THE SYMPTOMS AND TREATMENT OF TRENCH FOOT.

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(1) INTRODUCTION.

Winter is coming on, and with it the mud which is now such a by-word in France and Flanders. And of all the diseases that the mud brings with it, the most important, perhaps, is trench foot. The wastage from this affection is very high at times, and, although prophylactic measures are beneficial, nothing has yet been found that is likely to prevent the disease from occurring again this winter. Trench foot will occur, and this fact must be faced—that in the previous winters of the war no standard treatment for trench foot has been adopted in the British Expeditionary Force.

The camphor treatment of Médécin-Majors Raymond and Parisot met with great success in the French Army in the year 1916, and a D.M.S. in our Army instituted a systematic trial of this treatment in the medical units under his command last winter. Having treated, in collaboration with Captain Carswell Marshall, R.A.M.C.(T.F.), over 600 cases of trench-feet at a casualty clearing station during this period, I am convinced that the camphor treatment, with slight modifications as described below, is the best treatment that has yet been found both for trench foot and for frostbite.

Many cases have been followed up by letter, and of these every single case which, on leaving the area, still required treatment, had the treatment changed. And, judging by the reports received, in every case the change was for the worse as far as the effect upon the feet and their rate of healing was concerned. I therefore venture to urge very strongly that this treatment be much more widely adopted, at least until such time as a better shall have been discovered.
Fig. 1.—Late stage of severe trench foot. The blister has been cut away, and the slough is beginning to separate; on the proximal side of the sore, healing is commencing.

Fig. 2.—Four stages in the detachment of a toe. A. The discoloured area shows a definite edge; no blister has formed as yet. B. The blister has formed and been excised; the tip of the toe is gangrenous; the rest is viable. C. Represents rather a more severe case in which the whole toe has become gangrenous and separated; the phalanges with their ligaments are left; the base of the toe is granulating healthily. D. The two distal phalanges have been removed; the toe is now ready for a resection of the proximal phalanx at the joint; healing of the skin at the edge of the granulation tissue has commenced.

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(2) ETIOLOGY.

Trench foot seems to bear such a well-defined syndrome of symptoms, resembling several other conditions, but not identical with any, that it may be considered as a clinical entity. Moreover, Médecin-Majors Raymond and Parisot, who have done much work on the subject in the French Army, have isolated a saprophytic organism, Scopulariopsis koningii; to which they attribute the condition. This organism was found in the mud of the trenches, and under the toe-nails of persons afflicted with trench feet; through which channel it usually enters the foot. It has been found by these observers to obey Koch’s postulates, having been isolated from the bile of severe and jaundiced cases of trench foot. When injected into animals, it has produced the characteristic patches of local gangrene usually associated with trench foot.

Predisposing causes seem to be the following:—
(1) Soddenness of the feet, especially if brought about by wet mud over a period of several days.
(2) Cold.
(3) Prolonged stasis and inactivity.
(4) Tightly laced boots and puttees. The condition is always worse in cases who have had ankle boots, tightly laced, than in those who have worn gum boots. Moreover, the affection seldom extends above the ankle.
(5) Previous attacks of trench foot.
(6) General exposure. The hands, and, in kilted regiments, the penis, are sometimes attacked.

Considered entirely from the clinical standpoint, the condition seems to be an acute peripheral neuritis. This explanation would account for:—
(1) Vasomotor disturbance, coldness of the feet and the occurrence of local gangrene, which is always superficial, and somewhat resembles a trophic gangrene.
(2) Pain, sometimes intense, and sometimes very persistent.
(3) Anaesthesia, always present for a short time, and often followed by
(4) Hyperaesthesia of portions of the foot.
(5) Persistent neuritis of the foot and leg, often lasting for several weeks; this occurs in about seven per cent of cases, to a greater or less extent.

(3) SYMPTOMS.

Owing to the diversity of the symptoms in the different grades of cases, it is desirable to consider these in separate groups, both as regards their symptoms and the appropriate treatment:

Class A.—Slight Cases. Twenty-five per cent of all Cases.

These have pain in the feet and sometimes also in the calves. There is also more or less anaesthesia, especially of the dorsum of the foot; there is little or no swelling of the feet. This degree of the malady is not serious, and passes off in a week or two.
Class B.—Moderate Cases. At least sixty per cent of all Cases.

Besides having pain and anaesthesia with or without hyperaesthesia of parts of the feet, these cases present a very characteristic swelling of the foot. Clinically it does not resemble an ordinary œdema, and often does not pit on pressure. Nor is it at this stage a blister, though it often exhibits some degree of fluctuation. It is, in fact, a condition intermediate between these two, and its semi-fluctuating, tense nature is very characteristic. After a few days (three to fourteen) the swelling subsides and the case becomes similar to those in Class A.

Class C.—Severe Cases. Nearly fifteen per cent of all Cases.

These cases, at first like those of Class B, with pain, swelling and disturbance of sensation, develop in addition a localized discoloration of the skin of the foot. This is most evident on the dorsum of the foot, and is of a dull copper-red colour at first, changing after a day or two to a more bluish shade. Part only of the discoloured area persists (generally the distal portion). This soon develops a definite edge, and over the discoloured area, extending roughly as far as the edge of it, the œdema resolves itself into one or more blisters of variable sizes. These are usually on the dorsum of the foot, and nearest to the two edges of the foot. The blisters of small size (as large as a sixpenny-piece or less) sometimes subside in a few days. The larger ones often spread and become confluent. When they burst or are cut off, an area of superficial necrosis, a little smaller than the area of the blister and of a greyish-purple colour, is revealed. In two or three days this necrosed portion of tissue begins to turn black and to separate slowly, commencing at the edges. Underneath these patches exists granulation tissue, and the necrotic portion rarely involves more than the dermis or subcutaneous tissues. The further appearances are described under the heading of Treatment. Healing takes place from the edge of the area where the blister has been, and is sometimes surprisingly rapid under appropriate treatment.

In less severe cases the swelling and discoloration both subside, and the case shows the characters of those in Class B.

In the more severe cases the discoloration involves the whole of one or more toes which become gangrenous. This gangrene seldom or never extends beyond the metatarso-phalangeal joint, except that which involves the skin only. The gangrenous portions separate as already described, and healing takes place by granulation.

Class D.—Grave Cases. Very rare, one Case in 200 to 500.

These patients, besides having the condition already described as regards their feet, show also serious constitutional symptoms, with high pyrexia (up to 105° F.), great prostration and later jaundice, nephritis, and œdema of the lung; sometimes the affection is fatal. I have seen but two such cases among over a thousand patients.
Tetanus is fairly common, occurring in one to two per cent of uninoculated cases. Of one series of 250 such cases from the same battalion, four died of tetanus in the second or third week after exposure to trench feet. Neuritis persists for weeks in some cases, attacking the feet, legs, thighs and groins.

(4) PROPHYLAXIS.

Of prophylactic and preventive measures the writer has had no experience. It is advisable, however, for the sake of completeness, to mention here the main principles on which this is conducted.

(1) Drainage of the trenches.
(2) Disinfection of the foul or stagnant parts of the mud therein, as far as is possible.
(3) The cleansing of the feet of those who are about to enter the trenches. For this purpose they are well scrubbed with either:

(a) Camphor soap made of—

<table>
<thead>
<tr>
<th>Powdered camphor</th>
<th>...</th>
<th>...</th>
<th>4 oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powdered borax</td>
<td>...</td>
<td>...</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Soft potash soap</td>
<td>...</td>
<td>...</td>
<td>10 lb.</td>
</tr>
</tbody>
</table>

If this is not available, one may employ:

(b) Ordinary soap used with warm water which has been made alkaline with carbonate of soda, about a handful of soda being used for a tub of water.

The toe-nails are cut short and thoroughly cleaned. The feet are dried and powdered with—

<table>
<thead>
<tr>
<th>Talc powder</th>
<th>...</th>
<th>...</th>
<th>...</th>
<th>40 parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powdered Camphor</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1 part.</td>
</tr>
</tbody>
</table>

Clean, dry socks are put on. The boots are washed out with a strong solution of carbonate of soda. This should be done last thing before entering the trenches, and, if possible, twice a week at least when out of the line.

(5) TREATMENT.

A.—The Camphor Treatment.

On admission to a dressing station or casualty clearing station at least 500 units, and in severe cases 1,500 or even more units, of antitetanic serum should be given if not already done. In addition to this the feet should in all cases be washed thoroughly with the camphor soap described above, and the toe-nails should be cut and cleaned. Further treatment is different for the different degrees of severity of the complaint.

Class A.—After the feet have been washed and thoroughly dried, they should be wrapped in cotton-wool bound loosely round with a bandage. They should be sent to bed, or if beds are not available, to lie on stretchers, with plenty of blankets. The ward should be comfortably warmed. After
three or four days, if pain and tenderness have to a great extent disappeared, the patient may be allowed up, at first without boots, and afterwards with them. After a few days he may be given light duties in the hospital, and should not be sent back to full duty until his feet are quite fit. Two pairs of socks should be worn with the boots for several weeks after the patient has finished his treatment. Of over 100 cases, of this degree of severity, sixty per cent were fit for return to duty in under a fortnight.

Class B.—After the cleansing described above in all cases in which a swelling of the feet is manifest, in place of the dry cotton-wool a wet camphor compress is applied. A piece of cotton-wool, or, better, Gangee tissue, is dipped into the following lotion:

<table>
<thead>
<tr>
<th>Camphor</th>
<th>1 part.</th>
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<tbody>
<tr>
<td>Sodii biborae</td>
<td>15 parts.</td>
</tr>
<tr>
<td>Water to</td>
<td>1,000</td>
</tr>
</tbody>
</table>

The wool is gently squeezed out and put on very fairly wet, being wrapped around the foot and covered with a piece of jacent. A convenient size for the wool and jacent is about eighteen inches square. Dry wool is put over the dressing and loosely bandaged with a roller or triangular bandage. The patient is sent to bed and kept as warm and comfortable as possible. No special diet is necessary. The compress should be renewed every day as long as the swelling persists. After the swelling has nearly subsided it may be removed and dry cotton-wool wrapped around instead. From this point onwards the treatment is as in Class A, save that convalescence is rather longer according to the severity of the case.

Of this class of case nearly 400 were treated at this casualty clearing station, and except in the more severe cases, the following was found to be the average routine:

| Wet compress on feet | 3 to 8 days |
| Dry wool on feet, patient in bed | 4 to 7 |
| Up in ward in soft shoes | 3 to 4 |
| ... | ... |
| Light ward duties—kitchen orderly, etc. | 3 to 6 |
| Outside duties, including carrying rations, stretcher-bearing, etc. | 4 to 8 |

Total treatment before being fit for duty | 20 to 36 days |

The periods for which the patients were allowed on their feet, together with the nature of their duties, should be well graduated. A few obstinate

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1 A convenient way of making this is as follows:

A stock solution of four ounces of camphor to one pound of spirit, vini rect. is kept. Dissolve twelve ounces of sodii biborae in a quart or so of warm water. Add a gallon of cold water to this. Drop in three ounces of the camphor spirit solution. Fill up to five gallons, stirring all the time, with cold water. A five-gallon oil drum with the top cut off and used as a lid is a convenient receptacle for the lotion. As the liquid improves with keeping a good stock of it should be kept in wards and reception rooms or dressing rooms.
cases with pain, etc., require massage. As a routine treatment in this class of case it is useless.

**Class C.**—All cases of this severity should be sent to bed, if a bed is available, in a comfortable ward. They are treated as in Class B, until definite blisters or sores develop. When this occurs, blisters (except such of the very small ones as are not discoloured) should in every case be cut round their edges and taken away, together with all skin which is loose and easily detached. Over the raw surface thus exposed several layers of gauze are placed. On to them is dropped sufficient of the following solution thoroughly to moisten the gauze and the underlying parts:—

\[
\begin{align*}
\text{Camphor} & \quad \text{\ldots\ldots\ldots\ldots\ldots\ldots\ldots} \quad \frac{1}{2} \text{ oz.} \\
\text{Ether} & \quad \text{\ldots\ldots\ldots\ldots\ldots\ldots\ldots} \quad 1 \text{ lb.}
\end{align*}
\]

The wet compress already described is placed over this, and the dressing completed as in the case of Class B. This is done every day as long as the surface remains raw.

In these cases two things may happen:—

1. The raw surface remains pinkish-red and heals over from the edges. It must be kept clean at all costs. In the later stages the camphor treatment can be discontinued, and flavine solution or brilliant green ointment substituted. When the skin has healed over and is intact convalescent treatment is carried out as indicated above, but with longer periods to suit the gravity of the case.

2. Local sloughs may form. Generally they are roundish in shape on the dorsum of the foot, but they sometimes involve one or more entire toes. The sloughs should not be pulled or torn off, but allowed to separate of themselves under the dressing (which should be changed once or twice daily). If there is much pus present a day's dressing with Dakin's solution in place of the camphor lotion, followed by reversion to the camphor treatment, will clean up the sore considerably. When quite loose and detachable the sloughs can be pulled off with forceps, a freely granulating surface is revealed, and healing takes place from the edges of the sore. In those cases in which the toes are involved, when the flesh of the toe is loose it should be pulled off, the bones of the toe being removed at the nearest joint to the granulating surface. This can be done without an anaesthetic and does not hurt the patient. Subsequently the bone which is projecting from the granulating surface should be removed at the joint which is embedded in tissue (in nearly every case this is the metatarsophalangeal joint) under an anaesthetic. I have not seen a single case in which any amputation more extensive than this was necessary or desirable. Yet I know that such has been done. The foot in its early stages always looks worse than it ultimately turns out to be, and a foot that on the third or fourth day is blue and apparently dead from the tarsometatarsal joints onwards, will very likely resolve itself into a case in which only a few toes or parts of toes are lost. Keep the feet clean and camphorated and the patient comfortable, and Nature will do the rest.
The Symptoms and Treatment of Trench Foot

with far better judgment than the finest surgeon. Skin-grafting will be necessary in very few cases; the skin heals over from the edge of the granulating surface at a remarkable rate, and any dressing other than camphor lotion or flavine solution will decrease this rate.

As the condition localizes itself to the distal end of the foot, which it usually does in the second week (in this class of case), the affected part of the foot only need be dressed with the lotion. Prolonged soddenness of the sole of the foot, though doing no great harm, will slightly increase the period of convalescence.

*Class D.*—These require the same treatment as *Class C*, with the addition of a large dose, 2,000 units or more, of antitetanic serum, and several subcutaneous injections *per diem* of camphorated oil (one to three cubic centimetres at a time). Otherwise the treatment is symptomatic.

**Special Points to be Noted.**

The outstanding fact to be borne in mind with regard to all the more severe forms of trench foot is the importance of early application of the camphor compress. Under its influence the foot "settles down" in a remarkable way during the first few days, and a foot which if kept dry would soon show multiple sores will, under the wet treatment, very likely recover completely, or with only one or two blisters. This statement is based on the observation of over eighty cases in which comparative treatment was tried as outlined below. Throughout the early stages in severe cases, an injection of 1,000 units antitetanic serum should be given every seven days. All severe cases of trench foot are particularly liable to tetanus, even if the skin remains unbroken, and even in a few inoculated cases tetanus has occurred.

Another important point is the advisability of keeping the patient in the *recumbent position*. He should not be allowed to sit with his feet hanging down, or to stand, until the swelling has completely subsided.

*Warmth and comfort* are also necessary. In February, 1917, the severe weather, resulting, in the coldness both of the wards and of the patients' feet, retarded the progress of the disease in every stage, and even brought about one or two relapses. At this time the more severe cases, in an easily warmed bedded ward, did not suffer, comparatively, so much as the slighter cases in a tented ward which was impossible to heat thoroughly. Plenty of blankets, and hot-water bottles when needed, should be provided, and the food should be good and well cooked. The hot-water bottles may be put on the legs, but must not touch the feet. Patients exhibit much idiosyncrasy as regards their pain. Some have hot feet, while in other cases the feet are almost continuously cold; the cold compress relieves the pain of some, while apparently increasing it in other cases. Rubbing of the feet, which must be done gently, or the application of hot bottles, or the administration of aspirin or morphia may be necessary to relieve the pain.
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B.—Alternative Treatments.

As a means of comparing various treatments, eighty patients were chosen in whom the condition seemed on admission to be equally developed in the two feet. In these cases one foot was treated by one method, while the other had a different treatment. Thus in comparing one treatment with another the personal equation was eliminated as far as possible, and it was ensured that the respective subjects of experiment had had a similar history as regards exposure to the causes of the disease. The following treatments were thus tested:

1. Expectant Treatment.—Only appears to be advisable in the slightest cases.

2. Massage.— (a) with camphorated oil; (b) with lin. terebinth; (c) with powder only. This was found to be of very little use, and is certainly not worth the trouble involved; it is useful only in the later stages of convalescence of fairly severe cases.

3. Hot and Cold Water Baths.—The feet were kept for two minutes or so in buckets of hot and cold water alternately, for a period of half an hour or so. The object of this treatment was the stimulation of vasomotor action; it is a good accessory to treatment for patients whose feet are persistently cold; not recommended as a routine treatment.

4. Picric Acid.—This was tried in blistered cases, on the analogy of the treatment for burns; it is useful in maintaining the asepticity of the feet, but seems, as a treatment, to be very inferior to the camphor treatment.

5. Ambrene or No. 7 Paraffin.—This was tried on several of my patients on their arrival in England; the patients hated it, and said that it made their feet worse.

6. Fomentations (Hot Boric Lint).—Apparently increases the tendency to blister, and encourages the formation of gangrenous patches.

7. Ointments.—Useful only in cases with large superficial blisters which involve only the epidermis and are unaccompanied by local gangrene.

8. Camphorated Oil, applied as a Compress.—Camphor seems to be almost a specific treatment for the infective agent of trench foot. This being so, it was thought that a dressing of camphorated oil, which contains twenty-five per cent of camphor, might be superior to the lotion, which contains but 0.1 per cent. This was found to be the case in some instances, especially in those cases who showed severe oedema of the feet. For such cases this treatment might be tried on a large scale; it is rapidly applied and easy to work with, as no harm is done if a dressing is left on for two or three days. But on the whole, as a general treatment for all cases, the balance lies with the camphor lotion treatment, as outlined above.

9. Dakin's Solution (for the raw surfaces in bad cases).—This is useful, as already mentioned, if the necrotic parts have a foul smell, or if much pus is present. It is a useful disinfectant, but does not stimulate the healing processes in the same way as does camphor. The foot does not seem to
"tire" of the camphor dressing, in the same way as that in which wounds sometimes get indolent under Dakin's solution and similar liquids; and only in very rare instances is there any indication for the changing of the treatment. Camphor, in fact, seems to have a definitely proliferative action on the cells of the skin, similar to that exerted by allantoin and flavine, which, indeed, might be tried in the later stages with advantage. In the carrying out of these treatments much valuable advice, and every possible facility, were given me by my Commanding Officer, Lieutenant-Colonel G. C. E. Simpson, R.A.M.C. (T.F.).

(6) SEQUELÉ.

The majority of patients heal according to the descriptions given above, but in perhaps ten per cent. of cases some degree of trouble persists. The commonest sequel, as mentioned already, is neuritis, but this seldom lasts for more than a few weeks. Cold weather has a very deleterious effect on the convalescing feet. In many patients convalescence was much retarded during the severe frosty weather. The feet became painful and swollen in about two per cent. of cases, while the patients were still on light duty in the hospital. In one case in which the foot had healed, patches of necrosis appeared, due apparently to the effect of the severe weather.

Recurrence of the disease is more likely to occur on re-exposure to the requisite conditions, in patients who have recently suffered from the complaint. Besides this, an actual relapse, as distinct from a recurrence, occurs sometimes, though in all the cases observed only three relapses, within two months of entry into the hospital, were observed. Relapse after adequate treatment and a carefully graduated convalescence is a rare event.

The subject of tetanus has already been mentioned.

(7) THE RETENTION AND EVACUATION OF CASES.

In January, 1917, of all slight cases treated in this casualty clearing station, over sixty per cent. were returned to duty within three weeks, many of these going back after eleven and twelve days. Of the more severe cases, twenty to thirty per cent. were at duty within a month, in a period of very severe weather.

It would seem advisable, therefore, to retain the slighter cases in corps or army areas, and, after suitable treatment with a graduated convalescence, to return them to duty.

As regards the more severe cases, experience has shown that the early application of the camphor dressing and the placing of the patient in a recumbent position are the two most important points in treatment. Thus these cases should be evacuated to the base as lying cases, unless there is any definite contra-indication to so doing. In cases of considerable severity evacuation should not take place until the patient shows signs of definite
improvement, as the disturbances and discomforts incidental to an evacuation in cold-weather may be prejudicial to the case.

(8) FROSTBITE.

Mention should be made of this affection, which bears great resemblance to trench foot. A good many cases were observed last winter. The condition is generally similar to a trench foot of fair severity (Class C), with the exception that the whole process in the early stages of the disease is much quickened. Sometimes the line of demarcation of the discoloured area on the foot or hand is well established a few hours after exposure to the cold has taken place. The foot is very seldom swollen to any great extent, but the subsequent history of the case is similar to that of trench foot.

The blisters, areas of necrosis, separation of the sloughs, and healing process, resemble those of trench foot. Frostbite is rarely seen without some superficial necrosis at least.

The similarity between the symptoms in the two diseases suggested a trial of the camphor treatment for frostbite. It was found to be very good for hands and feet both if carried out exactly on the lines indicated above.

Several other treatments were tried, but none were found to be so useful as the camphor treatment. Massage, however, is useful—in fact, almost necessary—in the initial stages, i.e., when the feet have failed to recover their circulation. In later stages massage is injurious. If circulation is difficult to re-establish, the hands or feet may be put into cold water, the temperature of which is slowly raised by the addition of hot water. Some sodium carbonate should be dissolved in the water to render it alkaline.

(9) SUMMARY AND CONCLUSIONS.

The camphor treatment, as outlined above, appears to be at least as good as any other treatment for trench feet. Its adoption on such a large scale by the French Army Medical Service, as well as its success when tested in the Fourth Army of the B.E.F.; justify this claim.

Moreover, it is very simple: the stock solutions for its employment are easily made, and as easily dealt with in applying the treatment. It requires no cumbersome apparatus, and no special drugs except camphor and borax, both of which can be obtained with comparative ease in the quantities required.

Owing to the straightforward nature of the dressing, a large number of cases can be dealt with in a fairly short time.