THE PROPHYLAXIS OF TRENCH FOOT

BY

RAYMOND GREENE, D.M., M.R.C.P.

Physician, Emergency Medical Service

In every war in history trench foot has been a serious cause of casualties. In the last great war there were 84,670 such casualties in the British Army. In the week ending Dec. 16, 1916, there were 3,104 cases in France and Flanders alone. One blizzard in November, 1915, caused 15,900 cases in Gallipoli and 988 in Serbia. After 1916 the incidence fell rapidly. It was realized that trench foot is almost completely preventable.

The present spell of mild weather following a hard frost is ideal for the production of this malady, and the time seems appropriate for a summary of the teaching which has been given to a large number of medical officers of the three Services in the war medicine courses at the British Postgraduate Medical School of the University of London.

Given proper training and good equipment, the incidence of trench foot is an index of discipline. It is the army in retreat, low in morale and with its communications in disorder, that suffers most severely. In other circumstances, it is almost as foolish to get trench foot as to blow off one's big toe with a rifle. There are bound to be unexpected circumstances in war to make the occasional case unavoidable, but when once an epidemic has been controlled every case should be the subject of inquiry. Almost every such inquiry will bring to light an error in training, equipment, or discipline which, checked in time, will save not merely sections or platoons but even brigades and divisions.

There is a way of life in cold damp weather which must be learned not only by medical officers but by combatant officers and by every individual man. The maintenance of cold-weather discipline must be the responsibility of the combatant officers, but it is the duty of the medical officer to see to it that his brother officers understand the reasons for the rules, and are continuously alert for breaches of them. In the battle against cold there is no place for "toughness." The man who breaks the rules and gets away with it is not a hero but a lucky fool. Moreover, he is a stumbling-block to those who are less well adapted, and he should be treated as a criminal.

Preliminary Training

In the training of troops it should be remembered that the physiological reactions to cold, which are the concern of the adrenal medullae, the thyroid, and the autonomic nervous system, are themselves capable of being trained. In those habitually overclad they become dulled. Troops should accustom themselves to exercise for short periods in the minimum of clothing in the coldest weather. In safe surroundings no more clothing should ever be worn than is necessary to prevent shivering. It is probably not necessary to emulate the Finnish custom of "wallowing naked in December snows," but bathing in cold water and drill in frosty weather stripped to the waist are both of great value.

Clothing

Sir Thomas Lewis showed that if the whole body is chilled the local protective reactions against cold may fail. The clothing must be as nearly as possible waterproof, for it is the great thermal conductivity of water which is to blame for trench foot. It should also be windproof, so that the protective warm layer of air about the body is not too often blown away. The clothing should be in many light layers rather than a few heavy ones, for the air caught in the interstices is of more value than much wool.

All clothing must be loose, for the essential cause of tissue damage in trench foot is the exudation from damaged capillaries, and the slightest venous constriction raises the intra-capillary pressure to a serious degree. For this reason puttees were discarded. The boots must be loose, supple, well oiled, and preferably without toecaps. Socks should be undarned, and also loose. Most men can realize that tight boots are dangerous: they forget that tight socks are equally so. They forget,

too, that though it is a good thing to wear two pairs of socks if the boots are large enough to take them, it is dangerous if they are not. Ideally the outer pair of socks should be a size larger than the inner, but this is a refinement usually impracticable. Garters and sock suspenders should be forbidden, the socks being kept up by pinning them to the pants. Gloves also must be loose. Some people favour an inner glove of thin silk covered by a woollen one, with a big outer glove of waterproof material. Personally I have always found an ordinary woollen glove perfectly satisfactory and the silk one unnecessary. The outer waterproof glove is important. It should be made without separate fingers and should be loose enough to slip on and off easily when fine finger movements are needed.

Damp

Dry extreme cold is far less to be feared than damp slight cold. Trench foot has occurred in temperate climates even in the spring. For this reason it is absolutely necessary that wet clothes, especially boots, socks, and gloves, should be changed at every opportunity. Combatant officers are sometimes inclined to regard such an instruction as "soft": they must be overruled. A general routine order issued to British Armies in France in November, 1915, laid it down that every man should carry a second pair of socks, and that where possible battalion arrangements should be made for socks to be dried and reissued during each tour of duty in the trenches; and that while in the trenches boots and socks should be taken off from time to time if circumstances permitted and the feet dried, well rubbed, and covered with dry socks. Although much more is now known of the pathology of trench foot, it is almost impossible to improve on this general routine order and the later Fourth Army standing order of June, 1917. Obviously the one extra pair should be increased to several whenever possible. Even if the boots cannot be dried, dry socks are a considerable protection.

The provision of gum boots for use in waterlogged trenches is important, but it must be remembered that sweat is itself dangerous, and gum-boots are sweaty things. Men must not march far in them. In the last war it was usually possible to arrange for men going forward for a tour of duty in waterlogged trenches to call at a post where they removed their boots, performed foot drill, and put on dry socks and gum-boots. On their return they left their wet socks and gum-boots, again performed foot drill, and donned their own dry socks and boots before going down the line.

Foot drill was performed in pairs. Each man washed the feet of his opposite number in warm water and carefully dried them. He then, in the early part of the war, rubbed in whale oil, but it was later found that the oil was unnecessary and a powder of talc and camphor was substituted. The benefit of the whale-oil treatment probably rested in the rubbing. All abrasions were reported to the medical officer. A double washing with ordinary and special soap was ordered, but this is probably an unnecessary refinement. A single wash with ordinary soap is probably as good. Foot drill should be performed in cold weather, both in and out of the trenches. A good method of drying boots is to lay a 6-foot length of gas-pipe across a brazier, push one end into the toe of a boot, and blow air from the other end with a bellows. If the business end of the pipe is made like a toasting-fork many pairs can be dried at once. These measures were often regarded as fussy, but the proof of the pudding was in the eating. The incidence of trench foot fell dramatically after the winter of 1915-16.

Stagnation

After constriction the most important cause of increased intra-capillary pressure and consequent oedema and tissue damage is venous stagnation. The men must be taught not to stand still, slumped into their boots, but to keep the muscles of their calves continuously in motion. They must lie down whenever possible, with their feet higher than their heads—a manœuvre which lowers venous pressure. They must not sit on seats, boxes, or firesteps in such a way that the popliteal space is constricted. They must on no account bring their feet near to a fire if they are cold or numb, but warm them between a companion's hands or inside his clothes. The boots must be unlaced or, better, removed at every opportunity and at least twice a day.

Food

The warming power even of cold food is considerable, and men in danger of trench foot must be kept well supplied. Hot food is, of course, far better. Arrangements must be made by means of heat-insulated containers, self-heating tins, or such devices as "Tommy's cookers" for a regular supply of hot food and drink to men in exposed situations.

Trenches

The design of trenches in mobile warfare is easy to neglect, but is neglected at peril in time of thaw. Whenever possible they must be properly drained, or, as a second best, provided with duck-boards. Men cannot stand long periods in damp trenches. Commanding officers may be well aware of this in theory, but they may suffer from a wishful faith in the capacity of their own men to "rough it out." Such faith is always misplaced. Human physiology is remarkably adaptable, but it is not infinitely so. No equipment, however good, no precautions, however studious, and no watchfulness, however devoted, will avail if men have to spend more than 24 or at the most 36 hours in a waterlogged trench or fox-hole. If the prosecution of the war demands that men should fight in such conditions, then the High Command must allow for a high proportion of casualties. It is unreasonable that allowance should be made for casualties from firearms and not from the equally predictable hazard of cold. This hazard has not gone with the thaw. It has rather increased and will remain with the armies till summer comes.

AVIATION MEDICAL RESEARCH

AIR MARSHAL WHITTINGHAM'S ADDRESS

On Jan. 31 Air Marshal Sir Harold Whittingham, Director-General of the R.A.F. Medical Services, was presented with the John Jeffries Award of the Institute of Aeronautical Sciences of the U.S.A. We print below some extracts from his speech in acknowledgment of this honour.

Liaison across the Atlantic

Early in 1939 I had the privilege and pleasure of visiting the United States to see the high-lights of aviation and its associated researches. I visited 12 States, and was particularly impressed by the fine work done at Wright Field, in Dayton, by Col. (then Capt.) Harry G. Armstrong. I returned to the United Kingdom determined to build up so far as was in my power an aviation medical research organization much on the lines of Wright Field, where the aeronautical engineers and other scientists worked as a team with those engaged in the physiology of flight. The urgent problem was to fit the machine to the man, instead of the other way round, as had so long been the case owing to insufficient co-operation between the engineering and medical groups. That was a defect which this Institute has done much to eradicate.

Since 1939 there has been the closest and happiest liaison between British and American research centres and workers, both Service and civilian, including your National Research Council. To our mutual benefit, members of research groups from both countries have visited each other, and continue to do so, to study and discuss various problems at first hand. Thus on either side of the Atlantic and in the field, America, Britain, and Canada have pooled their knowledge and resources in aviation medicine to improve the comfort and efficiency of those engaged in flying during training and on operations.

Some Problems Investigated

Among the problems investigated, roughly in order of their occurrence, have been the following:

How to provide an adequate supply of oxygen, with the maximum of comfort, at all oxygen-requiring heights under the most adverse conditions.

How to protect air-crew against cold and the occurrence of frost-bite, which has now been reduced to negligible proportions (1 case in 2,000 bomber sorties—that is, 1 case in 12,000 individuals engaged in these sorties) by the provision of suitable clothing, particularly electrically heated garments.

How to prevent blacking out in combat during high acceleration without interfering with pilot-readiness, active movements, and performance under all climatic conditions.

How to guard the eyes against the glare of the sun and search-lights without reducing the field of vision or visual acuity, and how to obtain and maintain the optimum night vision under various flying conditions.

How to deal with such stratosphere problems as the prevention of bends, the physiological requirements in pressure-cabin design and development, including explosive decompression and bailing out from aircraft at altitudes over 30,000 feet.

How to lessen fatigue, which is such a potent factor in the causation of air accidents.

How to improve intercommunication, as poor intercommunication leads to fatigue and many errors, especially during the height of air operations.

How to protect those in cockpits and cabins of aircraft against the possible entry of noxious substances, such as exhaust gases or hydraulic fluids.

How to prevent air-sickness, particularly among paratroops.

Evacuation of Casualties by Air

In addition a considerable amount of research and development has taken place in connexion with air-sea rescue, and last but not least the evacuation of casualties by air.

The U.S. Army Air Force has done a stupendous job in evacuating casualties by air from all fronts to overseas bases and to the United States. Major-General David N. Grant, your Air Surgeon, deserves the greatest credit for this wonderful achievement, as he does also for the gigantic strides that your country has made in aviation medicine during this war.

The British endeavour, as regards evacuation of casualties by air, has been less only in proportion to the Forces employed. In 1944 the Royal Air Force alone evacuated approximately 300,000 cases of sick and wounded, mostly Army personnel, on all fronts—the Far East, the Mediterranean, and in Europe proper—without a single mishap, although this evacuation involved some 20,000 separate flights, and much of the flying was done from forward landing strips near the enemy, over jungle, mountain, and sea in all sorts of weather.

Outstanding Pieces of Work

I should now like to pay tribute to certain medical men of both countries who have done outstanding work for aviation. Some of our theoretical calculations of the effects of stratosphere flying on man have proved to be wrong; certain hazards were overstressed, others were underestimated, with resulting casualties.

In 1941, during the experimental phase of adapting the Boeing 17 for operational work at higher altitudes, two R.A.F. medical officers—Squad. Ldrs. W. K. Stewart and J. Robson—had the misfortune to be in one of these aircraft when it broke up at an altitude of some 32,000 feet. Stewart was the sole survivor.

Col. Randy Lovelace, of the U.S. Army Air Force, in 1943, purposely and courageously bailed out at 40,000 feet to make physiological observations in a parachute descent from such an altitude. He became unconscious almost immediately after bailing out and suffered severe frost-bite of the hand, but fortunately landed safely. Only last year another distinguished American research worker, Col. Boynton, met his death doing an experimental delayed parachute drop from 44,000 feet, though he knew the hazards. He was a very brave man and a great loss to science.

Again, Squad. Ldrs. Gibson, Pask, and Stewart carried out a series of dangerous experiments—to find out how long man could live during a parachute descent without additional oxygen—in rarified atmospheres similar to those between altitudes of 44,000 and 25,000 feet. These laboratory experiments were carried to just short of extremes and gave valuable information to help perfect apparatus and technique for bailing out in the stratosphere.

In studying the problems of high acceleration in aircraft, that brilliant young American scientist Lieut.-Cmdr. Lillienkrantz met his death tragically some two years ago.

In the Royal Air Force Squad. Ldrs. W. K. Stewart and S. Davidson have carried out since 1940 many hundreds of blacking-out experiments in the air, having to bail out from damaged aircraft on more than one occasion. Squad. Ldr. Davidson has also for the past year been engaged in experimental flying on jet-propelled aircraft to study various physiological problems. In this connexion it is of interest to note that some 120 R.A.F. medical officers are qualified pilots, many being highly skilled—flying Spitfires and even jet-propelled aircraft.

Many medical officers have made physiological and psychological observations during actual air operations against the enemy to assess the strain, fatigue, behaviour of air-crew, and general efficiency of