SEVERE MALARIA AMONG BRITISH TROOPS IN THE EAST AFRICAN CAMPAIGN.

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The problems presented by malaria on field service are quite different from those under peace conditions. Although it is now over nine years since the end of the Great War, certain peculiarities of the East African Campaign, worthy of careful study, have never been discussed. The official medical history of the campaign is very meagre, and few other articles have been written. I was on field service in the country for eighteen months and was, during a great part of that time, attached to some of the larger hospitals situated on or near the East African coast. I was thus able to see the conditions of shipping and disembarkation, as well as to treat the men when they returned to the coast, having left their units inland on account of sickness.

The chief points to which I wish to draw attention are:—

(1) Field service conditions are incompatible with the taking of adequate precautions against malaria.

(2) In the East African Campaign there were several factors which contributed to the outbreak of malaria; these were the equatorial climate, the long and malarious coast-line, numerous ports, and the fact that the troops were unused to tropical warfare and tropical conditions.

(3) The incidence of malaria was extremely heavy and the general health of the troops was, in consequence, poor.

(4) The large number of quinine-resistant cases, of cases showing intense malarial infection, and of cases of various severe types of malaria.

(5) The poor facilities for scientific diagnosis compared with the vast amount of clinical material available.

Although East Africa was one of the subsidiary theatres of war, about 300,000 allied troops were employed there. In the matter of sickness ratio, East Africa was by far the worst of all the war areas.

The admissions for disease of all kinds were 2,880 and 1,278 per 1,000 in 1917 and 1918 respectively, the former figure being several times higher than the figure for Macedonia, which area shows the next highest admission rate.

Malaria was the chief cause of disability and accounted for 57 per cent. of the total admissions. Between June, 1916, and October, 1917, there were no less than 107,000 admissions for this disease. Apparently figures are

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1 Paper read at the Royal Society of Medicine (War Section), November 12, 1928. Reprinted by kind permission from the Proceedings of the Royal Society of Medicine, vol. xxii, No. 2, December, 1928.
not available for the whole period of the war, but probably the total admissions for malaria amounted to at least a quarter of a million, 100,000 of these occurring among British troops, while African and Indian troops accounted for the remainder. On the average, every European was admitted to hospital two or three times annually on account of malaria.

 Disability due to the disease was, I found, much greater than the number of admissions shows. Many men ignored slight attacks of fever and only came to hospital when a more severe attack occurred. Others spent a fortnight in hospital followed by a few weeks on duty, and this process was repeated, and varied with an occasional trip to Nairobi or South Africa, till the man was finally sent to England as an invalid. The majority were not so much upset in health as in the cases quoted, and, even though they had malarial attacks from time to time, their general health was but little affected. This paper constitutes an attempt to explain the causes of the appalling incidence of malaria in this campaign.

CLIMATE.

The part of East Africa with which this article is concerned lies in the equatorial zone roughly between the latitudes 5° and 15° south. The climatic conditions on the coast, therefore, are similar to those found on the West Coast of Africa, at Singapore, and on the Isthmus of Panama, though these areas all lie north of the equator. These coastal areas are all similar in this respect—that there is a warm steamy climate throughout the year with very little seasonal variation of temperature. As the temperature is always above 60° F., the breeding of Anopheline mosquitoes occurs all the year round. Ample facilities for the breeding of mosquitoes exist in the neighbourhood of the various ports, as these are of necessity situated at the mouths of rivers and creeks whose shores are fringed with mangrove swamps. On the coast no extremes of heat or cold are found, the maximum day temperature, throughout the year, being about 100° F.

In East Africa the larger hospitals, for obvious reasons, were situated at these unhealthy ports.

MILITARY OPERATIONS: PROPHYLAXIS.

During 1916 and 1917 the main German column which had been operating in the north-east corner of their territory, gradually retired towards their southern frontier. In November, 1917, the column crossed the River Rovuma, between Portuguese and German East Africa, and by June, 1918, had penetrated into Portuguese territory as far as the neighbourhood of Quilimane. Having attracted our forces thither, the German Commander turned his steps northwards again, and, in September of the same year, he re-entered German territory. In November he invaded Northern Rhodesia, and a few days later he surrendered in that country under the terms of the Armistice.

He thus compelled us to keep ports open, for disembarkation of troops,
along nearly 1,000 miles of coast-line. His object, of course, was to keep engaged in Africa as large an Allied force as possible and thereby indirectly to influence the course of affairs in Europe. In this project he, from his point of view, admirably succeeded. If we view the situation from the sanitary standpoint, malaria became, in a sense, his best ally.

The usual method by which we reinforced our troops was as follows: British troops were sent out from England by the Cape route to Durban in transports plying between England and that port. At Durban these troops went into camp to await onward transport to Dar-es-Salaam, or other East African port. The next stage of their journey was in transports plying up and down the East African coast, between Durban and Dar-es-Salaam, and putting in as required in other ports, viz., Mombasa, Zanzibar, Kilwa, Lindi, Port Amelia, &c. These coasting vessels were actually old "tramp" steamers which had been adapted to the purpose of transporting troops. They were small, ill-equipped and always overcrowded.

Troops travelling in them suffered extreme discomfort throughout the voyage. Beds or cots were not fitted, so that the men could not use their mosquito nets; frequently they had not even brought mosquito nets. All they could do to obtain rest was to lie down on the floor of the various troop decks, and often they had not room to lie down at all.

These coasting vessels were never out of the tropical regions, except at the southernmost part of their voyage, and even the climate of Durban is hot for several months of the year. The steamers were mostly employed in the area between 5° and 15° south latitude. South African troops were also conveyed from Durban to East Africa in these vessels. Indian troops after reaching Dar-es-Salaam from Bombay and African troops from Mombasa and Zanzibar, were similarly shipped to their final port of disembarkation in these vessels, which were thus utilized for British, Indian, and African troops as occasion required.

Dar-es-Salaam, the capital of the country, became our headquarters and base of operations, but from time to time another port might become an advanced base. Reinforcements thus camped at Dar-es-Salaam, and often visited several other ports before they were able to leave the unhealthy coastal area and join their own columns in the African bush. In this way other ports as far south as Beira were opened up, often at short notice. The arrangements there were necessarily imperfect and the military situation naturally did not allow extensive camps being put up or ports rendered mosquito-free before the troops arrived. Port after port in Portuguese East Africa became actual or virtual "advanced bases" in rapid succession, and no one could possibly tell when a port partially given up might not suddenly be brought into use again.

During all this time, whether in steamers or in camps situated on the coast, the risk of the men becoming infected with malaria was very great. Indeed, it would be surprising if they escaped infection on shore, as there they found themselves in close proximity to an African population infected
with, though relatively immune to, malaria. Even when men are living in
buildings, under settled conditions, can speak the language, can have beds
and mosquito nets, and can rest during the periods of mosquito activity,
the prevention of malaria is difficult and often fails. When troops are
on the move and "kit" is cut down to the minimum, the difficulties are almost
insuperable, and sooner or later infection is sure to occur.

The following instance shows how troops may become infected while on
board ship.

In December, 1917, a transport arrived at Lindi, with reinforcements
which had come from England via Durban in the manner already described.
Some of the troops went into camp at Lindi, while others proceeded inland
next day to join their units. Of the former, some were brought to hospital
three days later and found to be suffering from severe primary malaria.
Of those who proceeded inland, a journey of several days' duration, many
never reached their units, or, if they did reach them, were passed back,
suffering from malaria, through the various hospitals, till they rejoined their
fellow travellers from the same ship in hospital at Lindi. Undoubtedly a
proportion of men from this ship failed to join their units; some had to be
sent to Nairobi, some to South Africa, and some even to England. These
men had never been in the tropics before the incident mentioned. The
ship in which they had travelled from Durban had been anchored for two
nights in Kilwa harbour, but the troops had not been allowed ashore. The
explanation which was accepted at the time to account for their infection
was that the ship had been visited by anopheline mosquitoes while it was
anchored in Kilwa harbour. This is a possible explanation, but it assumes
an incubation period of only five days. It seems to me much more probable
that the troops were all infected on board ship while on the voyage from
Durban, in spite of an issue of quinine at the rate of ten grains daily to
every man.

The following is an instance of a unit evidently infected while on shore,
in spite of all the usual precautions. The unit referred to consisted of the
entire staff of an expanded British casualty clearing station. Quinine in
solution, at the rate of ten grains daily, was given on parade to every
member of the unit, and this had been carried out from the day that the
unit had arrived in the country. The use of mosquito nets was also rigidly
enforced. Breeding places of mosquitoes were dealt with as far as possible,
and all the usual precautions were taken. In spite of these measures there was
a great deal of malaria among the members of the unit, and, further among
the individuals affected, the malarial attacks usually proved most resistant
to quinine. Many men of the unit were sent as invalids out of the country,
owing to the fact that quinine did not control their malarial attacks at all,
even while they were under treatment in hospital. Accordingly, I examined
the blood of every member of the unit (120) by the thick-drop method and
found malarial parasites present in seventy-five per cent. In fact, practically
every man was suffering from malaria and spent his time alternately
between duty and hospital. Once such a stage of infection is reached, it becomes impossible to distinguish between quinine treatment and quinine prophylaxis. Attempts at preventing malaria by the administration of quinine are now considered to be useless by most authorities, but, at the time of the war, great reliance was placed on this measure. It is now generally supposed that quinine given for this purpose fails to prevent malaria because it does not act on the trophozoite form of the parasite.

It is evident, therefore, that our troops, in spite of any precautions we were able to take, suffered severely from malaria.

Notwithstanding all that is known about malaria, we have as yet no simple and reliable means of preventing the disease. The means at our disposal at present are imperfect and uncertain. Our last line of defence is the mosquito net, but even this is not infallible, and in any case cannot be used throughout the entire period of mosquito activity. Under field service conditions many necessary measures cannot be carried out, and attempts at malaria prevention naturally fail, as they did in the campaign under consideration.

**Microscopical Examination of the Blood.**

Facilities for obtaining a diagnosis by laboratory methods were crude in the extreme; this state of affairs, also, can be traced to the facts that East Africa was regarded as a subsidiary theatre of war, and that the distance from England was so great. At Lindi, for instance, there was a staff of ten medical officers for the care of 1,500 sick in hospital. There was only one microscope, and no means of doing cultural work or carrying out agglutination tests, except by sending specimens to Mingoyo, a distance of ten miles by river. At Mingoyo was situated a mobile laboratory where simple cultural work could be done, the staff consisting of one medical officer and one African attendant. In advance of this point, along a line of communications about 200 miles in length, there was, I believe, not a single microscope, and consequently the diagnosis of fever cases was made on purely clinical grounds.

It is admitted that laboratories fitted out for cultural work are not, on the whole, mobile units, and unless they are accommodated in huts or buildings the results are not likely to be satisfactory. The roads that existed in Africa were far too rough for motor laboratories, and in the area in advance of the roads columns usually moved on foot along narrow paths through the African bush, where a motor vehicle could not follow them. The examination of the blood for malaria parasites, on the other hand, can be carried out if necessary in a small tent, but even for this work a building is a great convenience. The need of such units as the malaria-diagnosis units provided in Palestine was badly felt in East Africa, and, owing to the lack of such facilities, there must have been thousands of mistakes in diagnosis. The difficulty of examining blood-films, or blood-drops, under field service conditions can, I think, be exaggerated. The Germans, for
instance, regarded a portable microscope and simple blood-stains as an essential part of the equipment of their column, and their medical officers were usually able, even in the African bush, to examine the blood of fever cases when they reached bivouac for the night; and they showed their equipment to us at the end of the campaign.

The sick were brought down daily by river convoy to Lindi, and those requiring transfer were sent on to Dar-es-Salaam by hospital ship about once a week, there being a complete turnover about once a fortnight. The clinical material was vast. I endeavoured to do the microscopic work of a large hospital in addition to my own clinical work (100 beds). The microscopic work was often done at night with the aid of a hurricane oil lamp, as this was the only means of illumination. Only the simplest stains were available. Blood was examined by the thick-drop method and diluted Giemsa stain, diluted Leishman's stain, or even diluted methylene-blue being used for both dehæmoglobinization and staining. Even under these difficulties I was able to examine from twenty to thirty slides daily. I had had in India several years' experience of the thick-drop method of blood examination, and thus was able to appreciate its advantages and its fallacies. I found that the use of this method saved time and facilitated diagnosis, especially in cases where quinine had already been administered. Further, the difficulty as regards strict cleanliness of slides and reliable methyl alcohol was so great that the use of the thin films was given up, except for special cases where a blood-picture was required.

Benign tertian and subtertian parasites occurred in about equal numbers, and parasites were usually found in the first field or first few fields examined. Heavy infections were common, the slides showing from forty to fifty parasites in every field under the 40th in. objective; specimens showing anything from two hundred to four hundred parasites in each field were met with occasionally. It was noted that men whose peripheral blood contained large numbers of parasites were often anemic and debilitated, but that they did not always present acute symptoms. Presumably, if left undiagnosed, from lack of blood examination, and therefore untreated, such men would sooner or later become gravely ill. On the other hand, in the cases which were clinically of a severe nature, and especially in the cases with cerebral symptoms, it was noticed that parasites were often very difficult to find in the peripheral blood, doubtless owing to the fact that they were concentrated in the capillaries of the brain or other viscera.

When we examined, by the thick-drop method, the blood of Europeans in poor health, we found either malarial parasites or a reticular appearance of the red cells which formed the background of the field. This appearance is often, incorrectly I believe, called "basophile degeneration." We came to regard this reticular appearance as evidence of latent malaria, and considered it to have the same significance in the microscopic examination of the blood as splenic enlargement has in the clinical examination. Blood-
films, stained as controls in some of the cases in which this change had been observed, showed polychromasia of red cells and the presence of "brassy bodies." Unfortunately, I was not able to carry the research any further, but propose to do so at an early date. In the meantime, I suggest that this reticular appearance of red cells seen in thick-drop examinations corresponds to the appearance known as Schaudinn's figures found about malignant malaria parasites in the red corpuscles when the thin film method is used. Malaria pigment was present in such quantity in the blood-drop, in some of the severe cases, as to give under the microscope the appearance of a dirty slide. The first time I saw such a slide I discarded it on the assumption that it had been in some way powdered with fine coal dust. I then prepared a series of slides from the same case, taking especial care as regards cleanliness of slides and stain. I obtained an identical result in each slide and realized, therefore, that the appearance seen was due to pigment present in the blood.

Owing to the fact that parasites are often most difficult to find in the most urgent and dangerous cases, we felt greatly the need of some more delicate test for malaria such as culture of parasites, concentration of parasites and complement deviation; but, as has been shown, such methods were not available for us.

**Diagnosis and Clinical Features.**

The onset of some other illness appeared to bring about a malarial relapse, with the result that cases of enteric fever, or of dysentery complicated by malaria, were common. The mere finding of malaria parasites was thus often misleading, as the blood was not sent at a sufficiently early stage for cultural examination of the enteric group of organisms. The cases were diagnosed as malaria, the more serious disease being overlooked. The patient might then be regarded as fit to move and be transferred to another hospital. Many such cases must have ended fatally. The following is an instance of a case in which an incorrect diagnosis was made by me in the early stage of the disease:

In December, 1917, a young South African who had not been protected, by inoculation, against the enteric group of diseases, was admitted to hospital on account of high fever. He was anaemic and the spleen was enlarged nearly to the level of the navel. Subtertian rings and crescents were found in the blood in moderate numbers. Malaria was diagnosed and it was supposed that an acute attack had supervened on a chronic infection. Like many Rhodesians, this patient had suffered from malaria for some years before joining the East African force. Under vigorous quinine treatment the parasites disappeared from the peripheral blood and the spleen shrank to about half its former size; the temperature, however, remained high and continuous; in fact, clinically, the case became one of enteric fever, and this diagnosis (enteric) was confirmed by cultural examination of the stools in the third week of the disease.
In this case gradual recovery occurred. In other cases, in which the original diagnosis was malaria, persistent diarrhoea and high or irregular fever developed. Two such cases under my care ended fatally, and the amended diagnosis of enteric fever was confirmed at autopsy. In addition, there were numerous cases in which the fever was high and continuous for five, six or seven days. The actual malarial attack in many cases of benign tertian infection was severe—high continuous fever lasting five or six days, with vomiting and much constitutional disturbance. The cases in which the parasites of malignant tertian malaria were present were, in the absence of pernicious symptoms, often milder as regards the actual malarial attack.

Dysentery was commonly associated with malaria, but the diagnosis of the double disease did not usually present such difficulty as did the combination of malaria and an enteric group infection. Hæmorrhagic malaria may be mistaken for dysentery. In the following case I made this mistake, and, in consequence, anti-malarial treatment was postponed till it was too late to avert a fatal issue.

A West India soldier was admitted with symptoms of acute dysentery. His general condition was very grave and the stools, which he passed almost continuously, consisted entirely of blood and mucus. No amoebae were found in them, and cultural examination of the stools for dysenteric organisms was not carried out, as I had no means of doing this locally. For some reason an examination of the blood for malarial parasites was not made on the day of admission. Next day an overwhelming infection with subtertian parasites was found. He was then sinking, and an intravenous injection of quinine did not save his life. It is probable that this man would have died even if his case had been correctly diagnosed immediately on admission.

Vomiting, pain referred to the spleen, and jaundice were all common symptoms. Vomiting was often so troublesome that the patient was unable to take quinine by the mouth; also, if vomiting were persistent, the patients rapidly became exhausted. A large proportion of patients suffered from pain in the splenic region during the acute febrile attack, the pain being often so severe that a hypodermic injection of morphia was required for its relief. Many cases were admitted in which a diagnosis of gastritis had been made previously, the symptoms being epigastric pain, vomiting and anemia. Apparently, owing to the absence of fever, malaria had not been suspected, and the blood, in consequence, had not been examined. When an examination of the blood was made, a subtertian malarial infection was found, and the symptoms readily yielded to the intramuscular administration of quinine.

Acute abdominal symptoms were present in many cases both of benign tertian and subtertian infection, and the differential diagnosis from appendicitis and other acute abdominal conditions was difficult, especially when the symptoms were on the right side. In doubtful cases an intra-
muscular injection of quinine, followed by careful observation for a few hours, was preferred to immediate operation. We had also to distinguish cases of dysenteric localized peritonitis, of which the following is an instance:

A nursing orderly was admitted complaining of severe pain referred to the left side of the abdomen, and, on examination, this area was found to be rigid and tender. No splenic enlargement was made out, though the man had had several attacks of malaria. Careful inquiry elicited the additional information that a few days earlier there had been an attack of diarrhoea or dysentery so slight that the man had not sought admission to hospital. He had merely given himself a dose of castor oil and had continued at work. The stools on examination were found to contain mucus, but no amoebae were detected in them on microscopic examination. A provisional diagnosis of peritonitis about a deep dysenteric ulcer was made, and emetine was administered hypodermically, commencing from the day of admission. During the next few days a large tender swelling developed in the left lumbar region, but this gradually subsided and complete recovery occurred.

In this case, owing to the pain being left-sided, the diagnosis was fairly simple.

Malarial attacks simulating acute pneumonia were very common, but usually gave rise to little anxiety, as the attacks quickly yielded to the administration of quinine. On the other hand, in some cases the brunt of the disease fell on the heart. During the course of what appeared to be an ordinary malarial attack, the heart suddenly failed. Cases of this type gave great anxiety and many ended fatally. Dr. L. S. Dudgeon and Dr. C. Clarke in an excellent study of the histology of malaria carried out in Macedonia, found fatty degeneration of the heart-muscles and blocking of the capillaries, with infected red blood-corpuscles.

Blackwater fever was common, but calls for no comment.

Treatment. — The sulphate and the bihydrochloride of quinine were the only drugs available for the routine treatment of malarial cases. The usual method of treatment consisted in the oral administration of thirty grains of the sulphate daily. But when persistent vomiting was present, and when the attack did not yield to quinine given by the mouth, some other mode of administration was necessary. No one could have gone to Africa more prejudiced against the intramuscular injection of quinine than I was after eight years' military work in India. The danger of tetanus following these injections had been thoroughly impressed on me, as on every military medical officer in India. Colonel Semple's work, published in 1911, had been entirely accepted and, in consequence, throughout the Army the intramuscular injection of quinine had been strictly forbidden. As the result of Major MacGilchrist's work, we were further taught that quinine when administered intramuscularly was not absorbed and that, therefore, the method was pharmacologically unsound. Quinine, we were
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told, should be given orally or, in special cases, intravenously. In India, and especially while serving in the N.W. Frontier in 1915, I had seen among Indians cases of malaria not benefited by quinine orally administered, and the men so affected had usually been invalided to their homes. Such cases were comparatively few in number.

In Africa I found malaria to be a much more severe disease, and quinine, when given by the mouth, commonly failed to control it, even when enormous doses—up to eighty grains daily—were used, as they were by some officers. While in East Africa I gave more than 3,000 intramuscular injections of quinine. At first I used ready-made quinine phials and boiled the needle and syringe, but soon resorted to preparing my own solution and sterilizing the needle and syringe by chemical means.

I found it best to use quinine bihdrochloride, one-to-three solution, in distilled water. I boiled about 250 cubic centimetres of this solution in a glass flask on three consecutive days and then stored it in rubber-capped serum bottles, leaving a spare hypodermic needle pushed through the cap of each bottle to allow equalization of pressure when the bottle was reheated or solution extracted. The two cubic centimetres all-glass syringe with needle was sterilized by sucking up into it first pure liquid carbolic acid (or lysol), then methylated spirit, and finally sterilized water out of three ground-glass stoppered bottles kept for the purpose. Before a series of injections was begun the syringe and needle were left to soak for ten minutes in the carbolic acid bottle.

The injections were usually made into the buttock two inches or two and a half inches below the crest of the ilium; one and a half cubic centimetres, containing about eight grains, were injected out of the syringe, the needle being pushed well into the muscles. Other sites, such as the deltoid muscle or the posterior axillary fold, were sometimes utilized.

One injection was usually given daily for the first three days, and thereafter the treatment was continued by the mouth. Another single injection was usually given on the ninth or tenth day, as at about this stage a relapse commonly occurred. Two or three times a week, according to circumstances, the carbolic acid and spirit were thrown away and fresh supplies substituted. By this method, gradually evolved, all dangers of sepsis (including exogenous tetanus) were eliminated and only the irritating or necrosing action of quinine on the tissues remained. I found that, when everything was ready, I could give about twenty injections hourly by going round from bed to bed, an orderly following me with a tray bearing the necessary bottles.

It may well be asked why sterilization by chemical means should be preferred to boiling both syringe and needle. The answer is that we found the sterilization of needles by boiling to be quite impracticable. The life of a needle repeatedly boiled is very short, glass syringes sooner or later crack, and replacement of needles and syringes was not always possible. Sterilized chemically, both remained serviceable much longer. The whole
arrangement, of course, was devised solely for the purpose of giving a large number of injections daily under the special conditions prevailing.

Pain and local swelling occurred in some of the cases, and I consider them inevitable, as post-mortem findings and experimental work both show that local necrosis is produced in the tissues injected. If these symptoms are very troublesome, cold compresses are applied and resolution usually follows. The temptation to incise the swelling is great, but this should not be done in doubtful cases before palliative measures have been tried, as the wound once produced heals slowly, owing to the devitalizing effect of the quinine. I saw in Nairobi two cases showing the unfortunate effect which quinine injections occasionally have. In both cases the buttock had been incised some months before. Large gaping wounds, exposing the iliac bone, remained, and tracking into the muscles was still occurring in spite of the wound being widely open. Even at that stage further incisions became necessary from time to time. The occurrence of such cases was used, by some officers, as an argument for the prohibition of intramuscular injections of quinine; but we must set against this the opinion of most medical officers that hundreds of lives were saved by this method of treatment.

I saw no cases of tetanus following quinine injections. Operation was only called for on one patient to whom I had given an injection of quinine, and in that case no pus was found. If the patients have some focus of infection—such as severe pyorrhcea or furunculosis—I think the advisability of giving quinine by some other route should be considered, as the possibility of autogenous infection must always be borne in mind.

The value of, and danger attaching to, intramuscular injections of quinine have, of course, been the subject of discussion for many years, and a large amount of literature has accumulated. I do not propose to enter into this discussion. I only wish to point out that under the conditions of field service in East Africa, we found that the intramuscular was the best route for administering quinine to patients for whom quinine orally administered was unsuitable. Experienced officers working in other theatres of war came to the same conclusion. For the sterilization of syringe and needles chemical means were found necessary in other areas also.

Intravenous Administration of Quinine.—With this method of treatment I was disappointed. I gave quinine in this way in six cases, all of a desperate nature, and each of the patients so treated rapidly collapsed and died. The quinine was given in various dilutions, adrenalin being added to the solution. I can only suggest, by way of explanation, that my patients were exhausted as the result of field service and privation, and that they would probably have died whatever treatment was tried. But my impression at the time was that intravenous injection hastened the end, and consequently I discontinued it. Other writers, too, are not in favour of the intravenous injection of quinine in field units, as the patients are exhausted.
and the cardiac condition is likely to be at its worst. Under peace conditions I have great faith in the intravenous administration of quinine, and its use for severe cases is now well established.

**Rectal Administration of Quinine.**—Some medical officers, who had had experience of treating malaria on the West Coast of Africa, were strongly in favour of this method. They recommended the rectal administration of thirty grains of the bichloride dissolved in a few ounces of saline or starch solution. I tried it in a few cases and was disappointed. Either the dose was rejected, or, if it was retained, no benefit accrued. The method was inconvenient and interfered with the work of the ward. We were poorly supplied with trained nurses and with orderlies possessing the necessary experience. For eighty beds, full of acute cases under my care, I seldom had the assistance of more than one nursing sister and four nursing orderlies.

**Cases of Malarial Relapse.**—The greater part of our time was spent in treating cases which relapsed time after time whilst actually under treatment with quinine, either in hospital or after discharge from hospital. Relapse on or about the tenth day after the onset of a malarial attack was very common, even among patients confined to bed and taking thirty grains of quinine in solution daily. All except the slight cases were if possible kept in hospital for a period of ten days, and an intramuscular injection of quinine was given on the ninth or tenth day. Men who suffered from numerous relapses were sooner or later sent out of the infected area; but even when this was done relapses continued in spite of treatment; this I found by observation when I was afterwards on the staff of a hospital in Nairobi.

The patients who had been treated originally by intramuscular injections of quinine suffered from relapses quite as frequently as those treated by quinine orally administered. In a proportion of cases, in short, the results of treatment were most disappointing whatever method we used. We were not supplied with any derivatives of cinchona other than the quinine salts mentioned, nor was there available a sufficient quantity of any of the organic arsenical preparations to enable us to use them in the routine treatment of malaria.

In this connexion an interesting case under the care of Major R. S. Herrick, I.M.S., is worthy of record. A British patient, while undergoing a regular course of treatment for syphilis, had an attack of malaria with severe cerebral symptoms. Subtertian parasites were found in the peripheral blood. This man at the time had already received several injections of neosalvarsan.

**Cerebral Malaria.**—As regards the treatment of this serious condition, we made what we thought was a valuable discovery. In the coastal area at one time cases of cerebro-spinal fever were occurring among Africans, and therefore lumbar puncture for diagnostic purposes was carried out in all doubtful cases of illness in which cerebral symptoms were present. The
cases of meningitis were benefited or relieved to some extent by this procedure, but it was noticed that some which proved to be cases of cerebral malaria were benefited to a much greater extent, and in a few cases the effect was most gratifying. The following is an instance of such a case:

An Indian patient, admitted under the care of Captain Rao, I.M.S., was found to be deeply comatose and to have general rigidity. Diagnostic lumbar puncture was carried out by me at once, and at the same time a specimen of blood was taken for the examination for malarial parasites. The cerebrospinal fluid proved to be clear, but the blood contained subtertian parasites. An intramuscular injection of quinine was given immediately. Two hours later when I again saw the man, he was sitting up in bed and enjoying his food. He made a rapid recovery.

After this success, I deliberately tried the effect of lumbar puncture in cases of cerebral malaria that came under my care, withdrawing about 15 c.c. of fluid. In some cases the procedure was followed by improvement, and in no case was any deleterious effect noticed. I afterwards found that lumbar puncture had been recommended by other medical officers, but at the time I was not aware of this.

It has been suggested that any benefit which accrues to the patient is due to a simple lowering of the intracranial pressure. I make the further suggestion that the mechanical lowering of intracranial pressure allows a rush of quinine-laden blood into the clogged brain capillaries. It is, of course, understood that in cases with cerebral symptoms, in addition to the carrying out of lumbar puncture, quinine should be administered vigorously by any method selected. Administration by the rectum was recommended by some medical officers because, by that route, large doses (thirty or forty grains) may be given. I found this method most unsuitable. The patients were often so rigid and irritable that an anaesthetic was required to enable a nurse to give the injection. The intravenous injection of quinine was sometimes difficult to carry out for the same reason; indeed, some of the patients were so noisy and violent that it required several men to restrain them. To one such maniacal patient I administered sixteen grains quinine bichloride intramuscularly into each buttock, and in addition gave a dose of hyoscine hypodermically with a most satisfactory result.

**Disposal of Malaria Patients.**

Malaria is a disease in which there is a tendency to relapse. In civil life it is usually only the patient’s interests that have to be considered. On field service, however, once a man has contracted malaria, it may be difficult to reconcile his interests with the interests of the force in which he is serving. In this campaign a man relapsing time after time became little more than a passenger between his unit and a hospital or sanatorium. He thus occupied some of the already limited space in sick convoys, hospital
ships and returning transports, and his presence increased the overcrowding on each of these. If, on the other hand, every man who had contracted malaria had been invalided out of the country, the force would soon have ceased to exist; each case had to be considered by itself. The disposal of malaria patients was thus a difficult administrative problem.

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