

This month's meeting of Wilderness Medicine discussed a new proposal for the management of frostbite in austere environments. This article, in the recent journal *Wilderness & Environmental Medicine*, comes from a group of physicians who treated patients at K2 base camp. Apparently there are more austere environments than Brooklyn (excluding Pod A overnight shifts).

Traditional frostbite management involves warming the injured extremity with water, controlling pain and penicillin for infections. This helps initial injuries caused by ice crystals in tissue. Currently, research is focused on addressing the second stage of injuries caused by inflammation and decreased tissue perfusion from thrombosis. Proposed treatments include oxygen, ibuprofen, heparin, tPA and prostacylin.

This month's paper builds on the work of vascular surgeons in Utah in *Archives of Surgery*, 2007. They administered tPA to 32 patients with frostbite of the extremities and were able to reduce amputations from 41% to 10% (a statistically significant decrease). Here, tPA was given intra-arterially, in the controlled environment of the hospital and angiograms were obtained showing increased perfusion to the frostbitten extremities.

Our author's built off this protocol to treat patients at K2 base camp. The paper adds to the traditional classification of frostbite as first degree (red skin), second degree (blisters) and third degree (black, insensate skin) to grade the likelihood of amputation. After thawing, as tissue cyanosis approaches the metacarpal or metatarsal bones, the chance of amputation approaches 100%. For climbers (and many others) even a treatment with significant risk is worth a shot of not losing fingers and toes.

The authors rewarmed tissue in 37-39C water with ibuprofen and pain control. They briefly discuss future treatments to improve blood flow and oxygenation such as nerve blocks (sympathetic blocks control vasoconstriction), oxygen (oxygenation to vasodilate) and prostacyclins (iloprost vasodilates) before moving onto tPA.

The authors present two cases of IV tPA and heparin used at K2 base camp. Here tPA was given IV at 1.4 mg/kg over 15 minutes (faster and more than the stroke dose) along with 1000 mg of heparin every 4 hours. For the 42 year-old male who slept without a glove at 7400 meters, this saved his hand. However, the feet of the 40 year-old male who presented 3 days after reaching K2's summit were amputated even with the tPA protocol. Neither patient experienced a hemorrhagic event.

Our group discussed the risks of tPA and how to frame these risks when approached by patients (and neurologists). Though the study is small, it suggests a medication that may preserve the hands and fingers (especially important in groups like climbers). After the discussion, at a warm bar in Brooklyn, there were those who would opt for the tPA for themselves and those who felt it too risky. What would you want if a snowman bit you?

Bruen, Kevin J., James R. Ballard, Stephen E. Morris, Amalia Cochran, Linda S. Edelman, and Jeffrey R. Saffle. "Reduction of the Incidence of Amputation in Frostbite Injury With Thrombolytic Therapy." *Archives of Surgery* 142 (2007): 546-53.

Cauchy, Emmanuel, Christopher B. Davis, Mathieu Pasquier, Eric F. Meyer, and Peter H. Hackett. "A New Proposal for Management of Severe Frostbite in the Austere Environment." *Wilderness & Environmental Medicine* 27 (2016): 92-99.