REMARKS ON THE CONDITION KNOWN AS TRENCH FOOT.

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Two hundred and forty cases of trench foot were admitted to hospital during last December and January. Many hundreds of cases were admitted to other hospitals during the same period, but I only had the opportunity of studying these 240 cases. I had had during the previous winter a not inconsiderable experience of this condition.

The worst cases came from G—early in December, following the four days of severe rain and frost which were experienced at the end of November, 1915. The frost followed immediately on heavy rain storms. The cases on arrival in hospital were from five to twelve days from the time that symptoms of frost-bite were first noticed. Great numbers of men had to be evacuated from the Front, the hospital ships were necessarily crowded, and in the rush the locality became with its numerous hospitals and 20,000 beds one huge clearing station.

The following classification of frost-bite cases from the point of view of diagnosis and treatment was found of practical value at the hospital:

Class I was represented by a number of patients who when seen had almost recovered from the effects of exposure to cold. The feet were normal except for some tenderness and aching pain, chiefly at night. All that was necessary was to supply them with some thick, warm foot-gear and keep them in hospital for a time.

Pain and tenderness continued in some, though from physical examination no gross lesion could be detected; a neurotic element was undoubtedly present in certain cases, though the majority were genuine.

Class II. Slight Cases: those that would be fit for Duty in less than two Months.—On admission a patient of this class gave a history of swelling of the legs following the exposure to prolonged cold and wet. The swelling lasted for some days. It had now almost completely disappeared. As the swelling subsided severe pain described as rheumatism was felt in the legs. Walking was only possible with pain and difficulty, and when attempted
progression was effected by shuffling along the ward. Boots could not be borne. The feet and legs were at this time of nearly normal appearance, a little blue, or perhaps whiter than normal in places. Some of these cases had still edema over the heads of the metatarsal bones. Small patches of anesthesia were usually present on some part of the foot and above these patches areas of hyperesthesia. The general condition was unaffected.

CLASS III. Cases with Local Gangrene of Toes, or Toes and Heel, but without Constitutional Disturbance.—These cases were often sent on to England at once in order to (1) make room for the admission of fresh and perhaps more urgent cases, and (2) because they would not be fit for service for some months.

The general condition of these men was good, though they were not quite well like those of Class I. They were quite fit for the voyage to England.

The type showed superficial patches of gangrene limited to the toes and heels. The toes were in some cases ultimately lost. The gangrenous process varied in depth.

Generally beyond the gangrenous areas and often separated from them there was some impairment of the circulation in the feet and legs, as evidenced by edema, and patches or larger areas which were blue or white, and cold and anesthetic. The anesthetic areas in some extended up the leg for a considerable distance. Pain was conspicuous by its absence.

CLASS IV. These Cases were all Septic and all had more or less Constitutional Disturbance.—(a) In the slighter cases the toes were gangrenous, and pus was spreading into the sole of the foot, generally extending from the space between the first and second toes. In some the extension partook more of the nature of a cellulitis of the deeper tissues of the sole. The dorsum of the foot was edematous, as were also the tissues around the ankle. The putrid odour from the feet was marked. The temperature was raised, pain was not severe, but the patient had no appetite and felt ill.

(b) The next series of cases comprised a group in which the condition was worse than that described under (a). The purulent infection had involved the whole sole of the foot and fluctuation was sometimes found on either side of the tendo Achillis. The dorsum of the foot was more edematous and sometimes showed blebs. The oedema extended high up the leg. In some the posterior astragalo-calcanean joint was full of pus. The constitutional disturbance was severe.
(c) In the most severe cases the whole foot or the anterior half of it was obviously gangrenous, the skin being of a purple black or green colour and often mottled. The skin for some distance above the gangrenous part was of a dull red colour. When the foot was not in outward appearance wholly gangrenous, yet on incising the skin the cellular tissues and muscles were often grey in colour and obviously past recovery. In all these cases the metatarso-phalangeal joints were involved; also generally the cuboid-metatarsal joints and sometimes all the other joints with the exception of the astragalo-scaphoid and ankle joints. The spreading cellulitis around the tendo Achillis had often followed the line of the tendon into the deep parts of the back of the leg: The leg was oedematous as high as the knee. The temperature was 104° F. or 105° F., and in the worst cases of all, drowsiness, dry tongue; and slight albuminuria, all due to septic toxaemia, were observed.

Treatment.—All the cases on arrival had suffered from cold and wet several or many days previously. The primary condition was not observed and treatment in Malta was, therefore, directed to the later stages of frost bite.

Classes I and II.—These cases were very similar to those which I had to care for during the winter of 1914-15. The cause then was not due to the effect of severe frost but to long exposure to cold and wet.

It is to be noted that this exposure in all cases produced changes in the blood supply and in the innervation of the feet and legs. While the vascular obstruction remained obvious, little pain was experienced, and when it subsided pain and other nerve conditions became manifest. It was obvious that the frost had affected not only the vessels, but also the nerves of the feet and legs.

The damage to nerves persisted long after all other changes in the limbs had been recovered from—in other words regeneration of nervous tissue is a longer process than that of other tissues.

In the majority of cases the only treatment that seemed to be really useful was loose, warm stockings, overlays of wool, and foot coverings made of thick, warm, soft material, which came well above the ankle. In only a minority of cases anodyne applications, such as lead and opium, or stimulating greasy applications such as lanoline and turpentine, were of any service. Gentle massage was useful in some cases, but in others it could not be borne.

Time was the essential factor in the cure of the signs and symptoms depending on the changes taking place in the nerves, and while treatment could ameliorate the condition, time alone could cure it.
Class III.—These cases may be divided into two groups: (a) The *dry gangrene* cases were in the minority. They were treated just like dry gangrene in civil life—i.e., the attempt was made to keep them dry and free from sepsis. The parts were soaked daily with alcohol and dressed with boric acid or some other powder and cotton wool. When first admitted the toes and feet were very carefully cleaned with ether soap and then with turpentine or ether; (b) the *moist gangrene* cases were really only cases of foul septic wounds accompanied by some changes in the vascular and nervous systems. The most effective dressing was the use of a solution of iodoform in ether, 1 in 10, or the use of gauze soaked in eusol. Sometimes the former was used to wash the wound and then the eusol dressing was applied. This treatment was often observed to cause the moist wounds to take on much the same appearance as those grouped under the heading “dry gangrene.” In other words the septic condition was mastered.

The dead skin and subcutaneous tissue of the affected toes and heel separated, exposing a healthy granulating surface. This healed readily under eusol dressings and under treatment by red lotion or resin ointment.

When all the tissues of a toe were involved, a line of demarcation formed at the base of the toe. The toe was then disarticulated at the metatarso-phalangeal joint—usually no anaesthetic was required. The stump healed over quickly.

When the gangrene of the heel reached a deeper level than the superficial fascia, the period of healing was much delayed, sloughs of the soft parts and occasionally a superficial sequestrum of the os calcis separated before the wound could heal.

Class IV.—These cases on arrival were not cases of frost-bite, but were cases of spreading gangrenous cellulitis. In the infective gangrenous cellulitis of the lower extremity which the surgeon has to treat in peace time there is no disease of the vessels and nerves such as was present in these cases. The principles of treatment remain the same, but the war cases yield less easily to treatment because the infective cellulitis is complicated by a condition which weakens the resistance of the tissues.

In this class of case treatment was carried out on the following lines:

1. For oedema, cellulitis, and local abscess formation, *free incision*.
2. For hopelessly gangrenous cases, *amputation*.
3. *Antisera and vaccines*. 
(4) Certain intravenous antiseptics—such as ten cubic centimetres of 1 in 1,000 perchloride of mercury, 100 cubic centimetres of eusol solution.

(5) Ample nourishment and stimulation.

(6) Frequent moist dressings and in some cases baths.

An incision into a definite fluctuating swelling deep along the inner border of each foot in one case caused rapid convalescence; in fact, whenever an abscess was opened improvement was always assured. The bad cases, as might be expected, were those in which the condition was a spreading grey gangrene of the cellular tissue without local abscess but with much oedema. Free incision into this oedematous cellulitis was not as fruitful of improvement as in the spreading cellulitis where the vessels and nerves were not affected, and often yielded disappointing results.

In the sole of the foot when the latter was much swollen it was often difficult after a most careful examination to say whether a local abscess or cellulitis was present. It did not much matter as free incision in either case was indicated, unless it seemed better to amputate.

Amputation.—All cases improve, some marvellously, after a short time in hospital with good nursing and food. There is never any justification for an immediate amputation. Even when amputation is subsequently necessary, a few days in hospital greatly improves the local condition and general condition of the patient and fits him for the shock of the operation. Cases which appear to need a high amputation when admitted may, in a few days, require no amputation at all, or only a peripheral one. If amputated at the moment of admission such cases with high fever and much exhaustion are likely to die, though if no operation is done they may still die in a day or two.

The usual plan of performing a formal amputation and the cutting of classical flaps should be set aside by the surgeon in considering the site and type of operation to be carried out in many of these cases. The object in view is to place the patient in such a state that the immediate risk to life is diminished. At some later date, when the general condition is good, it will be time enough to consider whether the stump can be improved; as will often be the case, by some further operation.

No one of experience, seeing the result of some of the operations, would condemn them because the bone was not properly covered, or because it offended the eye by not being planned on text-book lines.
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It has been mentioned that, when the toes were gangrenous, with little assistance by way of operation they came away at the metatarso-phalangeal joints and healing took place. The result was a useful foot.

When the foot itself was involved the question of the amputation to be performed varied with the extent of the cellulitis or gangrene present. Satisfactory flaps could not always be cut on classical lines. One Lisfranc and one Chopart amputation were done. The Chopart amputation gives, as I am informed, a useful stump, if the nerves are cut short. If the nerves are not cut short the patient walks on them, as there is no arch to the foot, and of course the stump becomes painful, pointed, and unsatisfactory.

The Syme amputation was not always satisfactory since the suppuration in the sole has a tendency, as already described, to spread to the region of the tendo Achillis, and so the heel-flap was prone in part to perish. This did not necessarily mean another amputation, but all that was required was the resection of one to two inches of the tibia and fibula, when the bone could be easily covered. In some of the cases a higher amputation would have been better than the one performed, but it was done to save as much of the limb as possible, especially when both feet were gangrenous and deep cellulitis was sometimes discovered at the operation at a higher level than it had been previously suspected.

Amputation through the lower third of the leg was necessary when the gangrene involved the whole of the foot and lower portion of the leg. When the operation could be performed through tissues which were not oedematous to a very marked degree, without sacrificing too much of the limb, recovery and healing were comparatively rapid.

Circular, equilateral flaps, and modified flap and circular methods for amputation of the leg were all employed. For both speed of operation and after-results the latter form of operation was good. A circular incision was first made round the circumference of the limb, including skin and subcutaneous tissues down to the muscles, then an anterior and posterior vertical incision of 1 inch or 1½ inches so that two short lateral flaps were formed at the distal end of the circular amputation. These short incisions in the flap of a circular amputation were helpful in exposing the remaining tissues to division and the posterior one facilitated drainage. The muscles and tendons were divided at a rather lower level than the bones, and care was taken to cut the nerves short. Thus there was no unnecessary sacrifice of any portion of the limb in the formation of
classical flaps. The operation could be performed quickly and a good stump resulted. Few or no stitches were inserted, so that ample drainage should be provided; one stitch was often sufficient to prevent retraction of the flaps.

Scheme of Amputation.—(1) Open ether was used for the anesthetic so long as the lungs were healthy. An injection of atropin 1/50 grain, morph. tart. 1/8 grain was given half an hour previously.

(2) The limb was thoroughly cleansed and shaved at the proposed site for operation, careful washing with ether soap being followed by the application of ether. When quite dry it was painted with a two per cent solution of iodine in rectified spirit. A bandage which had been previously soaked in 1 in 20 carbolic acid was wound round the gangrenous portion, which was then covered with a sterilized towel.

(3) Ten minutes before the operation was commenced the great sciatic was injected with a four per cent solution of eucaine. In some cases, too, the skin and muscles just above the operation area were injected with the same solution.

(4) Up to 2½ pints of normal saline were infused either subcutaneously or intravenously at the same time as the operation was taking place; in some cases intravenous antiseptics were added to the infusion.

(5) Subcutaneous injection of thirty cubic centimetres of polyvalent antistreptococcal serum was given at the time of the operation.

(6) Great care was taken to keep the patient warm during and after the operation. In the worst cases special nursing, heart stimulants, and food were all-important during the first three days. By these means post-operative shock was reduced to a minimum, and was entirely absent in some of the very worst cases.

Antisera and Vaccines.—Polyvalent antistreptococcal serum was of great service in many cases where a streptococcal infection was present. We gave 30 cubic centimetres as the first dose, followed during the next twenty-four to forty-eight hours by two or three doses of 20 cubic centimetres or 10 cubic centimetres. Some cases showed marked improvement after the use of this serum.

A prophylactic dose of antitetanic serum was given soon after admission in all cases in which there was a wound. We had one fatal case of tetanus where a severely frost-bitten foot was the site of infection. This patient was admitted with tetanus and died twelve hours after admission. He had not had any antitetanic serum.
Vaccines were especially useful in some cases of the fourth class in which the suppuration was chronic, and the process of repair had come to a standstill. In these cases the use of an autogenous vaccine produced remarkable results and rapid healing. In cases with septicemia a blood culture was always taken and if an organism was isolated a vaccine was employed. A stock vaccine should be used till the autogenous vaccine is ready.

_Intravenous Antiseptics._—These were used at the time of operation and in some cases the injection was repeated a second or third time at intervals of several days. The perchloride of mercury seemed to be very useful in some cases, and certainly seemed to be of more value than intravenous eusol.

_Prophylaxis._—Loose-fitting watertight boots should be worn over two pairs of thick warm socks. I have heard it recommended that the feet should be kept smeared with some greasy preparation and I imagine that this precaution would be of use in preventing the effects of cold and damp. The feet should be kept as clean as possible, so that if frost-bite occurs infection will be less likely to follow—this, however, is not easily managed in trench life.

Regular physical exercise to maintain the tone of the vascular system is the finest preventive, but it is not, however, easily obtained under existing conditions of trench life during winter. When I was in France I found that frost-bite was least common in those regiments which occupied the best trenches. The reason, I believe, should be less attributed to the slightly more habitable conditions than to the regular amount of work done by these men in repairing their trenches under cover of darkness every night. Massage of the feet every night is a form of exercise which would have very beneficial results.

The wearing of puttees predisposes to frost-bite because they constrict the legs, more especially when they become damp and the material shrinks. In many of the worst cases admitted puttees had been worn. They were soaked in water and then froze on to the limbs. No wonder gangrene occurred.

**Some Notes of a Few Typical Cases Illustrating Examples of the Different Classes of Frost-Bite.**

Class II.—Pte. B., December 6: Admitted to hospital suffering from frost-bite. Both feet were blue, slightly oedematous and painful. No lesion of skin. The feet were thoroughly washed and dried, dusted with boracic powder and loosely bandaged over a thick
layer of cotton wool. Patient complained of considerable pain at night, which prevented him from sleeping. On December 10 the swelling was subsiding and pain less troublesome. December 30: The œdema had disappeared and the patient was walking about the ward. He complained of a good deal of pain after walking for any length of time. Improvement had been steady but very slow. January 17: Progress very slow, patient transferred to England.

Class III. “A.”—Private C., admitted December 13, 1915. Frost-bite affecting all the toes of both feet. The toes were gangrenous but dry. They were shrivelled and black in appearance with a well-marked line of demarcation along the proximal end. Above this the tissues of the foot were slightly œdematous. Temperature normal; very little pain. The wounds were dressed with iodoform in ether solution. December 23, 1915: Some of the toes disarticulated. January 11, 1916: Transferred to England; wounds granulating, clean and almost healed.

Class III. “B.”—Pte. B., December 3, 1915: Admitted to hospital. The toes of both feet were black and gangrenous. The feet were œdematous and blue with a large superficial ulcer on the dorsal aspect of each foot. Both feet were anaesthetic. The odour from the feet was most offensive. Temperature 104.2° F., but the general condition was not proportionately affected. December 13, 1915: Temperature only rising now to about 100°F every evening. The œdema is gradually diminishing and the feet, except for the toes, are now white. The toes were separating and suppuration was present at the line of demarcation. Dressings: Eusol fomentations and the application of iodoform in ether solution. December 20, 1915: All toes of both feet disarticulated. The œdema is steadily decreasing—general condition is considerably improved. January 10, 1916: The wounds are almost healed, though some œdema is still present. The feet are almost completely anaesthetic below the ankles. Patient has had an attack of malaria. January 12, 1916: Transferred to England.

Example of a Case of Local Abscess in Foot, Incision, Recovery; Simulating Gangrene.

Class IV.—Pte. W., admitted to hospital December 8. Great œdema of both feet and legs, the feet below the ankle are of a greeny black colour and mottled. Above this the legs are white and the skin glazed on account of the amount of œdema present. Both feet are anaesthetic to superficial and deep sensation. A very foul smell comes from the feet. Temperature 104.8° F. and the
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condition is most toxic. On the inner side of the left foot, just below the head of the astragalus, definite fluctuation is felt; on the right foot it is doubtful whether any fluctuation is present or not. An incision on 1½ inches in length was made over the site of the fluctuation on the left foot. This was deepened till the under surface of the tarsal bones was reached through more than an inch of boggy oedematous tissue; then, by thrusting a pair of sinus forceps deeply into the sole of the foot, at least an ounce of thick pus was found; a drainage tube was inserted. The right foot was similarly dealt with, about one tablespoonful of pus being evacuated. No anaesthetic was required and the patient experienced no pain whatever. The next morning the patient's general condition was greatly improved, temperature normal. The feet steadily improved. He left for England on December 31, having lost only two toes of one foot from gangrene. A small amount of oedema was still present and sensation was gradually returning in the feet.


Class IV.—Pte. H., December 6, 1915: Admitted to hospital, pale, emaciated, considerable pain; temperature 101·8°F. Both feet and lower part of legs oedematous, anaesthesia over these areas. Most of the toes gangrenous and septic. Superficial patches of gangrene on dorsum of each foot and both heels. December 8, 1915: Considerable pain, temperature goes up at night to 101°F, gangrenous patches on feet and heels separating. December 23, 1915: A number of toes amputated. Incisions