

intense extreme weather events. This is why those who visit the Dolomites precisely because of their Outstanding Universal Value, must be guided towards slow and informed tourism which better preserves and appreciates that value.

To experience the mountains in the climate-crisis era, an even stronger emphasis on prudence is required. On this basis, the UNESCO Dolomites Foundation, together with the Italian Alpine Club, mountain-hut associations, alpine guides, tourist agencies and Alpine Rescue, is running a communication campaign to promote best practice for hiking and alpinism. The increase in visitor numbers to the mountains is, in fact, inversely proportional to the average level of physical fitness, technical ability and, above all, planning capability and willingness to turn back in the event of (subjective or objective) obstacles.

As we know as mountaineers, there is no such thing as zero risk in the mountains. This is why we choose to speak about prudence and not safety, highlighting the need to adopt behaviours that limit subjective dangers, in the knowledge that objective dangers are always just around the corner. The word 'safety' leads people to think that safety must be guaranteed from the outside, whereas the concept of 'prudence' shifts the focus to personal awareness, responsibility and informed evaluation.

Enjoying the Dolomites World Heritage Site is a unique experience, and the best way to do so is to walk and climb with prudence and with our eyes open to the enormous richness of the landscapes and geological value before us.

DR CHRIS IMRAY

Once Bitten

Current Guidance for the Treatment of Frostbite

The prevention and treatment of frostbite has developed significantly over the past few decades, bringing us to a point where current best practice looks somewhat different to the advice many mountaineers received when they made their first forays into the high mountains. Responsible climbers should be aware of the best current advice and know both how to seek medical support and from whom.

The Wilderness Medical Society works to produce guidelines based upon the best available evidence on a great many topics. In 2011 I joined their writing team and helped them to put together guidelines for the treatment of frostbite, drawing on my experience as a vascular surgeon and high-altitude mountaineer with a longstanding interest in the topic. We have revised the advice twice since then, a vital process which takes about a year to complete. This article draws heavily upon the latest update, published in 2024.

Definition

Frostbite is a (cold) thermal injury, most often occurring to the extremities (usually fingers or toes, but also face, nose, ears and, very occasionally, male external genitalia). It ranges in severity from minimal tissue damage all the way through to substantial necrosis resulting in amputation.

Recent advances in medical treatment mean that those injured and also those looking after the injured should be able to recognise and treat frostbite effectively and in a timely fashion.

Mechanism of injury

To understand the newer treatments, we must first understand the mechanism of frostbite injury. Frostbite injuries appear to be the result of progressive and overlapping changes in blood flow which occur when tissue temperatures drop below freezing (-0.55°C). The phases are a pre-freeze phase, a freeze-thaw phase, a vascular stasis phase (in which blood stops moving), and a late ischaemic phase (in which tissues do not receive the oxygen they require).

This results in local cell damage and a loss of blood supply due to the sludging of the blood vessels, which become blocked by small clots (referred to medically as 'micro-thrombi'). It is this blocking of the blood vessels and the resulting lack of oxygen which causes the cell death and gangrene with which frostbite is associated.

The modern treatments of the vessel dilator iloprost and the clot-busting

drug Tissue Plasminogen Activator (TPA) both work to restore blood flow before cell death from lack of oxygen has occurred.

Classification

Frostnip is a superficial cold injury which is associated with intense vasoconstriction or shutdown of the blood vessels on exposed skin. Frostnip is distinct from and may precede frostbite. The numbness and pale skin which characterise frostnip will resolve quickly after warming the skin with appropriate clothing, direct contact, breathing with cupped hands over the nose, or gaining shelter. No long-term damage occurs. While not dangerous in itself, frostnip should be seen as a warning sign and steps should be taken immediately to prevent a frostbite injury from developing.

Frostbite, by contrast, involves permanent tissue damage. In a medical setting, frostbite is graded on a scale from 1-4 to help doctors plan their treatments appropriately. However, in the field, it is often more useful to divide it into just two major categories – superficial and deep. In cases of superficial frostbite, which is limited to the surface of the skin, we usually expect there to be no or minimal tissue loss. By contrast, in deep frostbite injuries, where tissues beyond the surface of the skin are affected, tissue is likely to be lost if treatment does not occur rapidly.

Risk Factors

There are certain risk factors for frostbite that we can do relatively little about, but which might alter the way in which you wish to approach cold environments. For example, there is some evidence that poor circulation, a feature common to conditions such as diabetes and Raynaud's as well as for those using beta blockers, can increase susceptibility to cold injuries.

Certain ethnicities, such as Afro-Caribbeans, also seem to be more susceptible to cold injuries.

While there may be little to nothing you can do to change these risk factors if they apply to you, you can be more cautious when climbing or travelling in cold environments, remaining aware that you may have less room for error than your companions.

Prevention

In medicine, we often say that prevention is better than a cure, and that's certainly the case when it comes to frostbite.

As the environmental temperature drops, the body's reaction is to vasoconstrict or shut down the blood supply to the peripheries. This is a natural response which attempts to maintain the body's core temperature but which has the side effect of lowering the body's peripheral temperature, putting it at risk from frostbite. As the skin temperature drops below about +10°C, a cold neuropraxia or numbness begins to develop, reducing the individual's awareness of the developing problem.

Whether this initial phase develops into frostbite as a result of prolonged heat loss is dependent on several factors, including absolute temperature

(often below -10°C), duration of exposure, inactivity, wind chill, altitude, and clothing. At this stage, steps can still be taken to prevent a permanent injury. These mostly involve actions which maintain blood flow to the extremities or reduce heat loss. Examples include:

- Maintaining adequate core temperature, hydration, and nutrition.
- Minimising the effects of known diseases, medications, and substances. Critically, alcohol is a vasodilator which can worsen heat loss and impair decision-making. It should be avoided.
- Being proactive in the behavioural response to ambient conditions (i.e. layering up or down as appropriate with effective insulating clothing and equipment).
- Minimising blood flow restriction, such as occurs with constrictive clothing, footwear, or immobility. Consider removing watches, rings etc, and ensure boots are appropriately sized.
- Using supplemental oxygen in severely hypoxic conditions (e.g. above 7500 meters)
- Keeping mobile where possible in order to generate heat. Move about at stances, remembering to move all of your limbs.
- Use of chemical or electrical hand or foot warmers may have a role.

Field Treatment

But what should you do if your efforts at prevention fail and you, or a member of your team, develops frostbite? There are a number of steps you can take in the field to reduce the likelihood of tissue loss and raise the chances of a more positive outcome.

When frostbite occurs, your first concern should be to prevent any further damage and to remove constrictive material such as jewellery from the affected body part. It's also important to remember that frostbite and hypothermia often occur at the same time. If the injured person is also hypothermic, treating their hypothermia should be a priority. (Guidance on treating hypothermia in the field is not the focus of this article, but the Wilderness Medicine Society also has guidelines for this.)

The next step is to **rewarm** the site of the injury. Protect the extremity from further damage and gently try to rewarm it by placing it into the armpit or groin. This should be done as soon as possible. You should also try to get out of the elements and into a place of safety and warmth where passive warming can take place. Depending on your situation, this could be a tent, emergency shelter, bivi, hut or snowhole. Once you're out of the weather, you can actively warm the area. This is best achieved by using water at 39-41°C (the temperature of a baby bath). The process generally takes around 30 minutes and is complete when the tissue takes on a red/purple appearance and becomes pliable once again. Be careful to dry the area gently, using a blotting technique rather than rubbing.

Under no circumstances should you rub snow onto the affected area.

Once the injury has been thawed, do not allow refreezing to occur as this

significantly increases the likelihood of severe tissue damage and is associated with worse outcomes.

Following rewarming, the next step is to focus on **rehydration** and **nourishment**.

In terms of **medication**, it is recommended that the individual with frostbite take 400mg of ibuprofen three times a day unless there are any contraindications such as other medical conditions or prescriptions. The ibuprofen will help with pain and is an anti-prostaglandin agent, working to prevent the blood vessels from narrowing. In terms of topical medications, aloe vera cream has a potent anti-prostaglandin effect and should be applied daily.

Damaged areas should be **dressed** with dry, non-adherent dressings. Care should be taken not to apply these too tightly as damaged tissue can swell, resulting in constriction of blood flow and further damage. This swelling of tissue can create other problems. Those suffering from frostbite to their feet often find that, once warmed, the resultant swelling prevents them from being able to put their boots back on. This was famously the case for members of Maurice Herzog's team on the 1950 first ascent of Annapurna. Affected areas should be elevated to help reduce swelling but even if this is successful, patients should avoid walking on frostbitten feet if possible, as they may cause themselves further injury due to an inability to feel pain in the damaged area. Of course, walking, and even climbing, may be unavoidable for evacuation. If this is the case, padding the affected area to reduce further injury is recommended.

Any **blisters** are best left intact in the field to reduce the risk of infection.

If **oxygen** is available, its use is recommended at altitudes above 4,000m.

Ideally, **evacuation** of the patient should be carried out as quickly as possible. The faster they receive professional medical attention, the better their outcome is likely to be.

Superficial frostbite can usually be managed in a clinic, emergency department or outpatient setting. Depending on where you are climbing, these may even be available locally. However, for deep or severe frostbite, you are best evacuating to a hospital. Modern treatments for severe frostbite, including intravenous iloprost and intra-arterial TPA, can only be administered in a hospital setting and, for the best outcomes, should be started within 24 hours of the injury occurring. As a consequence of the time-critical nature of these treatments, transfer to a major trauma centre or vascular unit with access to these interventions is urgent. During evacuation, it is important to confirm that you are being taken to an appropriate centre.

Hospital Treatment

If you are unlucky enough to develop a case of frostbite severe enough to warrant hospital treatment, what should you expect?

First of all, you'll be assessed by medical staff and, if you're also suffering from hypothermia or traumatic injuries, these will take priority over the frostbite. Then, if it couldn't take place in the field, the injured areas will be rewarmed and, in the most severe cases, imaging will be done to assess

the extent of the frostbite.

It's then likely that you will be given one of two drug treatments. Iloprost, the preferred treatment for frostbite, dramatically reduces the likelihood of amputation in cases of severe frostbite when given within 24 hours of the injury. It is given intravenously over five days.

The alternative is the clot-busting drug rTPA, which is also used in patients with heart attacks and strokes. However, it is more complex to administer and evidence suggests it is less effective than iloprost.

Whether or not you receive one of these drugs, any surgery is likely to be delayed for some time. Doctors will want to see exactly where the dead tissue ends and the good, living tissue begins. This can take from one to three months to become obvious. However, there are certain cases in which earlier surgical intervention is advised. There include patients with overwhelming sepsis (blood poisoning) or a potential compartment syndrome (swelling of the tissues that puts the blood supply to that part of the body in jeopardy).

Recent Advances

In the UK, the **British Mountaineering Council Frostbite Service** has been operating for 20 years. This service, which is run by Dave Hillebrand, Paul Richards and myself, offers expert advice over satellite phone or by email to those dealing with frostbite. All three of us hold the UIAA Diploma in Mountain Medicine and have practical expedition experience. We provide remote advice for affected individuals both locally in the UK and on expeditions abroad. The aim is to support and advise local providers or offer to take over care where appropriate. Contact details for all three of us are available via the BMC website (www.services.thebmc.co.uk/how-to-get-expert-frostbite-advice).

However, even the best advice will be of little use if you can't access the right treatments. Throughout this article, I've repeatedly mentioned the frostbite drugs iloprost and rTPA. In recent years, these drugs have revolutionised the care of those with more serious frostbite. Time is crucial and treatment with them should ideally be started within 24 hours of injury. The longer the delay, the less effective the treatment becomes as the frostbitten extremities die without a blood supply. Doctors use the phrase 'time is tissue' to indicate that the longer something is left untreated, the more tissue will be lost.

Speed is not the only consideration. It is also very important to go to a unit familiar with these modern treatments. Sadly, there have been a number of cases recently where climbers have been taken to units that do not offer iloprost, despite the presence of units offering the treatment within the same city. Because this information was not volunteered, digits were lost when they needn't have been.

To try and get around this issue, the recently set up **International Freezing Cold Injury Working Group** is establishing a worldwide database listing the units that offer iloprost and other complex frostbite treatments as well as a second database of clinicians who regularly advise on cold injuries.

Until recently, this first database would not have included sites in the

USA as iloprost was not approved for use there. This changed in February 2024, when the US Food and Drug Administration (FDA) approved the use of iloprost for the treatment of severe frostbite. You can now visit Alaska safe in the knowledge that, should you face a case of severe frostbite, regulation will not prevent you from receiving the best treatment currently known to science.

KILIAN JORNET

Climbing in the Himalaya: The Substance of Style



Oxygen bottles on Everest. (Kilian Jornet)

Editor's Note: A version of this article originally appeared on Mr Jornet's blog at mtnath.com. As you will see in the conclusion, Mr Jornet specifically appeals to alpine clubs, amongst others, to be part of the discussion he is seeking to begin. We felt it was fitting, given both Mr Jornet's stature in the field of mountain sport and the saliency of the issues he raises, to offer him a further platform in our pages through which to reach Alpine Club members and the wider mountaineering community.

As I write this, some of the world's best alpinists have been brought together in Briançon for the annual Piolets d'or awards: a celebration of alpinism, where the most significant ascents of the previous year are recognised. Even if none of the climbers were looking at being rewarded or recognised, highlighting their ascents and the commitment involved is important for the influence that cutting-edge alpinism has to every mountain sport practitioner.

Most of those climbs didn't come with ease. Many took several attempts and the engagement, determination and skills needed to achieve those ascents are out of reach for most of the world's climbers. But in a way it shows to all of us what humans can accomplish in the mountains when they adhere to general principles; the basic tenets of alpinism. Unfortunately, these climbs will probably pass unnoticed by most people, even climbers.

Mountaineering has a long and storied history, characterised by various motivations that have evolved over time. From scientific exploration to nationalist endeavours and from contemplation to individualistic pursuits;