of a large bore catheter into the cephalic vein or intraosseous catheter in the tibia or humerus for fluid resuscitation and delivery of vasopressors. This is covered in *Guidelines for Fluid Therapy and Resuscitation.*
7. If an (automated electrical defibrillator) AED is available, it may be used in large breeds (>30 kg dog), such as working dogs. Clippers are required to remove hair, to permit the patches to adhere, over each side of the chest with the canine heart being located at the 4–5th intercostal space (at the point of the elbow when the forearm is flexed toward the thorax). Patches should be placed ½ to 1 inch above the sternum (to avoid contact between them).

Discussion

For BLS, the RECOVER guidelines (Hopper K) provide an excellent summary of the initial efforts at CPR, including rapid assessment of the collapsed patient, prompt initiation of chest compression and ventilation. Resuscitation of blunt trauma victims with CPA is controversial in human medicine. The recommendation above to discontinue resuscitation efforts in a dog with severe trauma

or hemorrhage in full CPA in the field is based upon dismal prospects of success.

There is little peer-reviewed information available on field resuscitation of dogs with GDV. However, Goodrich et al. documented that gastric trocharization is as safe as passing a gastric tube in hospitalized patients. Additionally, it is a simple technique that can be successfully completed by a first responder. If the dog does not have GDV, other potential causes of abdominal distension (eg, hemoabdomen, ascites) would not be negatively impacted by placement of the needle within the abdomen. Similarly, in dogs with GDV, if the stomach was not successfully trocarized, there is little to no risk of damage to any internal organs. For further discussion, see the section on *Guidelines for GDV*.

The use of AED in the field has not been reported in dogs. Completely automated AED are designed to be used by individuals with no medical training. The joules delivered by these units are set for adults, but the absolute amount varies dependent upon if they are monophasic or biphasic. Thus, it is possible that a small dog or cat would be injured by an AED; however, the use of pediatric settings could be attempted if available.

Further Reading

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Section 6: Advanced Life Support (ALS)

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. First responder guidelines should follow **BLS guidelines**.
2. Consideration for delivery of advanced techniques should be pursued as quickly as possible and only undertaken by those individuals with medical training.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. For layperson responders, there are no specific guidelines additional to BLS recommendations.

Recommendations for medics in the setting of delayed veterinary care

1. Continue chest compressions at a rate of 100–120 per minute and ventilation at 10 breaths per minute in 2-minute uninterrupted cycles. The compressor should be rotated to prevent fatigue. This should continue for 15–20 minutes.
2. If only one rescuer is present, a 30:2 ratio of compressions to ventilation can be used.
3. Establish intravenous (cephalic or lateral saphenous vein) or intraosseous access (proximal humerus or medial proximal tibia). See *Guidelines for Fluid/Shock Resuscitation*.
   a. Fluid therapy may be considered in a dog with known or suspected hypovolemia. Administer a 10–20 mL/kg bolus of a balanced electrolyte solution, such as lactated Ringer's solution.
      i. Small dogs/cats (< 10 kg) administer 100 mL
      ii. Medium-sized dogs (10–20 kg) administer 250 mL
      iii. Large/working dogs (> 20 kg) administer 500 mL
      iv. See *Guidelines for Shock/Fluid Resuscitation*
   b. Fluid therapy should be avoided if normovolemia is present.
4. Place ECG pads on the foot pads of the dog. This will provide for rapid ECG assessment. ECG rhythm may be assessed by trained responders using similar criteria to people. Practically, the rhythm should be assessed as "shockable" or "nonshockable." Shockable rhythms include pulseless ventricular tachycardia and ventricular fibrillation, while nonshockable rhythms include asystole and pulseless electrical activity (PEA).
   a. If shockable rhythm, deliver external countershock (biphasic dosage of 3 J/kg and monophasic dosage of 5 J/kg) and resume chest compressions.
      i. Average countershock delivered:
         1. Small dogs/cats (< 10 kg) administer 30 J
         2. Medium-sized dogs (10–20 kg) administer 60 J
         3. Large/working dogs (> 20 kg) administer 100 J

b. Defibrillator paddles should be placed overlying the heart, mid-thorax, on opposite sides of the chest.
c. If an (automated electrical defibrillator) AED is available, it may be used in large breeds (>30 kg dog), such as working dogs. Clippers are required to remove hair, to permit the patches to adhere, over each side of the chest with the canine heart being located at the 4–5th intercostal space (at the point of the elbow when the forearm is flexed toward the thorax). Patches should be placed ½ to 1 inch above the sternum (to avoid contact between them).
d. If a nonshockable rhythm is present, and IV/IO access has been secured, administer 0.01 mg/kg (0.1 mL/10 kg/22 pounds of 1:1000) epinephrine IV/IO every 4–6 minutes.
e. If IV/IO access is not available, 3–10X the dose (up to 1 mL/10 kg) may be given intratracheal. Intratracheal medication should ideally be delivered via a long catheter, and followed with a flush of 10 mL saline or water and then an assisted ventilation breath (to help spread drug throughout the lungs)

5. If there is any potential chance of accidental exposure to narcotics, administer naloxone (0.04 mg/kg IV, IO, or IM).
6. In the setting of thoracic trauma, if ventilation is difficult or oxygen saturation is low with circulation, consider performing thoracic needle decompression with a large bore needle. See *Guidelines for Respiratory Distress.*

Discussion

Intubation is the preferred method for delivery of fresh gas. Mouth to snout ventilation or facemask may deliver gas to the gastrointestinal tract. Laryngeal mask airway (LMA) may be used but are not readily available in working dog sizes, and more practically, intubation is easily accomplished in the field using human endotracheal tubes. See *Guidelines for Respiratory Distress* for more discussion regarding intubation.

Intravenous access is very helpful for delivery of emergent medications and fluids, in the setting of hypovolemia. Location of vascular access has not been closely explored in collapsed dogs. However, given limited blood flow, it is logical to administer medications closer to the heart rather than to rely on CPR efforts and fluids to deliver medications to the heart and arterial vasculature. The cephalic vein in larger dogs is typically easiest to catheterize. In a laterally recumbent animal, the down leg should be used. The jugular vein is also an option, but is technically more difficult. Placement of a catheter in the lateral saphenous vein may be possible, but in cardiac arrest, there may be significant delays until medications reach the heart. Intraosseous (IO) catheterization, using the EZ-IO gun, is also practical and useful in the field for first responders that carry this device. The proximal humerus is the recommended site during CPR for placement of an IO catheter, although the medial aspect of the proximal tibia can also be used. The catheters are typically 15 gauge, and catheters that are 15 mm in length should be used for cats and small dogs while catheters that are 25 mm in length should be used for medium to large dogs.

The likelihood of exposure to narcotics is unknown. In working or drug detection dogs accidental ingestion while working, or during training, is possible. Suspected and actual narcotic overdoses in people are safely treated with naloxone. As such, it is available for emergency responders and can be safely administered to both dogs and cats.

Thoracentesis, or needle decompression, is a potentially controversial area. There is no evidence that bystander needle thoracocentesis is helpful in dogs. However, in people there is some evidence that treatment of tension pneumothorax is associated with improved survival. In cases of CPA, it is unlikely that needle thoracocentesis would be associated with any clinically relevant complications.

The reader is referred to the veterinary RECOVER guidelines for further discussion.

Further Reading

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Section 7: Analgesia/Sedation/Anesthesia

NOTE

Check infusion rates carefully (dose/kg/min versus dose/kg/h).

IV = intravenous, IM = intramuscular, IO = intraosseous, PO = Per Os (by mouth), SQ = subcutaneous. PRN = as needed

NSAID = Nonsteroidal anti-inflammatory drug

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective**

equipment (PPE) is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Perform a cursory exam and identify concerns such as shock, respiratory difficulty, external hemorrhage, etc. and proceed to Guidelines for those threats to life.
2. "*Scoop and Run*" and proceed to nearest emergency veterinary hospital
3. DO NOT administer human pain-relieving medications, such as aspirin or ibuprofen, or any oral veterinary NSAIDs, such as carprofen or meloxicam.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

Follow guidelines for First Response with noted exceptions below.

1. The following scenario may warrant sedation/analgesia prior to *scoop and run*:
   a. Upper airway obstruction:
      i. Follow *Guidelines for Respiratory Distress*
      ii. If unsuccessful, consider one of the following (combined with a benzodiazepine), if available:
         1. Acepromazine: 0.03–0.05 mg/kg IM
            a. This can be repeated if sedation is not adequate.
         2. Butorphanol: 0.2–0.4 mg/kg IM
         3. Dexmedetomidine: 3–6 mcg/kg IM (will cause bradycardia)
         4. Fentanyl: 5–10 mcg/kg IM
         5. NOTE: If sedation is utilized, be prepared to administer oxygen and possibly intubate.
         6. NOTE: All of the aforementioned drugs are better tolerated when combined with a benzodiazepine; consider midazolam (0.25–0.5 mg/kg IM).
      iii. Once sedated, align head, and neck to ensure a patent airway, administer oxygen, and pull tongue outward (if able).
      iv. See *Guidelines for Respiratory Distress* and transport ASAP.
2. DO NOT administer human pain medications, such as aspirin or ibuprofen, or any oral veterinary NSAIDs, such as carprofen or meloxicam.
3. DO NOT administer oral drugs to an injured animal that has a compromised airway, loss of gag reflex, or altered mentation/attitude.
4. For MILD pain, without the aforementioned conditions, consider:
   a. Butorphanol or nalbuphine: 0.1–0.5 mg/kg IM (if available) q 2 h PRN
   b. Tramadol: 3–5 mg/kg PO q 6–8 h
5. For MODERATE to SEVERE pain:
   a. Consider use of morphine IV, IO, or IM, fentanyl IV, IO, or IM, and/or ketamine.
      i. See medic guidelines below for further information.

Recommendations for medics in the setting of delayed veterinary care

Follow guidelines for first and delayed response above with the following additional recommendations.

1. If injectable analgesia is needed, place an IV or IO catheter (see *Guidelines for Fluid Resuscitation* for a list of options).
2. **Analgesia options**:
   a. Morphine: 0.10–0.5 mg/kg IM or 0.10–0.25 mg/kg IV or IO (use low end of dosage in cats and titrate to effect for both species)
      i. Note: If using IV/IO route inject over 5 minutes; morphine can cause histamine release and hypotension in dogs if given rapidly.
      ii. Morphine may cause vomiting; remove muzzle if necessary.
      iii. Duration of action is ~ 4 hours.
      iv. In delayed scenario consider constant rate infusion: 0.1–0.3 mg/kg/h; requires a 0.5 mg/kg IV/IO loading dose.
   b. Fentanyl
      i. Single injection or loading dose: 2–5 μg/kg IV/IO (preferred) or IM q 20–30 min
      ii. Constant rate infusion (IV):
         a. 3–5 μg/kg/hour [0.05–0.08 μg/kg/min]; requires a 2–5 μg/kg IV/IO loading dose.
   c. Ketamine
      i. Choose an alternative, if possible, in the setting of head injury or a penetrating corneal injury.
      ii. Dosage: 0.25–1.0 mg/kg IV/IO or 2–4 mg/kg IM.
      iii. Constant rate infusion for analgesia at 2–10 μg/kg/min; this will require dilution to a concentration of 10 mg/mL [1 mL of 100 mg/mL ketamine mixed with 9 mL of saline].
      iv. Ideal for use in combination with an opioid.
      v. It is strongly recommended to coadminister a benzodiazepine (diazepam at 0.2–0.4 mg/kg IV or midazolam 0.2–0.4 mg/kg IV or IM) to reduce muscle rigidity/myoclonus.
      vi. Ketamine can also be used for rapid induction at 5 mg/kg IV with a benzodiazepine (diazepam or midazolam at 0.25 mg/kg IV).

   d. Lidocaine
      i. Dogs: 1–2 mg/kg IV/IO.
      ii. Maximum dose for dogs = 8 mg/kg IV, IO.
      iii. May be sprayed onto wounds for topical analgesia.
      iv. Infusion rate: 0.6–3.0 mg/kg/h (10–50 μg/kg/min); requires a 1 mg/kg IV/IO loading dose.
      v. Should not be used in cats due to cardiac depression.
3. **NOTE**: Opioids, ketamine, and lidocaine may be coadministered. One example is a Morphine-Lidocaine-Ketamine (MLK) protocol for dogs:
   a. Remove 30 mL of fluid from a 500 mL bag of LRS or 0.9% saline and add:
      i. 60 mg [0.6 mL of ketamine (100 mg/mL)]
      ii. 60 mg [4 mL of morphine* (15 mg/mL)]
      iii. 500 mg [25 mL of lidocaine (20 mg/mL)]
      iv. DELIVER THE MIXTURE AT 0.5–1.0 mL/kg/h
         1. *Note: can substitute 1.2 mg (24 mL) FENTANYL (50 μg/mL) for morphine–if this is used, remove 50 mL of fluid from the bag before adding the analgesic drugs.
4. **Sedation/anesthesia options**:
   a. Rapid Induction if needed can be achieved with ketamine (5 mg/kg IV) and diazepam or midazolam (0.25 mg/kg IV). These can be mixed together and given IV (or IO).
      i. Will provide 15–20 minutes of anesthesia.
      ii. Monitor respiration and provide oxygen by facemask. Be prepared to intubate and support ventilation (Ambu bag) if needed.
   b. Dexmedetomidine (0.5 mg or 500 μg/mL): 5–10 mcg/kg IV or 10–20 μg/kg IM.
      i. Note: heart rate will decrease after administration.
      ii. Additional doses can be given to achieve desired level of sedation.
      iii. Vomiting may occur; remove muzzle if necessary.
      iv. Dexmedetomidine can be reversed using atipamezole (5 mg/mL)–use equal volume to the administered dexmedetomidine and give IM.
      v. Dexmedetomidine and opioids can be coadministered.
   c. Benzodiazepines
      i. Midazolam or diazepam: either can be given at 0.2–0.4 mg/kg IV/IO.
      ii. Diazepam may be administered per rectum IM administration results in unpredictable uptake.
      iii. Midazolam may be administered IM, but is not absorbed effectively per rectum.
      iv. Diazepam and midazolam may be administered intranasally; a novel midazolam gel is superior to the injectable formulation.
      v. Typically combined with an opioid (butorphanol) for balanced sedation.
      vi. Benzodiazepines alone provide minimal sedation and can sometimes lead to excitation.
   d. Butorphanol/Nalbuphine
      i. Administer at 0.2–0.4 mg/kg IV or IM for sedation; this will provide some analgesia (sufficient for mild pain).
      ii. Duration of action is approximately 1 hour.
      iii. Can combine with a benzodiazepine as described above.
      iv. NOTE: nalbuphine can be used in the same manner as described for butorphanol.

Discussion

If an animal is severely injured anesthesia may be needed for humane reasons and to render the dog unconscious so that it can be transported, treated, or euthanized.

1. General guidelines
   a. Always start at the lowest end of the recommended analgesic or anesthetic dose range and titrate up until the desired clinical effect is reached.
   b. Combinations of drugs from different classes (eg, opioid plus ketamine) will reduce the dose of each drug, will increase efficacy, and may help reduce side effects.
2. Opioids in dogs:
   a. Dogs are less susceptible than people to the respiratory depressant effects of opioids. Respiratory depression is more likely after high doses of pure mu-agonists, such as morphine, and is rare with butorphanol.
   b. Monitor respirations (rate and depth) and mucus membrane color after administration of opioids. Consider giving oxygen.
   c. If respiratory depression does occur support respiration with a facemask and Ambu bag or Bag Valve Mask.
   d. Oral (eg, pills and tablets) formulations of opioids (morphine, codeine, hydrocodone) are not effective for the management of acute pain in dogs.
   e. Morphine may cause nausea and vomiting in dogs but this is less likely if it is given intravenously and to an injured (painful) dog
      i. Always be prepared to remove the muzzle if a dog begins to retch or vomit.
      ii. Ondansetron (0.2 mg/kg IV or IM) will decrease nausea but will not reliably prevent vomiting.

iii. Maropitant (1 mg/kg SQ) will prevent vomiting but must be given 45–60 minutes prior to morphine administration.

f. Opioids can be reversed:
   i. Dilute naloxone (0.4 mg/mL) by adding 1–9 mL of saline; give slowly IV until respiratory rate and/or depth increase; at this point, stop administration but continue to monitor.
      1. Naloxone is well absorbed intranasally if the IV route is not available.
   ii. Administer butorphanol (0.05–0.2 mg/kg); give slowly IV until respiratory rate or depth increase; stop administration but continue to monitor.
   iii. NOTE: To avoid complete reversal of analgesia give naloxone or butorphanol slowly and to effect.

3. Ketamine
   a. Ketamine can be used with opioids and benzodiazepines. Ketamine is a dissociative anesthetic but also provides analgesia.
   b. Ketamine is a good choice in a compromised animal as it produces minimal cardiovascular or respiratory depression.
   c. Ketamine should be used with caution if head trauma is suspected as it may increase intracranial pressure (ICP).

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Section 8: Neurological Trauma

Background

Neurological trauma in dogs and cats involves traumatic brain injury (TBI) and acute spinal cord injuries (SCI). Similar to people, neurological trauma in veterinary patients may carry a high mortality and morbidity rate. Common causes of neurological trauma in small animals include blunt force trauma (eg, vehicular, accidental, intentionally inflicted), animal attacks and falls.

Neurological trauma results in both primary and secondary injury. Primary injury occurs at the time of injury and results in direct damage to CNS tissues subsequent to the following mechanical forces: concussion, compression, shear, laceration, distraction, and contusion (coup or contrecoup). It is further classified by the extent of injury (focal or diffuse) as well as the location of injury. Primary TBI may involve epidural or subdural hematomas, subarachnoid hemorrhage, cortical contusions, and hematomas, and traumatic axonal injury. Vertebral luxations or subluxations, vertebral fractures, intraparenchymal contusions, traumatic intervertebral disk herniation, and or extra-axial hemorrhages are common manifestations of primary SCI. Secondary injury is multifactorial and a consequence of processes initiated by the primary injury and systemic factors that may further contribute to neuronal injury. Examples of these factors include: hypoxemia, hyper-, or hypocapnea, hypotension, hyper- or hypoglycemia, hyperthermia, acid-base and electrolyte abnormalities, systemic inflammation, intracranial hypertension, excitatotoxicity, cerebral edema, and lipid peroxidation. The combination of hypoxia and hypotension in a patient suffering TBI is associated with a higher mortality rate. For this reason, restoring and maintaining oxygenation and perfusion is vital to a successful outcome. Patients with TBI may also have skull fractures, facial, ocular, laryngeal, and or thoracic injuries. After addressing the patient's initial life-threatening injuries (see *Guidelines for Fluid Resuscitation and Respiratory Distress*), a thorough secondary survey is warranted to identify concurrent injuries.

Clinical signs indicative of head trauma may include facial abrasions or wounds, epistaxis, aural or oral hemorrhage, fractured teeth, hyphema, and scleral hemorrhage. A decerebrate posture results from a rostral brain stem (midbrain) lesion and is characterized by opisthotonus with extensor rigidity in the fore- and hind limbs. Decerebellate posturing manifests from a cerebellar lesion and is described as opisthotonus with forelimb extensor rigidity and alternating flexion and extension of the hind limbs. The major clinical difference between the two is patients with a decerebrate posture are comatose whereas those with a decerebellate posture remain conscious. A decerebrate posture also portends a guarded prognosis.

Patients with SCI will have a normal cranial nerve examination, but may present with tetra-, para-, and or hemiparesis and upper or lower motor neuron deficits depending upon the neuroanatomical location of the injury. Dogs and cats have 7 cervical, 13 thoracic, and 7 lumbar vertebrae, as well as a sacrum (tailbone) comprised of 3 fused segments. Spinal cord lesions may be localized to the primary segments of C1 – C5; C6 – T2; T3 – L3; and L4 – S3. Animals suffering a spinal cord trauma between

T2 – L3 may display signs of Schiff Sherrington Syndrome (SSS) that typically presents as pelvic limb paralysis with extensor rigidity of the thoracic limbs when the animal is in lateral recumbency. SSS results from interruption of the ascending spinal cord tracts from the lumbar intumescence that are responsible for inhibition of the forelimb extensors. Patients with SSS may have a good prognosis as long as deep pain sensation remains in the pelvic limbs.

An animal's level of consciousness (LOC) or responsiveness (LOR) is primarily controlled by the ascending reticular activating system (ARAS) of the brainstem. Many diffuse projections span from the ARAS throughout the animal's forebrain; therefore, an altered LOC/LOR in an animal often results from injury or insults to the brainstem and or cerebrum. Four common LOC are used in veterinary medicine, as follows:

a. *Normal* (bright, alert, and responsive);
b. *Obtunded* (dull, lethargic, slow to respond, aroused by nonnoxious stimuli);
c. *Stuporous* (somnolent; falls asleep if left undisturbed, requires repeated, and noxious stimulus to arouse); and
d. *Comatose* (unconscious; cannot be roused by even a noxious stimulus, "unarousable unresponsiveness").

The term "*depressed"* refers to a psychological state, not a level of awareness. Therefore, it is not typically used when describing the LOC/LOR of an animal. It is not uncommon for trauma patients to be obtunded when a first responder or EMS personnel arrive at the scene for multiple reasons. Thus, it may be hard to objectively determine if the patient has suffered a SCI. As a general rule, it is safer to lean on the side of safety and presume a SCI is present for the following situations, until proven otherwise: (a) Any blunt force trauma involving the head, neck, or thorax, (b) Fall from a height, and/or (c) Ejection from a moving vehicle. For these situations, the first responder/EMS should pursue interventions to immobilize the spine. In people, an exception to this rule is a patient with penetrating thoracic or abdominal injury. As compared to blunt force trauma, penetrating injuries alone have less risk of inducing an unstable spinal cord injury. In addition, mounting evidence in humans suggest that routine spinal immobilization on a backboard may cause more harm than good.

Another phenomenon called spinal shock may also develop following postblunt force trauma. Spinal shock is a misnomer in that it does not involve hemodynamic instability and therefore, it does not manifest clinically with the classic signs of hypovolemic shock (eg, tachycardia, hypotension). Instead, spinal shock is a transient dysfunction of the spinal cord that develops subsequent to an acute SCI. It clinically manifests as a loss of all neurological activity (eg, motor, sensory, reflex, or autonomic function) below the level of injury. Spinal shock may start as early as 30–60 minutes following a SCI, and may resolve in as little as 12–24 hours. The exact time course in dogs and cats is unknown.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Suspected or Known **Head Trauma**:
   a. Control any external bleeding with direct pressure over the wounds using impregnated hemostatic gauze (preferred) or standard gauze pads (see *Guidelines for External Hemorrhage)*
   b. Establish a patent airway as per *Guidelines for Respiratory Distress* in patients with:
      i. Upper airway obstruction due to trauma, edema, or hemorrhage
      ii. Decreased level of consciousness or comatose animals that cannot protect their airway
   c. Address breathing and hemodynamic disorders in accordance with *Guidelines for Respiratory Distress and Fluid Resuscitation*, respectively.
   d. Keep the head/neck elevated in a gradual plane of approximately 15–30 degrees (avoid kinking the neck).
   e. If available, provide oxygen via flow-by or oxygen mask (see *Guidelines for Respiratory Distress*) during transport.
   f. Remove all collars, leashes, or wraps from the neck to facilitate venous drainage and arterial blood flow. Take care to minimize manipulation of the neck in doing so.
   g. If unconscious, initiate BLS (see *Guidelines for BLS*) during transport. DO NOT delay transport to definitive veterinary care to start BLS in a trauma patient with head trauma.
   h. Transport ASAP to nearest veterinary center.
2. Suspected or Known Acute Spinal Cord Injury (SCI):
   a. Before transport, immobilize the spine by placing the patient in lateral recumbency onto a rigid stretcher (if available) or a flat board.
      i. If available provide a thin layer of soft padding to prevent pressure sores once the patient is secured to the rigid support.

ii. Exception: If the patient is in concurrent respiratory distress, lateral recumbency may exacerbate the work of breathing. In this instance, allow the animal to assume a position of comfort, typically sternal recumbency, and secure in that position.

b. Place the rigid support adjacent to the patient's spinal column and carefully move onto the stretcher.
   i. With two hands, scruff the animal's fur along the dorsal neck and dorsal rump, and gently and equally with both hands pull/slide the patient onto the rigid support.
   ii. Alternatively, with two or more rescuers, move the patient onto a sheet or blanket and then carefully lift or slide the animal on the backboard.

c. Secure the patient to the support with tape or nylon straps.
   i. Immobilize the limbs to prevent forward, backward, or rotational movement that could cause further SCI.
   ii. Place body straps behind the shoulder blades and just in front of the hips. Avoid placing straps or tape over the widest portion of the thorax or midabdomen to allow adequate chest excursion for ventilation.

d. Align the head and neck to maintain the cervical spinal cord in a neutral in–line position. This requires placement of a soft pad under the head to align it in a straight line with the cervical spine.
   i. Avoid placing the head and neck in a hyperextended position.
   ii. Do not attempt placement of the head and cervical region in a neutral in–line position if there is:
      1. Resistance to movement
      2. Immediate deterioration of clinical neurological signs
      3. Compromise of airway and ventilation
   iii. Do not attempt to align the head with the cervical spine before securing the patient to the rigid support.

e. Transport the patient to the nearest veterinary facility as soon as possible

3. Seizures
   a. Attempt to prevent trauma to the patient during a seizure.
      i. Place clothing, towels, or any other soft material under the patient's head.
      ii. Move hazards away from the seizing patient's immediate surrounding area.
      iii. DO NOT put your fingers into the mouth of a seizing patient.
   b. Transport as soon as possible

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Follow guidelines as described for First Response with the addition of the following recommendations.
2. Suspected or Known **Head Trauma**:
   a. If available, provide oxygen via flow-by or oxygen mask (see *Guidelines for Respiratory Distress*).
      i. If comatose and without spontaneous respirations, consider assisted ventilations via Bag-Valve-Mask using a flow rate of 50–100 mL/kg/min. Refer to *Guidelines for BLS*.
      ii. AVOID placing nasal or nasopharyngeal oxygen cannulas in patients with head trauma.
   b. Periodically reassess and record Small Animal Coma Score every 15–30 minutes (see Figure 6).
   c. Evaluate and record vital signs (heart rate, respiratory rate, mucous membranes, capillary refill time, pulse quality, and temperature) at regular intervals (approximately every 15 minutes) dependent upon personnel.
   d. Instill artificial tears or sterile ointment in both eyes q4h if the patient cannot blink.
3. Suspected or known acute spinal cord injury:
   a. Mitigate the risk of aspiration by elevating the head end of the rigid support by 15–30 degrees.
4. Seizures
   a. Attempt to prevent trauma to the patient during a seizure (see First Response guidelines above).
   b. With repetitive seizures, animals can become hyperthermic. Monitor rectal temperature (with other vitals) and initiate cooling if rectal temperature exceeds 40°C [104°F]. Cease active cooling once rectal temperature reaches 39.7°C [103.5°F]. See *Guidelines for Heat Exhaustion*.

Recommendations for medics in the setting of delayed veterinary care

1. Follow guidelines described above with the addition of the following recommendations. Perform the following based on provider skill level and scope of practice as well as available resources.
2. Suspected or known **head trauma** or **spinal cord injury**:
   a. Efforts should focus on preventing or mitigating secondary neurological injury.
   b. Maintain adequate oxygenation. If available, use pulse oximetry to target a $SpO_2 > 92\%$. The goal with O_2 therapy is to achieve a normoxia (eg, SpO_2 94–98%) and not necessarily hyperoxia. See *Guidelines for Respiratory Distress* for methods of oxygen administration.
      i. AVOID placement of nasal, naso-pharyngeal, and or naso-tracheal catheters due to the

Small Animal Coma Scale

Motor activity		Time:	Time:	Time:	Time:	Time:	Time:
Normal gait, normal spinal reflexes	6						
Hemiparesis, tetraparesis, or decerebrate activity	5						
Recumbent, intermittent extensor rigidity	4						
Recumbent, constant extensor rigidity	3						
Recumbent, constant extensor rigidity with opisthotonus	2						
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1						
Brain stem reflexes							
Normal pupillary light reflexes and oculocephalic reflexes	6						
Slow pupillary light reflexes and normal to reduced oculocephalic reflexes	5						
Bilateral unresponsive miosis with normal to reduced oculocephalic reflexes	4						
Pinpoint pupils with reduced or absent oculocephalic reflexes	3						
Unilateral, unresponsive mydriasis with reduced or absent oculocephalic reflexes	2						
Bilateral, unresponsive mydriasis with reduced or absent oculocephalic reflexes	1						
Level of consciousness							
Occasional periods of alertness and responsive to environment	6						
Depression or delirium, capable of responding to environment but response may be inappropri	5						
Stupor, responsive to visual stimuli	4						
Stupor, responsive to auditory stimuli	3						
Stupor, responsive only to repeated noxious stimuli	2						
Coma, unresponsive to repeated noxious stimuli	1						
TOTAL SCORE							
List current medications that may affect examination (e.g., opioids, sedatives, antidepressants, etc)							
		Score interpretation:		**3-8 Grave**	**9-14 Guarded**	**15-18 Good**	

Courtesy L. Palmer, 2015

Figure 6: Chart used for serial monitoring of the Small Animal Coma Score.

potential risk for inadvertent cerebral penetration due to compromise to the cribiform plate as well as induction of sneezing, which increases intracranial pressure.

c. Establish a patent airway if compromised/obstructed or patient is unconscious/comatose (see *Guidelines for Respiratory Distress*). Consider orotracheal (endotracheal) intubation in unconscious patients. See *Guidelines for BLS* if the patient is hypoventilating or apneic.
   i. If intubation becomes necessary, maintain ventilation by monitoring end-tidal carbon dioxide ($EtCO_2$).
      1. Target an $EtCO_2$ = 35–40 mm Hg
      2. Provide no more than 8–10 breaths/min with a 1 second inspiratory time.
   ii. AVOID prophylactic hyperventilation of the patient ($EtCO_2$ < 30 mm Hg). This may cause cerebral ischemia. Exception: Therapeutic hyperventilation may be implemented as a last resort when signs of imminent brain herniation are present and the patient remains refractory to the ALL other therapeutics.
      1. If performed, therapeutic hyperventilation should target an $EtCO_2$ of < 30 mm Hg using a rate of 20–25 breaths/minute and be terminated once signs of intracranial hypertension resolve.

d. Measure noninvasive blood pressure (NIBP)
   i. Place the BP cuff on a forelimb (between the elbow and the carpus or wrist), a hindlimb (between the stifle/knee and tarsus/ankle) or at the base (closest to body) of the tail.
   ii. For an accurate BP recording, the cuff width should be approximately 40% of the circumference of the limb/tail upon which it is placed. Too wide of a cuff will result in falsely low readings, whereas too narrow of a cuff may lead to falsely high readings.
   iii. Target a mean arterial pressure (MAP) of > 80 mm Hg or systolic blood pressure of > 100 mm Hg.

e. Correct hypotension and restore perfusion:
   i. Place IV or IO catheter and start fluid resuscitation to restore perfusion (see *Guidelines for Fluid Resuscitation*).
   ii. Options for fluid resuscitation:
      1. 3–7.5% Hypertonic Saline (2–5 mL/kg IV); repeat twice as needed to achieve endpoints of resuscitation.

2. Colloid (5 mL/kg IV); repeat as needed.
3. Crystalloid (10 mL/kg IV); Use when colloids or hypertonic saline are not available and the patient is suffering circulatory shock; repeat as needed.
    a. Avoid excessive administration, especially with concurrent thoracic trauma/pulmonary trauma.
    b. Ideally, a total volume of < 20–30 mL/kg is preferred.

f. Periodically monitor and record Small Animal Coma Score (SACS; Figure 6).
   Impending signs of brain herniation include:
   i. Declining SACS
   ii. Cushing's response (severe bradycardia with marked hypertension)
   iii. Deterioration of pupillary size (bilateral miosis to bilateral mydriasis) and pupillary light reflexes (normal response → sluggish → nonresponsive)
   iv. Progressive loss of motor function
g. Administer hyperosmotic therapy if any signs of intracranial hypertension (ICHP) or cerebral herniation are present or SACS worsens. Signs of ICHP/cerebral herniation may include being comatose in conjunction with having dilated and nonreactive pupils, or displaying characteristic signs of the Cushing's response (rise in systolic blood pressure, widening pulse pressure, bradycardia, and irregular breathing):
   i. 3–7.5% hypertonic saline.
   ii. Mannitol (0.5–1.4 g/kg IV/IO) administered slowly over 20–30 min every 4–6 hours.
   iii. Avoid in patients with hypotension/hypovolemia, renal insufficiency, or hyperosmolality.

3. Seizures:
   a. First line anticonvulsant therapy
      i. Benzodiazepines:
         1. Diazepam (0.5 mg/kg IV or intranasal); per rectum can be also be given (1 mg/kg).
         2. Midazolam (0.5 mg/kg IV, IM or intranasal); not effective per rectum.
         3. Either drug listed above may be repeated as needed to control seizures.
         4. Lorazepam (0.2 mg/kg IV, IM or intranasal); not effective per rectum.
   b. Second line anticonvulsant therapy
      i. Levetiracetam (Keppra) (30–60 mg/kg IV) for status epilepticus.
4. Provide Analgesia for neurological trauma as pain triggers the stress response and can increase intracranial pressure. See Guidelines for Analgesia.
   a. IV or IM pure mu-agonist opioids (eg, morphine or fentanyl) are most effective. Start at a low dose and titrate to effect. NOTE: Oral administration of opioids is not a very effective route of administration in dogs or cats.
5. Monitor blood glucose concentration if possible. Hyperglycemia is often a more common occurrence in patients suffering head trauma, whereas patients suffering status epilepticus or cluster seizures may be more prone to hypoglycemia.
   a. Correct hypoglycemia (< 3.8 mmol/L [<70 mg/dL]) by supplementing 0.5 mL/kg of 50% dextrose diluted 1:4 with an isotonic crystalloid. If patient remains persistently hypoglycemic consider a 2.5% to 5% dextrose infusion. AVOID hyperglycemia (serum glucose > 10 mmol/L [>180 mg/dL]).
6. Transport to the closest veterinary facility as soon as possible.

Discussion

Similar to any other traumatic event, the approach to the neurological trauma patient begins with addressing any conditions that threaten airway, breathing, and circulation. Primary injuries cannot be altered once they occur. Therefore, once life-threatening conditions are mitigated all efforts should focus on preventing or minimizing secondary neurological injury. Restoring and maintaining perfusion and adequate mean arterial pressure (MAP) is a key tenet of managing the neurological trauma patient. Cerebral perfusion pressure (CPP) is determined by the difference between mean arterial pressure (MAP) and intracranial pressure (ICP) (CPP = MAP – ICP), whereas spinal cord perfusion pressure (SCPP) is the difference between MAP and cerebrospinal fluid pressure (CSFP). According to this concept, any decrease in MAP inherently leads to a subsequent decrease in perfusion. Other key interventions for minimizing secondary brain injury include maintaining oxygenation and ventilation, providing analgesia, correcting acid-base and electrolyte disorders, and administering hyperosmotic therapy (eg, hypertonic saline and mannitol).

Hypertonic saline versus mannitol

The evidence supporting the use of hypertonic saline (HTS) versus mannitol as first-line therapy for neurolog-

ical trauma remains controversial. Both HTS and mannitol carry their own inherent risks for inciting adverse events. Mannitol's primary adverse effects include volume depletion and acute kidney injury, especially during states of hyperosmolality (> 320 mOsm/L). Mannitol is contraindicated in states of hypovolemia due to the risk of further compromising MAP and subsequently jeopardizing cerebral perfusion pressure. The primary concern with HTS is the risk of inciting acute, marked hypernatremia. This is of particular concern in patients with preexisting moderate to severe dehydration (eg, > 10% dehydration) or in patients that are already hypernatremic. Most recommendations advise not giving HTS when serum sodium is > 160 mEq/L. Considering the lack of scientific evidence from clinical, randomized trials supporting the use of HTS in place of mannitol as first-line therapy in TBI, the Brain Trauma Foundation Guidelines currently recommend mannitol as first-line therapy. The exception to this recommendation is in the setting of hypovolemia where the volume expanding effect of HTS would be more beneficial for restoring MAP and, thus, CPP.

Corticosteroids for neurological trauma

Current evidence does not support the use of corticosteroids for reducing cerebral edema or improving outcome in TBI. The MRC CRASH trial is the largest randomized multicenter, placebo-controlled trial to date that aimed to confirm or refute an effect of corticosteroids on TBI. The steering committee halted the recruitment of patients and stopped the trial after enrolling 10,008 patients. Data from the interim analysis revealed that patients given corticosteroids had a worse outcome and a higher mortality rate. On the other hand, corticosteroids for acute SCI remain controversial in both human and veterinary medicine. Methylprednisolone sodium succinate (MPSS) has been touted as the corticosteroid of choice for administration in people with acute SCI due to its proposed neuroprotective effects as a free radical scavenger and anti-inflammatory agent as well as its ability to improve regional blood flow. However, the 3 largest trials evaluating the use of MPSS in humans with SCI failed to provide absolute support that it has a significant benefit for improving function. To date, there is one clinical prospective, blinded, randomized, placebo-controlled trial evaluating MPSS, and polyethylene glycol in canine patients with acute SCI secondary to naturally occurring intervertebral disc disease (Olby et al). This clinical trial did not show a benefit of either MPSS or polyethylene glycol in the treatment of acute, severe thoracolumbar intervertebral disc herniation when used as adjunctive medical treatment administered to dogs presenting within 24 hours of onset of paralysis. There is also one study evaluating the use of dexamethasone in dogs with SCI that failed to identify any benefit. The greatest concern with steroid administration includes their high risk of complications such as immunosuppression and gastrointestinal ulceration. Considering the proposed, unproven benefits do not outweigh the known risks, most current guidelines do not recommend the usage of corticosteroids in patients with neurologic trauma.

Further Reading

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Section 9: Management of Penetrating Trauma

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. The patient may be uncomfortable and somewhat fearful. Restrain and use muzzles cautiously as many styles (especially cloth or mesh "medical" muzzles) restrict a dog's ability to pant, and may exacerbate respiratory distress. Basket muzzles are preferred if available.
2. Allow the patient to sit, stand or lay however it is most comfortable. If the patient is conscious, it will naturally assume a position that is physiologically efficient for breathing.
   a. If recumbent, clear the airway by opening the mouth and extending the head and neck.
   b. If the patient is unconscious, extend the head and neck and pull the tongue out and down between the lower canine teeth. Ensure the patient is breathing with a palpable pulse. If cardiopulmonary arrest is suspected start chest compressions and refer to *Guidelines for BLS and ALS*.
3. If available, provide oxygen supplementation by the least stressful means, such as flow-by (10–15 liters per minute) or mask (6–8 liters per minute). If respirations are labored or distress is present, refer to *Guidelines for Respiratory Distress*.
4. Injuries severe enough to cause impalement may result in other threats to life such as respiratory compromise, shock, fractures, or external or internal hemorrhage. Refer to *Guidelines for each of the aforementioned* as needed.
5. **Open or sucking chest wounds**
   a. Immediately cover all OPEN or SUCKING CHEST wounds with your hand to prevent further air accumulation within the chest cavity until adequate material to seal the wound is obtained.
   b. If commercial material to seal the wound is not available or usage of chest seal is unfamiliar, common materials can be used to fashion a chest seal (cover the hole) and tape it on all 4 sides (see step d below).
   c. If skills and scope of practice allow, place an occlusive (air/water tight) dressing over any penetrating wounds found from the abdomen up to the chest (seal/cover all holes).
   d. Chest seal technique:
      i. If hair clippers are available, quickly clip hair around the wound, to allow an airtight seal.
      ii. If hair clippers are not available place water-soluble lubricant on the underside of the chest seal to facilitate a more occlusive seal.
      iii. Most commercially available "combat" chest seals will work on dogs if reinforced with tape on the edges.
      iv. Makeshift materials can also be used to construct a chest seal: eg, plastic baggies, Saran wrap (cellophane), empty IV fluid wrappers. These items should be cut large enough to cover the defect with a 1–2 inch margin on all sides. Place water-soluble lubricant, if available, on the underside of the seal (1/2 inch away from the edges) and cover the defect.
      v. Tape/seal any occlusive dressing (commercial or makeshift) on all 4 sides or entire perimeter of dressing. This can be done with waterproof tape, porous medical tape, or duct tape. Continuous monitoring for tension pneumothorax is required (see below).
   e. A **tension pneumothorax** is a life-threatening emergency and occurs when the penetrating trauma lacerated both the chest wall and lung lobe. This allows air to escape from the lungs into the chest. Once the chest wall is sealed this air can build up within the chest preventing the lungs from expanding. Death is imminent if not treated.
      i. To avoid a tension pneumothorax, a vented chest seal is preferred (commercial). If one is not available, a nonvented seal is adequate with close monitoring for respiratory distress.
      ii. If any increase in distress is noted after the chest wall is sealed, the seal should be burped (opened on one to two sides to allow gas to escape).
6. For open chest wounds, especially those associated with gun-shot wounds, always search for both an entry and exit wound. If both an entry and exit wound are found, they should both be treated.
7. **Chest wall impalements**
   a. Do not remove a penetrating object if it is still impaled. Removing the impaled object may disrupt vital tissues, cause further internal damage, and release pressure off lacerated blood vessels that may contribute to uncontrollable cavity hemorrhage.
   b. Removal of an impaled object may only be warranted when removal of the object:
      i. Facilitates rapid extraction of the injured animal out of a hostile or destabilizing environment.
      ii. Is necessary because the injured animal is entrapped or pinned by an immoveable structure (eg, protruding steel rebar from a collapsed building foundation or a fence post). If possible, cutting the object is preferable to removing it from the animal.
      iii. Is required to perform chest compressions for basic life support.
   c. All impaled foreign material should be secured in-place.
      i. Support the impaled object in place with bandage material, tape, etc. as needed. A "donut"

dressing may help stabilize objects protruding from the patient's body.
   ii. Seal the edges of the wound around the impaled object with an occlusive chest seal to prevent air and other contamination from entering the chest cavity. Caution: Watch for signs of tension pneumothorax (See 5e above).
8. Transport as soon as possible, preferably to a facility capable of performing a thoracotomy.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Follow recommendations for "**First Response**" noted above.
2. Be wary of other threats to life and monitor patient closely. *Follow scenario dependent guidelines* as needed.
3. In the event of evisceration of abdominal contents, keep them covered, clean and moist:
   a. Wash off any gross contamination with a balanced crystalloid solution, or clean water if crystalloids are not available.
   b. Moisten a sterile or clean, nonadherent cloth (eg, dressing, gauze, or even a clean towel) with a crystalloid solution. Clean water can be used as an alternative. Cover/wrap the eviscerated contents in the moistened cloth and continue to keep it moist for the duration until definitive care is reached.

Recommendations for medics in the setting of delayed veterinary care

1. Follow guidelines as listed above with additional recommendations listed below.
2. Suspect tension pneumothorax based on:
   a. Mechanism of injury (MOI), to include known or suspected:
      i. Penetrating thoracic or abdominal injury
      ii. Blunt thoracic trauma (eg, blast overpressure)
   b. Clinical signs:
      i. Dyspnea, gasping, agonal breathing, or short/shallow labored fast breathing
      ii. Progressive respiratory distress with rapid, shallow, and open-mouth breathing while acting agitated or unable to get comfortable
      iii. Head and neck extended
      iv. Minimal chest excursion with more abdominal and head component
      v. Elbows and upper front legs held out away from body
      vi. Reluctance to lie down while focused on breathing
      vii. Cyanotic (ie, blue) gums; typically, a late finding
      viii. Lack of or decreased lung sounds ausculted on either or both sides (if able to auscultate)
3. If a tension pneumothorax is suspected, perform needle decompression:
   a. If a chest seal is present when the tension pneumothorax is detected. It is recommended to first "burp" the seal by opening it on one side to allow any air under pressure to escape.
   b. *Needle decompression:* Using a 10–16 Ga, 2–3.25 inch over-the-needle IV catheter, needle, or commercially available 10 Ga 3 inch thoracic trocar needle; insert the needle perpendicularly through the 7–9th intercostal space into the pleural space on either side of the patient's body, midway between the ventral (sternum) and dorsal (spine) borders of the chest.
      1. Avoid intercostal blood vessels and nerves by positioning the needle closer to the cranial (towards the head) aspect of the rib, similar to people.
      2. *Catheter:* Once seated in the pleural cavity, the stylet can be removed and the catheter left in place until air leakage stops. The catheter should then be removed for transport.
      3. *Needle:* The needle should be directed caudally with the bevel pointed outward toward the pleural space. Once air leakage ceases, keep the needle in the same plane and pull it out cranially or toward the head of the animal.
      4. It is recommended to first evacuate the side that is most affected (using auscultation) or the side with the most severe injury.
         1. If respiratory effort persists, consider decompressing both sides of the chest regardless of the external location of the wound. Ballistic projectiles and shrapnel may travel erratically throughout the thorax leading to lung damage in both hemithoraces. In addition, and unlike in people, the mediastinum in dogs has small fenestrations that allows communication between the left and right hemithoraces and, thus, allowing air accumulation in the uninjured side.
   c. Look, listen, and feel for release of air from the chest and for improvements in breathing. Once air leakage ceases, remove the catheter or needle.
   d. If signs persist, repeat the procedure on the opposite side of the chest.
   e. The procedure may need to be repeated if time to definitive care is prolonged. Assess the need for repeat decompression based on worsening of clinical signs as described above.

Discussion

The use of three-sided occlusive chest seals has given way to four-sided, vented chest seals in people with penetrating thoracic trauma. For the purpose of this discussion, "four-sided" means completely occlusive around the perimeter of the dressing, as many of these seals are oval or circular in shape. Vented chest seals have an opening or openings in the center of the seal to act as a one-way valve to allow air to escape, but not enter the chest through the wound. A study using a swine model demonstrated decreased development of tension pneumothorax and better outcome using four-sided, vented chest seals vs. four-sided unvented chest seal. The effectiveness of four-sided vs. three-sided occlusive seals, or vented versus unvented seals have not been evaluated in dogs. However, in a retrospective study of gunshot wounds (GSWs) in military working dogs (MWDs), all of chest seals applied to the dogs were four-sided or four-sided/vented (personal communication). No complications were reported as a result of the type of seal. Based on the available evidence, the authors recommend the use of a four-sided occlusive seal that is vented, when available. These best-practice guidelines are suggested for two reasons: 1. There is no evidence that a three-sided dressing is any more or less effective than a four-sided dressing, 2. Four-sided seal or four-sided, vented seal complies with current human Tactical Combat Casualty Care (TCCC) guidelines. Unless a compelling reason exists for using a separate standard for animals, the adoption of accepted techniques and available materials will facilitate treatment.

A retrospective study of MWDs incurring combat-related GSWs demonstrated that military paramedics and canine handlers with advanced training successfully performed needle decompression using large-bore (10–14 Ga) over-the-needle catheters on MWDs with tension pneumothorax. Of the four that incurred tension pneumothorax, three were decompressed by medics or handlers and survived to eventually return to full duty. One dog died of unrecognized and untreated tension pneumothorax after arrival to veterinary care. A study of GSWs in companion dogs and cats showed that 23% underwent needle thoracocentesis. These two studies suggest that a pneumothorax is relatively common in dogs with penetrating chest wounds, and that with prior training, medics can safely and effectively perform this procedure without direct veterinary supervision.

Further Reading

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Section 10: Blast Injury

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions). NOTE: All bomb events have the potential for chemical or radiological contamination.

Background

1. Injuries sustained from explosions are usually multidimensional, involving numerous different body systems and various levels of severity.
   a. Injuries can be classified into 4 categories:
      i. *Primary*: Injury from the supersonic pressure wave (blast wave) hitting the body. For example: tympanic membrane rupture, pulmonary damage (pneumothorax), air embolization, or hollow organ injury (most notably the large intestine). The lungs and abdomen are the two systems at highest risk of serious injury from primary blast.
      ii. *Secondary:* Injury from flying debris (eg, bomb fragments, shrapnel). This results in penetrating trauma, fragmentation injuries, and blunt trauma.
      iii. *Tertiary*: Injuries from displacement of patient by the blast wind. This results in blunt or penetrating trauma, fractures, and traumatic amputations.
      iv. *Quaternary*: All other injuries associated with the blast. This may include: crush injuries, burns, asphyxia, toxic exposures, and exacerbations of chronic illness.
   b. Patients exposed to explosions in confined spaces (eg, buildings, large vehicles, mines) or structural collapses are associated with greater morbidity and mortality.

   c. Repeatedly examine and assess patients exposed to a blast.
   d. Acute loss of hearing is common in blast injuries. The canine may not be able to hear and thus, may not respond to auditory commands.
   e. Consider the need for spinal stabilization and additional resources. The use of backboards, stretchers or towels/blankets should be considered to prevent further injury from unrecognized, unstable orthopedic, or neurologic injuries (See Guidelines for Neurological Trauma).
2. Protect the responder(s)
   a. Anticipate secondary events
      i. After an initial explosion, it is common for additional events to occur that can injure first responders
         1. DO NOT BECOME A CASUALTY YOURSELF
3. Whenever possible, protect casualties, the public, and the crime scene
   a. Blasts are often the result of terrorist/criminal activities

First response (< 20 minutes)

1. Perform a general assessment and consider threats to life. Considerations are numerous and should include (See *Guidelines for each scenario below, if applicable*):
   a. External hemorrhage
      i. Apply pressure and hemostatics, if available.
   b. Neurologic trauma
      i. If suspected, ensure patient is immobilized and carried on a litter or gurney.
   c. Signs of shock due to internal hemorrhage or rupture of a hollow organ.
      i. Do not offer anything by mouth.
      ii. Avoid placing pressure on the abdomen.
   d. Respiratory difficulty
      i. Blast lung injury (BLI) should be suspected.
      ii. Supply oxygen, if available.
      iii. Allow the canine to remain in a position of comfort and avoid excessive movement.
   e. Fractures
   f. Penetrating injury
      i. Do not remove a penetrating object if it is still impaled. Removing the impaled object may disrupt vital tissues, cause further internal damage, and release pressure off lacerated blood vessels that may contribute to uncontrollable cavity hemorrhage.
      ii. Removal of an impaled object may only be warranted in specific circumstances (see *Guidelines*).
   g. Toxin exposure
   h. Smoke inhalation and/or burn injury
      i. Supply oxygen, if available.
      ii. Stop the burning process.
      iii. Remove restrictive garments, leads, and collars from the animal.
      iv. Remove any smoking or smoldering coverings from the animal.
      v. Rapidly cool the isolated burn (cool water irrigation, no ice) to reduce the zone of stasis associated with initial thermal injury but avoid hypothermia.
      vi. Apply dry sterile or clean dressings to wounds to limit secondary contamination.
   i. Ocular injuries.
2. Keep the patient warm and avoid hypothermia.
3. Consider transport to facilities skilled in the management of trauma patients for high-risk injuries. Refer to the websites / resources listed in Guidelines to General Approach and Transport.
4. In general, *Scoop and Run* is recommended for first response, with the few exceptions noted above.

Recommendations for responders and medics in the setting of delayed veterinary care

1. Follow guidelines as described for First Response above.
2. With delayed transport, follow *Guidelines for each scenario* that is apparent (eg, burn, fracture, hemorrhage).
3. Special considerations for the blast injury victim that may not be readily apparent include:
   a. Blast associated lung injury (BLI)
      i. Caution should be exercised if intubation or bag-mask ventilation is used as positive pressure may increase the risk of alveolar rupture, pneumothorax, and air embolism in patients with BLI.
      ii. Pneumothorax should be considered in patients with persistent respiratory distress, cyanosis, a "barrel-shaped" chest, and decreased lung sounds in both or one hemithorax. See *Guidelines for penetrating injuries* (for needle decompression) and *Respiratory Distress*.
      iii. With patients transported by air (eg, helicopter, plane), caution should be exercised as this may aggravate unrecognized pneumothorax or air emboli. See *Guidelines for General Approach and Transport*.
   b. Abdominal hemorrhage or ruptured organ
      i. Progressive signs of shock are likely and *Guidelines for Fluid Resuscitation (Scenario 4)* should be followed.
      ii. Place an intravenous or intraosseous catheter to facilitate resuscitation if needed.

iii. Exercise caution with fluid administration due to BLI.

c. Traumatic brain injury
   i. Monitor neurological status using the Modified Glasgow Coma Scale (GCS). See *Guidelines for Neurological Trauma.*

Further Reading

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Section 11: Fracture/Luxation Stabilization

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Examine for any immediate threats to life (ie, airway, breathing, circulation) and refer to *Guidelines for those scenarios* as needed.
2. Control external hemorrhage with direct pressure and hemostatic dressing where applicable. See *Guidelines for External Hemorrhage*.
3. Muzzle the animal and or have someone securely restrain the dog or cat prior to manipulating a fracture.
4. Temporary stabilization or support of long bone fractures or distal limb joint luxations should be performed whenever possible to avoid further soft tissue and neurovascular injury. Patient movement should be minimized.
   - Note: attempting to splint a fracture may cause stress and pain to the animal. If transport times are anticipated to be less than 20 minutes, and patient movement can be minimized, one can consider delaying splinting until definitive veterinary care is reached.
   - If time and skill level allow, and no other threats to life are present, an outline of bandaging/splinting are covered in steps 4 and 5 for medics below.
5. Whenever possible, transport on a rigid surface to limit motion.
6. Open wounds associated with orthopedic trauma should be covered with a clean dressing to prevent further contamination.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Follow aforementioned guidelines for First Response.
2. Skin wounds associated with fractures and joint luxations should be lavaged using sterile, isotonic fluid, and covered with a clean nonadherent dressing. Grossly contaminated wounds may be initially lavaged using clean tap water to remove debris.
3. Excessive movement should be discouraged to avoid further soft tissue and neurovascular injury and minimize discomfort.
4. If bone is protruding from wound or the fracture is angular/displaced:
   a. If distal limb pulses are absent, attempt to realign the fracture to neutral position using mild traction. If significant resistance is met, stop immediately and splint in position found.
   b. If distal limb pulses are present, splint in position found.
   c. If unsure of pulse, splint in position found.
   d. Recheck pulse of the affected limb after splint application.
5. Cover any open fracture with a moist dressing to keep the tissue and bone moist. Secure the dressing in place with a soft-padded bandage.
6. Whenever possible, transport on a rigid surface to limit motion.
7. A cold compress may be applied to the affected region and the extremity may be elevated to help reduce swelling and improve comfort.

Recommendations for medics in the setting of delayed veterinary care

1. Follow the aforementioned guidelines for first response.
2. Refer to *Guidelines for Analgesia* and administer available analgesics dependent on resources and skill level.
3. Always muzzle/restrain animal prior to manipulating wound or fracture site.
4. Open wounds should be clipped/cleaned:
   a. Don gloves.
   b. Apply sterile water-soluble lubricant to the wound, and then clip the fur surrounding open wounds.
   c. Lavage the wound with sterile, isotonic fluid. Grossly contaminated wounds may be initially lavaged using clean tap water to remove debris.
   d. Wounds should be covered with a sterile dressing. Cover any open fracture with a moist dressing to keep the tissue and bone moist.
5. Temporary stabilization of fractures is achieved using a soft padded (modified Robert Jones) bandage with

an incorporated rigid splint (SAMM or casting tape) or heavy cotton bandage (Robert Jones).
   a. The bandage should incorporate the joint above and below the point of injury to limit motion and pressure.
   b. Do not attempt bandaging on femur (above the knee) or humeral (above the elbow) fractures (see below).
   c. Ensure the bandage is not too tight by leaving the toes exposed and checking them for sensation and warmth.
6. Antibiotics: Recommended for all open fractures. Consider using potentiated aminopenicillins [eg, amoxicillin/clavulanic acid (14–20 mg/kg PO every 12 hours), ampicillin/sulbactram (20–25 mg/kg IV every 8 hours)] or a cephalosporin (eg, cephalexin (22–30 mg/kg PO every 8–12 hours)].

Discussion

Whenever possible, particularly when anticipated availability of definitive veterinary care is > 20 minutes, immediate immobilization of long bone fractures and joint luxations should be performed to prevent further injury, reduce swelling, and improve comfort. If veterinary evaluation will be delayed, fur surrounding open wounds associated with fractures, luxations or shearing injuries should be clipped. Wounds should be lavaged thoroughly with sterile, isotonic fluids such as 0.9% sodium chloride or lactated ringer's solution to remove debris and reduce contamination. Open wounds should be covered with a sterile contact layer.

For injuries distal to the elbow and stifle (knee), immobilization is achieved using a soft padded bandage (modified Robert Jones) with an incorporated rigid splint (eg, molded fiberglass, spoon, SAMM, or thermoplastic) or heavy cotton bandage (ie, Robert Jones). Improvised bandaging and splinting material may include clean cloth, wood, or rolled magazines/newspaper, etc. To stabilize injuries of the distal (lower) thoracic limb, splints are applied on the caudal aspect of the leg. To stabilize injuries of the distal pelvic limb, splints are applied on the lateral aspect of the leg.

Immobilization of injuries proximal to the elbow or stifle (knee), such as humeral or femoral fractures may be difficult and further injury may be caused by inappropriate coaptation. In most cases it is recommended that immobilization not be attempted and instead, patient movement is minimized until veterinary care is provided. In situations where movement cannot be minimized or veterinary care will be delayed, a lateral Spica splint (molded fiberglass, SAMM splint or commercial plastic or thermoplastic) may be applied. In these cases, a bandage is applied that incorporates the entire limb and is secured around the thorax or caudal lumbar/pelvic region, respectively.

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Section 12: Gastric Dilation with Volvulus (GDV)

Background

Gastric Dilation-Volvulus (GDV), also known as "bloat," is a life-threating condition of dogs where the stomach rotates from 180° up to 540° causing gas or fluid to become trapped within the stomach. Progressive stomach distension and associated increased pressure impedes venous return to the heart and disrupts venous drainage and arterial blood supply to the stomach wall and spleen. Increased intraabdominal pressure against the diaphragm can also interfere with lung expansion, which may further contribute to global hypoxia.

There is no known definitive cause for this condition. Consistently reported risk factors include breed (large and giant breed dogs) and body type (deep-chested breeds), with German Shepherd Dogs representing the most common breed identified. Although several other risk factors, such as once a day feeding and exercise soon before or after feeding, have been reported, these associations have not been consistently validated. Anecdotal recommendations for reducing the risk of GDV have been published in reviews on the topic, but evidence-based guidelines for the prevention of GDV do not exist in veterinary medicine; other than prophylactic gastropexy, which is recommended for all working dogs.

Bloat can quickly become life threatening and will require recognition and prompt treatment in the field if access to veterinary care will be delayed more than 30–60 minutes. It is important to remember that field treatment is supportive only, not curative. Definitive care and veterinary attention are mandatory, even with cessation of clinical signs; usually due to an intervention. Field treatment is solely intended to delay impending shock and provide time to get to veterinary care for surgical correction of the condition.

Recognition
The diagnosis of GDV cannot be definitively made by physical examination alone. Radiographs of the abdomen are usually needed to visualize an image indicating gastric dilation as well as volvulus. However, since this is not likely available in a field situation, the following signs can aid the first-responder's assessment that this condition is occurring in the dog:

1. Distension of the front of the abdomen when viewed from above the dog. Look for outward (left-right) distension, especially just behind the last ribs; often described as "sprung" in the ribs. Distension of the ventral (downward) abdomen may not be present. This may be harder to see in deep-chested dogs.
2. General discomfort, restlessness, agitation, frequently changing position as if trying to get comfortable.
3. Retching/attempting to vomit with little or no production of vomitus (eg, dry heaves or retching of saliva), often accompanied by drooling.
4. High heart rate with decreased femoral pulse pressure, pale mucous membranes, and prolonged capillary refill time.
5. Rapid, shallow, and or labored breathing, ± mouth open, ± head and neck extended.
6. Dog found in kennel/housing location lying on its side, with decreased responsiveness or unresponsive, with no other known mechanism of injury/illness. Dogs identified in this condition are critically ill and will require urgent therapy for survival.

Management of Gastric Dilation-Volvulus

General precautions (see general approach to prehospital trauma)
Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)
1. Arrange for immediate transportation to the nearest veterinary facility.
2. If dog is standing, conscious, and responsive, transport immediately to veterinary care without additional intervention (eg, *Scoop and Run*).
3. If dog is lying down with diminished response or unresponsive, treat during transport if possible:
   a. If trained, perform needle gastric decompression (trocarization; see method below) to temporarily relieve pressure from stomach. Allow dog to stand or lay in the position of comfort on either side of his body. Note: with an anticipated time to definitive care of < 20 minutes, this should be reserved for moribund or recumbent canines that are unlikely to survive transport.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)
1. Follow recommendations for first response.
2. If the dog is lying down with diminished response or unresponsive, perform **needle gastric decompression (trocarization)** as described below. Ideally this should be done within 10–15 minutes or in transport, if feasible.
   a. Percuss the abdomen while listening with a stethoscope (or your ear to the body wall) and choose the location (right or left abdominal wall just behind the ribs) that has the loudest hyper-resonant "ping." This technique helps identify the side of the animal where the gas-filled stomach is closest to the body wall without interposed organs, such as the spleen.
   b. Clip and clean a 1–2 inch square area of fur overlying the most distended part of the abdomen behind the last rib. If clippers not available, clean the area with medical-grade alcohol or other medical-grade skin disinfectant if available.
   c. Place a large bore (ie, 14–16 Ga x 3.25″) over-the-needle catheter into the most distended section. A long needle (eg, 18 Ga, 1.5 inch) may be used if a catheter is not available. The needle should be perpendicular to the body wall or, ideally, angled slightly toward the stomach (cranial abdomen under the last 3 ribs). Foul smelling gas and or fluid should begin to flow out of the needle once in the stomach.
   d. You can gently compress the opposite side of the abdomen to encourage gas to escape through the needle.
      i. If using an over-the-needle IV catheter, remove the stylette but leave the catheter in place while gas is escaping.
      ii. When escape of gas has stopped and the abdomen appears significantly less distended, remove the needle or catheter from the abdomen at the same angle it was placed.
3. If trained, place an IV or IO catheter into the right and/or left forelimb(s) (avoid hind limb IV catheters) and bolus 20 mL/kg IV isotonic crystalloid fluid. In a typical "working dog" between 50 and 90 lbs, this will be approximately 500–1000 mL. Do not delay transport to a veterinarian in order to start an IV catheter or administer IV fluids. See *Guidelines for Fluid Therapy/Resuscitation.*

Recommendations for medics in the setting of delayed veterinary care

1. If responsive and oriented, transport to definitive care as soon as possible.
   a. Place IV catheter in left and or right cephalic veins while awaiting transport in preparation for possible clinical decline.
2. Monitor vital signs. If mentation declines or vital signs become altered, proceed with steps 3 through 5.
3. If depressed, recumbent or not oriented, initiate placement of IV or IO catheter in right and/or left forelimb(s) and administer an IV or IO fluid bolus (LRS or NS) of 20 mL/kg. If dog's level of consciousness has not improved, continue bolus fluid administration per *Guidelines for Fluid Resuscitation* (Scenario 3). Once the dog improves, maintain the fluid rate at approximately 5 mL/kg/h (between 100 and 200mL/h for a 50–90lb dog) until definitive care is reached.
4. Perform gastric trocarization (see technique above).
5. Administer appropriate analgesics (see *Guidelines for Analgesia*).

Evacuation in all scenarios

1. Transport as soon as possible as surgery is necessary for definitive care.
2. If needle decompression was performed, inform veterinary staff at definitive care facility that a penetrating wound to the abdomen was created and may need to be explored.

Discussion

Field or home decompression of bloat has been advised for many years. Decompression by passing a stomach tube is no longer recommended without adequate analgesia due to potential for extreme pain and gastric or esophageal rupture. Trocharization of the stomach is a reasonable intervention in the field in a dog in extremis. In general, decompression results in an immediate improvement in venous return, and the potential for reperfusion (eg, blood flow returning to an area that was previously not getting blood flow). However, reperfusion may also be associated with complications without adequate fluid therapy. Therefore, the affected dog should be directly transported to a hospital able to provide definitive therapy.

If the first responder is mistaken, and bloat is not present, there is little likelihood of damage to any internal organ. If the stomach is not decompressed but the abdomen is penetrated, it is possible to inadvertently puncture the spleen, causing hemorrhage, or to puncture the intestinal cavity. Both of these injuries are tolerated and generally require no specific therapy. Even in a veterinary hospital setting (Goodrich et al.), trocarization was more likely to be successful than passing an orogastric tube for decompression. Regardless, it is advised to transport any dog suspected of bloat and make the definitive care facility aware of any attempts at trocarization.

Further Reading

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Section 13: Heat Exhaustion

Background

Heat-related illness is a continuum or spectrum of disease that may culminate into cardiovascular instability, neurological deterioration, and multiple organ system damage known as heat stroke. Although this continuum exists in companion animals, one is often unable to discern between stages in a prehospital setting. For this reason, while the descriptive terminology is provided below, a distinction between stages will not be made in the guidelines that follow. In a natural environment, heat-related injuries occur almost exclusively in the dog and very rarely in the cat. When cats suffer from heat-related injuries it usually involves exposure to an external source of heat for a prolonged period of time, such as being stuck in clothes dryer or trapped inside a hot vehicle.

Dogs and cats dissipate heat through four major mechanisms: Conduction, Convection, Radiation, and Evaporation. Dogs and cats do not perspire like people as they are lacking in sweat glands by comparison. When the ambient temperature rises above body temperature, the primary mechanism for heat dissipation in dogs and cats is evaporative loss through the respiratory tract. With that in mind, it becomes apparent that the degree of relative humidity is an important contributing factor in heat-related injury. Humidity levels above 35% can begin to jeopardize evaporative cooling. With relative humidity above 80%, even the use of a muzzle may impair panting enough to hinder evaporative losses. For this reason, muzzles should be used with caution when training or working Operational K9s (OpK9s). To prevent heat-related injuries on hot and humid days, consider training or exercising during cooler parts of the day, such as the early morning or early evening. Also, consider the aforementioned environmental factors when a dog is moved and exerts itself prior to acclimatization, which takes an average of two to four weeks, for physically fit animals

with daily heat exposure versus less fit, respectively. The stages of heat-related illness are listed below:

1. *Heat stress* is a mild to moderate form of heat illness that is associated with a moderate to severe elevation of body temperature with an inability to sustain necessary cardiac output. Oral fluids may be adequate if caught in this early stage and progression is halted.
2. *Heat injury or exhaustion* is an intermediate condition characterized by a severe elevation of body temperature with organ and tissue damage.
3. *Heat stroke* is life-threatening and characterized a by a severe elevation in body temperature coupled with central nervous system dysfunction as well as organ and tissue damage. Two forms or classifications exist:
   a. *Exertional* heat stroke occurs when the heat generated by physical and strenuous activity in hot, humid environments exceeds the body's ability to dissipate the heat. This form occurs most commonly with OpK9s or dogs with a conformational impediment to heat dissipation, such as obesity or upper airway disease such as tracheal collapse, laryngeal paralysis, or brachycephalic syndrome.
   b. *Classical* heat stroke occurs when an exogenous heat source overwhelms the body's ability to compensate, such as being locked in a car or clothes dryer. When heatstroke occurs in a cat, it is usually this form.

A list of signs exhibited by dogs experiencing some degree of heat-related illness is provided in Table 6. If the dog's history (eg, locked in a vehicle without air conditioning) or clinical signs implicate heat-related illness, evaluation by a veterinarian is recommended.

There are also several signs one can appreciate when a dog may be approaching heat stress. If noted, it is recommended remove the dog from the situation and follow guidelines in First Response, Step 1 below. These include:

1. Shade seeking
2. Flattening of the tongue and elongation (hanging out more)
3. Less direct return to the point of interest or handler when retrieving
4. "Squinty eyes"
5. Excessive panting; may appear to be smiling due to retraction of corners of the mouth

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Stop the heat injury by removing the source and decreasing the body temperature. This is accomplished through the following:
   a. Extricate the animal from the heat source (classical) or remove/stop the inciting scenario (exertional).
   b. Move to cool, shaded, low-humidity, ventilated, or air-conditioned environment.
   c. Remove any gear or "clothing."
   d. If a thermometer is available, take a rectal temperature and if > 41.1°C [>106°F], proceed with external cooling measures (Step 2).
   e. If a thermometer is not available, and heat illness is suspected, proceed to Step 2.
2. Provide external cooling using one of the below methods:
   a. Immerse young, otherwise healthy patients (typical OpK9) in cool water. Any water < 18.3°C[< 65°F], such as tap water, is acceptable. Immersion should not include the head and should not be performed in animals with altered mental states. If immersion is not possible, continuous dousing with cool water is an alternative.
   b. In geriatric animals or those with comorbidities (other conditions/diseases), place cold packs or ice in the axillae and groin. Spray the skin and fur with room temperature (tepid) water and continuously fan.
   c. In both scenarios, monitor response to cooling and avoid shivering. If shivering occurs, vigorously rub or slightly warm the patient until it stops. Halt cooling when rectal temperature is ≤ 40°C [≤104°F]; if measurement is feasible.
      i. Note: Fanning can occur in transit through the use of air conditioning and opening the windows of a vehicle.
3. *Scoop and run* to an emergency facility.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Follow all steps outlined in First Response.
2. If patient is mentally alert, able to swallow, with normal vital signs, encourage rest, and water by mouth.
3. See *Guidelines for Fluid Therapy/Resuscitation* and follow recommendations for one of the following if able:
   a. Dehydration with clinical signs, but no signs of shock (category 2)
   b. Or dehydration with clinical signs of shock (category 3)

Table 6: Normal canine vital parameters/signs compared to heat stroke

Variable	Normal resting range	With heat stroke
Temperature (°F /°C)	100–102.5/37.8–39	Typically > 105; may exceed 110; (*See Note)
Heart/Pulse rate (per minute)	< 20 kg: 100–160/min 20–40 kg: 60–120/min > 40 kg: 50–80/min	Tachycardia will prevail. In small dogs (< 10 kg), a relative bradycardia may ensue once body temperature drops with delayed presentation.
Respiratory rate (per minute)	6–30/min	> 40; typically panting heavily with rates > 200
Capillary refill time (CRT) and color	1–2 s/pink	Will be < 1 s and mucous membranes will be brick red in color. As shock ensues and temperature drops, will begin to prolong to > 2 s (see below)
Arterial pulse Pressure	Systolic: 105–145 mm Hg Mean: 90–110 mm Hg Diastolic: 60–85 mm Hg	Compensatory vasodilation will cause a drop in vascular tone and a hyperdynamic or bounding pulse pressure. The two palpable arterial pulses are the femoral and dorsal pedal. If you lose both, marked hypotension is present. The femoral is stronger and maintained with moderate hypotension. Hypotension is typically a systolic of < 90 and a mean of < 70 mm Hg.
Mentation/Attitude	Alert and interactive	Progressively dull. May have difficulty following commands. Agitated and unable to initially find a position of comfort progressing to recumbency.

*During strenuous exercise, training or work, Operational K9s and sports/performance dogs routinely have rectal temperatures that range between 104–108°F. As long as they are not displaying clinical or behavioral signs of heat-related illness, these temperatures may be considered "normal" for such a dog.

4. If seizures occur:
   a. Attempt to prevent trauma to the patient during a seizure.
      i. Place clothing, towels, or any other soft material under the patient's head.
      ii. Move hazards away from the seizing patient's immediate surrounding area.
      iii. Do not put your fingers into the mouth of a seizing patient.
   b. Consider hypoglycemia as a cause and give corn syrup (eg, Karo syrup), or similar glucose substitute, if patient regains consciousness and ability to swallow. If intravenous dextrose is available, following recommendations in step 7 below.
5. Provide oxygen supplementation if available (see *Guidelines for Respiratory Distress*).
6. Transport as soon as possible.

Recommendations for medics in the setting of delayed veterinary care

1. Follow all steps outlined in First Response. If a temperature probe is available, insert as far as possible into rectum to attain closer to core temperature for monitoring purposes.
2. If patient is mentally alert and able to swallow, encourage rest, and water by mouth.
3. See *Guidelines for Fluid Therapy/Resuscitation* and follow recommendations for one of the following:
   a. Dehydration with clinical signs, but no signs of shock (category 2)
   b. Or dehydration with clinical signs of shock (category 3)
4. Airway management:
   a. Watch for signs of distress in patients with heat stroke. Pulmonary edema can occur with resuscitation.
   b. Transport as soon as possible, preferably with flow by oxygen if available. Refer to the *Respiratory Distress Guidelines* for methods of oxygen administration or intubation, if needed.
5. If patient becomes unconscious, follow *Guidelines for BLS and ALS*, as indicated
6. If seizures occur:
   a. Administer a benzodiazepine:
      i. Diazepam (0.5 mg/kg) IV or intranasal; per rectum can also be administered (1.0 mg/kg)
      ii. Midazolam (0.5 mg/kg) IV, IM or intranasal; this is not effective per rectum
         1. Note: Either drug listed above may be repeated as needed to control seizures
      iii. Lorazepam: Alternative to diazepam or midazolam: (0.2 mg/kg) IV, IM or intranasal once; this is not effective per rectum.
   b. Consider hypoglycemia as a cause and administer dextrose (see below) as a precaution if a blood glucose concentration cannot be obtained.
   c. Consider hypernatremia and hemoconcentration as a cause, especially in animals in prolonged heat without access to water.

7. Hypoglycemia or hyperglycemia can occur. Hyperglycemia need not be managed in the field but hypoglycemia must be addressed as follows:
   a. 50% dextrose (0.25–0.5 mL/kg or 0.25 grams/kg) IV bolus; dilute 1:3 with saline if possible
   b. Consider the addition of 2.5% dextrose to IV fluids at a maintenance rate of 2 mL/kg/h. Can increase to 5% if hypoglycemia persists.
   c. Human glucometers can be used to check blood glucose concentrations. The lancet can be used on the pinna, buccal mucosa, or the edge of the metacarpal/tarsal pad. Normal ranges are similar to people (3.9–6.7 mmol/L [70–120 mg/dL]).
8. The development of melena is an early marker of severe heat injury.
9. Disseminated intravascular coagulation and liver failure are possible sequelae. If any signs of bleeding are noted, a blood transfusion may be necessary.
   a. Follow recommendations for the administration of blood in the *Guidelines for Shock/Resuscitation* under recommendations for the management of hemorrhage for medics.
   b. If fresh frozen plasma is available, 20 mL/kg can be administered in lieu of whole blood if the patient is not bleeding or anemic. This can be administered over 4–6 hours, or it can be given rapidly (< 1 hour) if hypotension is present.
10. Transport as soon as possible.

Discussion

There is no consensus regarding the best method in which to reduce a patient's body temperature. In people, there is consensus that duration and degree of hyperthermia are predictors of outcome in exertional heat stroke. However, two recent systematic reviews in humans failed to identify one superior approach to core temperature reduction with respect to outcome. Their findings suggest that immersion in ice water is effective among young people, military personnel, and athletes, while those with comorbidities or altered mentation may benefit from a multimodal approach encompassing evaporation (eg, spraying with water), conduction (eg, water and cool surface or blanket), and convection (eg, fanning). There have also been no studies supporting the use of cooling based on medications, such as antipyretics or muscle relaxants. In a double-blinded, randomized clinical trial in people, dantrolene (a muscle relaxant used to treat malignant hyperthermia) was ineffective in reducing the cooling time, length of hospital stay, and mortality. It has also been shown to be ineffective in an experimental dog model of heatstroke.

In a retrospective review of heatstroke in 54 dogs, an overall mortality rate of 50% was reported. Disseminated intravascular coagulation and acute renal failure, defined as a persistent azotemia despite 24 hours of fluid therapy, were identified as risk factors for death. Hypoglycemia, seizures, obesity, and prolonged prothrombin time (PT) and activated partial thromboblastin time (aPTT) were also identified as risk factors for death. Notably, a lag time of greater than 90 minutes to hospital admission yielded a higher mortality rate, whereas survival was 100% in 6 dogs that were cooled by their owners prior to or during transit and admitted to the hospital within 90 minutes.

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Section 14: Burn Injury

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Initiate BLS Treatment if indicated (See *Guidelines on BLS*) or ALS if capable and deemed appropriate (See *Guidelines on ALS*).
2. Stop the burning process. Extricate the animal from the fire or heat source or remove the heat source from the animal.
   a. If the history suggests internal heat (ie, burning tissue) may be causing further damage, cool the wound with copious amounts of tepid water.
   b. If water is not available, smother any flames with a jacket, blanket, or any other available material. Rolling the animal on the ground may also be effective.

3. Remove any items that may cause constriction, such as vests, collars, or boots. Do not pull away any items that are stuck to the animal's skin.
4. Apply a dressing in the following order of preference
   a. Dry nonadherent sterile dressings
   b. Any clean dry dressing
5. Animals with burns to > 20% of their total body surface area (TBSA) are not able to retain body heat and are extremely susceptible to hypothermia. Make every effort to preserve body temperature by applying layers of blankets over the animal.
6. Do not debride or otherwise remove any dead tissue. Do not break open any blisters. Do not wrap tightly, as constriction may result once edema begins.
   a. If blisters are broken open, apply topical antibiotic ointment, if readily available, and apply dressing as described above.
7. Caustic or acid burns:
   a. For rescuer protection, do not transport before decontamination.
   b. Remove contaminated garments and brush powders off the fur or skin before irrigating.
   c. Irrigate copiously for 15-30 minutes
   d. For chemical burns to eyes (eg, acids or alkalis) irrigate eyes copiously with normal saline (if available) for 15-30 minutes (*see Guidelines for Ocular injuries*). If saline is not available clean tap or bottled water can be used.
      i. Hold eyes open during irrigation.
      ii. Irrigate away from the unaffected eye, so that you do not flush contaminants from one eye to the other eye.
      iii. When feasible, continue to irrigate the eye during transport.
8. Electrical burns:
   a. Be aware of transmission injury from surrounding electrical hazards and or patient.
   b. Be aware that marked tissue destruction and necrosis may be present that is not readily visible. Always seek veterinary evaluation.
9. If there was heat, particulate / smoke exposure involving the face, be sure to flush both eyes with eye wash or normal saline solution and lubricate with sterile eye ointment (that does not contain any steroids) if available. One can also flush with clean tap or bottled water, if available.
10. In the setting of burn wounds secondary to fire, assume the possibility of smoke inhalation is present and refer to *Guidelines on Smoke Inhalation*. If available, flow by oxygen should be provided during transport.
11. When feasible, burned extremities should be elevated during transport to reduce the degree of swelling in the affected area(s).
12. Avoid picking up the animal at burned areas to prevent causing further tissue damage or degloving injury.
13. Airway management:
   a. Watch for signs of stridor or distress in patients with burns involving the oral cavity and face. Transport as soon as possible, preferably with flow by oxygen if available. Refer to *Guidelines for Respiratory Distress* for methods of oxygen administration.
   b. Options for medical personnel in the event that upper airway obstruction or distress occurs include: needle or surgical tracheostomy, crycothyroidotomy, or intubation (if unconscious or sedated). See *Respiratory Distress guidelines* or *Guidelines for BLS* in the event of respiratory arrest.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Continued monitoring of vital signs is required.
2. It is recommended to seek out medical personnel and pursue the recommendations for medics below if definitive care will be delayed beyond one hour; especially if affected TBSA (see below) exceeds 20%.
3. If prolonged wound care is required, consider application of aloe, unpasteurized honey, or silver sulfadiazine (not around eyes) to wounds.

Recommendations for medics in the setting of delayed veterinary care

1. Estimate the TBSA burned to the nearest 10% using the "Rule of Nines" as listed below. Example: a burn occupying the left hemithorax, left hemiabdomen, and the proximal half of the left rear leg would represent 27% (or 30%) TBSA.
   a. Each rear limb represents 18%
   b. Each forelimb represents 9%
   c. Each hemithorax represents 9%
   d. Each hemiabdomen represents 9%
   e. The head represents 9%
   f. The neck represents 1%
2. Intravenous fluid administration:
   a. A large bore intravenous catheter should be placed in a peripheral vein (two if possible). Ideally, this should not be through burned tissue, although this is appropriate if no alternative sites exist. Intraosseous administration can also be considered (see *Guidelines for Fluid Resuscitation*).
   b. Dogs: Begin administration of intravenous fluids using the "Consensus" formula: Calculate 4 mL/kg per percentage TBSA using equivalent "Rule of Nines." Half of the fluid (LRS or NS) is

given in the first 8 hours and the remaining half is given over the next 16 hours.
   c. Cats and small dogs (< 7 kg): Apply a modified version of "Consensus" formula; Calculate 2–3 mL/kg per percentage TBSA using equivalent "Rule of Nines." Half of the fluid (LRS or NS) is given in the first 8 hours and the remaining half is given over the next 16 hours.
3. Analgesia: Fentanyl or other suitable pure-mu opioid should be given in repeated small IV doses titrated to maintain effective relief of pain. See *Guidelines for Analgesia.*
4. For pediatric burn patients (< 6 months of age), check blood glucose concentration, if able, and consider supplementing dextrose. More detailed guidelines for supplementation are in the *Guidelines for Heat Exhaustion.*

Discussion

Basic cooling and wound management techniques in both animals and people have become fairly standardized. There is some discussion as to whether to use wet or dry dressings during initial care. Wet dressings are less effective than tepid/cool running water to stop the burning process, and once the burn process has been stopped they create a potential risk of hypothermia, particularly given higher TBSA wounds. Current recommendations are to apply a dry, sterile nonadherent dressing over the wound.

With regards to fluid administration, the "Consensus" formula is an aptly named approach. Although not validated in small animals, it is widely used for the human patient and is currently recommended in the veterinary field. This human and small animal cross use provides an advantage to the prehospital provider that is likely already trained and experienced in using this formula.

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Section 15: Smoke Inhalation

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

NOTE: If possible, have first responders trained in SCBA and PPE remove patient from smoke environment.

First response (< 20 minutes)

1. Follow *Guidelines for BLS* if the animal is not breathing, is bradycardic (ie, has a slow heart rate) or no detectable pulse.
2. All animals exposed to smoke should have oxygen administered whenever possible (eg, face mask, nasal prongs through muzzle, flow by). Refer to *Guidelines on Respiratory Distress*.
3. If the patient is wheezing, has stridor (high pitched or noisy breathing) or any difficulty breathing, facial burns, or carbonaceous sputum, consider a bronchodilator if skills and scope of work allow administration.
   a. See Medic Response (Step 3) below for dosages.
   b. Note: This deviates from *Guidelines for Respiratory Distress* as a first response due to presence of inhaled irritants.
4. For patients with concurrent burn injuries, cover affected areas with a dry burn sheet or sterile/clean dressing and follow Guidelines for Burn Wound Management.
5. Rapid transport to a veterinary emergency facility with 24-hour supportive care, including continuous oxygen support is paramount. The ability to ventilate and/or provide hyperbaric oxygen therapy are preferred if available.
   a. See *Guidelines for General Approach and Transport* for information regarding trauma/veterinary emergency facilities (websites).
6. Take note of elements consumed in the fire to relay potential toxin exposures to the veterinary team [eg, cyanide (nylon/silks), chorine/benzenes (plastics), carbon monoxide (wood)].

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Patients may appear asymptomatic on initial assessment but may develop significant signs up to 36-hour postexposure. Follow aforementioned protocols, including oxygen administration.

2. Continue BLS and ALS with monitoring, as needed.
3. Respiratory distress due to irritants/toxins (bronchoconstriction/wheezing) or laryngeal edema (upper airway obstruction with stridor) can develop over the course of minutes to hours. Vigilance and continued monitoring are necessary. Refer to *Guidelines for Respiratory Distress*.
   a. An advanced airway may be needed if upper airway difficulty is noted; approach is up to scope and skills of responder.
   b. Consider the administration of bronchodilators if available (see recommendations below for dosages if available).
4. Smoke inhalation is often accompanied by *burn wounds and ocular injury*. Refer to *Guidelines* for these injuries as needed.
5. If respiratory or neurologic signs persist or worsen despite supportive care, administer hydroxocobalamin IV (see Medic response below); if skills and scope of practice allow.

Recommendations for medics in the setting of delayed veterinary care

1. Follow first response guidelines above, including oxygen administration.
2. Follow *Guidelines for ALS or BLS* as indicated:
   a. An advanced airway may be needed if upper airway difficulty is noted; consider endotracheal intubation. A surgical or needle tracheotomy (midtrachea between rings) or cricothyrotomy may also be considered if intubation is not possible (see *Guidelines for Respiratory Distress* for more discussion on techniques).
   b. An increased percentage of inspired oxygen should be employed to increase removal of carboxyhemogloblin; see discussion below if employed.
      i. Up to 100% can be administered.
      ii. However, percentages above 40% should be limited to less than 6 hours unless cooximetry is available to dictate that longer therapy is required.
   c. Follow *Guidelines for Shock/Resuscitation* if signs of shock are present.
      i. Consider low dose crystalloids to avoid alveolar flooding/edema. Administer to effect. See *Guidelines for Shock/Fluid Resuscitation* (Scenario 5).
      ii. If concurrent burns are present, avoid placing a catheter through traumatized skin.
3. If respiratory effort is noted, administer a bronchodilator. Administer one of the following, in order of preference:
   a. Albuterol 1–2 puffs MDI (90 μg per activation) every 15 minutes (maximum of 3 doses) to be used with facemask and holding chamber or nebulizer.
      i. Use with difficulty breathing that is not obstructive (upper airway obstruction) in nature (Refer to *Guidelines for Respiratory Distress*).
   b. OR Terbutaline (0.01 mg/kg) IV, IM, or SC.
4. If exposure to cyanide is considered likely (eg, burning of silk, nylon, or other material) or respiratory or neurologic signs progress despite supportive care, administer hydroxocobalamin. This requires intravenous access.
   a. 150 mg/kg should be administered IV over 10–15 minutes.
      i. A 5 g vial of hydroxocobalamin for injection is reconstituted with 200 mL of diluent using the supplied sterile transfer spike. The recommended diluent is 0.9% Sodium Chloride (0.9% NaCl). Lactated Ringers and 5% Dextrose (D5W) solutions are also compatible and may be used. Following the addition of diluent to the lyophilized powder, the vial should be repeatedly inverted or rocked, not shaken, for at least 60 seconds prior to infusion.

Discussion

Two of the more common concerns with patients suffering smoke inhalation include carbon monoxide (CO) and cyanide (HCN) intoxication. In people, carbon monoxide is often cited as the most common cause of immediate deaths due to its ability to invoke a state of cerebral and myocardial hypoxia. Carbon monoxide's stronger affinity for hemoglobin (Hb) competitively displaces oxygen (O_2) from the Hb molecule resulting in the formation of carboxyhemoglobin (COHb) instead of oxyhemoglobin (O_2Hb). Increased concentrations of COHb in the blood induce an "anemic hypoxia" via the aforementioned displacement of oxygen as well as decreasing hemoglobin's ability to offload the oxygen that is bound. Currently, available pulse oximeters are unable to distinguish between COHb and O_2Hb and, therefore, overestimate arterial oxygenation (SaO_2) in patients suffering CO poisoning. Cooximetry affords direct measurement of COHb and O2Hb and is required for an accurate assessment of arterial oxygen content in these patients. Patients experiencing CO poisoning require immediate O_2 supplementation. Increasing the fraction of inspired O_2 (FiO_2) increases the arterial partial pressure of O_2 (PaO_2) and speeds the rate of CO disassociation from the Hb molecule. In patients breathing room air with a FiO2 of 21%, the half-life of COHb is approximately 250 minutes. Increasing the FiO_2 to 100% reduces the half-life of COHb to approximately 30 to 150 minutes. Hy-

perbaric oxygen therapy (HBOT) may further enhance the CO disassociation process. However, HBOT is not readily available in the prehospital environment. It may be beneficial if available at the definitive care hospital, but it is not required for treatment.

Cyanide is a major concern with fires involving wools, silks, and synthetic nitrogen-containing polymers (eg, urethanes, nylon). Unlike CO, HCN causes a "histotoxic hypoxia" or cellular hypoxia by interfering with the utilization of O_2 at the cellular mitochondrial level. The incidence of HCN toxicity subsequent to smoke inhalation for veterinary patients remains completely unknown. Similar to CO, HCN poisoning may be hard to definitively diagnose in the prehospital arena. In people, hyperlactatemia, independent of hypoxemia, has been shown to be a sensitive indicator of HCN poisoning. Lactate may be easily detected in the preshospital setting using hand-held point-of-care analyzers. Treatment for HCN also involves the administration of supplemental oxygen. In addition, administration of cyanide antidotes as soon as possible is highly recommended. In a hospital setting, cyanide antidote treatment may involve administering a combination of intravenous sodium nitrite and sodium thiosulfate. Sodium nitrite results in the formation of methemoglobin and often is not considered an appropriate treatment for patients suffering smoke inhalation as it exacerbates their already hypoxic state. In these cases, administering sodium thiosulfate alone may be considered. A safer alternative to either drug now exists with the administration of hydroxocobalamin, which should be administered first if available.

Hydroxycobalamin or HCO (a vitamin B_{12} precursor) is an alternative for the management of acute cyanide poisoning caused by smoke inhalation. It does not require the formation of methemoglobin in order to clear HCN from the body; rather HCO converts cyanide into nontoxic vitamin B_{12}, which is then renally excreted from the body. Hydroxocobalamin has been used for treating smoke inhalation in humans in other countries for nearly a decade and was approved by the Food and Drug Administration (FDA) for use in the United States in 2006. Hydroxocobalamin is available as the *"Cyanokit"* and is now carried by many first responders as their first-line therapy for treating cyanide toxicity. Hydroxycobalamin and sodium thiosulfate may be used in combination for managing acute cyanide toxicity. Although the data are limited, HCO has also been shown to be effective for treating canine patients suffering HCN poisoning.

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Section 16: Allergic Reactions and Anaphylaxis

Background

Anaphylaxis is an acute, generalized, and possibly severe allergic reaction that can be rapidly fatal. An anaphylactic (or anaphylactoid) reaction is considered a multiorgan systemic hypersensitivity with signs that can be divided into 4 major categories:

1. Cutaneous: generalized erythema (redness), urticaria, pruritus (itchy), and facial angioedema (swelling).
2. Respiratory: dyspnea, bronchospasm, stridor, tachypnea, and cough.
3. Cardiovascular (CV): pale mucous membranes with a prolonged capillary refill time, poor pulse quality, hypothermia, and a depressed to dull mentation; see *Guidelines for Shock/Resuscitation*.
4. Gastrointestinal (GI): nausea, vomiting, and diarrhea, which may be hemorrhagic.

There are multiple causes of anaphylaxis. The most common causes (allergens) are injected substances such as medications (eg, penicillins) or vaccines, venoms (eg, reptile and insect/*Hymenoptera*), and intravenous contrast materials. In people, up to 20% of anaphylactic reactions are considered idiopathic. Management is based upon severity of signs.

Recognition and treatment of anaphylaxis should occur within 20 minutes to avoid fatalities. Both dogs and cats can exhibit cutaneous signs only that do not progress, cutaneous signs with rapid progression, or

multiorgan anaphylaxis with no evidence of cutaneous manifestations. Mild systemic reactions may develop more slowly and with less severe signs. Moderate to severe reactions rapidly develop and progress. Anaphylaxis should be suspected in any patient with exposure to an allergen and rapid (< 10 min) progression of the following:

1. In dogs, cutaneous signs are most commonly seen. However, with progression clinical signs are often associated with the CV and GI systems. Respiratory signs may also develop, along with urticaria (ie, hives), pruritus (ie, itching), seizures, and anxiousness progressing to weakness and collapse. Signs include:
   a. CV: tachycardia, weakness, weak pulses, mucous membrane color changes
   b. GI: urinating, vomiting, and diarrhea that is often hemorrhagic
   c. Respiratory: increased respiratory effort, wheezes, crackles
2. In cats, respiratory and GI systems are commonly affected, but one may also see facial and head pruritus, followed by dyspnea, salivation, vomiting, incoordination, and collapse.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

1. Contact a veterinarian for advice and seek immediate attention.
2. Place the patient in a position of comfort.
3. Check for respirations. Initiate BLS (*Refer to BLS guidelines*) if you cannot confirm respirations are present, and/or you are unsure if a pulse is present. If arrest is not readily reversible, and patient is in need of ALS, *scoop and run* and consider the following steps in transport.
4. Determine treatment based on signs (see step 5 for dosages):
   a. Cutaneous only; administer antihistamines.
   b. CV and GI; Administer epinephrine.
   c. Respiratory; Administer a bronchodilator (albuterol) and epinephrine.
5. Medications based on signs (see above):
   a. Epinephrine
      i. EpiPen Jr (0.15 mg) can be used for ≤ 20 kg patient
      EpiPen (0.3 mg) can be used for ≤ 20 kg patient
      ii. Repeat every 5–15 min for a total of three doses IF signs of anaphylaxis continue or return despite initial response to treatment
   b. H1 antihistamine (one of the following):
      i. Diphenhydramine: 2–4 mg/kg PO every 8–12 hours
      ii. Cetirizine: 0.5–1.0 mg/kg PO every 24 hours
      iii. Hydroxyzine: 2 mg/kg PO every 12 hours
   c. Bronchodilators
      i. Albuterol 1–2 puffs MDI (90 μg per activation) every 15 minutes (max of 3 doses) to be used with face and holding chamber or nebulizer.
         1. May be used in patients with continued respiratory distress that are refractory to administration of epinephrine.
         2. Use with difficulty breathing that is not obstructive (upper airway obstruction) in nature (Refer to *Guidelines for Respiratory Distress*).
         3. Caution: May potentiate epinephrine-induced arrhythmias.
6. Initiate transport as soon as possible, with BLS continued in transport if needed.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Follow all guidelines for First Response with the following exceptions.
2. ALS (*Refer to ALS guidelines*) if capable.
3. Cutaneous signs; diphenhydramine: 2–4 mg/kg IM (preferred) or SQ; alternative and preferred route to PO above if scope and skills allow.
4. CV, GI, or respiratory; epinephrine: 0.01 mg/kg (0.01 mL/kg of 1:1000 solution) IM, as alternative to EpiPen above if scope and skills allow.
5. To treat delayed or biphasic reactions; dexamethasone: 0.1–0.15 mg/kg IV or IM can be administered if scope and skills allow.

Recommendations for medics in the setting of delayed veterinary care

1. Follow all guidelines listed above.
2. Fluid Resuscitation:
   a. If signs consistent with shock are present that do not normalize with the aforementioned efforts, proceed to fluid algorithm provided in *Guidelines for Shock/Resuscitation* (Follow Category 3 – with signs of shock).
3. Check blood glucose if weak or altered level of consciousness is present. If glucose concentration is below 3.3–3.9 mmol/L [60–70 mg/dL]:
   a. Administer D50W (50% dextrose)

i. 0.5–1.0 mL/kg IV bolus every 5 minutes until hypoglycemia resolves. Ideally, this should be diluted 1:3 with saline or other crystalloid fluid.
ii. Assess blood glucose hourly for 4 hours, and then every 6–8 hours.
iii. If glucose normalizes then drops again after bolus therapy, consider supplementing intravenous fluid bag with dextrose. Administer 2–4 mL/kg/h of lactated ringers solution or normal saline with 2.5% dextrose (50 mL of 50% dextrose into a 1 L bag after removing 50 mL of volume).

Discussion

The use of epinephrine as the primary drug of choice in anaphylactic patients experiencing CV, GI, or respiratory signs is generally undisputed. However, some debate remains around the effectiveness of anti-histamines. Regardless, clinical recommendations continue to advocate the use of antihistamines, alone or combined, as they may relieve cutaneous signs and symptoms, reduce gastric acid, improve cardiac function, and assist in calming the animal, with little risk. Although evidence based dosage recommendations for the use of antihistamines in dogs and cats are lacking, diphenhydramine, hydroxyzine, and cetirizine are most commonly recommended.

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Section 17: Poisoning Guidelines

Background

This guideline addresses primarily operational canine (eg, Police K9, military Working Dog [MWD]), exposure to a potentially toxic material. The following routes of exposure will be considered in this guideline:

1. *Oral exposure* occurs when the agent is ingested. Chemical agents that contaminate food and drink can be absorbed through the gastrointestinal tract.
2. *Dermal exposure* where the agent is in contact with the fur or skin. Mixed dermal and oral exposure can occur since dogs will often groom their fur resulting in ingestion of the chemical. Dermal absorption of a chemical can vary. In general, wounds or abrasions are presumed to be more susceptible to chemical absorption than the intact skin. Additional factors that affect absorption include occlusion of contaminated skin and warm and moist environments.
3. *Inhalation exposure*. When inhaled, gases, vapors, and aerosols may be absorbed by the respiratory tract. Absorption may occur through the mucosa of the upper and lower airway to include the nose, mouth, throat, or the alveoli of the lungs. Depending on the chemical, dermal exposure is also likely to occur.
4. *Ocular exposure* from fumes, liquids, particulate matter, and corrosive agents carries the main medical concern of inciting moderate to severe corneal injury. Severe corneal injury may result in blindness that could end the career of some operational canines. From an operational standpoint, ocular exposure may cause local irritation and discomfort as well as conjunctivitis that may interfere with the canine's ability to work effectively. Please refer to the *Guidelines on Ocular Injury*.
5. Liquid droplets and solid particles can be absorbed by the surface of the skin, eyes, and mucous membranes.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First response (< 20 minutes)

Immediate transport is always considered the preferred course of action for personal pets and operational or service dogs < 20 minutes from veterinary care (eg, "*Scoop and Run*").

1. If toxicity is suspected or known, proceed to the nearest veterinary emergency facility.
2. *Exceptions:*
   a. If dog/pet is otherwise stable and exposure is dermal, consider decontamination prior to transport (see Dermal Exposure below).
   b. Ocular exposures, especially when corrosive injury may occur, should involve timely flushing of the eyes for 10–15 minutes prior to seeking veterinary attention (see *Guidelines on Ocular Injury*.)

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training)

1. Consultation with a veterinary toxicologist is highly recommended. If definitive care will be delayed beyond 20 minutes, it is advisable to contact an animal poison control center for advice prior to or during transport. A fee is often charged but may be waived for service and OpK9s. Options for consideration, in alphabetical order:
   a. Animal Poison Control Center (ASPCA) at (888) 426-4435
   b. Pet Poison Helpline at (800) 213-6680

Recommendations for medics in the setting of delayed veterinary care

These guidelines are provided for first responders and advanced medics in the setting of delayed veterinary care. This is most likely to occur with operational canines that are owned by the personnel administering the care; hence, permission to take action is inherent.

1. It is advisable to contact an animal poison control center for advice prior to or during transport (See Delayed Veterinary Care above). Specific items to note are dependent upon type of exposure. This information will aid in identification (if unknown) and treatment.
2. **Prevent ongoing human and animal exposure**
   a. Wear proper Body Substance Isolation (BSI) and personal protection equipment (PPE) when handling exposed animals, animal waste, or bodily fluids. May require:
      i. Respiratory protection;
      ii. Protective eye wear or face shield;
      iii. Wear proper gloves and outer protective garments. Certain chemicals can rapidly penetrate ordinary clothing.
   b. Food and equipment including leather leashes and collars and leather or plastic muzzles are subject to surface contamination and may be difficult to decontaminate.
      i. Avoid surface contamination of medical and other equipment.
      ii. Expert advice regarding proper surface decontamination methods may be needed. If available, consult the on-site toxicologist or decontamination/disaster management team.
3. **Limit or prevent exposure to operational canines for handlers**:
   a. Prevent dermal exposure by considering:
      i. K9 booties
         1. some canines do not tolerate these
         2. may compromise footing
         3. may frequently fall off
      ii. Protective eyewear for dogs
      iii. Bathing and rinsing off hair coat frequently. Disposable wipes may also be used.
      iv. Flushing eyes on a regular basis
      v. Light-weight, plastic canine poncho
   b. Do not let the dog drink any ground water or ingest any foreign material from the scene site. If your dog has been exposed to a hazard:
      i. Keep the dog isolated and quiet.
      ii. Do not let the dog shake, lick its fur or feet, or scratch.
4. **First aid (human victims)**
   a. This may be especially important during chemical mass casualty situations. Examples of scenarios where this may occur include:
      i. Terrorist actions with chemical agents or industrial chemicals.
      ii. Industrial fires where chemicals are stored.
      iii. Large-scale leakage from chemical storage vessels (eg, maritime accidents, train derailments).
      iv. Use of riot control agents.
      v. Smoke inhalation exposures from household or industrial fires.
   b. Self-aid measures include individual decontamination and assumption of the appropriate personnel protection equipment. **Protect yourself first** then consider buddy aid, which may include an operational canine.
   c. Buddy aid consists of emergency actions to restore or maintain vital body functions in a patient who cannot administer self-aid. Mental confusion, muscular incoordination, physical collapse, unconsciousness, and cessation of breathing may occur so rapidly that the individual is incapable of providing self-aid. Dependent on clinical signs and symptoms, the toxicant, skill level, and scope of practice, trained EMTs and other individuals may need to:
      i. Establish a patent airway and ventilate
         1. Administer supplemental oxygen.

2. Treat bronchoconstriction with bronchodilators in the case of bronchospasm or reactive airways.
ii. Start IV infusions for control of shock.
iii. Enforce rest to reduce exertion. This may be especially important following inhalation of certain chemicals.
iv. Administer anticonvulsants (eg, valium).
v. Administer atropine (eg, following exposure to nerve gas agents, organophosphate, or carbamate insecticides).

5. **Assess chemical exposure**
a. Evidence of exposure
i. Direct observation that an exposure occurred.
ii. Indirect evidence of chemical exposure.
1. *Odor*. Some agents have odors, which may aid in their detection and identification. May impart an odor to the skin or fur. Many chemicals are essentially odorless.
2. *Discoloration* to the skin or fur.
3. Foreign material observed in vomitus, feces, or gastrointestinal contents.
b. Note clinical signs/exam findings and progression from initial onset/exposure. The duration and rapidity of clinical signs should also be recorded.
i. Inhalation
1. Inhalation of irritant gases, vapors, and other inhalation hazards is often marked by dyspnea (ie, shortness of breath), coughing, and changes in respiratory rate, effort, or quality.
2. Crackles and abnormal lung sounds and a decrease in arterial oxygen saturation may occur but are often present later in the course of disease.
ii. Dermal
1. Presence of chemical odor or discoloration to the skin or fur.
2. Evidence of dermal irritation (eg, scratching, rubbing).
3. Evidence of erythema (ie, redness), skin edema, skin blistering.
iii. Oral exposure
1. Clinical signs can vary depending upon the agent but may include vomiting, abdominal pain, or diarrhea.
iv. Ocular
1. Scratching at or rubbing at the eye; excessive tearing; squinting; hyperemic sclera (ie, red eye); red, inflamed conjunctiva; chemosis; blepharoedema (ie, swollen eyelids); blepharospasm (ie, eye twitching).
c. Identify agent
i. Identification of the chemical agent will assist in the treatment of chemical toxicities.
ii. **Do not** delay treatment of life-threatening conditions or toxicosis for the sole reason of trying to confirm the toxic agent involved (*"Treat the patient, not the poison").*

6. **Emergency medical management** (Airway, Breathing, Circulation, Disability, or ABCDs)
a. Airway/Breathing (Refer to *Guidelines for Respiratory Distress*)
i. Unconscious animals without obstruction of the airway or conscious animals with respiratory distress/effort should be transported on oxygen when possible.
ii. Ensure neck is extended (not kinked/flexed) and deliver oxygen by facemask at 3–8 L/min. If conscious, some animals will not tolerate the rubber diaphragm around the mask. In this case, remove the diaphragm or use any flow-by that will be tolerated.
iii. If the airway appears obstructed and the animal is stuporous or unconscious, attempt to the clear the airway (See *Guidelines for Respiratory Distress*) and consider intubation and inflation of low pressure cuff. If spontaneous ventilation is present, oxygen can be flowed by the front of the tube to increase the amount of inspired oxygen.
iv. If the animal is not breathing, intubation, and assisted ventilation should be delivered via Ambu-bag at 8–12 breaths per minute. Refer to *Guidelines on BLS*.
b. Circulation/shock (See *Guidelines for Fluid Resuscitation*)
i. A 16–18 Ga catheter can be placed in the cephalic or lateral saphenous vein. If stuporous or unconscious, an intraosseous (IO) catheter can be placed in the humeral head or medial tibial crest.
ii. Fluid resuscitation
1. See *Guidelines for Fluid Resuscitation*.
iii. If cardiac arrest is present, follow *Guidelines for BLS and ALS* and deliver thoracic compressions (lateral recumbency; widest portion of thorax; typically the 8–10th rib space) at a rate of 100–120 compressions per minute.
c. Neurologic/seizures
i. In the event of a seizure:
1. With IV or IO access, administer diazepam or midazolam (0.5 mg/kg). Consider lorazepam (0.2 mg/kg) if aforementioned are not available.
2. Without vascular access, consider the following routes:

a. IM: Midazolam (0.5 mg/kg)
b. Intranasal: Diazepam or midazolam (0.5 mg/kg), lorazepam (0.2 mg/kg).
c. Per rectum: Diazepam 1–2 mg/kg.

ii. If recumbent, keep head, and neck aligned in a neutral position and elevated at 15–30°.
iii. Avoid jugular compressions or kinking the neck.

7. **Medical management of oral exposure**
   a. Corrosive ingestion including acids (eg, muriatic [hydrochloric] acid) or bases (eg, bleaches). Other examples of acids and alkalis include: Lye, concentrated hydroxide, drain cleaners, electric dish washing detergents, and batteries.
      i. Dilute with ingestion of milk or water. May require flushing the mouth for 15–20 minutes with tepid water.
      ii. Gastrointestinal protectants (eg, sucralfate) and demulcents (eg, milk, egg white, kaolin-pectin) may help protect from mucosal damage if administered shortly after exposure.
      iii. Neutralization of the corrosive with vinegar, sodium bicarbonate are contraindicated since thermal injury may occur.
      iv. Do not induce vomiting.
   b. Petroleum distillate (eg, kerosene, diesel) or volatile hydrocarbon (eg, lighter fluid, mineral seal oil) ingestion. This also applies when these chemicals are used as solvents used with certain pesticides, cleaning products, and other agents.
      i. These volatile liquids can cause pneumonia if aspirated or inhaled. The signs of petroleum distillate toxicity include vomiting, difficulty of breathing, tremors, convulsions, and coma. Death is by respiratory failure.
         1. Provide supplemental oxygen
      ii. Do not induce vomiting unless under the advice of a veterinarian
   c. Other ingested chemicals (ie, noncorrosive or petroleum distillate based). If asymptomatic, consider administration of an emetic to induce vomiting and administration of medical-grade activated charcoal (often with a cathartic) to decrease gastrointestinal absorption of the chemical.
      i. Indications
         1. Emetics
            a. Recent exposure within 1–2 hours of ingestion
            b. Asymptomatic animal
            c. Toxic dose ingested
         2. Activated charcoal
            a. Recent (< 2 to 6 h) ingestion
            b. Toxic dose ingested
            c. Binds activated charcoal
         3. Cathartic (eg, sorbitol, magnesium sulfate)
            a. Agents combined with activated charcoal to accelerate clearance of gastrointestinal contents
            b. Give once; usually combined with first administration of charcoal
         4. Cholestyramine
            a. Prevents enterohepatic recirculation of bile acids and associated bound substances
            b. Limited veterinary experience
      ii. Contraindications
         1. Emetics
            a. Chemical agent's (product) label instructions state: "Do not induce vomiting."
            b. Symptomatic animal. Do not administer if the animal is severely depressed, comatose, unable to swallow, or experiencing seizures.
            c. Previous episode of vomiting.
            d. Ingestion of a corrosive/caustic chemical, petroleum distillate, or hydrocarbon.
         2. Activated charcoal
            a. Same contraindications as listed for emetics
            b. Dehydration/hypovolemic shock
            c. Avoid in patients with excessive free water loss
            d. Gastric or intestinal obstruction
            e. Does not bind to activated charcoal (eg, certain metals, aliphatic alcohols and other low molecular weight chemicals)
            f. Hypernatremia
         3. Cathartic
            a. Agents that affect renal function
            b. Ingestion of a chemical with cathartic effects
            c. Presence of dehydration or hypovolemia
            d. Patients with excessive free water loss
         4. Cholestyramine
            a. Presence of dehydration or hypovolemia
            b. Patients with excessive free water loss
      iii. Emetics and their doses (in order of preference)
         1. Apomorphine: 0.03 mg/kg IV or 0.04 mg/kg IM, or eye drops if available (follow label instructions).
         2. 3% hydrogen peroxide: 1–2 mL/kg PO once, repeat 5–10 minutes later if no emesis. Not to exceed 50–150 mL per dog.

3. Emetic efficacy
    a. Vomiting will generally occur within 10–20 minutes after administration of these drugs.
    b. Repeated episodes of vomiting (2 or more) are also common.
    c. Often removes approximately 40–60% of the stomach contents. Repeated administration of emetics is unlikely to increase recovery rates.

iv. Activated charcoal administration
1. Administer orally at 1–4 g activated charcoal/kg. Consider repeat administration every 4–6 hours for 1 or 2 days (consult poison control).
    a. Repeated dosages are typically smaller in volume (lower end of dose) for patient compliance.
    b. Often formulated as a slurry (suspension) with 5–10 mL water per gram of activated charcoal.
2. Premixed products with and without a cathartic for veterinary use are available (eg, ToxiBan).
    a. ToxiBan dose is 10–20 mL/kg
    b. Only use products containing cathartics for the initial treatment. Repeated treatments of activated charcoal combined with a cathartic may lead to excessive free water loss and clinically significant hypernatremia.

v. Cholestyramine
1. Oral administration of cholestyramine: 0.3–1 g/kg every 8 hours.

8. **Medical management of dermal exposure**
    a. Skin decontamination serves two purposes: It prevents the animal's system from absorbing additional contaminants. It also protects medical personnel treating the animal and equipment and supplies from surface contamination.
    b. Keep the dog isolated from other people and animals. Prevent the dog from licking or scratching at its skin or rubbing at it eyes.
    c. Utilize on-site decontamination stations whenever available.
    d. Bathe skin with a mild detergent (degreasing) shampoo (eg, Dawn dishwashing soap) when possible. Alternatively, flush area with lukewarm water for 20 minutes.
        i. Avoid use of detergents containing insecticides
    e. Moist disposable wipes may be used to clean around the eyes, nares, and mouth.
    f. Flush the animal's eyes with saline solution and apply eye ointment/lubricant (NO steroids).
    g. Consider clipping fur that is matted with or will not wash clean of toxic residue (eg, tars).
    h. Once decontaminated, reexamine the dog for any remaining contaminates. If still contaminated repeat the cleaning process.
    i. Once fully decontaminated, dry the dog off to prevent hypothermia.
    j. If less than 20 minutes from definitive care, transport at this time.
    k. Consider administering activated charcoal if oral exposure through grooming may have occurred (see Oral Exposure above).
    l. Specialized approaches to skin decontamination are needed for management of skin exposure to certain chemical agents including nerve agents, blistering agents, vessicants. Seek advice of a veterinarian or on-site toxicologist or decontamination team.
    m. Decontaminate or dispose of the dog's gear and equipment.

9. **Medical management of inhalation exposure**
    a. Reminder: Protect and treat yourself first. Don PPE prior to entering the scene, and perform self-decontamination as appropriate.
    b. Pending the hazard, do not enter the scene without appropriate respiratory protection (eg, self-contained breathing apparatus, air-purifying respirator).
    c. Always approach upwind of the exposure.
    d. Suggested measures include:
        i. Remove patient from exposure source. Whenever possible take care to move upwind and into fresh air.
        ii. Remove any restrictive materials/collars, vests, muzzles etc.
            1. Be aware of the toxic agent off-gassing from the canine.
        iii. Administer oxygen. Hypoxemia may be controlled by supplemental oxygen given by flow-by, oxygen mask, or in an unconscious animal via an endotracheal tube. See *Guidelines for Respiratory Distress*.
        iv. Depending on the hazard (eg, ocular irritant), flush the animal's eyes with saline solution or sterile water for 10–15 minutes and apply eye ointment/lubricant (no steroids).
        v. Rest and warmth. An animal with potentially significant unprotected exposure to a lung-damaging agent should be kept at rest until the danger of pulmonary edema has passed, if the situation permits.
        vi. Monitor for progression of clinical signs.

e. Measures with restricted application (Refer to *Guidelines on Respiratory Distress* for options and dosages):
   i. Sedation should be sparingly used, unless the toxicant is causing upper airway obstruction, which requires sedation. If used, ensure adequate oxygen is available and facilities for possible respiratory assistance are available.
   ii. Bronchodilators (eg, albuterol) may be warranted if signs of bronchospasm, such are wheezing, are apparent.
   iii. Steroids may be useful for treatment of some chemical injury and may lessen the severity of chemical-induced pulmonary edema or upper airway edema. Steroid administration should be performed on advice of a veterinarian.

10. **Emergency information**
   a. An animal poison control center is usually your best resource for additional information because it is staffed by veterinarians trained in the diagnosis and management of animal poisonings. Centers include:
      i. The ASPCA Animal Poison Control Center in Urbana, IL, charges a consultation fee that may be paid by credit card. They may be reached at **(888) 426-4435**. Their website has additional information and is located at: www.aspca.org/pet-care/animal-poison-control.
      ii. The Pet Poison Helpline, which is located in Bloomington, MN and is a service of Safety-Call International, PLLC, charges a consultation fee that may be paid by credit card. They may be reached at **(800) 213-6680**. Their website has additional information and is located at: http://www.petpoisonhelpline.com/.

Discussion

Significant uncertainty remains regarding the efficacy of activated charcoal and other adsorbents (eg, cholestyramine) in the management of exposed people and animals. Systematic reviews of the literature often fail to demonstrate any benefit associated with their use despite promising in vitro binding studies or in vivo data indicating reduced chemical absorption. These inconsistent results may reflect delays in the administration of activated charcoal or oral exposures that result in significant residual free chemical available for gastrointestinal absorption. Despite these concerns, activated charcoal remains a mainstay treatment for the management of acute (< 1–2 hours) ingestion of many toxic agents.

Further Reading

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Section 18: Ocular Injury

Background

Ophthalmic injuries occur commonly in the field, both in companion animals and working dogs. Ocular trauma should be treated particularly seriously, as open wounds from penetrating injuries can rapidly lead to sight-threatening infections.

Terminology: **Injuries to eye may be described as**

1. *Closed globe injuries*—the eye wall is intact (eg, corneal ulcer; ocular surface foreign body).
2. *Open globe injuries*—the eye wall (cornea or sclera) has been breached. Open injuries arise either from a penetrating object or from a blunt injury severe enough to cause rupture of the globe. Open globe injuries may be called a penetrating injury, perforating injury, or ruptured globe.
3. An *intraocular foreign body (FB)* is a type of penetrating injury where a penetrating object remains in the eye.

Focused ocular assessment

The animal should be initially assessed for any threats to life. If none are present (airway, breathing, circulatory) and ocular injury is the primary concern, a more focused assessment can be performed. If threat to life is present, refer to the appropriate *Guidelines* and consider a more focused ocular assessment in transit or defer to definitive care.

A detailed and accurate history is important to determine the approximate time of injury and the potential underlying mechanism of injury (MOI) that led to the ocular trauma. Trauma-related MOIs may be defined as blunt or penetrating and low versus high-velocity impacts. It will be important to quickly determine whether or not the dog sustained a high-velocity injury with

increased the risk for open globe trauma (eg, *dog was near power tools, lawn equipment, sports activities [eg, golf, baseball], glass, explosion*). Further defining characteristics for MOIs to consider include physical, chemical, and thermal properties, nature and size of object, and the possibility of a foreign body (on the surface or penetrating).

Review of an ocular examination

1. NOTE: If there are signs of an **open globe (penetrating) injury**, stop the examination and see "Open globe (penetrating) eye injuries" section, below. DO NOT manipulate the eye or apply any pressure to the globe. Do not measure the intraocular pressure.
   a. Examination findings suggesting a possible **open globe injury** are: history of sharp/high-velocity injury; deep eyelid laceration; distorted globe; subconjunctival hemorrhage; conjunctival laceration (may be subtle); black protruding uveal tissue; distorted iris or pupil; teardrop-shaped pupil; hyphema (blood pooled in eye); ocular hypotony; shallow anterior chamber; positive Seidel's test (see "Seidel's test," below).
2. Examination of the eye should be performed from front to back using the following systematic approach:
   a. Consider placing a single drop of topical anesthetic (1% Proparacaine HCl) into the eye if the dog cannot open their eyes because of pain—do not force open a painful, blepharospastic eye. Note: The degree of pain or visual impairment in ocular trauma does not necessarily correlate with the seriousness of the injury.
   b. *Orbit and eyelids*: evaluate for lacerations, subcutaneous, or subconjunctival emphysema, bruising, deformity of the orbital rim (orbital fractures)
   c. *Conjunctiva*: evaluated for hemorrhage and lacerations (small lacerations can be subtle and can indicate an open globe injury).
   d. *Cornea*: lacerations may be small and missed. One can perform a Seidel's test first (to assess for leakage from the cornea) and then assess for corneal abrasion with dilute fluorescein. Use of fluoroscein would only apply to delayed care by a medic, if scope of work and supplies allow.
      i. *Seidel test:*
         1. Apply a slightly moistened fluorescein strip directly to the suspicious cornea area creating an orange deposit of concentrated fluorescein.
         2. Do not allow the dog to blink.
         3. *Positive test*: A stream of fluid will be seen in the pool of dye. This indicates that aqueous fluid leaking through the corneal defect is diluting the orange fluorescein.
         4. A positive Seidel's test warrants treatment as an **open globe injury.**
   e. *Anterior chamber*: evaluate for depth of the chamber (compare to opposite eye, if possible) and presence of hyphema.
   f. *Iris and pupils*: evaluate for shape, size, symmetry to the opposite pupil, and direct and consensual pupillary light reflexes. Any pupil or iris damage is a serious sign of ocular trauma.
   g. *Lens*: evaluate for location of the lens (should be behind pupil), ability to see edge of lens (never is this normal—indicates luxation or subluxation), or opacity.
   h. *Cataract* – acute development may indicate a penetrating injury.
   i. *Ocular fundus*: a loss of tapetal reflex (bright/iridescent reflection when light is shone through pupil) could be due to opacification of the ocular media (eg, cataract, blood in vitreous) or a retinal detachment.
   j. Ideally, intraocular pressure should also be assessed unless you suspect an open globe injury. Use of a tonometer to assess pressure would only apply to delayed care by an advanced medic, if scope of work and supplies allow.
3. Ocular examination findings that would suggest serious symptoms and need for immediate care:
   a. Reduced or lack of menace response (vision loss).
   b. Pain unrelieved by local anesthetic drops.
   c. Deep eyelid laceration—possible undiagnosed underlying globe injury.
   d. Subconjunctival hemorrhage or laceration: possible globe penetration.
   e. Any pupil, iris, or fundus abnormality.
   f. A positive Seidel's test—indicates penetration of the cornea, that is open globe injury.
   g. Abnormalities of eye movements or position (excessive protrusion or recession of eye): proptosis, exophthalmos, or enophthalmos.
   h. Chemical or thermal burn of the eyelid or cornea.
   i. Intraocular penetrating foreign material—known or suspected (if a high-velocity injury, this must be excluded).
   j. Corneal foreign body that cannot be removed by gentle saline irrigation.

General precautions (see general approach to prehospital trauma)

Ensure in all scenarios that the **scene is safe** before approaching the patient, **personal protective equipment (PPE)** is used if needed, and the **animal is properly restrained**, including a muzzle if necessary (see exceptions).

First Response (< 20 minutes) (See Figure 7):

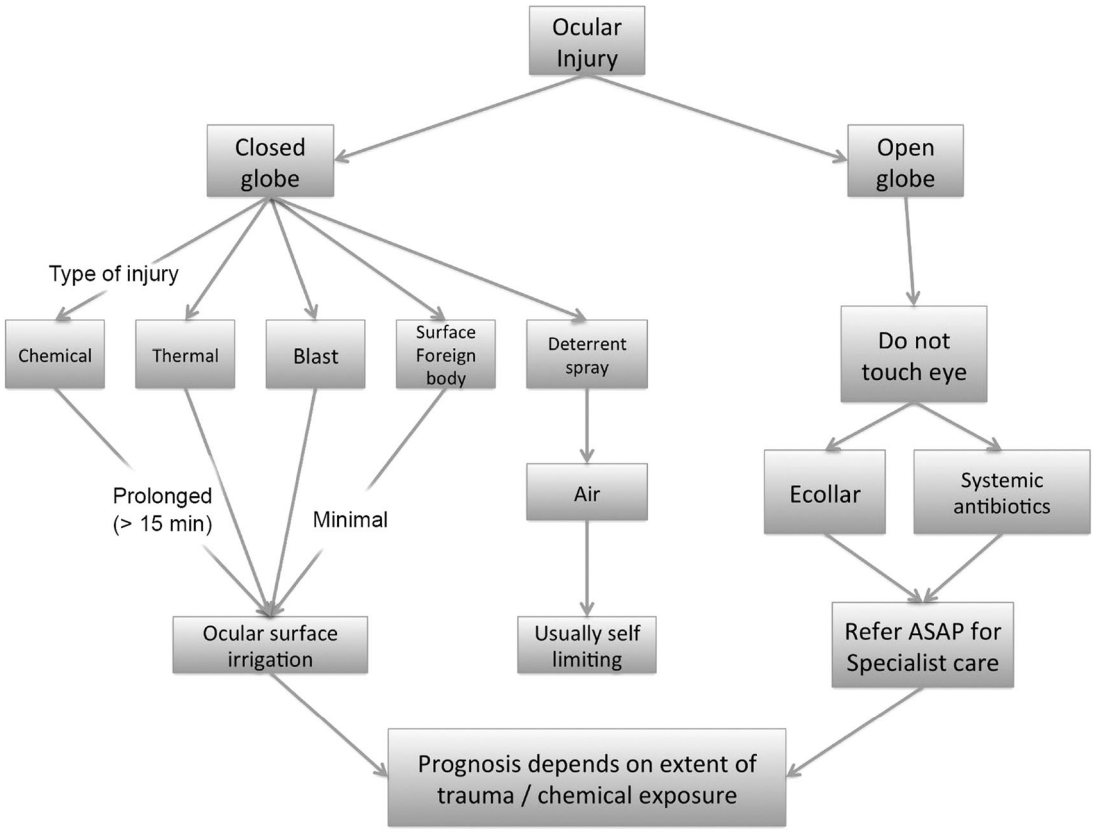

Figure 7: Algorithm depicting the approach to ocular injury in the canine or feline.

1. Assess ABCDs and stabilize any threats to life; see *Guidelines for each scenario*.
2. **Chemical injuries**
   a. Chemical injuries develop after ocular surface exposure to an alkali or acid substance. Alkali burns are more serious, as they may result in a deep or penetrating eye injury. Examples: Acids—sulfuric, sulfurous, hydrofluoric, acetic, chromic, and hydrochloric. Alkalis—ammonia, sodium hydroxide, and lime.
      i. Copious irrigation for 15–30 minutes using normal saline—evert the lids to irrigate out any trapped particulate matter. If saline or eye irrigation solution is not available, clean tap or bottled water can be used.
      ii. Topical anesthetic can be applied every 5 minutes to help keep the eye open; if scope of practice/work allows.
3. **Thermal injuries**
   a. Thermal injuries to the eye generally occur as a result of exposure to scalding liquid, hot objects, direct flame (eg, fire place; house fire), or rarely from an explosive blast. Usually, the injury is to the surrounding adnexal structures (ie, periocular skin, eyelid, eyelashes) and only rarely is the cornea and conjunctiva affected. Determining the source of the heat injury is important to determine prognosis because hot oils and greases are more adherent and subsequently result in deeper thermal injury.
      i. Remove the dog from the source of thermal injury (refer to *Guidelines for Burns*).
      ii. Irrigate the eye with normal saline or clean tap or bottled water for 15 minutes followed by application of cold compresses (decrease thermal injury and help to relieve discomfort).
4. **Open globe (penetrating) eye injuries**
   a. An open globe occurs after the injury penetrates the cornea or sclera.
      i. Do not touch or manipulate the eye or eyelids.
      ii. Do not remove foreign bodies if present; this could cause prolapse of eye contents.
      iii. If an Elizabethan (E) collar is present, put it on the dog to prevent further self-trauma. Alternatively, hold the dog's legs during transport to prevent scratching.
5. **Ocular or intraocular foreign bodies**
   a. Foreign bodies (FB) become lodged on the surface or penetrate the globe from sharp or from

high-velocity injures. Intraocular FB must always be excluded in high velocity eye injuries or where the cause/history of injury is unclear. Organic ocular FBs (eg, plant material, tissue, insects) are usually poorly tolerated by the eye and result in high rates of infection. Metals such as copper and iron are highly inflammatory. Inert materials such as glass or high-grade plastic cause severe injuries but are relatively well tolerated by the eye (ie, no secondary inflammation).

i. If a FB is located on the corneal surface (or surface of the eye), very gentle irrigation with saline, preferably, or clean tap water may be performed to irrigate the FB out of the eye.
ii. If the saline does not remove the FB or if you believe the FB is penetrated into the eye (ie, intraocular), DO NOT attempt to remove it—this could cause leakage of aqueous humor (fluid in eye).
iii. Place an E collar, if available, or restrain the dog to prevent pawing, rubbing, or movement of the eye and associated foreign material.

b. Most lodged FBs require surgical removal—this should be done as soon as possible to prevent further inflammation, ocular damage, and infection.
c. Transport as soon as possible

6. **Deterrent spray (eg, CS gas, tear gas, mace, pepper spray) injuries**
   a. Deterrent sprays produces ocular irritation that usually lasts 15–30 minutes, though it can be prolonged (up to 3 days). Injuries can also result from the mechanical force or powder involved when the spray is used at close range. Clinical signs are most commonly severe blepharospasm, lacrimation, and conjunctival swelling. Pepper spray contains oleoresin capsicum and may result in corneal ulcers.
      i. Expose animal to fresh air. Blowing dry, cool air with a fan across the dog's eyes may help to vaporize the gases faster.
      ii. If no improvement or with pepper spray, use irrigation as described above for chemical injuries.
7. **Blast (bomb) injuries**
   a. Most blast injuries to the eye are caused by rapidly accelerated sharp particles (glass, bomb metal fragments, wood, concrete, other) and cause both sharp and blunt trauma resulting in a laceration of the eyelids or rupture of the cornea or sclera. Usually both eyes are affected. Injuries may range from minor corneal ulcers and foreign bodies to extensive eyelid lacerations, open globe injuries, intraocular FB, or orbital fractures. Blunt trauma may result in nonpenetrating injuries including cataract, hyphema, vitreous hemorrhage, retinal detachment, and optic nerve injuries.
      i. After a blast injury to the eyes, assume there is an **open globe** and manage as described above. Use only minimal irrigation and do not put pressure on the eye.

Recommendations for responders in the setting of delayed veterinary care (assumes minimal to no medical training) (see Figure 7)

1. Follow all recommendations listed under First Response with minor categorical additions as noted below.
2. **Chemical injuries**
   a. When irrigating, one can check pH of the ocular surface (litmus paper IF available) every 5 minutes and continue irrigation until pH has returned to 7.4.
3. **Thermal injuries**
   a. Thermal injuries are painful. Refer to *Guidelines for Analgesia* for guidance on proper pain-relieving medications to administer.
4. **Deterrent spray**
   a. Wash the head and neck to remove residual spray material to prevent further irritation.

Recommendations for medics in the setting of delayed veterinary care (see Figure 7)

1. Follow the above recommendations cited above under First and Delayed Response with minor categorical additions as noted below:
2. **Chemical injuries**
   a. Consider treating corneal ulceration and secondary uveitis with:
      i. Topical oxytetracyline or available antibiotic drops (one drop every 30 minutes).
      ii. Cycloplegics (1% atropine or tropicamide (HCl) (one drop).
      iii. Oral antibiotics (dependent upon availability) (eg, amoxicillin/clavulanic acid (14 mg/kg body weight PO every 12 hours).
      iv. Analgesics (see *Guidelines on Analgesia*).
3. **Thermal injuries**
   a. Apply topical antibiotic drops (Topical oxytetracyline or available antibiotic drops (one drop every 30 minutes).
   b. Apply topical atropine (once).
4. **Open globe (penetrating) eye injuries**
   a. Administer oral antibiotics, dependent upon availability (eg, amoxicillin/clavulanic acid (14 mg/kg

body weight PO every 12 hours) to prevent secondary infections.

b. Avoid touching the eye.

5. **Ocular or intraocular foreign bodies**
   a. If sedation and analgesics are available, one can use further precautions to ensure the FB does not move or cause further damage. See *Guidelines on Analgesia* for recommendations regarding sedation and analgesia.
   b. While sedated, stabilize the foreign body in place:
      i. Form a doughnut ring made out of 2-inch role gauze.
      ii. As you make the ring, adjust the size of the inner diameter to fit around the eye.
      iii. Place the ring around the object without bumping the object.
      iv. Secure the gauze doughnut to the eye using roll gauze bandaged around the head.
      v. Cover the uninjured eye to prevent eye movement that would cause the injured eye to move as well.

Further Reading

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