Case Report

Barriers to frostbite treatment at an academic medical center☆

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1. Introduction

Frostbite is a tissue injury, typically of the digits, and sometimes the face, which occurs due to cold exposure. Freezing injuries can be sustained in varied environments, from the wilderness where outdoorsmen may be exposed to prolonged cold to urban settings where laborers or homeless individuals may spend extensive time outside in winter weather [4,5].

Treatment begins with rewarming, wound care, and analgesia. Historically, this was the extent of intervention until weeks after the injury when affected digits either recovered or were amputated. Recent advances in understanding of the pathophysiology of frostbite injury have led to a more proactive approach to management. Several hospitals including the University of Utah Health Center, Helsinki University Hospital, and Hennepin County Medical Center in Minnesota pioneered protocols centered around the early administration of intra-arterial (IA) thrombolytic therapy [1-3]. Studies from each institution have demonstrated decreased rates of amputation and improved patient outcomes with such treatment. As a result, early thrombolytic therapy has become the standard of care for severe frostbite injury [1-3]. There is also evidence that prostacyclins such as iloprost have comparable digital salvage rates and should have a role in treating frostbite injuries [2,6].

2. Case presentation

A 47-year-old Hispanic male, with a history of opioid use disorder, homelessness, HIV, and untreated hepatitis C, was transported to the emergency department (ED) with cold exposure and frostbite in both hands precipitated by a period of record breaking sustained cold in the northeastern United States.

Initial evaluation demonstrated frostbite injuries to both hands with hemorrhagic bullae extending over the intermediate and proximal phalanges of digits 3–4 on the left hand and digits 2–5 on the right (Fig. 1). There was also a non-hemorrhagic blister over the plantar surface of his right foot. The hand injuries were associated with significant pain and decreased sensation in the affected digits. The foot injury caused no pain, discomfort, or sensory change. The patient received immediate wound care and pain control.

Because there was no established protocol for the treatment of frostbite at the hospital, there were persistent delays in care. On day two, approximately 48 h after admission, the patient underwent a technetium-99 bone scan which demonstrated preserved flow in the digits of the left hand. In contrast, there was absent flow and decreased soft tissue and bone uptake in the majority of the right hand, as well as the middle and distal portions of the fourth digit. Based on these findings, nifedipine and sildenafil were initiated for vasodilation.

On the fourth day of hospitalization, for further vasodilation, IV epoprostenol was initiated in accordance with an established hospital protocol for treatment of severe Raynaud’s phenomenon and digital ischemia secondary to scleroderma. Epoprostenol was uptitrated to 6 ng/kg/min, the maximum dose tolerated by the patient. Per that
Several case reports and series have also reported the use of iloprost therapy contraindications to thrombolysis or incomplete responses to tPA tacyclin analog which causes vasodilation, in cases in which there are either perfusion has been successfully restored [1-3]. If there are limitations of thrombolytic therapy is guided by repeat imaging to determine whether perfusion has been successfully restored [1-3]. If there are prominent signs of persistent vascular compromise on repeat imaging, tPA is continued for a maximum of 12 to 48 h, with heparin continued for 2 to 4 h after tPA is discontinued [1-3]. At the University of Utah, frostbite patients treated per the institution’s protocol for thrombolytic therapy had a digital amputation rate of only 10% compared to a rate of 41% in patients treated conservatively [1]. The University of Helsinki and Hennepin County Medical Center reported amputations rates of 25% and 19% respectively after the institution of their thrombolytic-based treatment protocols [2,3].

The Helsinki protocol also incorporates the use of IV iloprost, a prostacyclin analog which causes vasodilation, in cases in which there are either contraindications to thrombolysis or incomplete responses to tPA [2]. Several case reports and series have also reported the use of iloprost either alone or following tPA [7,9,14,15]. Cauchy, et al. compared amputation of at-risk digits in patients treated with IV iloprost alone versus iloprost with tPA, and found amputation rates of 0 and 3.1%, respectively [6].

Because IV iloprost is not available in the United States, substituting IV epoprostenol might be a reasonable alternative. Epoprostenol is a prostacyclin currently used intravenously for treatment of pulmonary arterial hypertension [16] and digital ischemia associated with severe Raynaud’s phenomenon secondary to scleroderma [17]. To our knowledge, there are no reports of treating frostbite with epoprostenol. Despite some improvement in this patient’s digits with this treatment (Fig. 1), the overall outcome was poorer than that reported in the above studies. However, this may have been due to a delay in instituting epoprostenol rather than a failure of the medication.

Increased time from rewarming to thrombolytic therapy has been significantly associated with amputation with a 26.8% decrease in salvage for every hour of delay [18]. However, while patients with delayed treatment do appear to have higher rates of amputation, Pandey et al. recently reported on five patients who received IV iloprost up to 72 h after their initial injury whose tissue loss was less than expected [19,20]. They suggested that iloprost can be beneficial for severe frostbite up to 72 h after injury. It seems likely that a similar relationship would exist between delayed initiation of epoprostenol therapy and tissue loss. Further investigation, using a standardized treatment protocol similar to the Helsinki protocol, is warranted to determine whether epoprostenol is an effective substitute for iloprost.

In conclusion, this case illustrates the importance of early imaging and intervention in order to successfully treat severe frostbite. While the combination of thrombolytics and/or vasodilators that are used may vary between institutions, timely initiation of treatment is crucial regardless of the treatment regimen. Hospitals in cold climates should establish triage and treatment protocols to ensure that they are prepared to quickly identify and treat patients with severe frostbite, prevent amputations, and, ultimately, improve patient outcomes.

### Author contributions

Study concept (SLK, RP, TM, SS, RJ, HWF); literature review (SLK, TM, RJ), drafting of the manuscript (SLK, TM, SS); critical revision of the manuscript (SLK, RP, HWF); approval of the manuscript (HWF).

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Disclosures

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References


