JOINT TRAUMA SYSTEM K9 CLINICAL PRACTICE GUIDELINE

Hypothermia and Cold Injuries (K9 CPG: 10)

This CPG provides guidance for treatment of hypothermia or cold induced injuries in Military Working Dogs (MWDs).

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Original publication date:19 Nov 2018	Publication Date: 22 June 2026	Supersedes: 19 Nov 2018

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SUMMARY OF CHANGES

1. Updated to new format.
2. Provided definitions for different types of rewarming.
3. Reformatted Table 1 for clarity.
4. Added Performance Improvement (PI) monitoring and Class VIII Medical Materiel Appendix.

CLASSIFICATION OF HYPOTHERMIA

Hypothermia in MWDs is classified as primary from environmental exposure to low temperatures for extended timeframes or secondary to trauma, toxicity, underlying illness, anesthesia, surgery, and overzealous treatment from heat injury.[1] While the clinical causes of primary and secondary hypothermia may differ, the clinical effects are similar.

MWDs with primary hypothermia can tolerate more severe temperatures than MWDs with secondary hypothermia. Adverse effects due to hypothermia have been reported in dogs with secondary hypothermia at higher temperatures than patients with primary hypothermia.[1,2]

- Primary hypothermia is classified as mild (90-99°F), moderate (82-90°F), severe (68-82°F), or profound/critical (less than 68°F).[1]
- Secondary hypothermia is classified as mild (98-99.9°F), moderate (96-98°F), severe (92-96°F), or profound/critical (less than 92°F). This can occur in warm environments.[1]

MANAGEMENT OF HYPOTHERMIA

The mainstay of treatment for primary and secondary hypothermia is to rewarm the patient. In cases of secondary hypothermia, underlying causes of co-morbidities should be identified and addressed.

Warm hypothermic MWDs at a targeted rate of 2-4°F per hour.

Provide cardiovascular support, manage co-existing problems, and prevent rewarming complications (see Table 1).

Rewarming methods include passive surface, active surface, and active core rewarming.[1,2,3] For primary and secondary hypothermia, use a combination of the following methods based on the severity of hypothermia.

- Passive surface rewarming utilizes the K9's internal heat production via shivering to increase core temperature.[1] Rewarm otherwise healthy MWDs with mild hypothermia and normovolemia using this method.
  - Dry the MWD off and apply blankets, towels, or other devices (e.g., heat reflective shell) to prevent heat loss while the otherwise healthy MWD generates heat by shivering.
  - Wrapping or covering limbs and extremities with clear plastic wrap, bubble wrap, socks or thermal blanket to provide insulation can help reduce heat loss.
  - This method alone will not be effective if shivering is absent.[1]
- Active surface rewarming utilizes externally applied heat sources (e.g., forced-air devices, warm water circulating heating pads, Hypothermia Prevention and Management Kit) to increase core temperature.[1] Use in MWDs with severe or profound hypothermia.
  - Heat sources provide heat to offset the K9's inability to generate heat and increase core temperature.
  - Ensure devices will not burn the MWD's skin. Vasoconstriction may occur in the skin, inhibiting the skin's ability to distribute heat.
  - Prioritize applying heat to the thorax and abdomen, to avoid peripheral vasodilation and prevent the decreased thermoregulatory response seen when extremities are warmed, both of which contribute to persistent hypothermia and afterdrop.[1,4]
- Active core rewarming applies heat to the core and should be used in MWDs with severe or profound hypothermia. Always use in conjunction with active surface rewarming.
  - Warmed IV fluids should not exceed 107°F to avoid injury to cellular components of the peripheral blood.[1,2,4]

- Provide warmed inhaled air if the MWD is intubated and warming humidifiers are available on anesthesia circuits. This method works by warming the brain and heart through delivery of warm air directly to large vessels of the chest and neck.[1]

Apply these principles to primary and secondary hypothermia treatment:

- Warm hypothermic MWDs to a temperature of 98.6°F, then stop all warming methods except passive warming.
- Provide IV fluids at moderate rates (10-15 mL/kg) during active rewarming in hypovolemic shock. Fluid overload can occur with normal shock rates.[1]
- Always use active surface warming concurrently with active core warming.

Table 1. Management of hypothermia in MWDs.

MANAGEMENT OF HYPOTHERMIA IN MWDS
1. Warm the MWD by initiating the appropriate re-warming method (passive surface, active surface, or active core re-warming). Increase the body temperature by 2-4° per hour. Warm to a temperature of 98.6°F and then cease use of all warming methods except passive warming. Minimize MWD's exposure to the cold environment, remove any wet outer wear, pat dry any wet hair coat and place onto an insulated, dry surface.
▪ **Mild hypothermia** with adequate blood volume: ▫ Warm using passive surface warming (wrap MWD in blankets or towels; hospitalize in warm environment). ▪ **Moderate to severe hypothermia** or mild hypothermia with inadequate blood volume: ▫ Warm using active surface warming (use of externally applied heat sources such as forced air warmers, nonelectric heating pads, or dryers). Avoid placing external heating devices in direct contact with the MWD's body surface. ▫ Apply heat to the thorax and abdomen, not the extremities. ▫ Perform passive warming as above. ▪ **Severe to profound hypothermia**: ▫ Warm using active core warming (e.g., warmed intravenous fluids). ▫ If unconscious, protect the airway and provide warm, humidified oxygen therapy. ▫ Perform active and passive warming as above.
2. Provide cardiovascular support.
▪ Give warmed intravenous fluids at moderate rates (10-15 mL/kg/hour) until normothermic if evidence of hypovolemic shock is present. ▪ Provide oxygen supplementation for severe to profound hypothermia to reduce risk of cardiac arrhythmias. ▪ Administer canine whole blood products if hypothermia is due to hypovolemic shock from massive blood loss.
3. Anticipate and manage complications.
▪ Perform continuous ECG monitoring. Bradycardia is common as well as atrial and ventricular fibrillation. DO NOT treat arrhythmias until body temperature is > 90°F. Many arrhythmias will be resolved with rewarming. ▪ Obtain a baseline CBC, chemistry and electrolyte panel with PT/PTT. ▪ Monitor glucose, electrolytes, and blood lactate status every 4-8 hours if derangements are noted or if changes to the MWD are noted. ▪ Provide analgesia as needed. Analgesia is frequently needed in MWDs whose temperature is < 93°F. ▪ Perform continuous or intermittent blood pressure monitoring, lactate clearance, changes in mentation, and urine output to monitor for "rewarming shock." ▪ Perform continuous core temperature measurement to monitor for correction of hypothermia and "afterdrop." ▪ Consider vasopressors early if hypotension is unresponsive to fluid therapy. ▪ Consider pantoprazole 1 mg/kg IV or omeprazole 1 mg/kg PO every 12 hours.

COMPLICATIONS RELATED TO HYPOTHERMIA AND REWARMING

It is important to recognize complications rather than specific temperatures at which to expect these problems. Providers must be aware that measures to correct hypothermia can cause complications to develop, such as afterdrop and rewarming shock. Careful warming and close monitoring are essential when managing hypothermic patients.[4,5]

- Afterdrop is the continued decrease in core temperature as warming is provided, due to the return of cold peripheral blood to the central circulation. Prioritize warming the MWD's chest and trunk to reduce the risk.
- Rewarming shock develops with rapid warming and is due to the sudden systemic vasodilatation. This vasodilatation causes hypotension at a time when the circulatory system may not be able to react.[1] The systemic hypotension is aggravated by the increased metabolic demand that develops as hypothermic patients are rewarmed, which increases the demand for perfusion. To prevent or reduce rewarming shock, IV fluid therapy must be provided and assessment of volume status (e.g., serial body weight measurement, clinical signs of hydration), systemic blood pressure, and tissue perfusion (e.g., evaluation of CRT, lactate clearance, change in mentation, urine output) must be monitored carefully.

Additional systemic effects of hypothermia include:

- Cardiac
  - Tachycardia and hypertension are common in mild-to-moderate hypothermia. As hypothermia worsens, bradycardia and hypotension develop. Cardiac arrythmias are common. Continuously monitor ECG and blood pressure. Avoid giving medications, including anti-arrhythmic agents, until the body temperature is >90°F (medications thought to be ineffective below this temperature).[1,4]
- Hepatic and Gastrointestinal
  - Decreased hepatic blood flow occurs preventing clearance of lactate and processing of medications.[1] Reduced gastrointestinal motility occurs and hypothermic patients are at an increased risk of gastric ulcers.[1]
- Metabolic
  - Hyperglycemia is common in mild and moderate hypothermia; specific measures to reduce blood sugar are seldom necessary. Hypoglycemia can develop in severely hypothermic patients, and dextrose supplementation (5% dextrose solution made by adding 100 mL of 50% dextrose in 1 liter of IV crystalloid fluids) is recommended empirically.
  - Hypokalemia is common in mild-to-moderate hypothermia, and supplementation is necessary (potassium chloride [KCl] in IV crystalloid fluids, 20 mEq/L) empirically. Do not add KCl to fluids used for rapid vascular expansion and do not exceed 0.5 mEq/kg/hour. Hyperkalemia is reported in severe hypothermia; specific measures (e.g., insulin-dextrose administration, bicarbonate administration) may be necessary if potassium is >7-8 mmol/L. Monitor electrolytes, if able.
  - Metabolic and respiratory acidosis are reported in most types and degrees of hypothermia; these are typically corrected with fluid therapy and patient warming.
- Hemostatic
  - MWDs are commonly in a hypocoagulable state with prolonged clotting times due to inhibition of the enzymatic clotting cascade.[1] Platelet sequestration and poor aggregation from impaired platelet function occur.[1] A disparity can exist between coagulation testing and clinically observed signs in the MWD.[2] Any MWD with evidence of bleeding should be urgently evacuated to a veterinary facility to be able to receive K9 blood products

COLD INDUCED INJURY

Cold-induced injuries include non-freezing and freezing injuries, typically to an extremity, and tend to be related to geographic location (i.e., freezing climates).

NON-FREEZING INJURY

Non-freezing injuries typically involve extremities, occur despite the tissue not actually freezing, and are commonly due to prolonged cold exposure. In humans, common terms to describe these types of injuries are "chilblains" and "immersion foot" or "trench foot;" similar terms are not used in veterinary medicine.

With non-freezing injuries, extremities (ear pinnae, paws, tail tip, scrotum) are exposed to cold temperatures above freezing for prolonged periods (>12 hours), causing intense erythema of the skin, pain, and pruritus. If skin is exposed to damp conditions or submerged and exposed to cold, tissue edema and maceration may also develop.

Treatment of non-freezing cold injuries involves removing the MWD from the cold environment and passively warming the affected tissues slowly. Passive warming of non-freezing injuries can be accomplished by moving the MWD to a warm room (e.g., hospital, indoor facility) and gently wrapping the patient or affected body part in warm blankets or towels.

FREEZING INJURY

Freezing injury, or "frostbite," is the development of cold injury in which tissues freeze with crystallization (ice formation) of tissue and cell water. Frostbite is seen at environmental temperatures below 32°F and primarily affects the distal extremities, ears, nose, scrotum, and tail. Frostbite varies in severity from superficial (1st degree frostbite) to deep injury (4th degree frostbite). The extent of injury may not be apparent for several days following re-warming.[3]

- 1st and 2nd degree (superficial) frostbite clinical signs include gray-to-white, waxy appearance of affected skin; blistering of affected skin may be present with 2nd degree frostbite.
- 3rd and 4th degree (deep) frostbite involves the entire epidermis, but not subcutaneous tissues (3rd degree) or involves subcutaneous tissues, including muscle and bone (4th degree frostbite). Tissues affected with deep frostbite may be black and friable. In all cases of frostbite, pain may be intense, especially during rewarming of tissues.

Management of MWDs with freezing injury is summarized in Table 2. Treatment of frostbite involves gradual warming of affected tissues, supportive care (e.g., treatment of whole-body hypothermia, trauma, or shock as appropriate), analgesia, and protection of affected tissues.

- Affected tissues may be warmed by immersion in a water bath that is 104-108°F for at least 20 minutes or until thawing has occurred, or by wrapping the affected tissues with warm, wet towels for 15 to 20 minutes and changing the towels every 5 minutes.[3,6]
- Do not use dry heat to warm tissues and never rub or massage the tissues; this may cause further injury.
- Provide systemic analgesia as needed; frostbite is painful.
- Protect the affected tissues by applying loose protective bandages, minimizing movement (confine to a cage), and attaching a bucket-collar device to prevent self-trauma.
- Prophylactic antibiotic use is not recommended. Culture an infected wound for antibiotic selection, when indicated.[3,6]
- Aseptically aspirate large blisters that develop.

Table 2. Management of freezing injury (frostbite) in MWDs

MANAGEMENT OF FREEZING INJURY (FROSTBITE) IN MWDS
Treat whole-body hypothermia, trauma, or shock as directed in the supporting K9 CPGs.
Provide systemic analgesia.
Remove the MWD from the source of frostbite and warm frozen tissues gently and slowly, using one of two methods: ▪ Immerse in a water bath that is 104-108°F for at least 20 minutes or until thawing has occurred. ▪ Wrap with warm, wet towels for 15-20 minutes, changing the towels every 5 minutes. ▪ DO NOT use dry heat or rub or massage tissues while warming.
Apply loose protective bandages.
Minimize movement (confine to a kennel).
Apply an Elizabethan collar or similar device (e.g., bucket secured to the collar) to prevent self-trauma.
Aseptically aspirate any clear, serum filled large blisters that develop. Blood-filled (hemorrhagic) blisters should remain intact.[7] Do not allow areas to refreeze after thawing.
Manage open, infected, or necrotic wounds.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All MWDs with hypothermia or cold-induced injuries.

INTENT (EXPECTED OUTCOMES)

Recovery from hypothermia or cold-induced injuries with return to duty.

PERFORMANCE / ADHERENCE MEASURES

- Number and percentage of patients in the population of interest (deployed MWDs) that sustained hypothermia.
  - Number of MWDs that had any systemic effects secondary to hypothermia (e.g., clotting disorders, metabolic abnormalities, cardiac effects).
  - Number and percentage of MWDs that returned to duty.
- Number and percentage of patients in the population of interest (deployed MWDs) that sustained cold-induced injuries.
  - Number of MWDs that had permanent tissue injuries from cold-induced injuries (e.g., tissue necrosis and sloughing, amputation).
  - Number and percentage of MWDs that returned to duty.

DATA SOURCE

- Patient Record
- Department of War MWD Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this K9 CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by direction of the K9 Committee for Combat Casualty Care Chair.

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7. Zaramo TZ, Green JK, Janis JE. Practical review of the current management of frostbite injuries. Plast Reconstr Surg Glob Open. 2022 Oct 24;10(10):e4618.

APPENDIX A: CLASS VIII MEDICAL MATERIEL

Assessment & Monitoring

- Digital rectal thermometer (preferred)
- Thermometer lubricant
- Watch/timer for serial temperature checks
- Patient care documentation form (DD Form 3073, DD Form 3074 or equivalent)

Passive Warming

- Hypothermia Prevention and Management Kit (HPMK) or equivalent
- Ready-Heat blanket (or similar active warming blanket)
- Wool blankets
- Fleece blankets
- Space blanket/emergency blanket
- Waterproof tarp or casualty bag to protect from wind, snow, and moisture

Active Warming

- Water circulating heating pads
- Forced-air warming device (Role 2/3 capability)
- Warm shelter/tent capability

Fluid Administration & Warming

- Lactated Ringer's, Plasma-Lyte A, Normosol-R, or normal saline
- IV administration set
- 18–20 gauge IV catheters
- Saline lock/extension set
- Syringes (10–20 mL)
- Tape or catheter securement device
- IV fluid line warmer (if available)

Cold Injury / Frostbite Care

- Sterile saline for gentle cleansing
- Non-adherent dressings
- Sterile gauze pads
- Rolled gauze
- Self-adherent wrap (VetWrap/Coban)
- Padded bandaging material
- Towels for drying wet animals

Evacuation & Environmental Protection

- Litter/stretcher capable of carrying a K9
- Insulating pad or sleeping pad
- Waterproof covering
- Windproof outer covering

For additional information including National Stock Number (NSN), please contact dha.ncr.med-log.list.lpr-cps@health.mil

***DISCLAIMER**: This is not an exhaustive list. These are items identified to be important for the care of combat casualties.*