COLD INJURY IN KOREA

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In this paper is described the treatment of 152 cases of frostbite sustained by British Commonwealth troops in the Korean campaign in the winter of 1950-51.

Climatic Conditions

The climate of Korea in winter is very severe, and temperatures range from around freezing point to as much as −20°F (52 degrees of frost); strong winds accompanied by snow, sleet, and hail occur.

Military Circumstances

During the greater part of the winter the two Commonwealth Brigades were fighting rear-guard actions or holding defensive positions, forward troops were either standing-to or sleeping in the open, and the lighting of fires was, of course, impracticable.

Clothing

Various forms of protective clothing were available, although some troops had only the standard boots, ankle, marching. Unfortunately, figures of the relative numbers of troops with the different forms of clothing were not available, so no appreciation of the relative merits of each type could be made; however, cases of frostbite occurred in men wearing all types of protective clothing and it would appear that no type at present in use has any marked superiority.
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CLINICAL FEATURES

In Forward Areas:

"Early cases.—Cold, well circumscribed area of pallor, painless with loss of epicritic and protopathic sensation. No circulatory return. This either proceeds to a bright red reactive warm stage with mild throbbing pain and the return of protopathic but not epicritic sensation, or to the:

"Later stage when the affected area goes blue with no circulatory return. All sensation is lost, the area is cold and there is a tendency to blister formation. Proximal to these areas are well demarcated zones of the reactive stage described above." (Kilgour.)

In the Base Area (i.e. one to five days after injury).

Cases were difficult to classify as there was a continuous grading from the case with no objective signs to those with black and shrivelled extremities. The following classification was adopted:

- **Incipient Cases**: with no skin changes but complaining of numbness and paraesthesia.
- **Slight Cases**: with reddening or brownish pigmentation and symptoms as above.
- **Moderate Cases**: with vesiculation and/or patchy blackening.
- **Severe Cases**: with blackened and shrivelled extremities.

Oedema was not a common finding, but some cases had very marked swelling, and resembled trench foot rather than frostbite; this factor is discussed below. In all but three cases the part involved was the foot, three cases had slight cold injury of the hands as well as the foot; no cases involving exposed parts of the face (i.e. ears or nose) were seen. The great toe was invariably affected, then in declining order of frequency the other toes, the fore part of the foot, the heel, the whole foot, and in only one case the leg above the ankle.

TREATMENT

**Incipient Cases**.—The literature on cold injury paints such a gloomy and alarming picture of the complications and prognosis that the first few cases were admitted and treated most actively along orthodox lines, but as our experience increased, and also as the numbers, both of cold injury and battle casualties, began to cause overcrowding, incipient cases were treated as out-patients, being discharged on the arrival of the convoy.

The treatment adopted was simple, consisting of contrast baths twice daily, and foot exercises repeated hourly. The patient should be assured that complete recovery is the rule in this stage.

**Slight**.—Cases with reddened and hyperhidrotic feet, sometimes also showing brown pigmentation, were kept in bed with the feet exposed to the air until blanching of the nails on pressure, with rapid return of colour on the release of pressure, indicated that the circulation in the foot was adequate. These cases
were then treated as above. Hyperhidrosis was occasionally severe, but most cases responded to a simple foot powder containing one-sixth part of camphor. It was noticed that most cases showing marked hyperhidrosis gave a history of constitutionally "sweaty feet."

Hyperhidrosis was by no means universal and several cases showed anhidrosis.

**Moderate.**—Cases with vesiculation were given one million units of penicillin intramuscularly before being taken to the operating theatre, where, under sterile precautions, the blistered area was carefully and gently cleansed with Cetavlon and the dead superficial skin removed. It was noticeable how the underlying raw area changed colour from blue-black to red as soon as this was done.

The patient was then returned to bed and the feet were left elevated and exposed to the air, no dressings being employed, but penicillin therapy was continued until a flexible black crust had formed. Exposure to the air and recumbency were continued until the crust had flaked off, leaving a healed, pink surface, resembling a healed superficial burn. This took four to six weeks to occur, and separation was completed in six to nine weeks. As soon as it was clear that no loss of tissue had occurred, and the crusts had completely separated, treatment by contrast baths was instituted.

**Severe.**—Cases with blackened and shrivelled extremities. The initial treatment here was simply exposure and recumbency, with elevation of the limbs if œdema was present. Earlier cases received prophylactic penicillin, but this was discontinued when experience had shown that, as long as the part was dry, infection did not occur. Surgery was withheld until obvious separation of the tissues had commenced. The test devised by Lange and Boyd (injecting 10 ml. of 5 per cent. fluorescein in 5 per cent. sodium bicarbonate solution, and inspecting in a darkened room by ultraviolet light) was not employed as it is only claimed to be reliable if performed within fourteen hours of exposure, and our experience was that even in cases which appeared clinically to have complete dry gangrene of the fore part of the foot the degree of recovery was remarkable, and in one or two cases outstanding (see below).

**Cases with Loss of Tissue.**—When finally separation had commenced, the dead tissue was removed under general anaesthesia, any protruding bone was excised and immediate skin grafting performed, unless there was hæmorrhage from the tissues; if hæmorrhage occurred, pressure dressings over tulle gras were applied and grafting delayed for two days.

Grafting was preceded by the administration of one million units of penicillin parenterally, and split skin postage-stamp grafts were used unless the area was small, when pinch grafts were used; the grafts were laid on the raw area and no dressings of any kind were applied, the exposure being continued.

Earlier cases were dressed in a more conventional manner with pressure dressings, but experience with the exposure method in grafting buttock wounds had proved so successful that the exposure of grafts whenever possible is now my standard practice. It was considered that cases with loss of toes and cases with split skin grafting on the feet would not be likely to serve in a forward medical
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category for some time, and that further plastic surgery might be necessary, so, as soon as complete skin cover was achieved, these cases were invalided home.

RESULTS

Incipient Cases (41 cases).—Adequate follow-up on these proved impossible, and in any case inquiry among officer patients revealed that numbers of such cases did not go sick, but remained with their units.

Slight Cases (32 cases).—Average length of stay in hospital was 9 days. Cases were temporarily downgraded to P3L3R for three months, and a recommendation made that they should not be employed in extremes of climate for this period.

Moderate Cases (61 cases).—Average stay in hospital was 36 days.

The disposal was the same as the slight cases, but it is probable that some of these will not be fit for upgrading at their next medical board in three months.

Severe Cases (18 cases).—Except for four cases, all these were evacuated from the theatre of operations. The average stay in hospital of the four cases ultimately returned to duty was 74 days, and all these cases were downgraded for six months.

ILLUSTRATIVE AND INTERESTING CASES

Case 17, Rifleman H.—Frostbite sustained at Suwong, in South Korea, on 12th January. Admitted to base hospital, 14th January. Was wearing British field pattern boots with two pairs of socks, and was on guard in the snow in foggy, freezing weather. On admission he had severe cold injury of both feet, which were black, shrivelled, and apparently dead from the toes to the level of the mid-tarsal articulation. Treated as above he began to desquamate after 30 days in hospital. His evacuation was arranged, but owing to a hitch in the air evacuation he could not go until he had almost entirely healed, only the big toes still being covered with black crust. At his own request, he was removed from the evacuation convoy, as he wished to continue serving abroad, and after minimal grafting of the toes, he was eventually discharged on 27th April. The degree of recovery in the man was quite astounding, and it had originally appeared certain that he would lose all his toes and probably part of the feet.

Case 19, Rifleman F.—In the same platoon as case 17, and sustained his cold injury at the same time. On admission on 17th January he had severe cold injury of the fore part of both feet, not quite so extensive as case 17. He was treated as above, and, on separation of the first, second and third toes of the right foot being apparent, these digits were amputated at the metatarso-phalangeal joints, and immediate skin grafting performed on 1st March. Healing was complete by 14th March and he was evacuated to England on the 23rd. This case appeared originally to be less severely injured than case 17, and both feet appeared to be equally affected.

Case 20, Rifleman A.—In the same platoon as the two preceding cases, and injured on the same “Stand-to,” but on his Field Medical Card was the entry by the Medical Officer: “Incredible but true! this man went on guard in three pairs of socks only, as his boots were frozen to the ground.” The patient confirmed this statement, explaining that he was unable to get his boots on, so had put on an extra pair of socks instead.
After reading these notes it was with considerable surprise that examination revealed only moderate frostbite of the great toes, with minimal vesiculation and pigmentation.

He also had moderate frostbite of the fingers of the left hand, and full recovery of sensation in the hand delayed his recovery and he was not discharged to duty until 14th March. No skin loss occurred in this case, in spite of inadequate protective clothing.

Case 35, Fusilier H.—This man was the driver of a truck which broke down and he spent several hours during the night in the cab of his vehicle, crouched over the engine attempting to repair it. On alighting he found that he could not stand, and he was evacuated with cold injury, arriving two days after injury, on 23rd January. Clinically he presented the typical picture of trench foot, although he had been exposed to dry cold. The feet and legs were blue and grossly swollen and acutely tender. On elevation and exposure the swelling subsided in four days and the legs and feet were dry and painless. This patient was evacuated to England on 20th February for compassionate reasons, and I have heard that considerable skin grafting was required, but no amputation was necessary.

Case 74, Private J.—Injured on 15th January south of Inchon in conditions of severe cold with snow when he was on patrol wearing American “Shopaks” (a rubber and canvas laced half-boot of the “Lumberjack” pattern) and two pairs of socks. He had severe cold injury of the right second toe and both great toes, with moderate cold injury of the other toes. He was treated in the manner described above, but his recovery was delayed by his absenting himself and sustaining a venereal infection before healing was complete. Re-epithelialization and full recovery of sensation were complete on his discharge on 27th April.

Case 94, Private McC.—Sustained cold injury whilst on guard at Taegu on 15th January. Admitted to Osaka Hospital (U.S. Army) on 20th January and treated there with intravenous procaine, penicillin, intramuscular nicotinic acid and multivite pills. Admitted to 29 General Hospital on 22nd February with severe cold injury of both great toes and the fifth little toe, early separation being apparent. These digits were amputated on 3rd March, with immediate skin grafting; some further sloughing necessitated further skin grafting on 13th March, but healing was complete on his evacuation to England on 28th March.

DISCUSSION

Cold injury has been the subject of much research, chiefly by American and Scandinavian workers, and the conditions known as frostbite, trench foot and immersion foot have been described. Cold injury does not occur until the tissue temperature falls below 15° C., vascular contraction does not occur until a temperature of 10° C. is reached, and freezing of the tissues does not occur until the tissue temperature drops to −2.5° C. (Stray). Full recovery is possible even after freezing provided that the oxygen requirements of the tissues at no time exceed the supply; thrombosis is not a feature of cold injury unless infection or necrosis supervenes, but the phenomenon of “conglutination” (Blackwood), when the capillaries become blocked with a solid plug of cells, left after the exudation of plasma, is responsible for the damage which occurs on recovery from cooling. Recent experimental work (Finneran and Shumacker) suggests that the best degree of recovery is obtained by the rapid warming of the tissues to blood
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heat or slightly above, but the application of this to first-aid measures in the field is of doubtful practicability. Briefly, frostbite occurs when relatively ischaemic tissues are subjected to rapid cooling, and trench foot when a dependent and engorged limb is subjected to slow cooling in mud or water at or near freezing point. It is felt the conditions in Korea, where troops were continuously in the open and exposed to intense cold by night, but only moderate cold by day, gave rise to a form of cold injury intermediate between frostbite and trench foot, not hitherto described, and affecting the lower limb almost exclusively.

The prevention of cold injury is simply the maintaining of an adequate tissue temperature, and this can be achieved in two ways—(a) by preventing heat loss and (b) by increasing heat production. The prevention of heat loss in conditions such as Korea is more difficult than in true arctic conditions, as completely insulated and impervious clothing leads to increased sweating during the relatively warm hours of daylight, and as the sweat cannot evaporate, the feet, being wet, will freeze at night; greater attention should therefore be paid to increasing the warmth of the tissues by avoidance of constriction, and the routine performance of foot exercises. Case 20, it is felt, illustrates the importance of avoiding constriction and of allowing free movement of the feet, as this man, in totally inadequate clothing, was less severely injured than some of his comrades.

The forward treatment of these cases was by preventing further trauma to the affected part and the slow restoration of circulation by: (a) Removing the casualty to warm shelter; (b) application of warmth to the body; (c) no attempt to apply heat directly to the affected part; (d) keeping the affected area dry; and (e) protecting the area with cotton-wool against trauma in transport. (Kilgour.)

The treatment outlined above for cases after their arrival at the base hospital was adopted for a number of reasons, principally because it was felt that, by the time that these cases had arrived in hospital, recovery had commenced and that rest and the avoidance of infection were the primary requirements. Heparin was not exhibited as our supplies were extremely limited, and the available literature stressed that thrombosis is not a common concomitant. Vasodilators were not employed as all cases showed marked clinical vasodilatation, and the place of these drugs in the condition is not yet proved; for the same reason, smoking was not forbidden. Sympathectomy has been shown to have no value, and indeed some authorities state that it is harmful; it may have a place in the treatment of severe causalgia, but none of our cases exhibited this sequela. As indicated above, a number of cases had tender feet which necessitated their being temporarily downgraded into a lower medical category.

Incidence

Incidence of cold injury among the wounded was not at all marked, except among the Marine casualties in the retreat from the Chosin Reservoir; and, excluding these cases, only two wounded men also exhibited cold injury, both being classified as slight. As was to be expected, the incidence was greatest in the infantry, with a rate of 2.13 per cent. and a range of from 7.82 per cent. in one battalion to 0.65 per cent. in that at the other end of the scale. Other troops had
an over-all ratio of 0.37 per cent. with a range of from 1.54 to 0.12 per cent. Although a greater incidence was expected in older troops, this difference was not marked, and the battalions composed of recalled reservists were all below the average; similarly there did not appear to be a marked difference in the degree or time of recovery in the older men.

CONCLUSIONS

With adequate clothing and training, the incidence of cold injury, even under extreme conditions, can be kept down to a relatively insignificant figure.

A simple and conservative line of treatment gives a high proportion of recovery.

Recovery is, however, slow, and most cases must be regarded as non-effectives for a period of months.

Surgery, in the absence of infection, has no place in the early treatment, but should be delayed until the death of the tissues is clearly evidenced by separation of the dead tissues.

Apologia.—It is regretted that the above account is not as detailed or as informative as I could have wished, but during the time that these cases were under treatment some 800 battle casualties were admitted, in addition to the usual accidentally injured and sick cases from the Commonwealth force.

SUMMARY

The management of the cases of cold injury occurring in the Commonwealth troops fighting in Korea in the winter of 1950-51 is described and the mechanism, prevention, and treatment of cold injury discussed.

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REFERENCES

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