THE PREVENTION OF MALARIA IN WAR, WITH SPECIAL REFERENCE TO THE INDIAN ARMY.

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(1) PRELIMINARY REMARKS.

It would be instructive, if it were possible, to determine the loss of military efficiency produced by malaria during the present War. In making any such computation it would be necessary to know not only the number of deaths attributable to malaria (including the number of cases in which its debilitating effect condued to a fatal result in the course of other diseases), but also the total number of men invalided on account of malaria (either alone or in combination with other diseases) and the period during which they were rendered unfit for field service.

The time has not yet arrived when this estimation can be made with any approach to accuracy, but in the writer's opinion there can be little doubt that the result of such a calculation would indicate to a degree not yet realized the profound effect exercised by malaria on military operations.

From the financial point of view, the influence of the disease on the cost of the War cannot have been less marked or less striking. Apart from the pay, the gratuities and the pensions of those temporarily or permanently incapacitated by malaria, the cost of training and equipping recruits to fill their place must have been great. In the field considerable additional expenditure must have been incurred in providing accommodation for the sick, whilst the difficulties associated with their transport and their evacuation to the base will have been accentuated. Finally, the cost of the provision of hospital accommodation along the lines of communication, in hospital ships and in "overseas" hospitals cannot fail to have been enormous.
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The writer's experience during the present War has been chiefly confined to the Indian Army, and the result of numerous observations has led him to conclude that the major portion of the sickness occurring in the Indian Army is attributable either directly or indirectly to malaria. In short, it is considered to be no exaggeration to state that the prevalence of malaria amongst Indian troops is a matter calling for most serious consideration. It is probable that this statement will fail to meet with universal acceptance and that it will be considered to represent an unduly exaggerated view of the case.

The statement is indeed an unproved and therefore a valueless assertion—though some of the reasons which have led to its adoption will shortly be detailed—but it will suffice for the present argument if it be conceded that malaria is responsible for an appreciable amount of preventable disease. This statement of the case will, it is thought, be readily conceded, but it will be asserted that malaria is a disease which, it is well-known, is difficult or impossible to control under field service conditions and that its occurrence in these circumstances—as an acquaintance with the medical history of campaigns in malarious countries clearly proves—must be regarded as an unfortunate but inevitable result of military operations in paludic areas.

If such a view indeed be held it is undesirable that it should remain uncombed. The difficulties of controlling malaria amongst troops on field service are admittedly great and they are sometimes insuperable, but it would be to ignore the fruits of modern scientific research and the advance in knowledge of anti-malarial measures that has thereby resulted, to conclude that the experience of the Walcheren Expedition in 1809 need necessarily be reproduced in all its details over 100 years later.

It is therefore proposed to examine the problem presented by malaria in the Indian Army in the light of modern knowledge of the disease, to estimate its prevalence so far as may be and to determine whether and to what extent, and in what manner, it is possible to reduce its incidence with a view to promoting the well-being of the Army in times of peace and its efficiency in time of war.

(2) The Prevalence of Malaria in the Indian Army.

It is not proposed to detail the official statistics dealing with the prevalence of malarial fever in the Indian Army mainly on
account of the fact that the point it is sought to elucidate has reference to the incidence of malarial infection rather than the frequency of attacks of acute malaria.

The importance of making this distinction will become apparent later and it must, therefore, suffice to state here that a true appreciation of the part played by malaria in the Indian Army necessitates a knowledge not only and not exclusively of the recorded number of "attacks" of fever (which may include numerous attacks in the same individual) but also of the number of individuals whose health has been detrimentally affected by the parasite of malaria.

The writer is unaware of any statistics bearing on this point and it is, therefore, necessary to fall back upon the following personal observations which, though somewhat lacking in precision, are it is thought, sufficient to render it probable that they represent average conditions with approximate accuracy.

During a period of fifteen months, whilst the writer was serving in Muscat, reinforcements coming from India were examined as a routine measure immediately on arrival for evidence of chronic malarial infection. It was found that a considerable proportion of the new arrivals exhibited, in the shape of enlargement of the spleen, distinct and unmistakable evidence of old-standing infection. Thus, out of a total of nearly 300 men, some twenty-five per cent showed obvious enlargement of the spleen which was the undoubted result of malarial infection. In one particular instance no less than twenty-one out of a small draft of twenty-nine men exhibited splenic enlargement on arrival, and of these fifteen were admitted to hospital within one week with acute attacks of malaria associated with the presence of malaria parasites in the blood.

This experience may be considered—and it was so considered at the time—to be of an exceptional nature, but after return to India in February, 1916, the writer, during the succeeding twelve months, examined many hundreds of Sepoys belonging to various regiments which included Sikhs, Jats, Rajputs, Punjabi Mussulmans and Gurkhas and it was again found that a considerable—though varying—proportion of the men exhibited enlargement of the spleen with or without some degree of debility and anaemia.

It is particularly significant that many of these men were presumed to be healthy and these were only examined as a routine measure prior to proceeding on field service. They comprised the majority of those whom it was necessary to reject on medical grounds as being unfit for field service.

During the same period at various depot hospitals the majority
of the patients (except during an outbreak of mumps and measles) under treatment were invariably the subject of malaria.

Finally, towards the close of the year, the writer was attached to a regiment which had not previously been on field service. Here also malaria was the most common disease encountered before the regiment left India.

Thus, to take a day at random, on December 13, 1916, the total number of men in hospital was 17, of whom 6, or about one-third, were suffering from "fever" and enlargement of the spleen. There were also 7 "detained" cases (detention lasts twenty-four hours, after which the patient must be either "admitted" or "discharged") of whom 5 exhibited splenic enlargement.

In addition to these 24 patients there were 57 out-patients, which included 18 men suffering from anaemia, debility and enlargement of the spleen. Finally, 23 others were attending hospital for medicine, but doing duty, which included 7 cases of chronic malaria and enlargement of the spleen. Whilst, therefore, the official returns of this regiment for December 13 only showed 17 men in hospital, including 6 cases of malaria with enlargement of the spleen, there were in fact 104 men under treatment of whom 36 or 34.6 per cent exhibited evidence of chronic malaria.

But even these 36 men do not fully represent the true malaria morbidity on the day in question, for in the above computation only those cases of "fever" who had also enlargement of the spleen have been taken into account. If circumstances had permitted blood examinations to be made of all patients exhibiting "fever" it is probable that the true malaria morbidity would have been found to have been somewhat greater than thirty-four per cent, and it would not be far wide of the mark to suggest that it might have been as high as fifty per cent, of the total sickness in the regiment.

The official returns, therefore, fail to give a complete representation of the true prevalence of the disease. Thus in the above-quoted instance the actual prevalence of malaria was about six times greater than might have been gathered from a scrutiny of the official statistics.

This circumstance, it should be added, is not the result of the efforts of medical officers to burke the facts, but it is largely due to the fact that the prescribed method of preparation of the official returns fails to take into account the special circumstances connected with the treatment of a chronic disease like malaria. Thus it is not always necessary—and indeed there is not always sufficient accommodation in Indian Troops' hospitals—to admit to hospital
every case of chronic malaria. Many men report sick on account of debility, diarrhoea, or perhaps slight attacks of dysentery who, if suitably examined, will be found to be suffering from chronic malaria with anaemia and enlargement of the spleen. Others come to hospital with a history of previous attacks of slight fever, but with no other signs or symptoms of malaria except enlargement of the spleen and some degree of debility. These include many cases of so-called "latent" malaria. The majority of these cases do not require to be "admitted" to hospital for they can readily undergo treatment as out-patients.

Since, however, the official returns fail to take cognizance of any patients other than those "admitted" to hospital it follows that these returns fail to reflect the true prevalence of the disease.

Then again the association of malaria with other diseases is, in the writer's experience, marked. Thus sub-acute and chronic malaria (with a small degree of enlargement of the spleen) is often found to co-exist with attacks of diarrhoea, dysentery and other diseases; thus in a recent instance six out of eight consecutive cases of acute pneumonia treated in the regimental hospital also exhibited splenic enlargement. [Two of these men developed acute attacks of malaria during convalescence.]

These cases of so-called "masked" malaria, if appearing at all in the official returns, will be shown under the head of the disease for which they were admitted to hospital, and the fact that they are also infected with the malaria parasite will not be apparent from the official statistics.

The above observations lend support to the view that malaria is widespread throughout the Indian Army.

It is held that the official statistics do not fully represent the prevalence of acute malaria and, what appears to be of even greater importance, they fail to throw light on the incidence of chronic malaria, or to take into account either "latent" or "masked" malaria.

It is not contended—nor was it actually found to be the case—that all Indian units are equally infected, for the degree of prevalence in any given unit would be anticipated to be dependent upon a variety of circumstances, but it is thought that the facts related above warrant the conclusion that, quite apart from the results of infection acquired on field service, malarial infection prevails to a degree which is at present not appreciated throughout the Indian Army.
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(3) The Nature of the Malaria Problem.

It is now proposed to examine, in the light of modern knowledge, the nature of the problem presented by malaria in the Indian Army.

This army is composed of races who exhibit not only a wide divergence in caste, creed and customs, but there is an equally wide variation in the climatic and other environmental conditions to which they have been subjected during early life.

The chief recruiting ground of the Indian Army is, however, the Punjab, and it will, therefore, suffice for our present purpose to review the conditions encountered in this province in so far as they affect the problem under consideration.

As the result of the epidemiological study of malaria in the Punjab it is known that the disease is apt, from time to time, to exhibit itself as an epidemic of great magnitude so that sometimes the entire population of extensive tracts is prostrated by the disease. At this time the mortality, especially amongst children, is excessively great, whilst the health of all is seriously and often permanently impaired.

These epidemics, however, only occur at irregular intervals, usually at not less than five years; during intervening periods the disease as a cause of mortality is of relatively small importance but nevertheless in each autumn a small rise in the "fever" death-rate takes place and attacks of malaria become common throughout all parts of the province.

It is found that the disease is more common in rural areas than in towns and that it is more frequently encountered in the latter than in large cities. It is a disease of agriculturists rather than of those whose business or pleasure entails residence in the heart of a great city.

Finally it has been shown that the occurrence of famine or even of lesser degrees of economic stress is usually associated with a rise in the mortality and in the morbidity of the disease in the succeeding autumn.

It is from amongst the agriculturists of the rural areas of the province that the Indian Army is mainly recruited and since they rarely or never undergo a course of curative treatment it follows that many of them must continue to harbour malaria parasites for a long period of time.

The actual proportion of infected individuals cannot even be roughly surmised since it must necessarily vary in accordance with numerous circumstances.
In a year following a severe epidemic, for instance, it can confidently be asserted that almost every recruit from the affected tract would be infected. At other times and in other circumstances the proportion of infected individuals would be less, but in the absence of more precise observations it is only possible to put forward the general proposition that all the circumstances of the case point to the conclusion that the prevalence of malarial infection amongst recruits joining the Indian Army must at all times be considerable. As confirmatory evidence of the accuracy of this view the facts already related in regard to the prevalence of malaria infection amongst the Indian troops in India may be cited.

The next point it is necessary to discuss has reference to the question of the acquirement of infection and re-infection and the occurrence of relapses amongst these young soldiers.

In the Punjab it is known that malaria infection and re-infection is not contracted throughout the year and that, whilst the frequency of infection is subject to both annual and seasonal variation, it is chiefly, though not entirely, during the months of July, August, September and October that the disease is actively transmitted by means of anopheline mosquitoes.

In the absence of measures to prevent the access of mosquitoes the troops are therefore subjected to a variable degree of fresh infection during the course of their service. The number of infected individuals is thus maintained, the actual incidence at any given time being dependent upon the relationship existing between the number of cases that have been spontaneously or artificially cured and the number of fresh infections that have recently been acquired.

In these circumstances the onset of the "fever season"—the season favourable both to the acquirement of fresh infection and to the occurrence of relapse attacks—is associated with a rise in the malaria morbidity.

In many cases, attacks of so mild a type ensue that they fail to attract attention until the occurrence of debility, anaemia, giddiness or the onset of some intercurrent infection (such as mild dysentery) renders the individual unfit to perform his duties and thus renders it necessary for him to seek medical aid.

A considerable number of men in this condition remain on duty, or apply for and obtain leave of absence, and eventually regain, at any rate in part; their normal health without medicinal treatment. More frequently they attend hospital for a few days and then return to duty.

But should they during this period be called upon to undergo
any unusual strain, such as a prolonged and trying march in the sun, an attack of "fever" is promptly precipitated. In this manner may be explained the not uncommon occurrence of extensive outbreaks of malaria in regiments on manoeuvres or on the line of march, amongst whom previously but few cases of "fever" had occurred whilst in cantonments.

To a similar train of circumstances the return to India on account of "fever", of large numbers of Indian troops, after only a few weeks' residence in Mesopotamia, must probably be ascribed.

It is well known that privations, exposure and prolonged physical strain especially under tropical and semi-tropical conditions, is apt to produce relapse attacks in malarious subjects. Their great importance in this respect has however been recently emphasized by the writer, who showed that in Muscat an important reason for the unenviable reputation of this town, as a malarious locality, was the fact that the environmental conditions were of such a nature as to be exceptionally favourable to the production of repeated relapses in malarious subjects.

It was proved that for prolonged periods of time the active transmission of malaria was almost, if not completely, in abeyance, yet during this period the malaria morbidity figures continued to be great and sometimes excessive. [In this connexion the case (already quoted) in which fifteen out of twenty-one malarious subjects developed acute malaria within one week of arrival at Muscat may be cited.]

Indeed, as the result of the study of malaria at Muscat it was concluded that outbreaks of malaria under certain conditions do not necessarily or always imply that much fresh infection is being acquired.

On the contrary, it was found that these outbreaks may be independent of any fresh infection, and they may be almost, if not entirely, due to the subjection of a malarious body of troops to certain climatological, meteorological and other environmental conditions which are favourable to the production of malarial relapses.

[The writer has no personal knowledge of the conditions prevailing in Mesopotamia, but there is reason to believe that at any rate in certain localities, and during certain seasons of the year, the climatic and other circumstances are not markedly different from those prevailing in Muscat.]

In the light of these considerations the conception of the problem presented by malaria in the Indian Army may be summarized as follows:
The Army is recruited from a population which is annually subjected, in a variable degree, to malarial infection and re-infection. During this period they rarely or never submit themselves to curative treatment, their freedom from symptoms being perhaps dependent upon the acquirement of a partial degree of immunity, whilst their freedom from infection is associated with the complete disappearance of the malaria parasite as the result of natural causes.

After enlistment in the Army the condition of affairs is not widely different. In the absence of steps to prevent the access of mosquitoes' infection and re-infection continue to take place in the same manner as formerly.

A certain number of cases of malaria thus continue to occur, but in many instances, owing perhaps to their previous acquirement of a partial degree of immunity, fever of so mild a nature results that it entirely escapes detection, or it is masked by the occurrence of other diseases.

Under normal conditions little apparent harm appears to result, but should circumstances supervene such as those associated with field service in a tropical climate, a further deterioration in health results, which is either followed by repeated attacks of ague or a condition of debility is produced which eventually, either alone or associated with some intercurrent infection, renders the individual unfit to perform his duties.

The above views, the importance of which, if correct, it is impossible to over-rate, give rise to the conclusion that one of the most important methods of reducing the incidence of malaria in the Indian Army on field service comprises measures which have for their object the detection and cure of standing infections as well as the prevention of fresh infection of the troops serving in India.

The conclusion is of fundamental importance, since it serves to combat the view that breaks of malaria are the inevitable consequence of military operations in paludic countries. On the other hand, it also suggests that the elimination of all degrees of malaria infection, however slight, from the Indian Army, should form an important feature of military medical administration in India.

The object in view should indeed be to render the Army in peace time free from any appreciable number of infected individuals, for if, in addition to the malaria infections the result of avoidable infection acquired on field service, a vast number of relapse attacks due to infection acquired in India also occur, the problem
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presented by malaria on field service assumes formidable proportions and presents difficulties which are not a necessary concomitant of field service, and which are not capable of being readily dealt with in such circumstances.

(4) The Prevention of Malaria amongst Troops.

(a) The Prevention of Malaria on Field Service.

In view of the facts related in the preceding chapter it is clear that the prevention of malaria amongst bodies of troops comprises two distinct problems:

(i) The prevention of infection and re-infection.

(ii) The cure of old-standing infections.

It has been shown that whilst these are both of great importance they are subject to variation in different localities and in varying circumstances. On the one hand the prevention of infection may be the main problem and on the other the prevention of relapses may be of equal or even greater importance than the former. But from the practical point of view anti-malaria measures may more conveniently be divided into the following categories:

(a) The prevention of malaria on field service.

(b) The prevention of malaria in cantonments.

In regard to the prevention of malaria on field service it is clear that if the measures necessary to prevent infection and to cure old-standing infections have been carried out successfully in peace time the prevention of malaria on field service will solely comprise measures which have for their object the prevention of fresh infection. The solution of this problem may perhaps present difficulties, but however great these may be it will, not be complicated nor aggravated by the occurrence of large numbers of relapse attacks due to infection contracted previous to the War.

A nation, therefore, which has adopted and carried out in time of peace an anti-malaria policy which has eliminated malaria from its army, will in time of war reap a reward of the first magnitude. Success will more readily attend the military operations of its forces and at a lesser cost of both blood and treasure than in the case of armies whose efficiency is prejudiced by reason of the prevalence of chronic malaria infection.

Adopting therefore for the moment the view that the army takes the field in a malarious tropical or sub-tropical country (such as Mesopotamia, the Balkans or Palestine) free from malaria infection what are the measures that can be carried out to safeguard the
troops from acquiring the disease? Clearly these must depend upon the climatic and other conditions of the locality in which the troops are serving. They must also be affected by the prevailing military necessities. In some cases, practically no measures can be taken to prevent the occurrence of fresh infection and to this extent malaria must be looked upon as the inevitable result of campaigning in paludic countries. In such category would be a military force engaged in active operations in the highly malarious jungles of East Africa or in other severely infected countries during the "fever" season.

In such circumstances military considerations may over-ride all others, and questions of health must be subordinated to military necessity.

But it may happen that, warned of the risks of committing the troops to active operations in pestilential swamps, an alternative plan of campaign may commend itself to the military authorities. An instance, indeed, is said to have occurred during the present War, where the opposing General gave ground in such a manner as to manoeuvre the allied forces into highly malarious valleys from which he is reported to have said he would not endeavour to eject them as "malaria would do the work." If this statement was, indeed, made, his prescience was abundantly justified by the event, for it has been officially reported that the Allied forces, operating in these valleys have been voluntarily evacuated ( alas! a year too late), owing to the onset of the malaria season.

Failing the possibility of combining tactical and medical problems, it is necessary to consider what other measures may be carried out in order to mitigate or prevent the widespread infection of troops serving in highly malarious areas. It is obvious that if the troops can be protected from the bites of mosquitoes, the transmission of the disease will be rendered impossible. Much time, money, and ingenuity has been expended in endeavouring to comply with this desideratum; masks for the face, gloves and leggings for the extremities, have been provided, dug-outs have been fumigated, or they have been protected by netting, whilst a mosquito net has been added to the kit of the already over-burdened soldier.

None of these or many other similar contrivances have in actual practice proved successful, nor as long as troops are in daily contact with the enemy is it probable that preventive measures of this nature can be carried out with reasonable efficiency.

In these circumstances it would appear that the only possible method of safeguarding the health of the troops is by means of the exhibition of quinine in prophylactic doses.
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This measure has also been tried with a success which has varied to a marked degree; in some cases the drug has apparently completely failed to achieve the object in view, whilst in others a gratifying measure of success has attended its exhibition.

In the writer's hands, as the result of an experiment carried out amongst school children in the Punjab, the prophylactic use of quinine has yielded results of the greatest value, and provided that certain principles are acted upon, there is reason to believe that quinine is a drug capable of yielding, if certain precautions be observed, profoundly beneficial results which, moreover, are attainable even under the exacting conditions of active military operations.

The principles underlying successful quinine prophylaxis are as follows:

1. Owing to the fact that quinine is almost completely eliminated from the system within forty-eight hours, the drug requires to be exhibited at intervals of not less than this period.

2. The amount of quinine requires to be varied in accordance with the intensity of local malaria, and in places where the disease is highly endemic a daily dose of not less than ten grains of quinine should be given to adults.

3. In the case of malarious subjects it is not reasonable to expect that quinine given in prophylactic doses will suffice to prevent the occurrence of relapses as well as the acquirement of fresh infection. In such cases the patient requires to be placed on a curative system of treatment.

4. The arrangements for the exhibition of the drug must be of a nature which will ensure that the quinine either in liquid or tablet form is consumed with regularity.

5. The prophylactic use of quinine may, if circumstances permit, be combined with anti-mosquito measures, but the energies of medical officers and others must not thereby be distracted from prosecuting the main line of defence, viz., the inauguration of an efficient system of quinine prophylaxis.

6. In countries possessing a sub-tropical climate, in which the active transmission of malaria is confined to a certain season of the year, the above procedure need only be continued during the malaria season.

But the troops are not always engaged in active operations and it will often happen that they will be under conditions not markedly different from those prevailing in peace time. In such circumstances it will be possible to carry out to a variable degree the measures (to be shortly detailed) applicable to troops serving in cantonments.
Thus much may often be done by the careful selection of camping grounds to reduce the opportunity of acquiring infection in permanent camps. These camps, therefore, should not be laid out in malarious countries without a previous survey of the locality by a malaria expert.

It may happen that there is no alternative between camping alongside a malarious swamp and forming a camp in an open desert two or three miles from water. But it may equally be that the provision of a pipe water supply to such a camp would in the long run be a cheaper and more efficacious method of safeguarding the health of the troops than permitting them to camp alongside the swamp, even though an extensive and necessarily expensive antilarval campaign should be initiated.

The measures suitable and proper under peace conditions, however, constitute a large and important programme which cannot readily be carried out on a large scale under field service conditions.

It thus comes about that if, in addition to the malaria cases, the result of infection acquired on field service, a large number of relapse attacks, due to infection acquired in peace time, have to be dealt with, not only will the efficiency of the force be seriously prejudiced but the medical organization throughout its whole length from the front line to the base will be subjected to a severe strain.

(b) The Prevention of Malaria in Cantonments.

Although the antimalaria measures that may appropriately be adopted in cantonments during peace times are discussed here, some of these measures may equally be carried out in war time, more especially in the case of troops stationed on lines of communication or on garrison duty at the base.

In view, therefore, of the fact that malaria infection is rife amongst many of the units of both the British and the Indian Armies that have served in India or in the Eastern theatre of war it will be clear, from what has gone before, that the percentage of wastage in the front line, and the maintenance of the efficiency of field armies generally, will be dependent upon the extent to which these measures are capable of being carried out during the course of the war.

(i) Curative Measures.—It is obvious that an accurate knowledge of the incidence of malaria must necessarily precede the adoption of curative measures, but it has been shown that in the case of the Indian Army the true prevalence of the disease is not fully disclosed.
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by the official statistics. It would, therefore, appear to be essential that steps should be taken to place the diagnosis of malaria in Indian troops on a more satisfactory footing. For this purpose it would appear to be essential that in each regimental hospital both the medical officer and his subordinates should not only be competent to carry out the simple procedure involved in making a microscopical diagnosis of malaria, but that they should be provided with the necessary equipment for so doing.

This equipment is indeed required not only for the diagnosis of malaria but for the detection of many other diseases common amongst Indian Sepoys, not as a substitute for divisional laboratories but to supplement them in matters of everyday routine.

But even in the absence of these facilities there exists in the "spleen test," provided it is properly carried out, an exceedingly simple, rapid and fairly accurate means of detecting chronic malaria, which, moreover, can be carried out under almost any conditions. The value of the test is well known and many reports have been published, especially during recent years, in regard to its importance both as an aid to diagnosis and as a guide to treatment. So far as is known, however, the attention of medical officers has not been directed to the value of this test and from the writer's experience it would appear to be both little known and but little appreciated.

It is, therefore, not out of place to detail the procedure. It is usually quite useless in the case of an adult, to carry out the examination in the upright position. The patient should be placed on a bed or couch in the supine position with the thighs flexed. The examiner standing on the right side of the patient lightly palpates the abdominal wall below the left costal margin with the right hand. If the spleen cannot be felt the patient is asked to distend the abdomen by taking a deep breath and then slowly to relax it by means of a prolonged expiration. The spleen, if enlarged appreciably, will then usually be found to descend below the costal margin with inspiration and to slip back during expiration. By the adoption of these two methods, or even of the latter alone, the true prevalence of malaria in a unit can be quickly ascertained.

In the case of Indian units it is important that every man attending hospital should be examined in this manner, for by so doing many cases of chronic malaria will be discovered. It is also desirable that every recruit on enlistment should be similarly examined.

These procedures, more especially the spleen test, offer no
difficulty in execution and the writer has found it possible to carry them out both on field service and in Indian cantonments.

The next point consists in entering the names (by companies) of malarious subjects in a special register—the "Malaria Register," in which the size of the spleen, the presence or absence of parasites and their species, if detected, should be noted.

Armed with the information contained in this register the treatment of the disease can now be carried out in a systematic manner.

With this object the patient's name should be entered in a "Quinine Register," and he should also be given a "Malaria Card," showing the nature of the infection, the dose of the drug and the period during which the "treatment" should be carried out.

A difference of opinion may exist in regard to the exact dose of quinine and the length of time during which it should be administered (and experience shows that both of these data may be varied in different cases) but it is at any rate certain that an occasional dose of quinine given at irregular intervals during the few days following an attack of ague is not calculated to effect a cure.

It may be that finality has not yet been reached in regard to this question, but the writer can state as the result of a prolonged and carefully controlled experiment carried out in Indian troops at Muscat that the following method of "treatment" and "after-treatment" is capable of yielding highly satisfactory results.

A.—Treatment.

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<th>Week</th>
<th>Treatment</th>
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<tr>
<td>1st</td>
<td>(i) During continuity of fever (usually not more than three days) t.d.s. in solution.</td>
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<tr>
<td></td>
<td>(ii) For the four following days Ditto.</td>
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<tr>
<td>2nd</td>
<td>(iii) For one week whilst &quot;attending&quot; hospital Ditto. Bis di.</td>
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<tr>
<td>3rd</td>
<td>(iv) For one week whilst on &quot;light duty&quot; Ditto.</td>
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(v) On discharge to duty Ditto. Once daily for 4—6 months.

When possible it is preferable that the drug should be administered on parade and that the attendance at this parade should be noted daily in the quinine register. In cases where this is impossible the soldier should be provided with quinine in tablet form and he should be instructed to take the requisite number of tablets daily.

If the soldier suffers from an attack of fever, or is in need of quinine whilst absent on leave or on detached duty, he should be
instructed to present the "malaria card" to the appointed medical attendant who will thus be in a position to carry on the treatment with a full knowledge of the man’s past history.

(ii) Prophylactic Measures.—It now remains to consider the measures necessary to prevent the acquisition of fresh infection.

Of these the prevention of access of mosquitoes is a measure of the first importance, but at present, except in the case of War Hospitals and of troops stationed in Burma (where mosquito nets are issued at the rate of 1½ per cent of strength) Indian troops are not provided with mosquito nets as a Government issue and it is left to the regimental authorities to provide them if they have the funds and the inclination to do so.

It is, however, one thing to provide nets and another matter to ensure their proper use. In the writer's experience nets are rarely used properly by the Indian Sepoy; they are frequently removed at night on account of the heat and, when used, they are often faultily applied. The mosquito net is moreover a fragile structure and care and constant attention are necessary if it is to prevent effectively the ingress of mosquitoes. It is obviously insufficient and indeed it is useless to provide mosquito nets unless steps are taken to see that they are properly used.

It is for officers to set an example to their men in this respect, both by precept and by example, for if the former are not firmly convinced in the efficacy of the mosquito net it is scarcely to be expected that the latter will exhibit greater wisdom.

In each locality the malarialogist will be able to determine the period of the year during which mosquito nets should be used, and it should be made obligatory on all ranks to use them during this period.

But experience shows that the use of mosquito nets by troops is fraught with many difficulties, and it would appear to be preferable from the point of view of efficiency, as well as of comfort, that other means should be adopted to prevent the access of mosquitoes. It has elsewhere been suggested by the writer that in the case of bodies of men the protection afforded should take a collective rather than an individual form.

Such an arrangement might consist of screened enclosures of wire gauze (fitted in their interior with electric fans or punkahs) erected in the vicinity of barracks.

In the case of troops on field service, other than those serving in the front line, the use of a mosquito net is a most valuable as well as a practicable means of preventing malaria infection.
Unfortunately, its advantages are not fully appreciated and it is but rarely efficiently used.

If all the malarious subjects are treated on the lines already outlined, and if the acquirement of fresh infection is prevented by the use of measures to prevent the access of mosquitoes, little need will arise, at any rate, under normal peace conditions, for the exhibition of quinine in prophylactic doses. But if circumstances prevent the adoption of these measures, either in whole or in part, it may be advisable to carry out quinine prophylaxis during the "fever" season in the manner already described.

If, however, the outbreak of malaria is the result of relapse attacks, following old-standing infections, it would be clearly unnecessary to exhibit the drug indiscriminately to entire units. In such circumstances it would suffice to adopt this procedure only in the case of those individuals whose names appear in the malaria register.

Finally it is important, more particularly at the season of the year when relapses are common and during the early stages of a curative course of treatment, that all causes likely to lower the powers of resistance of the individual should, so far as possible, be avoided.

Thus in the case of a malarious unit, attention to the general health, the provision of an ample supply of suitable food, the avoidance of undue fatigue and excessive exposure to the sun and the prevention of chills are all anti-malaria measures of considerable value.

(5) Conclusion.

A consideration of the facts given in this paper suffices, it is thought, to establish the view that not only is malaria far more prevalent in the Indian Army than is generally recognized, but that the time has arrived for a radical alteration to be made in the methods of grappling with the problem of its prevention.

The important point has also been established that on the thoroughness of the preventive measures carried out in time of peace the efficiency of the army in time of war is largely dependent.

It has also been shown that malaria is not necessarily an inevitable result of military operations in paludic countries, and that the scientific application of modern knowledge of the disease renders it possible to mitigate in great part the sickness and inefficiency to which malaria gives rise.
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If these conclusions are well founded it is difficult to overestimate their importance, for they serve to enunciate general principles on which the anti-malaria policy of the future should largely be based. But it is hoped that this paper will also serve an immediately useful purpose by directing the attention of medical officers serving for the first time in malarious countries to the importance and difficulties of the problem presented by the prevention and treatment of malaria in time of war.

REFERENCES.

