Arctic Tactical Combat Casualty Care

Introduction

Multidomain operations (MDOs) have the potential to span a variety of environments. While the military strives to improve operations in all environments, from land and sea to space and cyberspace, the need for Arctic capable forces is growing. In light of increased competition with peer and near-peer adversaries with Arctic territories, we wish to draw increased attention to combat casualty care in the extreme cold.[1] In anticipation of Arctic MDOs in the near future, the medical military community must proactively identify knowledge gaps and areas for improvement.

Background

History

US military forces have been involved in numerous conflicts in cold environments but relatively few in extreme or hazardous cold, defined by the Army as –25 to –40°F and below –40°F, respectively.[2] The Attu (Aleutian Island) Campaign in World War II and Battle at Chosin Reservoir during the Korean War are two such examples. In each, there were numerous cold weather injuries (CWIs)—about 30% of casualties at Attu and about 40% at Chosin suffered from CWIs.[3–5] In each iteration of arctic warfare, the military has made small, steady improvements to standard issue equipment. Despite advancing equipment, CWI prevention and casualty care in extreme cold remain challenges.

Tactical Combat Casualty Care

Tactical Combat Casualty Care (TCCC) is the mainstay of casualty care in the military.[6] While care under fire/threat (CUF/T) tenets are largely applicable in Arctic environments, extreme cold temperatures present hurdles for tactical field care (TFC). Further study and modifications are required to ensure feasibility and safety of TFC in the Arctic.

Areas for Improvement

The following concerns and recommendations discussed are in the setting of trauma care in Arctic environments, where temperatures frequently remain at or below –25°F. See Table 1 for a consolidated list of concerns and recommendations for improvement.

Care Under Fire/Threat

Once a casualty begins to lose blood and heat to the environment, the risk of hypothermia increases and their chance of survival further decreases. Therefore, in the CUF/T phase of TCCC, we recommend a modified initial triage pathway for Arctic care: (1) place a hasty tourniquet on any obvious hemorrhaging limb, and (2) move the patient to an area of warmth. If the patient is not transferrable to an area of sustained warmth, we recommend shifting to an alternate "Arctic TFC," with an emphasis on CWI prevention. Next are some recommendations highlighting particularly challenging portions of TFC.

Tactical Field Care

Addressing massive hemorrhage is the first step in the TFC MARCH algorithm. One boon of extreme cold is that exposed wounds freeze and slow or stop continued exsanguination until rewarmed. To assess for unrecognized hemorrhage, medics and providers often learn to strip a casualty naked, though not explicitly recommended in the TFC guideline. However, in an Arctic environment, removing protective garments may hasten hypothermia and death. Frostbite can occur in 30 minutes or less of dry skin exposure to less than –25°F ambient temperature, sooner with superimposed hemorrhage, wet skin, and direct contact with cold surfaces.[7] I recommend striking the notion of "trauma naked" from the lexicon of Arctic field care.

Addressing the airway in an Arctic environment is perhaps even more challenging. The standard equipment of airway management has been nasopharyngeal airways, extraglottic airways, endotracheal intubation, and cricothyroidotomy kits. In Arctic conditions, secretions freeze and can obstruct tubes, and there are cold-related risks of equipment failure and equipment-induced harm. Contact with metallic surfaces at 5°F and below can cause frostbite within seconds.[8] Nonmetallic materials, like the iGel, also freeze and may cause contact frostbite if not thoroughly warmed prior to insertion. Mechanical ventilation using ambient air will decrease core temperature and exacerbate hypothermia. Some units have air warmers, but most are battery powered. From field experience it has been found that most batteries fail within 2 hours of exposure to cold. Cricothyroidotomies require too much dexterity for providers to complete effectively while wearing protective gear to prevent frostbite. Unfortunately, there is no simple solution for this problem. At this time, additional research is needed to rigorously test current tools and techniques and find alternatives if suboptimal.

In regard to respiratory conditions, treatment options are limited as well. The standard is to listen for equal breath sounds bilaterally or look for equal chest rise. If the casualty is appropriate dressed, a provider will not be able to reliably see chest rise or hear breath sounds. This makes diagnosing chest wounds and pneumothoraces very difficult. A possible solution is to use a limited evaluation by unzipping the armpit vents in the Extended Cold Weather Clothing System (ECWCS) level 5 jacket and using that "window" for evaluation. This approach would also allow for improved auscultation, minimize heat loss, and allow lateral placement for needle decompression

TABLE 1 *Actionable Areas of Concer*

Area of Concern	Potential Issues in Extreme Cold	Recommended Course of Action
Assessment for unrecognized hemorrhage	Exposure of bare skin	Limit duration of exposed skin. use wind breaks.
Application of tourniquet to skin	Exposure of bare skin	Use Hasty Tourniquet technique.
Establish airway with iGel	iGel freezes, risk of contact frostbite	Develop nonfreezing equipment.
Establish airway with cricothyroidotomy	Requires provider hand dexterity, risk of contact frostbite	Develop hand warmers for medical providers to maintain dexterity.
Assessment and treatment for tension pneumothorax	Exposing the chest can hasten hypothermia	Consider alternate chest evaluation (e.g., ECWCS level 5 side vents).
Pulse oximetry	Does not reliably detect accurate Spo_2 due to peripheral vasoconstriction	Need improved pulse oximeters.
Battery life in extreme cold	Current equipment battery life is rapidly drained.	Further research to improve batteries.

of pneumothorax. This would then allow for closure of the jacket vent to maintain warmth with access for "burping" of chest seals if needed.

For the cardiovascular portion of TFC, the mainstay is maintaining hemodynamic stability, often with warmed whole blood or crystalloids. There are multiple steps that make this challenging. Obtaining intravenous (IV) access requires significant exposure of patient skin and provider dexterity. Intraosseous (IO) access circumvents these issues, but then comes the challenge of warming resuscitation fluids. Most fluids will freeze while carried in aid bags and, even if thawed, the fluids will remain at temperatures low enough to induce hypothermia if not adequately warmed. Current fluid warming systems, like the Buddy Lite, are battery operated, but again, battery life is limited in extreme cold temperatures. Solutions for this would be finding insulators efficient enough to maintain warm fluids while stored in extreme cold. In addition, development of batteries that last for 72 hours in extreme cold may make adequate fluid warming possible in the field.

Evaluation for hypothermia remains vital. We have already discussed strategies to decrease hypothermia by maintaining vigilance throughout preceding steps of the MARCH algorithm. During the dedicated hypothermia evaluation, providers must also take care to check for frostbite. Providers and medics must be trained in prevention, diagnosis, and treatment of these conditions in the field to prevent mismanagement. For example, an untrained provider might immediately rewarm a frostbitten area, unaware of the risks of additional injury if warmth cannot be maintained, or roughly transport a patient if unaware of the cardiac irritability and risk of arrhythmia caused by hypothermia. While most providers are versed in managing cold weather injuries, few have experience practicing TCCC or prolonged field care in extreme cold temperatures. A dedicated Arctic medical and general survival course would be an appropriate pre-deployment training to help educate on both prevention and treatment.

Conclusion

The shift in focus to Arctic military readiness must be accompanied by an effort to optimize Arctic medical practices. Casualty care in the Arctic has historically and will continue to involve the provision of medical care in sustained temperatures of −25°F and below. Medical technology and field care practices have evolved since the last extreme-cold conflict involving US forces. However, information on equipment ability to withstand extreme cold and freeze–thaw–freeze cycles is limited, and our current tools and practices require further study and revision. I recommend consideration for a dedicated evaluation of our current TCCC equipment and development of new arctic-durable equipment. In addition, the creation of a multiservice Arctic working group will allow for a unified effort toward a modified Arctic TCCC algorithm.

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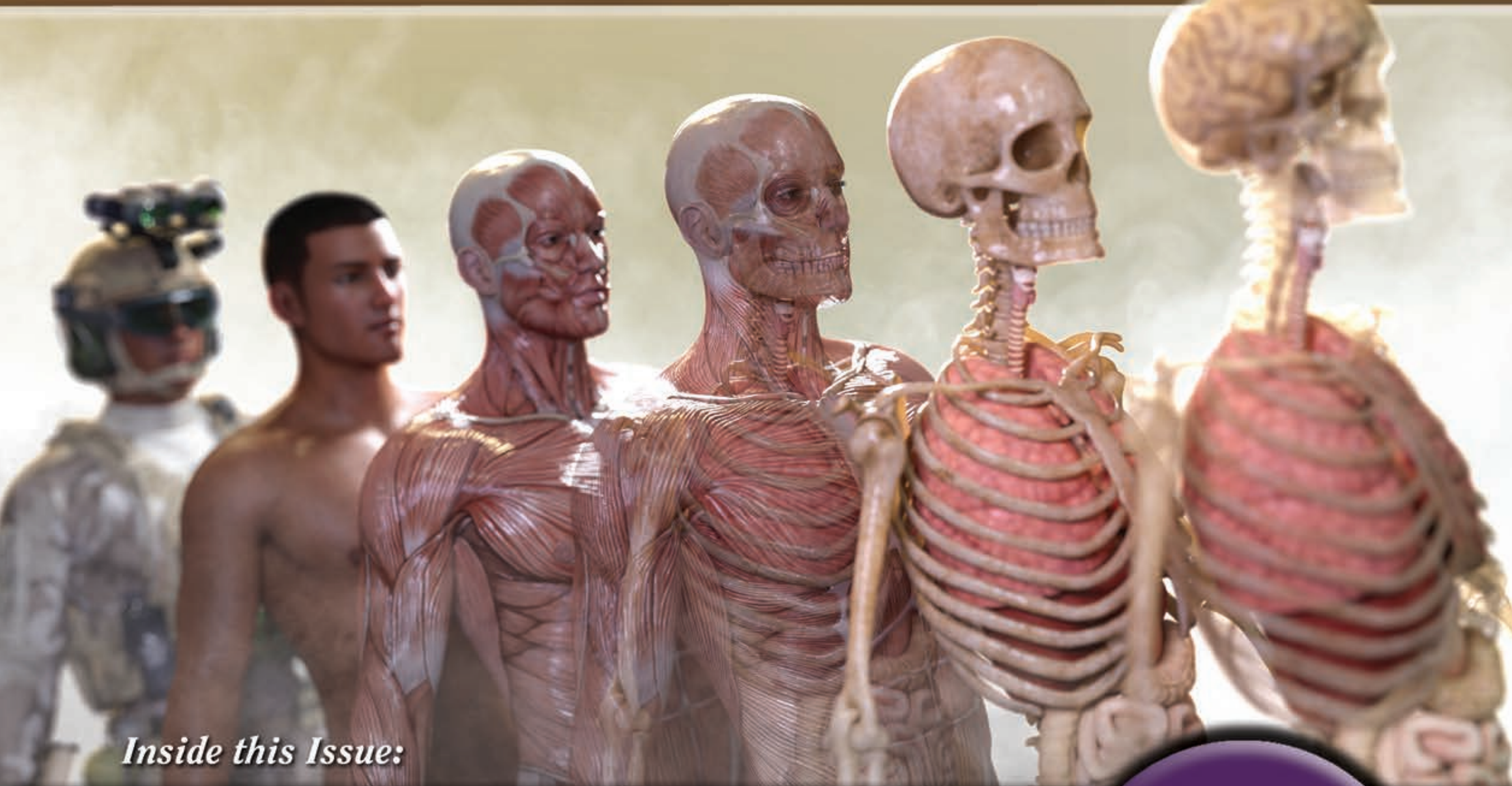

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