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LESSONS FROM HISTORY

Frostbite and Other Cold Injuries in the Heroic Age of Antarctic Exploration

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Frostbite and other cold injuries on the early polar expeditions were common. This paper explains how frostbite was described, prevented, and treated on the Antarctic expeditions of the heroic age, comparing them with modern recommendations. Nonfreezing cold injury probably also occurred but was not differentiated from frostbite, and chilblains were also described.

Key words: frostbite, cold injury, expedition medicine, Antarctica, history of medicine

Introduction

During the heroic age of Antarctic exploration (1895–1922), there were at least 18 expeditions to the Antarctic, and the literature of this period contains vivid descriptions of the medical conditions encountered. Perhaps the commonest of these was frostbite. The causes, symptoms, and signs are as relevant today as they were then. The aim of this paper is to describe the recommendations made, at that time, for the prevention and treatment of frostbite, and to compare these with modern advice.

Prevention of Frostbite

The prevention of frostbite requires some understanding of its causes. Doctor Macklin (surgeon on 2 of Shackleton's expeditions, and with experience of the cold during the Russian campaign of the First World War) wrote "the time that it [bare skin] can be exposed [before developing frostbite] depends upon the temperature, the amount of moisture present, and the strength of wind . . . . Much depends upon the circulation, for if a job is attempted after the body has been for some time at rest frost-bite sets in quickly. If, on the other hand, the individual has been working hard, walking or running, and the blood is pulsating actively, the hands and other parts can be exposed for comparatively long periods without harm."[1]

Ponting describes the effect of wind rather more poetically: "Seventy or eighty degrees of frost can be endured by any healthy individual if seasonably clothed and there be no wind. But if a breeze, be it *ever* so gentle, gets astir in such a temperature, it behooves one to be well alert, for Jack Frost is ever on the watch to take his toll, and he will bite as often and as deep as he gets the chance."[2]

Macklin said that predisposing causes were "cold (of the body generally), fatigue, exhaustion, hunger and vitamin deficiency, especially scurvy."[3] In cold conditions, exhaustion is likely to be associated with a low core temperature and dehydration, both of which predispose to frostbite by reducing the supply of warm blood to the tissues and because the exhausted person will fail to take adequate precautions against the cold.[1]

The importance of maintaining body temperature, ensuring good nutrition, and avoiding moisture are all recognized in recent guidelines on preventing frostbite as is the role of exercise, while avoiding exhaustion.[4] (Scurvy, though, is no longer a problem.) These guidelines also stress the importance of maintaining hydration. This was not mentioned by the doctors at the time or expedition members who were sledding and were probably chronically dehydrated as the Antarctic is very dry. On the march, all water had to be melted from snow, and fuel was limited. The effect of wind on the cooling rate can now be quantified by use of the wind chill factor.

Appropriate clothing is, of course, vital, and Macklin said that the principle is "to provide a non-conducting airspace round the skin"[1] with wool or fur[3] and to avoid wetness. Doctor Jean-Baptiste Charcot, leader of the 2 French expeditions, recommended layering of clothes and stressed the importance of wearing mittens rather

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than gloves.[5] Footwear is important.[5] "If one can wear soft foot-gear exclusively the risk of frost-bite is far less than if one is compelled to wear stiff boots; in soft foot-gear, of course, the foot can move far more easily and keep warm."[6(pp82–83)] Unfortunately, soft footwear is not suitable for skiing or climbing. Macklin warned, "The cramming of a foot with too many pairs of socks into a boot too small for them is bad, for the circulation of blood to the toes is restricted and the air space is lost. Cold feet have often been cured by telling the wearer to *remove* a pair of socks."[1] The modern mountaineer will usually wear clothes made from synthetic fabrics, but layering of clothing is still recommended as is the avoidance of dampness and of constricting the blood flow within boots.[4]

Some individuals seem to be less prone to frostbite than others.[5] On Scott's *Terra Nova* expedition (1910–13), "Bowers . . . enjoyed a greater resistance to cold than any man on this expedition . . ."[7(p213)] and ". . . was never worried by frost-bitten feet."[7(p244)]

Scott noted that "places that have been frost-bitten become extraordinarily susceptible to a recurrence of the evil. . . ." Those who overwintered the first season had all been frostbitten to a greater or lesser extent, "consequently it was much rarer to see people working with bare hands than it was in the first winter, when so many delighted to show their scorn of cold fingers."[8(pp183–4)]

Frostbite also resulted from touching metal, and this was prevented by covering the metallic portions of instruments with flannel. Scott warned in rhyme:

> "Ah me what perils do environ
> the man who meddles with cold iron"[8(p350)]

Such frostbites may be called cold burns and do not always affect the fingers. Doctor Frederick Cook on the Belgian expedition (1897–99) recorded how: "Danco came in after making his sights . . . with a piece of skin, torn from his eye, frozen to the metal of his instrument" and "[o]ne sailor . . . placed two nails in his mouth. He snatched them out quickly bringing along with bits of his tongue and lip, and leaving ugly wounds which in character were exactly like the injuries of a hot iron."[9] At temperatures of –15°C, frostbite from touching metal can occur within 2 to 6 seconds.[10]

On the *Southern Cross* expedition (1898–1900), "the men rubbed glycerine into their faces and hands . . . ."[11] to prevent frostbite, and Bernacchi (who had been on that earlier expedition) complained that this was not available on the *Discovery* (1901–04).[12] Macklin accepted that "[v]aseline and glycerine have been used on the face to protect it from strong winds, and apparently with success,"[3] but elsewhere warned, "[t]he application of Vaseline or ointment is the worst treatment possible, especially if the part is liable to be again exposed to cold" and describes experiments that he had done to confirm that.[1] More recent work supports Macklin's view and suggests that although petroleum jelly makes the skin feel warmer, it has no effect on skin temperature and by creating a false sense of security might lead to an increased risk of frostbite through neglect of efficient alternative measures.[13,14] Rubbing fat into the skin also makes it more difficult to see frostbite.[5]

Sites of Frostbite

The commonest sites of frostbite were the face, the feet, and the hands.

"Even in the coldest places it is necessary to keep ones face . . . uncovered,"[8(p183)] and so it is often frostbitten, a problem described in rhyme by Dr Levick, surgeon to the *Terra Nova*'s Northern party 1910–13:

> "Wrapped up in your windproof your body's all right
> With your hand lying snug in its mitten
> But your beautiful nose is exposed to frostbite
> And as often as not is frostbitten
> Whatever you wear in the wind, there remains
> The ever insoluble puzzle
> Of how to be happy though blue in the face
> With icicles stuck to your muzzle"[15]

Frostbite of the face was often combined with sunburn. Frostbite of the hands was also common but is easily detected by simply removing the gloves, so "the parts most liable to permanent damage are the feet."[3]

Gourdon describes a case of frostbite of the penis on the *Français* expedition (1903–05) which healed with scarring that caused a phimosis requiring surgery (presumably a circumcision) when the sufferer returned to Buenos Aires.[16] Other cases have been mentioned but not described.[17,18] Frostbite of the penis is uncommon but recognized.[19]

Symptoms

Scott wrote, "under ordinary conditions one has a distinct sensation on being frost-bitten; the blood seems to recede from the veins in the exposed part with a suddenness that almost conveys the sound of a 'click' and the feeling of a prick with a sharp instrument." However "the frostbites that come when people are doing hard work are more serious, as the first prick may pass unnoticed and the superficial freezing continues to take deeper hold without any further sensation."[8(p183)] Charcot stressed that frozen skin is painless.[5]

Whereas frostbite in the face and hands will usually be recognized early, this lack of symptoms is particularly

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