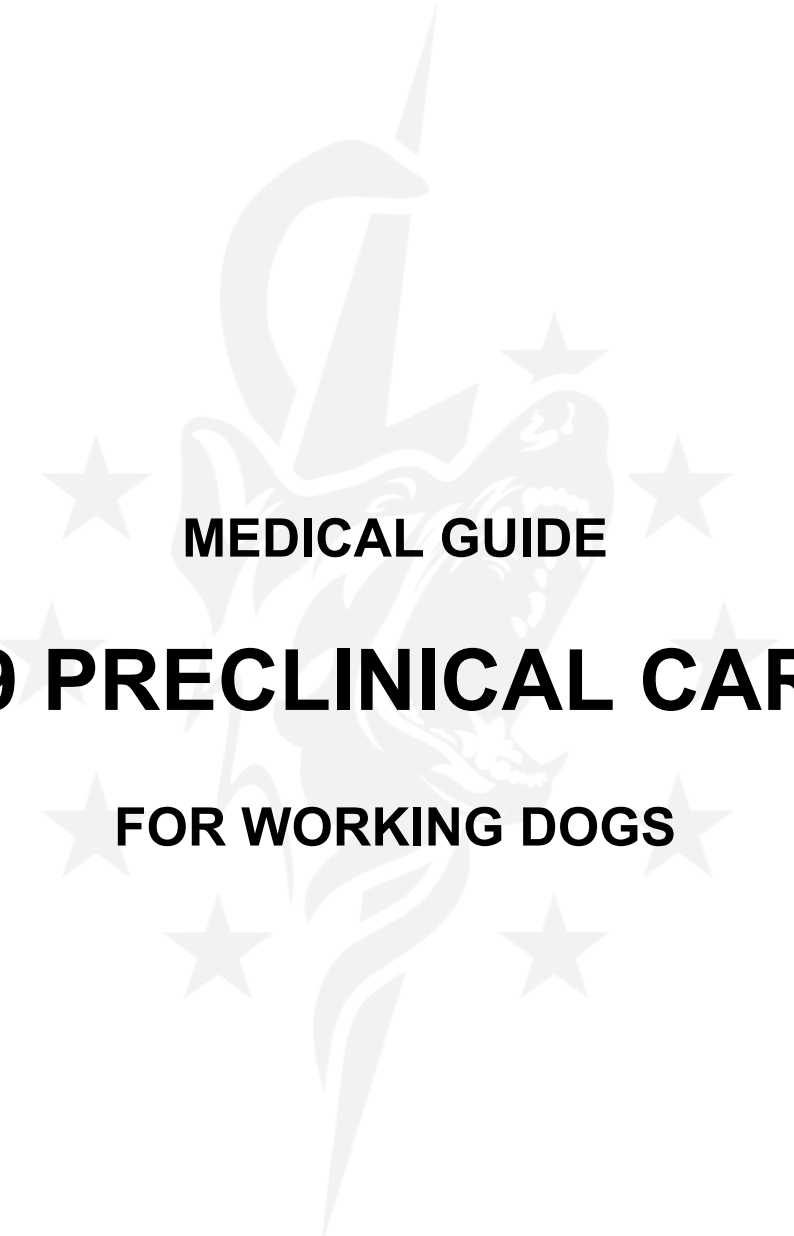


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MEDICAL GUIDE

K9 PRECLINICAL CARE

FOR WORKING DOGS

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INTRODUCTION

The task of a K9 first responder is to provide preclinical first aid to the service dog in cases of acute, life-threatening illness or injury until the dog can be handed over to higher levels of care within the chain of survival.

This includes not only the treatment of trauma, but also the correct recognition of internal pathological findings, using all possible diagnostics and choosing the correct treatment within the medic's skillset in order to stabilize the dog, enabling evacuation and therefore recovery and survival of the service dog.

This guide is divided into several sections: introduction into K9 physiology and monitoring, acute trauma care using the MMARCH scheme, internistic emergencies as well as prolonged field and evacuation care.

Remember: Before you can aid a casualty in combat, return fire and take cover! In a civilian setting, be sure your scene is safe! **Self protection is always the higher priority.**

Recall or move the K9 to a safe location if you can maintain positive control. Keep collars or tactical vests on to restrain or aid in the movement of the dog.

Priority for casualty care is given to human casualties over K9 casualties!

The dog handler and K9 should stay together, when appropriate and the situation permits.

The clinical examination should be carried out in the posture in which the dog feels most comfortable. For some treatment it is necessary for the K9 to lay on the side while being restrained. To do so, an

assistant positioned on the dog's back, holds the extremities facing the ground above the ankle or wrist. If the K9 is uncooperative, the assistant can immobilize the dog's head with his elbow and his bodyweight.

Target group of this guide are working dog handlers such as members of authorities like police, military, search and rescue or other emergency services as well as their teammates and medical professionals such as paramedics, EMTs or first responders who can assist in the care of an injured K9.

Depending on the skill level of the K9 handler and the medical provider, this guide is intended to raise awareness of clinical symptoms regarding internistic emergencies or trauma, to inform and educate about the options for monitoring, diagnostics and treatment and therefore aiding the K9 handler or medical professional during examination.

Disclaimer

This handbook has been prepared with the greatest possible care. However, no guarantee is given regarding the completeness, accuracy, or currency of the information provided.

This handbook is intended for educational purposes only and does not replace professional veterinary judgment. The application of the procedures and recommendations described herein is the sole responsibility of the user and must always comply with applicable laws, regulations, and local protocols.

K9 ANATOMY AND PHYSIOLOGY

Many physiological characteristics can be transferred from humans to dogs. Nevertheless, dogs have some unique characteristics in anatomy, metabolism and physiology. Providers should be aware of these in order to be able to take the specific differences into account.

ANATOMY

Special features of bone structure:

Dogs have disconnected shoulder bones, meaning they lack a collarbone, unlike humans. This allows a greater stride length for running and leaping.

As K9s have a digitigrade stance, they actually walk on their toes. Recognizing this helps to understand where certain bones or body features are located if you want to derive them from the human body (e.g. ulna, radius, humerus...).

Their spine consists of 7 cervical, 13 thoracic, 7 lumbar and 3 sacral vertebrae. The number of caudal / coccygeal vertebrae depends on the tail's length and is 20 - 23.

Special features of the body:

Studies have shown that a K9's vision consists of shades of yellow, blue and gray. Therefore they have a difficulty differentiating between red and green.

Dogs can basically only sweat on their paws, therefore temperature is regulated with panting.

Due to different metabolic processes, some well-known medications used for human medicine are not suitable for dogs and must not be used.

NORMAL PHYSIOLOGICAL VALUES

Check your dog's physiological parameters carefully in a quiet, controlled environment to determine the normal values for your dog. This is quite important so you can check for abnormalities.

When speaking of working dogs, we mostly refer to breeds like the Belgian Malinois. Therefore the physiological values we use in this document will refer to similar dogs with a bodyweight around 30kg. Some values are fitting for all dogs, some will be size/weight specific. Also, environmental influences may affect your normal values.

Respiratory Rate	15 - 30 / min
Heart rate	80 - 100 / min
Temperature	37,5 - 39,0 °C
Capillary refill time	< 2 seconds
Blood pressure	130 / 75 mmHg
SpO ₂	> 94%
Tidal volume	10 - 15 ml / kg BW e.g.: 300 - 450 ml at 30 kg BW
Blood volume	8 - 9 % of BW e.g.: 2,4 - 2,7 L at 30 kg BW
EtCO ₂	35 - 45 mmHg
Hematocrit (HCT)	44 - 57 %
Blood Glucose (BG)	80 - 120 mg / dl

MONITORING

If possible, initiate advanced electronic monitoring if indicated and if monitoring equipment is available. In case an automated device returns questionable values, rely on your basic monitoring skills and use equipment you are familiar with.

Pulse

The K9's pulse is most easily measured on the femoralis in the dog's thighs. A K9's heartbeat shows respiratory sinus

arrhythmia when at rest. This means that when breathing in, the heart beats a little faster and when breathing out, a little slower.

A palpable dorsal pedal artery pulse usually indicates a systolic pressure of ≥ 80 mmHg.

Respiration

Control the frequency and sufficiency of the breathing activity for at least 30 seconds for proper values. Check mechanical respiratory activity by placing your hand around the thorax. If needed, use a stethoscope to auscultate, assess and compare the breath sounds of both lung sides. Differentiate if your dog is breathing, panting or hyperventilating. For dogs, panting is a normal way to regulate body temperature. If the dog can not stop panting when you attempt to shut his muzzle with your hands, we speak of uncontrolled panting. If available and possible, use capnography to monitor the EtCO₂.

Inspiratory stridor occurs when there is an obstruction in the upper airway (e.g. due to a foreign body or swelling), while expiratory stridor occurs due to obstruction of the lower respiratory tract.

Blood Pressure

The Blood Pressure is measured with a proper sized inflatable cuff and an automatic device either below the elbow or on the base of the tail provides the most accurate readings. Manual measurement of the systolic pressure can be done on the front leg with a doppler device. Place the cuff below the elbow, trim the fur over the palmar metacarpal artery and apply the doppler probe with acoustic gel. Inflate the cuff to about 20 mmHg higher than the anticipated systolic blood pressure. You should not hear any whooshing sounds (arterial pulsations) at this pressure. Slowly deflate the cuff. As soon as you

hear the whooshing sound again, the cuff reached the systolic blood pressure. Regular pediatric cuff sizes fit most dogs.

Mucous membranes

The gum color can give you a fast first impression of a dog's medical status.

Pink: Normal

Blue or gray: Cyanosis

Pale: Poor circulation, hypotension, hypothermia

Bright red: Heatstroke or severe hypertension

Yellow: Metabolic liver issues

Remember, depending on temperature and blood pressure the tissues perfusion might change and give you wrong impressions. Also, pigmented skin may hinder the assessment.

Temperature

Temperature should be measured rectally for the best results. If rectal readings are not tolerated, you may use axillary temperature. Axillary temperatures are approximately 0,5-1 °C lower than rectal.

Hydration status

Test the skin's turgor to assess the hydration status. While the dog is standing, create a fold of skin between your thumb and index finger on the side of the thoracic wall.

After letting go, the skin fold should immediately disappear again. If the dehydration exceeds 5% of the body weight, the skin turgor decreases and the skin fold disappears more slowly.

Pulse oximetry

If possible, use a flat ear probe attachment on the tongue or non-pigmented portion of the lip. In conscious dogs, use the ear pinna, lip fold or inguinal skin fold. Although not optimal for oximetry, these alternate sites deliver reliable results. Also neonatal / disposable

adhesive pulseoxymeters can be attached to the base of the canine's tail, giving reliable values. If no electric measurement is possible, assess the mucous membrane color and capillary refill time. Keep in mind that SpO₂ sensors only differentiate oxygenated and deoxygenated hemoglobin. The sensor can not differentiate between oxyhemoglobin (O₂Hb), carboxyhemoglobin (COHb) and methemoglobin (MetHb) which may result in wrong readings.

Blood Glucose

A blood glucose test is used to find out if the blood sugar levels are in a healthy range. Moderately elevated glucose can even indicate infections. To measure the blood glucose we need a fresh drop of blood, for example from the needle of an established IV access or from a lancet puncture, which can be easily done on a dog's ear. Make sure the dog's ear is well perfused. You may warm it up with your hands to make collecting blood easier. Use disinfectant wipes and a sterile lancet to prick the skin. Collect the drop of blood on a glucose test strip as directed in the instructions for your testing device. You can also use blood from a hypodermic needle while establishing an IV line.

Capnography

Capnography is an important tool in monitoring ventilated patients. The information provided by the capnograph alerts the monitoring person to possible life-threatening complications. This can be achieved by either a digital sensor and monitor or an analog pH sensitive color capnography. Color capnometry is inferior due to the limitations of the device, but is inexpensive and rather easy to use. Most chemical CO₂ indicators display the values in % of atmospheric pressure. For example, to convert an end-tidal CO₂ of

5% to mmHg, calculate 5% of the total atmospheric pressure at sea level (760 mmHg), which equals 38 mmHg. Digital capnography monitors give you a precise measurement and a waveform which can give you more information about ventilation and perfusion. An anesthetized dog that is breathing well should have an EtCO₂ value in the low 30mmHg. A sudden decrease in EtCO₂ without change in breathing parameters means blood pressure and therefore perfusion has seriously decreased.

Mentation

Mentation provides a rapid assessment of the K9's neurological status and should be evaluated during every clinical examination. Changes in mentation may indicate neurological injury, systemic disease or impaired cerebral perfusion. This standardized classification is routinely used in small animal medicine for the initial neurological assessment of dogs:

BAR = Bright, Alert, Responsive

QAR = Quiet, Alert, Responsive

Dull = Reduced responsiveness

Stuporous = Responds only to strong stimuli

Comatose = Unresponsive

Modified Glasgow Coma Scale (K9GCS)

The Modified Glasgow Coma Scale (K9GCS) is used to objectively assess neurological function in dogs with suspected traumatic brain injury and to monitor neurological changes over time. The total score ranges from 3 to 18, with higher scores indicating less severe neurological impairment.

Motor Activity: 6 Normal | 5 Paresis | 4 Intermittent extensor rigidity | 3 Constant rigidity | 2 Rigidity + opisthotonus | 1 None
Brainstem Reflexes: 6 Normal | 5 Sluggish pupillary light reflex | 4 Bilateral miosis | 3

Pinpoint pupils | 2 Unilateral mydriasis | 1 Bilateral mydriasis
Level of Consciousness: 6 Alert | 5 Depressed / delirious | 4 Semicomatose, responsive to visual stimuli | 3 Semicomatose, responsive to auditory stimuli | 2 Semicomatose, responsive to repeated noxious stimuli | 1 Comatose, unresponsive

Electrocardiogram (ECG)

Even if an ECG application in the preclinical setup of first aid is very unrealistic, it is quite conceivable that an MedEvac vehicle carries a patient monitor with ECG function. Therefore, it is important to know where the electrode leads are attached on the K9s.

Red = right forelimb, placed behind the elbow (AHA: White lead)

Yellow = left forelimb, placed behind the elbow (AHA: Black lead)

Green = left hindlimb, placed at the front of the knee (AHA: Green lead)

Black = right hindlimb, placed at the front of the knee (AHA: Red lead)

Keep in mind, there are two color schemes used for the leads: The International Electrotechnical Commission (IEC) system and American Heart Association (AHA) system.

Hematocrit

You may want to check your dog's hematocrit level due to abnormal behavioral patterns such as excessive fatigue, dyspnea or apathy. This can be done using a makeshift centrifuge, heparinized capillary tubes, and a scale to read the result. Use disinfectant wipes and use a sterile lancet to prick the skin on the ear. Collect the drop of blood with the heparinized tube and centrifuge the sample. Use the hematocrit reader card to interpret the result.

eFAST Sonography

The goal of eFAST sonography is to identify internal life-threatening injuries and to take appropriate measures. The examination was initially developed for the initial assessment after a trauma event, but can also be carried out on other hemodynamically unstable patients to assess for internal bleeding and detect free fluids in body cavities or to assess for a pneumothorax. Immediate patient care should not be postponed for sonography assessment if not indicated.

eFAST can be performed by individuals with minimal ultrasound experience. With proper training, veterinary assistants can perform the exam.

The AFAST exam can be performed with the patient in the left or right lateral decubitus position. The primary focus is to look for free fluid between organs such as the liver, kidney, spleen, diaphragm, and body wall.

A complete TFAST exam is performed with the patient alternating left and right lateral decubitus positions or in the sternal recumbency. Primary goal of the TFAST exam is to detect gas in the left and/or right pleural space. The absence of a sliding sign indicates gas in the pleural space.

The sonographic image shows the following picture:

Soft tissue: various shades of gray

Fluids: hypoechoic or anechoic (black)

Fat: hyperechoic compared to other soft tissue (brighter than muscle tissue)

Bone and gas: very bright or echogenic and cause an acoustic shadow

TRAUMA CARE

Trauma is defined as a tissue injury that occurs more or less suddenly due to violence or accident. As the MMARCH algorithm covers a lot of trauma assessment and invasive measurements to treat them, we include it in this chapter.

MMARCH ALGORITHM

The algorithm for initial assessment and treatment of the K9 shares a lot of the standard MARCH algorithm we already know for us humans, with the addition of securing the muzzle for safety, creating MMARCH. This scheme can guide anamnesis in any type of emergency. With other literature you may also encounter M²ARCH² with separated Hs for Head and Hypothermia or even M³ARCH² with an additional M for “Move to save area”. To simplify things, we will stick to MMARCH. In Europe, the xABCDE scheme, which is also very similar to the MARCH scheme, is widely used in civilian emergency medical services. Therefore, many medical providers with civilian EMS background will be familiar with the MARCH algorithm quite fast.

Muzzle → secure dog's muzzle (self-protection)

Massive Bleeding → prevent massive blood loss

Airway → maintain a secure airway

Respiration → securing proper ventilation of lungs

Circulation → ensure hemodynamic stability and treat trauma

Hypothermia & Head → prevent hypothermia, assess head trauma & neurological status

In terms of equipment, basically all medical gear can be shared between humans and dogs, ensuring an easier supply chain and training on how to use and apply specific medical gear.

As with humans, you need to know how and where to apply the proper treatment.

MUZZLE

First of all, the dog's muzzle gets secured to prevent bite accidents. A dog may not be able to differ from friend or foe due to stress.

This can be achieved either with a muzzle sling made from a gauze bandage or similar material or with a conventional muzzle. The dog's breathing must not be impaired. Use a mouth spreader if needed. A mouth spreader can be improvised on the fly with the barrel of a 5ml / 10ml syringe with the needle adapter removed. Also a roll of tape or similar objects can be used, as long as they serve the purpose. We recommend cutting a proper sized, flexible PVC tube into 4 - 5 cm long pieces. Those tube pieces have no sharp edges and can be put over the canines of the dog, spreading and securing the muzzle open with the sling.

Unconscious dogs should always have a mouth spreader in place to maintain an open airway!

MASSIVE BLEEDING

During the massive bleeding step, only life threatening hemorrhages are treated! Smaller wounds are not of priority, as we need to **treat first what kills first**.

Use direct pressure, a tourniquet or a pressure bandage to stop those critical bleedings. Keep in mind that most TQs

are designed for humans and will not properly work on a dog.

The SWAT TQ is currently the only recommended tourniquet for use with dogs, as other CoTCCC recommended tourniquets - like the CAT-TQ or SOFTT-W tend to slip distally and fail. This also counts for other tourniquets with a windlass design. Elastic tourniquet designs with a rubbery, anti-slip texture seem to be the most promising ones.

If the situation, time aspect and circumstances allow, apply a pressure bandage over the wound. Wounds may be packed with hemostatic agents and gauze if feasible (mind the packable zones). Hemostatic dressings are coated with hemostyptic agents and actively promote blood clotting. For example, QuikClot® uses the mineral active ingredient kaolin: This activates the intrinsic blood clotting using factor XII and accelerates hemostasis. Celox® Gauze contains chitosan which binds to fibrinogen and triggers increased platelet aggregation, thereby stopping the bleeding. It also promotes vasoconstriction.

Convert TQs later during reassessment.

AIRWAY

Keep or establish an open airway! Remove airway obstructions if possible. To do so safely, force the mouth open and secure it in place to gain safe access to the mouth and pharynx. Use tools like a Magill forceps if needed.

Basic airway maneuver

If the dog is unconscious and no other airway obstruction is present, put the K9 into a recovery position: Overextend head and neck in line with the spine, protrude tongue lengthways from the oral cavity. You may use a compress to get a better

grip of the tongue. Again, consider spreading the mouth with the help of tools and secure the muzzle.

Be prepared to intubate the dog if necessary. Use the largest available endotracheal (ET) tube up to 10.0 mm internal diameter. How far the ET tube is inserted is measured half way between the shoulder and the larynx. A laryngoscope is not necessarily needed to intubate a dog due to the anatomy, but comes in handy due to the light source. Also, keep all other needed equipment for intubation ready: A roll of gauze for securing the tube and a syringe to block the cuff. Furthermore, a flashlight or headlamp might be handy for better visualization.

A BVM with HME filter should always be accessible in case of emergencies for assisted ventilation. We recommend always using an HME filter on intubated patients.

Intubation

Visualize the entrances to the trachea and esophagus. To do this, an assistant overextends the K9's neck and holds the muzzle open while the intubating person grasps the tongue with gaze for better grip and pulls it out to get a view at the vocal cords. If needed, depress the epiglottis with help of a laryngoscope to even better visualize the vocal folds and arytenoid cartilages. Pass the ET tube over the tongue (or laryngoscope), aiming for the trachea. Guide the tip of the tube over the dorsal surface of the epiglottis, and gently slide it forward. It sometimes helps to slightly rotate the tube as it enters the trachea.

The position of the ET tube in the trachea is confirmed by: visualizing the tube between the vocal folds, condensation appearing inside the ET tube with each

breath, auscultation of breath sounds on both sides of the thorax. Add an HME filter to the ET tube for hygiene and to allow the respiratory air to be humidified by the condensation on the filter membrane. If available, use a capnograph for monitoring.

A surgical airway may also be considered as a last option, but should be only performed by skilled experts.

RESPIRATION

Control the frequency and sufficiency of the breathing activity. Assess for cyanosis on the dog's mucous membranes and if possible monitor the SpO₂. In case of trauma, it is important to check the mechanical respiratory activity. Place your hand around the thorax, check for even and bilateral movement as well as firm thorax stability. If needed, use a stethoscope to auscultate, assess and compare the breath sounds of both lung sides.

Dogs with shortness of breath should be treated while sitting or standing and should not be forced to lie on their side, to minimize stress.

If a pneumothorax is detected, consider needle decompression. In case this develops into a tension pneumothorax, a needle decompression becomes necessary.

When dealing with penetrating thorax wounds, conventional chest seals may not achieve an airtight seal due to the fur. In this case, a dog's chest can be sealed using commercially available cling film, which is placed around the entire chest.

Unconscious dogs with a pneumothorax are generally transported lying on their

side with the affected side of the lung facing down in order to relieve the intact lung as much as possible.

If available, consider using sonographic imaging to diagnose and differ between pneumothorax or hemothorax.

Due to serial rib fractures, the ability to mechanically generate intrathoracic negative pressure in order to inspire can be lost, impairing breathing activity. Assess for the symptom of paradox breathing and distinguish the respiratory distress from open and closed pneumothorax. In case of severe serial rib fractures, you may need to provide assisted ventilation to the dog.

Needle decompression

A needle decompression is performed in the 7th - 9th intercostal space (ICS) of the K9. As dogs have 13 ribs and the first ones are usually covered by the shoulder blade, it is more convenient to count from the 13th rib down to the ICS that is suited for the needle decompression. When the correct ICS is found, locate the spot to perform the maneuver: midway up the lateral thoracic wall.

Insert the decompression needle at an angle perpendicular to the chest wall and cranial over the rib. Insert the needle/catheter unit together until the needle can be felt entering the pleural space. and hold it in place for 5 to 10 seconds to allow decompression to occur. To visualize successful decompression, you can add the barrel of a syringe with some NaCl 0,9% to the needle/catheter. Bubbles will rise up after penetrating the pleural space. Do not insert the needle/catheter unit any further than needed for the decompression to avoid injuring any other tissues. **CAVE:** Most K9's mediastinum is fenestrated. If the first decompression attempt has no effect,

consider decompressing the other side of the chest as well.

A hemothorax may require a chest tube due to the mechanical limitations of a 14g cannula to properly drain fluids.

Thorax drainage

Chest tubes should be considered in cases of recurrent pneumothorax / tension pneumothorax or pleural effusions, including hemothorax.

To ensure that the chest tube placement runs smoothly, all the equipment required for the procedure should be prepared in advance. Be familiar with the equipment you are provided with. The working area should be as sterile as possible to reduce the risk of infections and complications. Measure the drainage from the incision caudal to the thoracic inlet (approximately to the 1st ICS near the sternum). Take note of this measurement by using the markings along the tube.

If an assistant is available, the skin is pulled cranially during the procedure, creating a subcutaneous tunnel when the skin is released, which helps seal and fix the tube in place.

A partial thickness intercostal incision of about 1,5 - 2 cm is made parallel to the ribs at the 7th - 9th ICR. Identify the rib caudal of the insertion and dissect tissue cranial of said rib with haemostat forceps, avoiding the blood vessels and nerves beneath the ribs. Guide the forceps with the tip of your finger if needed. As soon as the pleural space is perforated, a sudden decrease in resistance can be felt. The thoracic drain should now be inserted, preferably guided by the finger. Using a thoracic catheter with trocar is also conceivable, but carries a higher risk of injury. As the patient should not be ventilated during the insertion or advancement of the trocar to further reduce the risk of lung puncture,

pre-oxygenation is advised prior to induction.

Once inserted into the pleural space, the tube should be reoriented to advance in a cranioventral direction. If available, connect a 3 way tap with a syringe and a heimlich valve to drain the chest. Use the syringe as a makeshift pump for better drainage of air from the thorax. Close the incision around the tube with a purse string suture around the base of the tube and secure the catheter with a chinese finger trap suture. Cover the incision around the tube with nonadherent dressing and use bandages around the whole chest to secure the tube. Monitor the drainage's output.

Placing a chest tube is one of the last resorts you should consider in the field and should be only done by experienced providers!

CIRCULATION

Assess the heart rate, pulse quality, capillary refill time and mucus membrane color for your first impression. If your SpO₂ measurement detects a pulse, use this for monitoring as well.

Femoral and dorsal pedal pulses should be palpated (ideally on both sides) while also checking the central pulse of the heart. Compare the heartbeat with the peripheral pulses.

The femoral artery is located on the inner thigh and is the easiest way to palpate your dog's pulse. The dorsal pedal artery is most easily palpated between the second and third metatarsal bone, right below the tarsal joint. Palpable dorsal metatarsal (pedal) pulses usually indicate a systolic pressure of ≥ 80 mmHg.

If possible, measure blood pressure either automated or manual.

With the evaluated data we can assess whether the dog is hemodynamically stable or going into shock. Depending on this result, we should adapt our priorities and next steps.

Perform a complete sweep of the body, searching for wounds and other trauma. We recommend to start at the tail, working your way from caudal to cranial, against the brush of the fur, thus making wounds more easy to detect. Palpate the abdomen to find unusual hardening due to internal bleeding and check the skeletal structure for fractures. Watch the K9 for any pain related reaction during the physical inspection.

Treat wounds with bandages or other hands-free pressure wound seals like the iTClamp as well as hemostatic agents. Due to the risk of restricting the airway and blood vessels that supply the brain, pressure bandages should not be applied to the neck. In such cases, solutions like the iTClamp are the preferred option.

Convert tourniquets if possible with proper pressure bandages. When applying bandages, use anchor points such as suited body regions, a collar or vest. If possible, incorporate some fur to prevent slipping.

Pelvic binders are not recommended in K9s at this time.

Intravenous access

Establish an intravenous (IV) access in case medication or fluids need to be administered, preferably on the front legs. IV catheters in the range from 20G to 17G are well suited. For blood transfusions, use at least an 18G catheter or bigger. A venous tourniquet is placed above the

elbow on the front leg or above the knee on the rear leg. The puncture sites can be cleaned with a generous application of disinfectant. With good congestion of the veins, fur does not necessarily have to be trimmed or shaved. By smoothing the hair in the direction of the fur, the veins get more visible. Secure the IV catheter to the limb with tape and bandages, and restrain the dog in such a way that it can not accidentally remove the IV line.

Intraosseous access

In larger K9s, like most working dogs, the flat medial surface of the proximal tibia can be used easily for intraosseous (IO) access. The access point is located on the proximal medial tibial crest, just distal to the knee joint on the inside of the rear leg. Since most dogs do not have much tissue at this body location and only the bone marrow needs to be reached, pediatric IO needles are often long enough.

Prepare the access point by clipping or trimming the fur if needed and apply disinfectant to clean the puncture site. The catheter is inserted perpendicular to the bone; a sudden yielding or reduced resistance signals that the bone marrow has been reached.

To confirm proper placement, bone marrow is aspirated with a syringe and the catheter is fixed in place.

Establishing an IO access should only be performed on an unconscious or sedated service dog and should be left to an experienced person due to the painful flushing and risk of complications. Due to the logistical and practical effort, IV access is preferable to IO access. In practice, IO access is almost never used for K9s due to said circumstances.

Depending on the access point, flow rates are rather slow, with access at the tibia resulting in about 0,3 ml / kg BW / min with gravity and 0,6 ml / kg BW / min with pressure infusion.

Volume substitution

A blood loss of approximately 15 ml / kg BW or more would indicate a volume substitute.

Hemorrhagic shock occurs after a blood loss of approximately 25 ml / kg BW. (30 - 40 % of the dogs total blood volume)

Depending on the scenario, you might determine your dog's HTC, as anemia can also occur without any trauma, for example due to poisoning with coumarin. If the hematocrit is below 20%, a blood transfusion is also indicated.

The resuscitation fluids of choice for K9s in hemorrhagic shock, listed from most to least preferred, are: K9 chilled or fresh whole blood > K9 plasma and RBCs in a 1:1 ratio > K9 plasma or RBCs alone > hemoglobin-based oxygen carrier (HBOC) blood substitutes > crystalloids infusions.

HYPOTHERMIA PREVENTION

Since hypothermia impairs the blood's ability to clot, it promotes a hypoxia induced metabolic acidosis, leading to decreased myocardial performance which also causes hypothermia. This is known as the trauma triad of death, which is especially seen in patients with serious trauma, resulting in higher rates of mortality.

To break this cycle, hypothermia prevention measures should be implemented as soon as possible. This includes passive and active measurements to inhibit the decline of the body's temperature.

Minimize exposure to cold environments: Move to a warm place indoors or in a vehicle. If no such option is feasible, use suited insulation material to the cold ground, wind and protect from rain.

Remove wet outer gear and pat the K9's fur dry gently. Use multiple layers of rescue blankets and insulating layers. Keep in mind that rescue blankets need an air pocket between the patient's skin and the blanket. If available, use active heating elements like heating blankets as soon as possible. Prevent burns by not placing active warming elements directly on the skin. If feasible, use a well insulated enclosed system like a hooded sleeping bag. Use improvised or battery-powered warming devices for administering required IV fluids to further prevent hypothermia. Monitor the patient's core temperature if possible.

HEAD INJURIES

While inspecting the head, also check the eyes for penetrating trauma and quickly assess the neurological status of the dog.

Treat injuries accordingly with the mechanism of injury in mind.

Inspect the eyes for penetrating injuries. Rinse injured eyes gently with 0,9% saline or clean water. Do not cover injured eyes but prevent the dog from scratching the injured eye. To do so, consider sedation as recommended in the K9TCCC Guidelines. Check if the pupils are the same size, round and have the same reaction to light.

To further assess the K9's neurological status monitor its behavior: Does the K9 react to verbal commands? Does it move his eyes? Can it walk / stand up properly? Is anything different compared to its normal behavior? Based on the mechanism of injury and any abnormalities observed in your findings, a traumatic brain injury may be present. The

Modified Glasgow Coma Scale / K9GCS helps with assessing the patient.

BURNS

Remove all gear such as collar, harness and booties but avoid pulling away any gear that is melted in the skin or coat. Give the highest priority to airway management, as inhalation trauma can cause serious airway deterioration within minutes due to swelling. This is why intubation should be considered early if the circumstances indicate it. Follow the MMARCH scheme to provide care.

Superficial and partial thickness burns of less than 15% of the total body surface area (TBSA) should be cooled with (sterile) water or saline. Do not cool with ice cold water or for longer times due to risk of hypothermia. Cover all burns with dry burn dressing to avoid infection. Monitor vitals, establish IV access and treat symptoms accordingly. If smoke inhalation is suspected SpO₂ readings may be wrong due to CO inhalation.

If shock presents due to fluid loss, perform fluid bolus of 20 ml / kg BW of crystalloids, if shock is not present and TBSA > 20% or full thickness burns present, administer 2 ml / kg BW x %TBSA burned within the first 8 hours.

Plasma transfusion might be needed to compensate for protein loss in the burned areas.

Patients with burns require aggressive pain control. Refer to the TCCC Guidelines for current analgesia recommendations.

WOUND MANAGEMENT

Depending on the mechanism of injury, wounds need to be treated accordingly. Depending on the injury, minor wounds or cuts can be treated easily by dog handlers or medics, without the urgent need for higher levels of medical care by a veterinarian and immediate evacuation.

Paw bandage

A paw bandage after an injury to the pad, skin between the toes or claw serves to protect the dog from dirt and thus the risk of infection, but also to immobilize the wound as much as possible until it has healed.

Such a bandage should fit well so that the dog does not lose it after a short time. Appropriate care and periodic renewal of the bandage is also important.

Clean the paw with clean water and carefully dry the area. If necessary, the fur around the wound may need to be trimmed slightly. Carefully examine the wound, remove any coarse dirt, stones, glass shards or thorns. If any foreign object can not be removed, add thick padding. Cover the wound with a sterile compress, then pad all areas between the toes, including the dewclaw, thoroughly to prevent pressure and friction. Use a gauze bandage or gauze for this purpose. Finally, secure everything in place with a gauze bandage. The paw should be fully bandaged, taking care not to apply too much pressure in order to avoid compressing blood vessels. Incorporate fur into the bandage to prevent it from slipping and to keep it in place. Place a self-adhesive bandage over the first bandage for better fixation and, if necessary, work in anchor points such as the collar or harness to prevent it from slipping.

The paw bandage itself can be protected from moisture and from the ground by attaching a bootie, rubber glove or plastic / poop bag as outer layer.

Ear bandage

Place a sterile dressing on the dog's head. Fold the injured ear upwards over the dressing. Place a second dressing on the ear so that it is sandwiched between the two dressings. Wrap the bandage widthways around the K9's head, leaving both ears out if possible so the dog can hear better and moisture can't build up within the ear. The healthy ear serves as an anchor point so that the bandage does not slip.

Bite wounds

Deep bite wounds should be rinsed and treated with antibiotics.

The aim of wound cleansing is to clean the wound cavity as best as possible to remove any foreign bodies in order to avoid further infection and proper healing. Use sterile saline 0,9% to rinse or use a diluted solution of povidone-iodine to disinfect the wound cavity.

Rinse with a syringe; a 18G catheter (without stylet) can be used to reach into deeper cavities. If a diluted iodine solution is used for irrigation, we recommend cleaning the wound cavity afterwards with pure 0,9% saline. Apply a dressing to the wound so it stays clean. Optionally, an ointment dressing with povidone-iodine can be used. To do this, put a small amount of ointment on the wound, cover it with a sterile compress and fix it with the bandage.

Antibiotics like amoxicillin/clavulanic-acid are effective against most infections of wounds caused by animal bites.

Abdominal wounds / evisceration

In the case of abdominal evisceration, the intestines should be rinsed with clean (if possible body-warm) fluid to avoid gross contamination. Uncontrolled bleeding should be treated with hemostatics such as QuickClot or similar. Exposed intestines should be covered with moistened, sterile wound dressings or with a foil bandage. A rescue blanket can also be used, which offers the advantage of retaining heat and shielding against light/UV radiation, which a foil bandage alone cannot achieve. **CAVE:** intestines shall be protected from UV exposure.

Repositioning should not be attempted if there are signs of intestinal perforation (loss of gastric / intestinal fluid or stool) or active bleeding. However, if there are no signs of bowel perforation and no visible bleeding, a single short attempt can be made to reduce / replace the excised abdominal contents without force. **CAVE:** Do not force the intestines or actively bleeding viscera back into the abdomen. To prevent further complications, the patient should remain nil per os (NPO) and needs prompt veterinary care and therefore urgent evacuation.

SPLINTING

Handle an injured dog with a fracture with care. If necessary, use appropriate restraint, sedation and / or analgesia before manipulating the fracture site.

Splints can be applied below the knee or elbow to stabilize the joint above and below the fracture.

Apply two or three medical adhesive tape strips to limb on opposing sites, the ends of the tape should extend 10 - 15 cm beyond the toes. These will help to fix the splint in place later on. If possible, cover the sticky sides of the tape with something

that can be removed from the tape later on so that the tape doesn't stick to other bandaging material during the splinting progress. Add padding around the limb, starting at the toes and wrap up past the joint above the fracture. Mold a splint to the outside portion of the fractured limb while centering the splint over the fracture site and wrap gauze bandage around the splint. Again, starting at the toes, wrap snugly up the limb but not so tight as to cut off circulation. Now stick the overextending part of the tape strips onto the bandage material / splint. To secure everything in place, add a cohesive elastic bandage around the splint and use anchor points to prevent slipping. Lastly, add time and date on the cast for documentation.

INTERNISTIC EMERGENCIES

Just like with humans, K9s can develop non-traumatic pathologies. Thermal emergencies, poisoning and dog-specific emergencies such as gastric torsion are emergencies that are often encountered when dealing with working dogs.

THERMAL EMERGENCIES

As dogs' primary method of regulating body temperature is panting, muzzles should be avoided during physical work if feasible. Use an open basket design muzzle to allow proper ventilation if no muzzle is not an option.

Recognizing a change in behavior due to heat is important to adapt to the situation and prevent further deterioration of the K9's condition. A distinction is made between three levels: Heat stress, heat exhaustion and heat stroke. Causes for increased body temperature may be environmental or due to exertion. Base the clinical assessment on presence and progression of clinical signs over core temperature. Well-conditioned, acclimated K9s may reach core temperatures as high as 41 °C while working.

Heat related emergencies may be accompanied by dehydration in said hot work environments due to the loss of body fluid and lack of water sources to rehydrate.

Also hypothermia accounts for thermal related emergencies. Especially during prolonged exposure to cold environments dogs can develop serious hypothermia due to lack of proper equipment to shield them from the elements.

DEHYDRATION

While factors like diarrhea or vomiting can lead to rapid fluid loss within a short time period, inconspicuous factors such as evaporation from the respiratory system, sweating and micturition over a long period of time can also contribute to dehydration.

To assess for dehydration, the skin's turgor is checked as instructed in the chapter MONITORING (Page 6). A slight increase in capillary refill time and tacky mucous membranes are also an indication for dehydration. Depending on the severity of dehydration the membranes can also be dry and signs of shock present.

The amount of fluid needed for therapy is the sum calculated from the maintenance dose, the volume of estimated dehydration and if present, ongoing losses due to sickness. Use isotonic crystalloid fluids for volume replacement.

Maintenance volume is about 50 - 60 ml / kg BW / d and is calculated from the following three values:

Sweating and evaporation during respiration: 20 ml / kg / d

Urine: 20 ml / kg / d

Feces: 10 - 20 ml / kg / d

The replacement volume of the current hydration deficit is calculated from body weight multiplied with the estimated factor of dehydration in percent, giving us the formula $[\text{kg BW}] \times [\% \text{ Dehydration}]$. The result in kilograms equals the fluid volume in kg that needs to be replaced (1 kg = 1000 ml fluid). Dehydration can be estimated by assessing the following signs:

< 5 %: Usually undetectable

5 - 6 %: Subtle loss of skin elasticity

6 - 8 %: Delay in return of skin to normal position, mucous membranes tacky

8 - 10 %: Considerable loss of skin turgor, dry mucous membranes, eyes may be slightly sunken into orbit

10 - 12 % Complete loss of skin turgor, eyes sunken in orbits, increased capillary refill time, signs of shock

Ongoing losses occurring due to sickness are not part of the maintenance volume and therefore also need to be accounted for:

Diarrhea: 100 ml / kg / d

Vomiting: 4 ml / kg / episode of vomiting

Pyrexia: 3 ml / kg / 1°degree rise above reference temp. / d

It's recommended to monitor ongoing losses with help of a scale. 1 gram of loss equals 1 ml of volume that needs to be replaced. Remember not to include normal amounts of urine and feces loss as it is factored into the maintenance amount!

For example, a K9 that vomited twice, with the body weight of 32 kg and an estimated 6% dehydration needs the following total replacement volume:

[Maintenance volume] + [Dehydration replacement volume] + [Ongoing losses volume]

[60 ml / kg x 32 kg] + [32 kg x 0,06] + [4 ml / kg x 32 kg x 2]

[1920 ml] + [1020 ml] + [256 ml] = 3196 ml

HYPERTHERMIA

Hyperthermia, also known simply as overheating, is a condition in which body temperature is elevated beyond normal levels due to impaired thermoregulation. The patient's body produces or absorbs more heat than it is able to dissipate. Extreme elevated temperature becomes a medical emergency requiring immediate

treatment to prevent long-term damage, disability or death.

Hyperthermia can be divided into 3 different stages: Heat stress, heat exhaustion and heat stroke.

Heat stress

Heat stress is not a life threatening emergency, but it paves the first step to heat exhaustion.

Usually heat stress is associated with a body temperature of 40 - 41 °C.

Symptoms are excessive thirst, discomfort with physical activity and slightly decreased performance. In the phase of heat stress the dog can still control panting. This means when you attempt to shut the K9's muzzle with your hands he is able to breathe at a normal rate.

To prevent escalation to heat exhaustion stop physical activities and bring the K9 to a cool shady area (e.g. vehicle or room with A/C), offer water and encourage drinking. Conductive cooling can be promoted by laying the dog onto a damp towel. If no A/C is available, use a fan to blow a light breeze on the canine. Remove any muzzle so the K9 can effectively pant. Monitor vital signs and temperature.

Heat exhaustion

Heat exhaustion usually occurs when the K9's temperature is between 41 - 42 °C. Again, the cause may be a hot environment combined with intense work.

Symptoms are the same as with heat stress in addition to unwillingness to work, fatigue, uncontrolled panting as well as unresponsive behavior to commands. In contradiction to the fatigue, dogs may seem to be restless / agitated due to the uncontrolled panting.

Treatment includes the same steps as with heat stress with the addition of active cooling. Carefully wet the fur with water to achieve evaporative cooling. This can be achieved by rubbing some water into the fur or by spraying mist onto it. Do not put damp cloths over the K9 as this may act like a blanket and would lead to further heat build-up.

Consider establishing an IV access with crystalloids to compensate for fluid loss due to excessive sweating. **CAVE:** do not use cold IV fluids as this may cause vasospasm, hypothermia and even cardiac arrhythmia!

Heat stroke

A heat stroke is the last stage of hyperthermia and a life threatening condition. It occurs when the temperature of the K9 exceeds 42 °C and is an urgent emergency where rapid cooling of the body needs to be achieved.

Again, the signs consist of those of heat stress and exhaustion with additional symptoms like seizures, collapse, ataxia (disturbance of movement coordination), emesis, diarrhea and even abnormal pupil size and blindness. Initially, cardiac output, peripheral vasodilation, and central vasoconstriction are increased. When these compensatory measures fail, venous blood pools, and central vasodilation leads to decreased circulating blood volume, hypotension, and shock.

The mucous membranes have an intense red color and are tacky or dry. If the mucous membranes get pale, it might indicate that the dog is going into shock.

Initial treatment is done the same way as with heat exhaustion. Soak fur down to the skin with water. Proceed with active cooling until the temperature reaches 40 °C. Stop further cooling to prevent hypothermia due to afterdrop.

Establish an IV line to administer medication or fluids if needed. If the K9 becomes unconscious, maintain a proper airway. Close monitoring of vital parameters is crucial.

HYPOTHERMIA

Hypothermia occurs when the dog's temperature drops below 37,5 °C. Mild hypothermia may occur through trauma, but severe cases mostly result from cold environments. As with hyperthermia, we can divide it into three stages with different symptoms. The three stages have a fluent transition into each other.

Mild hypothermia

Mild hypothermia is defined with the K9's temperature being as low as 37,5 - 34,0 °C. At this point, you may notice that the dog's extremities (ears, legs, feet, paws) feel cool to the touch.

Visible skin may appear pale due to centralisation to limit the loss of heat through the skin. This physiological response helps the dog survive but also increases the risk of frostbite. Other symptoms include shivering to produce warmth and ruffled fur to increase insulation. Movements can be stiff or clumsy due to the tension in the muscles.

For treatment, it is usually sufficient to go to a warmer place. Maintain body heat by using rescue blankets and insulation layers such as blankets, jackets or sleeping bags. Depending on the severity of hypothermia, consider active heat sources. For more information look up hypothermia prevention in the MMARCH algorithm (Page 14). Constantly monitor vital parameters.

Moderate Hypothermia

With moderate hypothermia, the temperature reaches around 34 - 30 °C. This stage is kind of an exhaustion stage: As the shivering stops, the body loses temperature more quickly. An arrhythmic bradycardia with hypotension and shallow bradypnea starts to develop. Due to the slow heart rate and breathing, perfusion and oxygen levels in the bloodstream drop, leading to increasingly lethargic and unresponsive behavior.

Treatment includes the steps for mild hypothermia with addition of slow, active external reheating of limbs and body. Heat needs to be applied slowly so blood pressure does not drop due to vasodilation combined with low cardiac output.

Severe Hypothermia

If the body temperature falls below 30 °C the K9 will fall unconscious. Pupils are dilated, response to light is impaired and muscle paralysis occurs. At body temperatures below 28 °C, it is difficult to determine whether the patient is still alive or already dead. In this state breathing can be too shallow, the pulse too slow and too weak, especially in the extremities with little blood flow. Simple methods such as feeling the pulse or assessing breathing are then not reliable. The term "apparent death" is occasionally used in this state. Crucial for preventing ventricular fibrillation is carefully rescuing the patient without excessive manipulation of the body to prevent cold blood from flowing back from the periphery. During the rewarming phase, sufficient volume therapy must be administered. Catecholamines should only be used when the body temperature is above 30 °C. Not only does proper treatment involve the use of i.v. warmed fluids, but it also requires intensive care equipment for active core rewarming that the primary care provider simply can not

provide. Follow the steps for mild and moderate hypothermia and consult a veterinarian ASAP.

POISONINGS

Depending on your environment and work, a K9 may encounter certain toxic materials such as explosives, drugs or biocides. Unfortunately, deliberate poisoning through poisoned bait also occurs, especially in urban areas.

If there is reason to believe that a toxin has been ingested recently, the administration of activated charcoal is recommended. As soon as symptoms of poisoning appear, administration of activated charcoal is no longer indicated.

As activated charcoal has an enormous adsorption surface of approximately 1,000 to 2,000 m² per gram, substances are physically bound by the activated carbon. This prevents absorption in the gastrointestinal tract and they are excreted via the feces.

However, not all toxins are bound by activated carbon.

In case of poisoning, immediate medical attention by a veterinarian with the appropriate medical equipment is required to determine the toxin and initiate appropriate therapeutic measures.

CUMARIN POISONING

Most rat poisons contain coumarin derivatives. Coumarins are anticoagulants from the group of vitamin K antagonists. The anticoagulant effect is achieved by competitively inhibiting the reactivation of vitamin K which means the vitamin

K-dependent coagulation factors, which are formed in the liver as inactive precursors, can not be activated due to the presence of said coumarin derivatives. After a period of 3 - 5 days, severe bleeding occurs after the remaining clotting factors have been used up.

Symptoms include visible bleeding such as haematuria (bloody urine), dark stools, hematomas, subconjunctival bleeding (in the sclera of the eyes) or internal bleeding in body cavities. The dogs appear apathetic or weak and may develop dyspnea due to anemia or even go into shock due to the blood loss. Assess for signs of anemia or shock like pale mucous membranes, tachycardia with hypotension and dyspnea.

If available, use sonographic imaging of the chest and abdominal cavities to detect internal bleeding. Check for anemia by measuring hematocrit.

Initial therapy of coumarin poisoning includes the immediate administration of vitamin K1 as an antidote. Recommended initial dosage is 5 mg / kg BW i.v. as a short drip. If an IV access can not be established it is also possible to administer the same dosage subcutaneously or intramuscularly to multiple depots. Oral administration is also possible with 5 mg/kg BW. Oral administration should be in conjunction with a fatty meal for better absorption.

CAVE: Subcutaneous and oral administration forms are poorly absorbed in hypovolemic patients.

Maintenance dose for vitamin K1 is given every 12 hours and is recommended at 1,25 - 2,5 mg/kg BW p.o. / i.v. / s.c. / i.m. if no bleeding occurs or 2,5 - 5 mg / kg BW i.v. / s.c. / i.m. as long as bleeding persists.

OPIOID INTOXICATION

Opioid overdoses may occur either when using the analgesic properties of opiates during the medical care of trauma patients or through accidental ingestion - for example with drug detection dogs.

The most common clinical signs of opioid overdose include miosis, lethargy and weakness, difficulty standing, unresponsive to commands, hypotension and with severe intoxication unconsciousness and bradypnea. Most canines start to show clinical signs within 15 minutes of exposure.

The initial measures should ensure hemodynamic stability and respiration. If unconscious, put the K9 into recovery position to maintain an unobstructed airway. Administer the antidote naloxone 0,04 mg / kg BW i.v or intranasal and repeat after 3 - 4 min if necessary.

CAVE: After administration of naloxone, the dog should be monitored for at least 2 hours, as the duration of action of naloxone may be shorter than that of opioids, which may lead to renewed respiratory depression.

METHEMOGLOBINEMIA (EXPLOSIVES POISONING)

Methemoglobin anemia occurs when methemoglobin formers are absorbed by the body. These are substances that can oxidize the iron ion of hemoglobin from Fe²⁺ to Fe³⁺ and thereby cause the formation of methemoglobin. This creates an inactive form of hemoglobin that is unable to transport oxygen.

Many explosives contain substances such as perchlorates, nitrates or nitrobenzene,

which cause methemoglobinemia. Intoxication with high doses of Paracetamol can also be a cause for methemoglobinemia.

Symptoms for methemoglobinemia are similar to those of anemia: Shortness of breath, cyanosis, mental status changes, fatigue, exercise intolerance, loss of consciousness and seizures. Depending on the concentration of methemoglobin the mucous membranes can have a mud brown color. SpO₂ sensors will give you wrong readings: Studies showed that SpO₂ readings of approximately 85% had an actual O₂Hb of > 50%. Also extracted blood samples will show a brown color.

Initial therapy consists of an immediate application of antidote. Either 2 - 4 mg / kg BW i.v. of toluidine blue diluted in 0,9% normal saline drip over 5 - 10 minutes (risk of shock due to drop of blood pressure when injected too quickly) or 1 - 2 mg / kg BW i.v. of methylene blue diluted in G-5% glucose over 5 - 10 minutes.

CAVE: SpO₂ readings give false values after administration of said antidotes due to the blue discoloration of the serum absorbing red light of the sensor. Also the mucous membranes, body secretions and urine can have a blue discoloration.

C-4 Poisoning

The data on C-4 intoxication is very limited. During a clinical experiment a dose of 14 mg / kg BW of C-4 was lethal for a dog: The dog developed signs of intoxication 7,5 hours after exposure and died 18 hours after exposure. Clinical signs included congested mucous membranes, hyperthermia, tachycardia, hyperventilation, intermittent tremors, rigidity, and convulsions.

As there is no antidote, you can only treat occurring symptoms.

SEIZURES / STATUS EPILEPTICUS

Epileptic seizures can occur as focal (partial) or generalized seizures.

In a focal seizure, only a small area of the brain is affected by abnormal electrical activity. In generalized seizures, the entire brain is affected. A distinction is also made between convulsive and non-convulsive seizures. Non-convulsive seizures can be easily overlooked because they only show up as a change in the patient's consciousness and behavior.

Focal seizures can lead to local cramps, often individual muscles twitch, for example in the face or limbs. More complex focal seizures can also lead to behavioral changes such as fear, screaming, snapping at imaginary flies, staring into the void or barking at fictitious objects or people.

Convulsive seizures lead to the typical tonic-clonic seizures that spread across the entire body. The dog rolls over on its side, its legs are stiff, stretched out and row up and down. Its eyes are rolled back and it no longer responds to being spoken to. It is possible that the dog salivates more during an epileptic seizure and urinates or defecates.

After such a generalized seizure, most K9s are exhausted and initially dazed and need to rest. While it is possible for a dog to recover within a few minutes from the seizure, disorientation, stiffness, and an unsteady gait may occur for some time after the seizure.

For stopping a seizure, intranasal administration of midazolam has been shown to be more effective than rectal administration. The recommended dose for intranasal application is 0,1 - 0,3 mg /

kg BW. This dose could also be administered intravenously or intramuscularly, but application of the medication during a seizure is easier intranasally with the use of a mucosal atomization device (MAD). It is not recommended to administer more than 1 ml per nostril, therefore a sufficiently high concentrated solution should be used.

ANAPHYLACTIC REACTION

Anaphylactic reactions are triggered by exposure to offending substances. Common causes include venoms from insects, foods, and medication. The reaction occurs due to the release of inflammatory mediators such as histamine from mast cells and white blood cells.

While localized allergic reactions are common, severe reactions that cause further release of the inflammatory contents of mast cells throughout the body, leading to a systemic anaphylaxis, are rare.

Depending on the route and amount of exposure to the antigen, the symptoms can vary.

In dogs, histamine is primarily released from the gastrointestinal tract into the portal vein, to the liver. The histamine causes hepatic arterial vasodilation and therefore increased arterial blood flow as well as a large venous outflow obstruction that results in a hepatic vascular resistance. As a result, venous return to the heart is decreased. This further contributes to hypovolemia, decreased perfusion and oxygen delivery to the tissues, leading to symptoms of shock.

CAVE: Mucous membranes may have an intense red color due to vasodilatation,

giving a wrong picture of the hemodynamic state.

Histamine also increases vascular permeability, leading to local swellings and edema, especially in the mucous membranes. Combined with bronchoconstriction this may result in impaired in- and expiration, making breathing more difficult, leading to hypoxia and hypercapnia. Depending on the airway obstruction, you may hear an inspiratory, expiratory or biphasic stridor. Other symptoms are vomiting and diarrhea.

Treatment is based on the severity of clinical signs, with immediate administration of epinephrine as the cornerstone of therapy. Depending on the patient's condition and available vascular access, epinephrine should be administered IM or IV. If progressive laryngeal edema compromises the airway, early endotracheal intubation should be considered. If intubation is impossible due to severe swelling, a surgical airway may be required.

Establish IV access as early as possible to facilitate drug administration and fluid resuscitation.

Critically ill patients should receive 0,01 mg/kg epinephrine IM or IV, repeated every 5 - 15 minutes according to clinical response. In severe or refractory cases, a

A "Dirty Epi Drip" may be considered according to K9TCCC recommendations. Administer 1 mg epinephrine in 1000 ml of 0.9% saline (or 0,1 mg in 100 ml) and titrate the infusion to clinical effect while continuously monitoring the patient.

Administer 10 - 20 ml/kg BW of a balanced isotonic crystalloid over 5 - 15

minutes, reassessing perfusion after each bolus.

Corticosteroids (e.g., methylprednisolone) may be considered as adjunctive therapy in selected cases but must never delay epinephrine administration, airway management or fluid resuscitation, as they have no immediate effect during the acute phase of anaphylaxis.

Continuous monitoring of cardiovascular and respiratory status is essential throughout treatment.

CARDIOPULMONARY RESUSCITATION (CPR)

Cardiopulmonary arrest requires immediate action. To standardize guidelines and training, the Reassessment Campaign on Veterinary Resuscitation (RECOVER) was developed.

Their guidelines cover basic life support (BLS), advanced life support (ALS), monitoring and a CPR algorithm. As for today they announced the updated guidelines for late 2024.

The K9TCCC guidelines do not recommend resuscitation attempts on the battlefield for victims of blast or penetrating trauma who have no pulse, no ventilations, and no other signs of life. If cardiopulmonary arrest is noticed during tactical field care they recommend performing bilateral chest needle decompression to ensure they do not have a tension pneumothorax prior to discontinuation of care.

However, for any other setting CPR should be started immediately if an arrest is expected. With breeds like Malinois, chest

compressions should be initiated in right lateral recumbency at a rate of 100 - 120 compressions per minute. Depth of the compressions should be $\frac{1}{2}$ the width of the chest, without leaning on the patient to allow for full chest-wall recoil.

If an endotracheal tube maintains a secure airway, CPR should be performed without interruption. Ventilation should be done with 10 breaths per minute. To minimize no-flow times and fatigue, change the compressor in two minute cycles.

Use a 30:2 ratio of compressions to ventilations if no secure airway is established. Perform mouth-to-nose ventilation by closing the mouth with one hand while creating an airtight ring on the nose with the index finger and thumb of the other hand to avoid direct contact during ventilation. Overextend the K9's head and neck (basically to achieve the same mechanism as recovery position) during ventilation to avoid mechanical airway obstruction.

To use a defibrillator, the patient should be placed in dorsal recumbency and the paddles should be placed on opposite sides of the chest. The first electrode gets attached to the thorax between the right foreleg and the sternum, while the second electrode is attached to the left side of the thorax behind the shoulder. Principally, the attachment of the electrodes is similar to that found in humans. The fur must be clipped using scissors and / or a razor for safe defibrillation. Electrode gel for defibrillation is also an option to ensure a safe flow of current.

Establish an IV or IO access to administer vasopressors and other medication that is needed during CPR.

Patient outcome usually benefits from the immediate administration of 0,01 mg / kg BW of epinephrine i.v. during

cardiopulmonary arrest. Depending on the cause of cardiopulmonary arrest other medications like antiarrhythmics are also indicated.

If return of spontaneous circulation (ROSC) is achieved, proper post-cardiac arrest (PCA) care and monitoring is required which usually only veterinarians with specialized equipment can provide. Rapid transport to such a medical facility should be the highest priority.

GASTRIC DILATATION VOLVULUS

Gastric Dilatation-Volvulus (gastric torsion / GDV) is a life-threatening condition in which the stomach rotates around his own axis, mostly seen in large, deep chested K9s, but it can happen with every dog. Although the exact reason is still unknown, immediate exercise after ingestion of large meals or large amounts of water may increase the risk for GDV. Without surgical intervention, the dog will die from the consequences.

As the stomach rotates, its entrance, exit and blood vessels can get blocked partially or completely resulting in life threatening symptoms. As gases that occur during digestion build up, pressure within the stomach increases, leading to bloating the dog and pain. Also gastric contents can not be transported to the following intestines. The main symptom is firm distension of the stomach with great tympany behind the rib cage.

Other symptoms, especially in the beginning, are not necessarily distinguishable from other kinds of distress. The animal seems to be in discomfort and may begin to adopt a protective posture to minimize abdominal pain and can be lethargic. Sometimes

nonproductive vomiting, drooling, dyspnea and shock occur due to blocked blood vessels.

CAVE: From firsthand experience, some dogs may be still able to drink and successfully force the water into the stomach, leading to a false impression of a non-occurring GDV.

Temporary treatment with needle decompression only extends the time window until emergency surgery can be done. Dilation is done with a 12g or 14g catheter: Palpate the dilated stomach and caudal edge of the rib cage. Puncture at the site of greatest tympany, usually about 2 cm behind the rib cage. Monitor for recurrent gastric dilation and decompress again if indicated. Rapid transport should not be delayed for measures like IV access.

DRUGS AND PHARMACOTHERAPY

ANALGESICS

Metamizole

Painkiller (abdominal colic pain) / antipyretic: 20 - 50 mg / kg BW p.o. / i.v. / i.m.

Carprofen

Painkiller (musculoskeletal system): 2 mg / kg BW every 12 hours p.o. / i.v.

CAVE: Do not confuse Carprofen with Ibuprofen as Ibuprofen is not suited for use with Dogs!

Paracetamol

Painkiller (musculoskeletal system) / antipyretic: 10 mg / kg BW i.v. every 8 hours

Cave: Methemoglobinemia intoxication on doses exceeding 100 mg / kg BW!

Butorphanol

Painkiller (visceral analgesia): 0,1 - 0,4 mg / kg BW per hour i.v. / i.m. / s.c. or 0,2 - 1 mg/kg BW p.o. (as analgesic effect lasts only 1 h, sedative effect 2 - 4 h)

SEDATION & ANESTHETICS

Midazolam

Sedation: 0,1 - 0,3 mg / kg BW i.v. / i.m. / i.n.

Ketamine / S-Ketamine

Anesthetic:

7,5 - 10 mg / kg BW Ketamine i.v. plus 0,375 - 0,5 mg / kg BW Midazolam i.v.

3 - 6 mg / kg BW S-Ketamine i.v. plus 0,375 - 0,5 mg / kg BW Midazolam i.v.

Anesthetic effect lasts about 10 - 15 minutes

Analgesic:

0,3 - 0,6 mg / kg BW / h i.v. as continuous drip infusion, for perioperative analgesia
0,5 - 1 mg / kg BW Ketamine i.m. or s.c. every 6 hours for perioperative analgesia

CAVE: S-Ketamine is twice as potent as R-Ketamine/Ketamine. (S-)Ketamine increases muscle tone and causes excitation in K9s and should therefore be used with neuroleptics or sedatives such as Midazolam or Diazepam.

Propofol

Anesthesia induction: 4 mg/kg Propofol + 0,1 mg / kg Midazolam i.v.

Anesthesia maintenance: 0,4 - 0,5 mg/kg BW per min i.v.

CAVE: Assisted ventilation may be needed. Propofol has no analgesic effect, additional analgesics may be needed for painful procedures.

K9TCCC guideline recommendations:

Mild pain: 50 mg Ketamine + 10 mg Midazolam i.v. / i.m.

Severe pain: Mild pain medication + 10mg Morphine i.m. (Autoinjector)

Chemical restraint / sedation: 100 mg Ketamine + 10 mg Midazolam i.v. / i.m.

VASOPRESSORS

Epinephrine

CPR: 0,01 mg / kg BW i.v. diluted to 0,1 mg/ml (repeat after 5 minutes)

Anaphylaxis: 0,01 mg/kg BW i.m. or i.v. (IV diluted to 0,1 mg/ml)

Shock: As required, up to 0,03 mg / min per IV drip until desired hemodynamic response is achieved (see dirty epi drip).

Dirty Epi Drip

Usually refers to an infusion with 1 mg of epinephrine in 1000 ml of normal saline 0,9% (0,001 mg / ml) and is used to buy you time until a pump or push dose can be set up for shock patients. Flow rates

depend on the IV catheter size and height of the IV bag over the patient, but usually is around 20 - 30 ml / min with a 18g and 15 - 25 ml / min with a 20g catheter while running wide open with gravity assistance only. It is advised to start with a lower flow rate and titrate up to effect.

GLUCOCORTICOIDE

Methylprednisolone

15 - 30 mg / kg BW i.v. during (hemorrhagic) shock or anaphylactic reaction.

ANTIDOTES

Vitamin K1

Initial dose: 5 mg / kg BW i.v. as a short drip over 5 - 10 minutes

Maintenance dose: 1,25 - 5 mg/kg BW p.o. / i.v. / i.m. / s.c.

Toluidine Blue

2 - 4 mg/kg BW i.v. as a short drip over 5 - 10 minutes

Methylene Blue

1 - 2 mg / kg BW i.v. as a short drip over 5 - 10 minutes

Activated Carbon

1 g / kg BW p.o. (e.g. dissolved in approximately 5 - 10 ml water per gram)

Naloxone

0,04 mg / kg BW i.v. or i.n., repeat after 3 - 4 minutes if necessary.

VOLUME SUBSTITUTION

Crystalloids

large-volume resuscitation technique: Initial infusion of 20 - 50 ml / kg BW of buffered, balanced isotonic crystalloids is given, followed by 5 - 15 ml / kg BW of a hydroxyethyl starch solution (HES).

Small-volume resuscitation technique: Recommended in hypovolemic dogs with closed cavity hemorrhage, head injury, pulmonary contusions or edema, cardiogenic shock, or renal failure: 10 - 15 ml / kg BW of balanced isotonic crystalloids.

CAVE: Crystalloid infusions may be contraindicated in cases of massive bleeding as they reduce the coagulation cascade and promote acidosis, hypoxia and hypothermia as seen in the "trauma triad of death".

Oxyglobin (HBOC) is increasingly used as an alternative to blood transfusion. 1 ml of oxyglobin has the O₂ capacity of 3 ml of whole blood. The colloid osmotic effect is roughly comparable to that of Hydroxyethyl starch (HES) 6%. The maximum infusion rate is 10 ml / kg BW per hour with a total volume of 15 - 30 ml / kg BW. **CAVE:** Oxyglobin must not be administered repeatedly!

K9 FIRST RESPONDER PACK LOADOUT FOR MWD

We recommend to layer the equipment for use regarding the MARCH algorithm and stages of casualty care: while the whole team has individual first aids kits (IFAK), the medic usually carries more dedicated medical gear: the 1st line contains the essentials for covering MARCH at the point of injury (POI), often carried in a MARCH belt setup. The 2nd line holds more equipment for tactical field care (TFC) and is usually carried in a smaller backpack. The 3rd line has more advanced items to sustain the patient until evacuation arrives and is usually stored in a big ruck in the team's vehicle.

The following list is a recommendation for a first responder pack, but can also guide for a 1st + 2nd line setup. The packing list must be adapted depending on the area of responsibility, availability of materials and skill level of the provider.

MASSIVE BLEEDING MODULE

- | | |
|--|--|
| ☐ SWAT TQ | ☐ Z-Folded Gauze |
| ☐ Celox Gauze | ☐ Emergency Bandage |
| ☐ QuikClot Combat Gauze | ☐ IT-Clamp (x2) |

AIRWAY MODULE

- | | |
|--|---|
| ☐ 5cm PVC Tube (x2) | ☐ Optilube |
| ☐ Gauze bandage (x2) | ☐ Gauze Swab |
| ☐ ETT Tube (Size 7,5 - 8,5) | ☐ HME Filter |
| ☐ 10ml Syringe | ☐ Tongue Depressor |

RESPIRATION MODULE

- | | |
|--|--------------------------------------|
| ☐ Decompression Needle 14G (x4) | ☐ Pocket BVM |
| ☐ Vented Chest Seal (x2) | ☐ PEEP Valve |
| ☐ Cling Foil | ☐ Capnography |

CIRCULATION MODULE

- | | |
|---|--|
| ☐ IV Catheter 20G (x2) | ☐ Three-Way Valve (x2) |
| ☐ IV Catheter 18G (x2) | ☐ Venous Tourniquet |
| ☐ Infusion Set (x2) | ☐ Medical Adhesive Tape |
| ☐ Infusion Solution 250ml (x2) | ☐ Gauze Bandage |
| ☐ Infusion Solution 100ml (x2) | ☐ Disinfectant Spray |

☐ Sharps Box

☐

HYPOTHERMIA MODULE

☐ Rescue Blanket (x3)

☐ Ready Heat Blanket

DIAGNOSTIC MODULE

☐ Stethoscope

☐ Thermometer

☐ Inflatable Blood Pressure Cuff

☐ Pulse-oximeter

AMPULLARIUM MODULE

☐ Medication (Provider Dependent)

☐ I.M. Needle

☐ Syringe

☐ Combi-Stopper

☐ Blunt Fill Needle

☐ Dosage Cheat Sheet

☐ MAD Device

☐ Waterproof Marker

SURGICAL MODULE

☐ Scalpel (x2)

☐ Suture Material (x2)

☐ ET Tube (x2)

☐ Surgical Forceps

☐ Sterile Gloves (x2)

☐ Surgical Drape

☐ Scissors (Blunt Tip)

☐ Sterile Tweezers

ADDITIONAL ACCESSORIES

☐ Headlamp

☐ Examination Gloves (x4)

☐ K9 Casualty Card

☐ Medical Scissors

☐ Waterproof Marker

☐ Splint

☐ MMARCH Cheat Sheet

☐ Cooling Pack (x2)

MMARCH ALGORITHM CHEATSHEET

M	M	A	R	C	H
Muzzle: Establish scene safety Actions ▸ Secure Scene ▸ Muzzle ▸ Muzzlesling (Unconscious: Spreader) 	Massive Bleeding: Control life-threatening hemorrhage Assessment ▸ Bloodsweep Actions ▸ Tourniquet ▸ Direct Pressure ▸ Woundpacking	Airway: Inspect and establish a patent airway Assessment ▸ Visual inspection ▸ Airway sounds Actions ▸ Positioning ▸ Clear airway ▸ Mouth spreader ▸ Intubation	Respiration: Assess breathing and ventilation Assessment ▸ Respiratory rate ▸ Respiratory effort ▸ Mucous membrane color ▸ Auscultation Actions ▸ Assisted ventilation ▸ Chestseal ▸ Needle decompression	Circulation: Assess circulation, stabilize and manage wounds Assessment ▸ Capillary refill time ▸ Pulsquality ▸ Hertrage ▸ Bodycheck Actions ▸ Convert TQs ▸ Wound-management ▸ Establish IV-access ▸ Gastric decompression	Head & Hypothermia: Assess for traumatic brain injury, neurological deficits and prevent hypothermia Assessment ▸ Pupillary size ▸ Pupillary reaction ▸ Mentation / GCS ▸ Temperature ▸ Skin turgor Actions ▸ Prevent heat loss ▸ Active warming

For more Information visit
www.europeanmedics.eu

SOURCES / REFERENCES

This handbook combines current veterinary evidence, clinical practice guidelines, tactical casualty care recommendations, and expert consensus. Where high-level evidence is unavailable, recommendations are based on established veterinary best practice and operational experience.

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