

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)



Frostbite and Immersion Foot Care (CPG ID: 59)

This CPG provides an overview of cold injuries and presents a standardized approach to providers in the evaluation and treatment of patients with cold injuries including the role of intravascular therapy

Contributors

Maj Andrew Hall, MC, USA
LtCol Jennifer Sexton, USAF, MC
LtCol Bruce Lynch, USAF, MC
Maj Felix Boecker, USAF, MC
Col Edwin P Davis, USAF, MC
Capt Emily Sturgill, USAF, MC

LT Mark Steinmetz, MC, USN
Col Stacy Shackelford, USAF, MC
LTC Jennifer Gurney, MC, USA
CAPT Zsolt Stockinger, MC, USN
COL Booker King, MC, USA

Publication Date: 26 Jan 2017

TABLE OF CONTENTS

Background.....	2
Evaluation.....	2
Trauma Evaluation	2
Cold Injuries	2
Immersion Foot.....	3
Treatment.....	3
Cold Injury/Frostbite.....	3
Debridement.....	5
Supportive Care.....	5
Immersion Foot	5
Performance Improvement (PI) Monitoring	6
Population of interest	6
Intent (Expected Outcomes)	6
Performance/Adherence Metrics	6
Data Source.....	6
System Reporting & Frequency.....	6
Responsibilities.....	6
References.....	7
Appendix A: Clinical Identification of Cold Injury	8
Appendix B: Additional Information Regarding Off-Label Uses in CPGs	9

BACKGROUND

Historically, cold injury, hypothermia and frost bite have been a severe problems for military units on the battlefield.¹ While not common in modern conflicts, the potential exists for large numbers of these casualties in war and during training.^{2,3} Cold injury requires two things: a low absolute temperature and an exposure duration. In general, the human body contains the mechanisms to preserve core body temperature and extremities even if limb perfusion is temporarily impeded in order to preserve core body temperature. When these mechanisms are overwhelmed, the result is permanent tissue damage. The ultimate mechanism of injury involves a combination of direct cold injury to the cells, direct intracellular and intercellular ice formation, ischemia from thrombosis of the vasculature, and reperfusion injury.⁴ The patients that are afflicted with cold injury generally fall into one of two categories: those involved in industrial accidents and those unable to escape their environment. Patients in the military predominantly will fall into the category of inability to escape the environment. Unlike other types of injuries, all forms of cold injury are potentially preventable with knowledge, equipment, and foresight. Acclimation to the environment provides some protection while those of African descent have increased susceptibility to cold injuries.⁵

Increased rates of frostbite occur at extreme high altitude secondary to ambient temperature decreases and microcirculatory changes that occur at altitudes greater than 17,00ft.^{6,7}

EVALUATION

TRAUMA EVALUATION

All patients with identified cold injury should be considered trauma patients first to identify other life threatening injuries. If possible, attempt to establish the circumstances which led to prolonged environmental cold exposure. In addition, patients are likely hypothermic and should be warmed expediently before focusing on cold injuries of the extremities. In the field, cold extremities may be warmed as a consequence of treating a hypothermic patient. It is imperative to prevent refreezing of the impacted extremity as it results in more tissue damage.

COLD INJURIES

Cold injury is not a single diagnosis but rather a spectrum with all categories possibly present on a single extremity, the most distal portion usually being the most severely affected. Normothermia must be established prior to making the diagnosis of cold injury. Many people experience numbness of extremities with prolonged cold exposure with return to normal function without any permanent damage; this in isolation, will not result in cold injury. Cold injury has occurred when upon re-warming there is pain and swelling or gross signs of ischemia or skin injury. There are classically four degrees, with depth of injury distinguishing the different degrees:

First Degree: Superficial skin injury; pain on re-warming, numbness, hyperemia, occasional blue mottling, swelling and superficial desquamation (desquamation starts at about 5 days)

Second Degree: Partial thickness injury to skin; in addition to first degree findings, vesiculation of the skin surrounded by erythema and edema (appears around day 2)

Third Degree: Entire thickness of skin extending into subcutaneous tissue; bluish to black and non-deformable skin, hemorrhagic blisters, vesicles may not be present, eventual ulcerations can be expected; area will likely be surrounded by 1st or 2nd degree injury

Fourth Degree: Similar to third degree, but full thickness damage including bone. Area may be cold to touch and may feel stiff or woody.

Another way to classify is superficial (First and Second Degree) and full thickness (Third and Fourth Degree) similarly to burns. The ultimate grade will not be truly known until treatment has been attempted and a period of time has passed.

There are very mild cold injuries labeled as Chilblains and Frostnip that do exist, but for the sake of caution in the field, the recommendation is to treat all acute presentations as first degree (superficial) frostbite as there is no morbidity in correcting hypothermia and rapid rewarming of suspected areas. Chilblains is a chronic condition, like a dermatitis, and if continues after initial treatment cold avoidance and supportive care can be provided.

IMMERSION FOOT

Commonly known as trench foot, it is a syndrome related to prolonged exposure to moisture. Classically it has been associated with cold water, but can happen in all climates. The syndrome generally happens slower in warm water, taking approximately 48 hrs, than cold water (earliest estimate 12 hours).

The clinical presentation is water logging of the feet, most pronounced in the soles. With continuous exposure, the foot becomes hyperemic, mottled, painful and edematous, gradually progressing into blistering, hypoperfusion, ulceration and gangrene.^{8,9}

TREATMENT

COLD INJURY/FROSTBITE

Rapid Re-warming and Re-establishment of Perfusion

The mainstay of treatment of the cold injury is re-warming. **Rapid active re-warming is done in 104-108°F (40-42°C) water for 15- 30 minutes** as long as care can occur in an environment where there is no risk of refreezing. The temperature is important, as there is reduced effect with cooler temperatures and higher temperatures will cause burns. Passive re-warming or dry heating is not considered acceptable, but may be the only option depending on the operational environment and involves using body heat and blankets; always attempt to move the casualty safely to a warmer environment. Do not use blow driers, space heaters, or the like as these will cause burns. The goal is complete thawing and maximum perfusion as evidenced by hyperemia, swelling, and pain.¹⁰ Rubbing the affected areas is to be avoided as this will further traumatize the skin. **The re-warming process can be expected to be very painful and narcotic and non-steroidal medications, including Ibuprofen/Aspirin and/or Ketamine should be utilized liberally.** It is tempting to re-warm slowly because this is better tolerated but tissue survival is improved with rapid re-warming. Pain usually subsides in approximately 3 days but prolonged aches, shooting pains, and throbbing can be expected for weeks.¹ Early surgical consultation should be made. Rapid re-warming can be conducted at point of initial care, but early evacuation to definitive care should be considered at the earliest available time. It is also very important that when rapid re-warming is done, it is to be completed, as refreezing after partial thawing will result in more severe injury.

During the course of treatment, patients should be prohibited from using any tobacco and nicotine-containing products as well as any medications inducing vasoconstriction. The limb should be elevated to reduce swelling. After re-warming, electrolyte abnormalities and rhabdomyolysis can occur. Electrolytes should be monitored every 6 hours initially, until normalized. Scheduled ibuprofen (400 mg PO every 6 hours) should be considered, with narcotics utilized for refractory pain. Sympathectomy and vasodilators have been attempted in studies, but there is insufficient evidence that these modalities improve outcomes and should not be routinely attempted. If available, hyperbaric oxygen can be considered and started between day 5 and 10.⁴ Evidence for the use of systemic prophylactic antibiotics is lacking and is not recommended. Regular application of topical aloe vera

may help limit tissue loss.⁴ After resolution of edema, whirlpool therapy combined with exercise can help maximize functional recovery of the extremity.

Photo documentation at point of injury when feasible can assist in continuum of care.

Thrombolytic Therapy

Care must be made to ensure patients are candidates for Tissue Plasminogen Activator (tPA) prior to therapy (see below). Patients should be within 24 hours of the start of injury. Patients should have evidence of severe frostbite as well as circulatory compromise as demonstrated by decreased or absent pulses, lengthened capillary refill, and/or ischemic discoloration of distal digits.¹¹

Candidates for tPA:

- Within 24 hours of start of injury.
- Evidence of injury with vascular compromise.

Relative contraindications to tPA for frostbite injury include:

- Concurrent trauma.
- Recent surgery or hemorrhage.
- Bleeding diathesis.
- Cold contact injury without frostbite injury.
- Greater than 24 hours of ischemia.
- Evidence of freeze-thaw-freeze injury.

Patients that are being considered for therapy should be taken for diagnostic arteriogram of the affected extremity. If perfusion is compromised, papaverine, a vasodilator, may be introduced intraarterially at a rate of 30 mg/hr to decrease local vasospasm. Intraarterial tPA should be administered through the arterial catheter as follows: 2-4 mg bolus followed by a continuous infusion of 0.5-1.0 mg/h into the extremity. If multiple extremities are involved, arterial catheters are positioned in each extremity. The maximum dose of tPA would then be divided amongst the number of extremities. For example, if two extremities are involved, the maximum rate for each extremity is 0.5 mg/h. In addition, intraarterial heparin should be administered through the arterial sheath at a rate of 500 units/h to prevent new clot formation and extension of existing thrombi. Serial labs including PTT, fibrinogen, Hgb/Hct, and platelets are repeated every 6 hours. There is no PTT goal as the dose is small for a normal-sized adult. Angiograms are to be repeated every 8 to 12 hours to evaluate response to therapy. Termination of therapy is recommended to end with complete perfusion or at 48 hrs, unless complications from tPA occur or fibrinogen levels fall below 150. Patients should be closely monitored for hemorrhagic complication, neurologic, and cardiovascular complications from the tPA. If a patient develops serious bleeding complications, the tPA and heparin should be discontinued. If revascularization has occurred, and final cessation of tPA is made, heparin should be continued for at least 72 hours.^{11,12}

A systemic, intravenous approach to tPA administration is available, but only with the ability to perform technetium scanning to confirm vascular compromise and response to therapy. The systemic approach is administration of a tPA bolus of 0.15 mg/kg intravenously followed by a 0.15 mg/kg/hr infusion over the next 6 hours to a maximum dose of 100 mg. After completion of tPA, heparin is started with a goal of two times normal control and is continued until conversion to Coumadin. Anticoagulation with Coumadin should be continued for 4 weeks.¹³

tPA should be avoided in a setting that lacks the ability to monitor and treat bleeding complications.

DEBRIDEMENT

Major surgical debridement, should not be performed in the operational environment for US Military or casualties that can be evacuated. Early excision is not part of the therapy for frostbite. Excision should be delayed until margins of injury are fully demarcated; this may take months. For minor injuries, local wound care can be performed with the addition of topical antibiotic and aloe vera gel or a sterile topical emollient every 6 hours. Wound care should be performed BID and sterile non-adherent dressing should be applied. Vesicles from second degree become dry, black, and hard in approximately 2 weeks and will generally peel away at 3-4 weeks.

Third degree frostbite forms an eschar and can be debrided in approximately 2-8 weeks depending on severity of the injury. There will be an ulcer and this will take further time to heal. The surrounding skin is easily traumatized from second degree frostbite.

With fourth degree frostbite, the mummification of the extremity or digit will become readily apparent in approximately 2 weeks. Most will continue the mummification process without sequelae and this should be a minimally painful process, but throbbing, shooting pains, and potentially severe aching can be expected for up to a month. Some moisture and purulence can be expected without significant concern unless signs of local or systemic sepsis present. The level of debridement/amputation can be delayed until mummification is complete.

For cases of full thickness injury (third and fourth degree) with infection, debridement and possible amputation are to be conducted expediently.

In general, surgical debridement should be done at a definitive care site outside of theater.

SUPPORTIVE CARE

Cold injury may have permanent symptoms after the injury. It is common to have patients with minimal injuries complain of persistent coldness, pain, and hyperhidrosis of the affected extremity. In addition, second degree frostbite will likely have intact, but easily damaged, skin. In many cases, patients are more susceptible to future cold injury which frequently is more severe than the initial insult.

Basic treatment for persistent side effects includes nonsteroidal analgesics and antiperspirants. These should be available at forward operating locations until further definitive dermatologic and surgical care can be provided.¹⁴

Mild injury can be managed at site of injury but any full thickness injury should be evacuated.

Tetanus booster should be provided based on immunization history.

IMMERSION FOOT

Similar to frostbite, re-warming of the extremity is required. This is done by **air drying at room temperature**. Pain control may be required along with debridement. Prophylactic antibiotics have not been shown to result in improved outcomes, but if concerned that infection is present, treatment should target streptococcal, staphylococcal, and *P aeruginosa* based on local antibiogram while awaiting any available cultures.⁹ Similar to other cold injuries, persistent life altering symptoms can persist.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients diagnosed with cold injury (frostbite) or immersion foot.

INTENT (EXPECTED OUTCOMES)

1. Patients with diagnosis of frostbite have rewarming of affected extremities with 104-108°F (40-42°C) water.
2. Patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury receive TPA, unless documented contraindication.
3. Patients with immersion foot have dry heat administered.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have documentation of treatment with water heated to 104-108°F (40-42°C).
2. Number and percentage of patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury who receive TPA.
3. Number and percentage of patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury who receive TPA or have a contraindication documented.
4. Number and percentage of patients with immersion foot who have documentation of dry heat administered.

DATA SOURCE

- Patient record
- Department of Defense Trauma Registry (DODTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this 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 the JTS Chief and the JTS PI Branch.

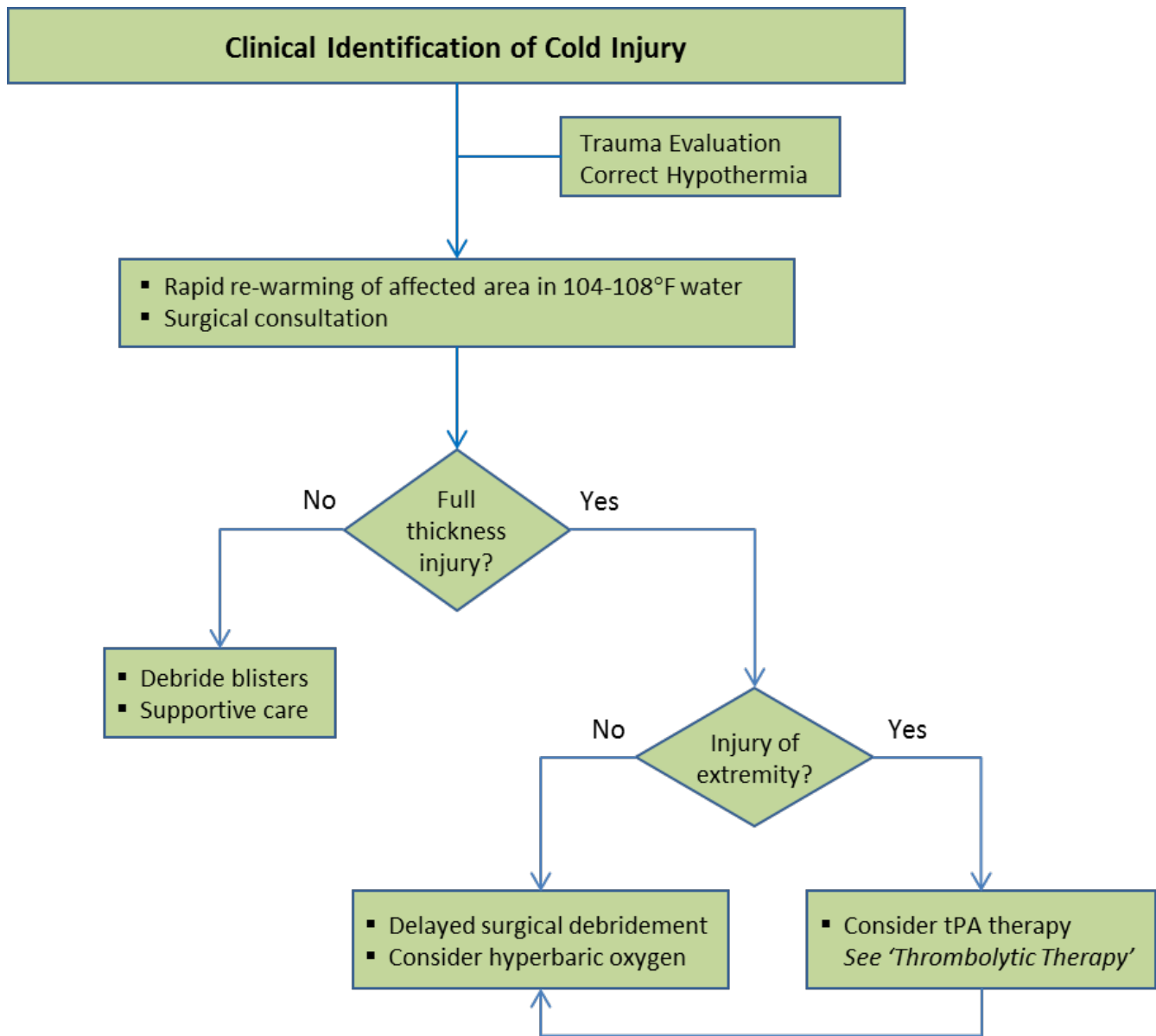
RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

REFERENCES

1. Orr K, Fainer D. Cold Injuries in Korea During Winter of 1950-51. Army Medical Research Laboratory, Fort Knox, Kentucky. 1 November 1951.
2. Cold Weather-related Injuries; U.S. Armed Forces, July 2004-June 2009. MSMR. 2009; 16(9):2-6
3. Hall A, Evans K, Pribyl S. Cold Injury in the United States military population: current trends and comparison with past conflicts. J Surg Educ. 2010;67(2):61-65
4. Murphy J, Banwell P, Roberts A, et al. Frostbite: Pathogenesis and Treatment. Journal of Trauma: Injury, Infection, and Critical Care. 2000;48(1):171-178
5. DeGroot D, Castellani J, Williams J, et al. Epidemiology of U.S. Army Cold Weather Injuries, 1980-1999. Aviation, Space, and Environmental Medicine. 2003; 74(5):564-570
6. Hashmi M, Rashid M, Haleem A, et al. Frostbite: epidemiology at high altitude in the Karakoram mountains. Ann R Coll Surg Engl. 1998 Mar;80(2):91-5
7. Martin D, Ince M, Goedhart P, et al. Abnormal blood flow in the sublingual microcirculation at high altitude. Eur J Appl Physiol (2009) 106:473–478
8. McMahon A, Howe A. Cold Weather Issues in Sideline and Event Management. Current Sports Medicine Reports. 2012; 11(3):135-141
9. Wrenn K. Immersion Foot: A Problem of the Homeless in the 1990s. Arch Intern Med. 1991;151:785-788
10. Roche-Nagle G, Murphy D, Collins A, et al. Frostbite: management options. European Journal of Emergency Medicine. 2008; 15:173-175
11. Bruen K, Ballard J, Morris S, et al. Reduction of the Incidence of Amputation in Frostbite Injury with Thrombolytic Therapy. Arch Surg. 2007; 42:546-553
12. Gonzaga T, Jenabzadeh K, Anderson C, et al. Use of Intra-arterial Thrombolytic Therapy for Acute Treatment of Frostbite in 62 Patients with Review of Thrombolytic Therapy in Frostbite. J Burn Care Res. 2016 Jul; 37(4): e323-e334.
13. Twomey J, Peltier G, Zera R. An open-label study to evaluate the safety and efficacy of tissue plasminogen activator in treatment of severe frostbite. J Trauma. 2005;59:1350-1354.
14. Murray C, Cohen J, Solish N. Treatment of focal hyperhidrosis. J Cutan Med Surg. 2007;11(2):67-77

APPENDIX A: CLINICAL IDENTIFICATION OF COLD INJURY



APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of “off-label” uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. “off-label”) uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing “investigational new drugs.” These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the “standard of care.” Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES**Balanced Discussion**

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.