DIAGNOSIS OF MALARIA IN WEST AFRICA

BY

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This paper is based upon experience of over 2,000 cases of malaria in white personnel at an R.A.F. hospital in West Africa. The type was almost exclusively malignant tertian. The vast majority of patients had not been exposed to infection prior to service in West Africa, and their stay was comparatively short. Drug suppression and antimalarial discipline were in force. Owing to a big drainage scheme and efficient screening, the infection rate, though not low, was less than in many places on the coast. Patients were nearly always admitted to hospital in an early stage of the disease. Pernicious cases were uncommon; only 9 of blackwater fever, 4 of cerebral malaria, and 1 of the choleraic type were seen, all of which recovered. No algid case presented. Chronic malaria was very uncommon; not more than 6 cases were seen.

M.T. malaria closely mimics many diseases; it is dangerous, and parasites are not always found in the blood. Treatment, therefore, often has to be on suspicion. However, it is possible to become a little obsessed with the diagnosis when malaria accounts for no less than two-thirds of medical admissions—with results which are not always happy. The following is an account of matters found helpful in diagnosis. Cases of malaria will be referred to as proved (or slide-positive) and clinical (or slide-negative), depending upon whether parasites were or were not found in the blood stream. Diagnosis was often helped by a short period of observation. Grave complications, however, are so liable to arise in seriously ill cases of malaria that treatment was not delayed in any serious febrile illness unless the clinical picture pointed definitely to a non-malarial disease. For routine purposes a temperature of 103° was taken as an objective dividing-line between seriously and not so seriously ill cases; these will be referred to as high- and low-fever cases respectively. In the great majority of low-fever cases it was found possible to reach a shrewd diagnosis within 48 hours; for the remainder, a working rule was adopted that antimalarial treatment should be tried when doubt still existed at the end of 4 days.

Pathological Diagnosis

Antimalarial therapy was started on finding a positive blood slide. Slides were taken on admission, before starting treatment, in all cases. The following trial was made to determine the optimal delay for blood slides in low-fever cases. Treatment was withheld in 136 virtually consecutive low-fever cases of suspected malaria—indefinitely in the first 71, and then for four days in 65. Blood slides were taken on admission, and night and morning. Ninety cases revealed parasites—66 in the first slide, 14 more within 24 hours, and 6 more within 48 hours; only 4 showed parasites at longer intervals. It was concluded that delay beyond 48 hours for this purpose was of little value. The figures are very similar to those in a series of 968 reported by Hughes and Bomford (1944) from another West African Service hospital. Slides were taken night and morning for 48 hours in high-fever cases even though treatment had been started, since it was found that parasites still appeared in an appreciable number of cases. In B.T. malaria parasites are most easily found on the rise of temperature in each rigor. Such typical rises are not common in M.T. malaria. Slides were taken in those which did occur, but parasites were by no means always found. Suppressive therapy was stopped while diagnosis was under consideration. It was started again as soon as malaria was thought excluded (i.e., a maximum suspension of 4 days).

Malaria parasites are harboured somewhere after an attack, possibly in the bone marrow. Until it is known that they cannot be found in the marrows of parasitized but symptom-free men a positive marrow smear cannot be accepted as diagnostic of active disease. Even were this the case, the number of blood-slide-negative cases of suspected malaria was far too great to justify the routine use of sternal puncture in West Africa. It was tried in a few such cases out of scientific interest, and parasites were sometimes seen.

Clinical Diagnosis

A number of clinical features were believed to assist in diagnosis. Splenomegaly was a very strong pointer. Other causes were rare. Admittedly 5% of 219 cases on the station had splenomegaly, and could be admitted with non-malarial illnesses, but this would hardly have accounted for more than 1 to 2% of admissions. The percentage, however, in febrile cases admitted to the medical wards was very much higher—approximately 25% of 406 consecutive cases. Tenderness of the spleen was virtually pathognomonic, and definite tenderness under the left costal margin, in the absence of a palpable spleen, came to be regarded as of great diagnostic value.

The anomalous behaviour of many cases of malaria superficially resembling other diseases was very helpful. Deterioration was of great assistance; the common non-malarial illnesses concerned in differential diagnosis (febrile catarrhs, simple enteritis, and dysentery) tended to recovery, and that fairly rapidly. Another valuable pointer was in the time relations between constitutional and local symptoms. In the usual non-malarial illnesses the onset might be with constitutional symptoms only, but local ones soon followed which persisted after disappearance of the former. In enteritis, for example, onset might be with 12 to 24 hours' headache, but the subsequent diarrhoea outlasted the headache by several days. In malaria, constitutional symptoms often preceded the local ones by days or persisted after their disappearance. The typical tertian periodicity of fever and symptoms was helpful when met, but unfortunately was not particularly common. Incidentally actual rigor was very uncommon and usually heralded blackwater fever. The combination of the symptoms of two non-malarial diseases, such as coryza and diarrhoea, was felt to indicate malaria. Two other points were of limited value. The degree of constitutional disturbance and the duration of illness might be incompatible with the non-malarial disease concerned. Thus a case with severe headache, a temperature of 105°, and coryza was hardly likely to be a febrile catarrh; such obvious cases were, however, exceptional.

The likelihood of malaria varied considerably between the various presenting symptom-complexes, and this was of much help in diagnosis. Very many cases presented with symptoms and signs of a general nature only. These included headache, backache, aching limbs, dry cough, vomiting, fever, splenomegaly, and herpes. They will be called constitutional cases. It was believed that all such cases should be regarded as malarial, positive slides or not, unless definite reasons appeared to the contrary. They were indistinguishable from proved cases. No common satisfactory alternatives existed; some form of heat exhaustion or an unknown virus was a possible cause, but little or no evidence existed for either. A number got worse or failed to recover until given antimalarial therapy. Others apparently recovered without, but of these an undue proportion returned shortly after discharge in frank attacks of malaria; splenomegaly was seen to subside without treatment in a case or two of this type. Constitutional symptoms might usher in many diseases which later declared themselves by local symptoms; such possibilities had to be excluded by a short period of observation.

An analysis of the symptom-complexes in 345 consecutive cases of proved malaria was rather instructive. Results (to the nearest 0.25%) are given in Table I. Four symptom-complexes

TABLE I

1. Constitutional group (dry cough in 25%)	..	..	83.25%
2. Coryza or productive cough	..	..	9.25%
3. Simple diarrhoea	..	..	4.5%
4. Dysentery	..	..	0.75%

accounted for 97.75% of cases. Constitutional symptoms only were found in the great majority. It was considered simply a coincidence that while coryza and productive cough and simple diarrhoea were the only other common symptoms, febrile catarrhs and a simple enteritis were the commonest diseases after malaria. Dysentery was found in only a handful of cases. Other syndromes occurred involving differential diagnosis from such diseases as pleurisy, acute rheumatism, appendicitis, cystitis, amoebic hepatitis, and conditions leading to coma. All these were uncommon, none occurring more frequently than 0.25%. It was obvious that while malaria might present in

many guises its common forms were few. The analysis is very similar to a larger series (846) reported by Hughes and Bomford (1944).

A mildly statistical inquiry showed the proportion of all cases with coryza and productive cough, simple diarrhoea, and dysentery which were due to malaria.

The total number of cases and the numbers yielding positive blood slides, with these symptoms, were collected for some months. The next step was to estimate the cases of clinical malaria in each group. These estimates were obtained in the following manner. First, it was assumed that all cases with constitutional symptoms only were cases of malaria (unless definite evidence had shown to the contrary). The total numbers and the number with positive slides in this group had been collected over the same period; the proportion of proved to clinical cases was noted. It was then assumed that this proportion remained the same in cases of malaria with any other symptom-complex. Figures for the cases of clinical malaria in each group could thereby be obtained from the known number with positive slides; the proportion of cases due to malaria either in the whole group or in those with negative slides could then be calculated. The results are given in Table II. The proportions were worked out separately for high- and low-fever cases. Similar calculations were made for cases of follicular tonsillitis to determine the frequency with which the activation of latent malaria by a non-malarial illness might be expected in this neighbourhood. For obvious reasons, the results can only be taken as rough guides. Sampling errors may be present in the smaller groups. The second assumption may be erroneous. Correction of the possible error in the first assumption (namely, that some slide-negative constitutional cases were not due to malaria) would, however, strengthen most of the conclusions which were drawn. Nevertheless some results were highly suggestive.

TABLE II.—*Estimated Proportion of Cases with Respiratory Symptoms, Simple Diarrhoea, and Dysentery, due to Malaria, and of Follicular Tonsillitis complicated by Malaria*

Symptom-Complex	Total Cases	No. with Positive Slides	Percentage of Cases due to Malaria	
			Whole Group	Negative Slides
Constitutional high fever	172	145	6 out of 7 gave positive slides	
Constitutional low fever	315	168	Every other case gave positive slides	
Coryza or productive-cough high fever	23	13	65	21.5
Coryza or productive-cough low fever	120	21	35	21
Simple-diarrhoea high fever	20	10	57.5	16.5
Simple-diarrhoea low fever	119	11	18.5	10
Dysentery high fever	19	4	25	4.5
Dysentery low fever	63	1	3	1.5
Follicular-tonsillitis high fever ..	14	2	16.5	3
Follicular-tonsillitis low fever ..	33	—	++ against (none with positive slides)	

The following conclusions were drawn. Positive slides could be expected in most high-fever cases of malaria, but probably with much less frequency in low-fever cases. The activation of a latent malaria by a non-malarial illness was uncommon in the area. Cases with dysentery and negative slides were most unlikely to be caused by malaria. Cases with simple diarrhoea, low fever, and negative slides were unlikely to be so caused. On the other hand, malaria was a not uncommon cause in cases with coryza and productive cough, or of simple diarrhoea with high fever.

A therapeutic trial produced results of interest.

All cases in the groups with low fever and constitutional symptoms, coryza or productive cough, or simple diarrhoea were observed without treatment unless (a) slides became positive, (b) the temperature rose above 103°, or (c) they had failed to recover after 5 or 6 days. Those recovering fully were discharged without treatment. Twenty-four of the constitutional and 70 of the other two groups were re-examined at the end of three months. Three of the 24 but only 1 of the 70 had returned in frank attacks of malaria; in all 4 instances return was within one month of discharge. The incidence of such return was thus 9 times as great in the constitutional group as in the others. Incidentally, 2 of the respiratory and diarrhoeal groups had developed subclinical malaria (see later); nothing that was remotely suggestive of chronic malaria had developed in any.

The importance of malaria as a cause in the constitutional group of cases received confirmation. Unfortunate sequelae in the respiratory and diarrhoeal groups were most uncommon, though with the methods used in the trial a number

of cases of malaria were undoubtedly discharged without treatment. It was concluded that if after more careful exclusion of malaria a case appeared to be one of febrile catarrh or simple enteritis it could safely be treated as such. The matter was not entirely academic, as much working time could be saved by accurate diagnosis.

Subclinical Malaria

This term was applied to a condition seen in ambulant personnel. The main complaint was of recurrent headache. Back-ache, aching limbs, and malaise occurred; the sense of well-being which followed treatment was a notable feature. Splenomegaly was present in about one-third of cases. Slight pyrexia probably occurred. The general condition was good and anaemia absent. Blood slides were usually, though not invariably, negative. The incidence was estimated at about 10% of men on the station. Response to antimalarial treatment was good. The absence of anaemia and the condition of the patients excluded the diagnosis of chronic malaria as usually accepted. Latent malaria suggests a symptomless parasitization. The term "subclinical malaria" was preferred to "incompletely suppressed malaria," which it was felt laid too much emphasis on control of infection by suppressive therapy, as opposed to that by natural immunity processes.

Its existence was inquired for as a routine in all cases admitted to the medical wards and, if found, led to a course of treatment before discharge. When doubt existed as to diagnosis, its presence was thought to favour malaria.

Affected ambulant personnel were treated by an increase in suppressive therapy.

Details of the clinical data upon which this account of "subclinical malaria" was founded will now be given. A number of these cases were seen, but only 61 were observed closely enough for their records to be worthy of analysis. 41 had had headaches more frequently than once a week, and were under observation for at least one month before and one month after treatment. Ten had had headaches between once a week and once a fortnight, and were observed at least two months before and two months after treatment. Relief was judged to have taken place in the first group if headaches occurred less than once a fortnight, but in the second group only if headaches had disappeared altogether. These 51 cases were given the ordinary hospital course of treatment. Seven of them relapsed after several months, and these and 10 others were placed upon increased suppressive therapy as out-patients. Periods of observation and criteria of relief remained the same. The results are given in Table III.

TABLE III.—*Results of Treatment in Subclinical Malaria*

	Total Cases	Relieved	Definite Improvement	Relief or Improvement	Little or No Improvement
Hospital treatment ..	51	32	13	45	6
Increased suppressive therapy	17	10	4	14	3

A Note on Treatment

Treatment was given as a routine for twice as long as it took for the temperature to fall to normal, with a minimum of 7 days. Mepacrine was administered from the start, 0.1 g. t.d.s. for a maximum of ten days. If longer courses were needed, quinine 10 gr. b.d. replaced mepacrine. Quinine 10 gr. t.d.s. was given in addition for the first 2 to 3 days for the sake of its better initial control. A five-day course was employed for cases considered likely to recover spontaneously. This short course was used in the hospital treatment of subclinical malaria. Routine suppressive therapy consisted of 0.2 g. mepacrine twice a week. In the ambulant treatment of subclinical malaria 0.1 g. mepacrine and 5 gr. quinine were given daily for two weeks; 0.1 g. mepacrine was then given 6 days a week, either temporarily or permanently. This flexible scheme of treatment was considered preferable to one in which a standard course was used for all cases. Such a course would have had to be a long one to cover the more serious cases, and the loss of working time would have been very considerable. Results seemed satisfactory.

Summary

An account is given of clinical and pathological points found helpful in the diagnosis of M.T. malaria. A condition occurring

in ambulant personnel is described, for which the term "subclinical malaria" is proposed. Specific treatment is also briefly described.

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REMOVAL OF PROJECTILE FRAGMENTS AND IMMOBILIZATION OF WOUNDS IN FORWARD AREAS

BY

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Trueta has applied John Hilton's principle of rest to the treatment of war wounds, through the agency of the plaster cast. This factor, immobilization, and another one in the attainment of rest in wounds in forward areas—the removal of the causal projectile foreign body—form the subject of this paper.

The Projectile Foreign Body

Trueta (1944) quotes Friedrich as aiming at complete excision of wounds, removing bacteria by excising the contaminated tissues in a single mass, like a malignant ulcer. Even those who attempt to carry out this aim most faithfully (Yudin, 1943) cannot do so in most instances without imperilling vital structures. Trimming and laying open for drainage is the best that can be done in the vast majority of cases. Incidental to this is the removal of projectile fragments. "The length and direction of a penetrating wound are unknown till the projectile has been located, nor has the tract been laid open throughout its extent till it has been removed" (*Lancet*, 1944). The attempt to remove the foreign bodies which act as guides to those "very complicated cavities," wound tracts, will help to establish the true nature of the wound (revealing, for example, a severed nerve, a torn joint synovial membrane, or a crack fracture), hitherto unsuspected.

"Time spent on reconnaissance" by x rays is "seldom wasted." "A forward operating centre without an x-ray unit is incompletely equipped, and only under exceptional circumstances can the omission of this important accessory service be justified" (*Lancet*, 1944). The passage of shell or mortar fragments often opens areolar planes, splitting fascia longitudinally, which closes behind them. This split may well be missed in the initial operation on the wound, and unless skiagrams are taken the presence of the foreign body may not be suspected. Fatty areolar tissue, moreover, opens before the entering projectile fragments and closes behind them as if never penetrated, and the fasciculi of coarse fibres of the deltoid and gluteal muscles rearrange themselves after the passage of a projectile, rendering a "blind" search uncertain of success. No surgeon can write complacently "Wound excised" on the patient's card unless he has had the patient x-rayed and the causal projectile demonstrated and removed. A blister or discoloured patch in the skin often acts as a guide for subcutaneous projectile fragments, and an incision there will reveal the foreign body and drain the wound tract. But deeper fragments have no such stigmata, and skiagrams are necessary. In the field the time required for accurate location as in hospitals at the base may not be possible. But views in two planes can always be taken, giving a sufficient guide.

A recent tragic case illustrates the complications that may ensue through leaving projectile fragments *in situ*.

Case History.—A C.C.S. orderly, wounded on March 17, 1944, in the C.C.S., was taken to the theatre two hours after wounding. He was found to have a shell wound at the outer aspect of the left

thigh, through the superficial fibres of the vastus lateralis. The wound was considered tangential, and layer by layer its edges were trimmed and then left open. Routine sulphanilamide powder, vaselined gauze, and a light plaster-of-Paris bandage were applied. He was evacuated on March 19 in fair condition; no undue pain had been complained of. Lieut.-Col. W. M. Capper, O.C., surgical division of a general hospital, has supplied the further history. "Admitted March 20, 1944, obviously ill and in pain. Pulse 140. Left leg tender and swollen; dark-brown oedema extending up thigh and over abdominal wall almost to umbilicus, and present in popliteal space also. Plaster removed. Local wound clean and not tender." After blood transfusion: "Operation. Wound explored locally and found to pass across thigh. There was escape of considerable amount of gas. . . . A large F.B. (about 2 in. by 1 in.) was found in an abscess cavity behind the femoral vessels. Pus and anaerobic oedema had tracked up and down the femoral sheath, and it was therefore present in the upper thigh and in the popliteal space; sartorius, rectus femoris, and vastus externus were excised, and part of the adductor magnus; he was too ill for amputation. In spite of parenteral sodium penicillin in large doses and A.G.G. serum, the patient died on March 21."

The foreign body was unfortunately missed at the primary operation. Even in a wound considered merely tangential, a skiagram should have been taken. The attempt to remove the F.B., guided by the skiagrams—antero-posterior and lateral views—would have opened the tract and given the required drainage in an area peculiarly liable to anaerobic infection.

In treating abdominal wounds the actual foreign body is often ignored. "The discovery of foreign bodies in these cases is of little importance. They may be difficult to locate in the posterior abdominal wall, and time spent in searching for them is wasted. They may also be difficult to distinguish from fragments of bone where part of the spine or pelvic girdle has been fractured in the tract" (Blackburn, 1944). But in the abdominal cavity, where vital structures are involved, the role of the foreign body, acting as a signpost directing the track of the wound, is most important. If the attempt to see the foreign body and actually feel it in the open wound is not considered essential, the preliminary view of its shadow on an x-ray plate is most valuable. It gives a clue to the probable viscera injured, and a guide to the position of the incision in the abdominal parietes.

In one campaign criteria for the removal of foreign bodies were when they were provoking pain, causing pressure on important structures, or aggravating sepsis (Mason Brown, Dennison, Ross, and Divine, 1940). Sooner or later the majority—H.E. shell fragments, mortar, bomb, or grenade fragments, pieces of projectiles from long-range artillery such as "Anzio Annies and Archies"—give rise to trouble. They press on nerves and erode blood vessels. The poisonous nature of certain projectiles, moreover, must be remembered. Blaxland (1942) describes a case of fatal phosphorus poisoning from a bullet.

If embedded near sphincters or in joints the constant movement in these places greatly reduces the chance of the foreign body being walled off by fibrosis. Not being walled off, the foreign body will act as a continual source of irritation and delay healing. At all times they are a potential source of sepsis liable to acute exacerbation. Though the "primary" metallic foreign bodies themselves may be sterile owing to their heat (and the familiar blister in the skin overlying the fragment that has not quite perforated testifies to this frequent high temperature), the "secondary" foreign bodies they carry in—mud, bits of equipment—are teeming with organisms. "Many of the most serious complications of infection, particularly secondary haemorrhage, can be traced to retained foreign bodies and the contaminated clothing around them" (Donald, 1944). The search for the metallic foreign bodies visible in the skiagram will help to find these non-opaque "secondary missiles, such as clothing" (Law, 1944).

A prolonged hunt for foreign bodies in shocked patients is unjustifiable, and the field surgeon leaves those in certain areas—i.e., the thorax and the head—to his colleagues with special facilities at their own centres. But in the general toilet of wounds as many as possible must be removed. The search is also advisable for psychological reasons, for patients invariably want to know if the bullet has been removed, and ask for the gory relics as souvenirs: extracted shrapnel demonstrates to the patient that his treatment has not been skimmed.