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EPIDEMIOLOGY OF DISAPPEARING MALARIA

I. THE EPIDEMIOLOGY OF MALARIA IN THE LATE STAGE OF ERADICATION
IN COUNTRIES WITH TEMPERATE AND SUB-TROPICAL CLIMATES¹

by

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In order to eradicate malaria, and to prevent, through a rational system of protective measures, its reappearance in places where it has been eliminated, it is necessary to gain more knowledge of some problems of malaria epidemiology, taking into account the various features of the transmission of this disease in different areas.

Judging from the dissimilar progress of malaria eradication in a number of countries, it is obvious that the disappearance of malaria is uneven and the degree of perfection in the maintenance of eradication varies in different localities.

It is characteristic of the completion of malaria eradication that in the majority of places where natural conditions for malaria transmission still exist, the transmission does not take place. The cessation of transmission in the overwhelming majority of such places is due to the previous antimalaria measures. In some areas, however, particularly in the south of the USSR, the absence of transmission is maintained by the continuation of large-scale measures (complete coverage with residual insecticides) even at the present time.

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Over a limited area in various geographical zones malaria transmission still continues, but its intensity is slight. Transmission has been sharply reduced as a result of intensified antimalarial measures, but has not entirely ceased, and cases of malaria are recorded every year, even though their numbers are gradually decreasing.

In some former malarious foci, where for a number of years there were no new cases of malaria, the transmission started again following the introduction of a source of infection from the outside, and the cessation of antimalaria measures.

In some inhabited localities, single cases of malaria have occurred despite the control measures taken. This was caused by changes in certain epidemiological factors for which allowance was not made in due time. (This is true with regard to some regions of Central Asia, where the numbers of Anopheles pulcherrimus have sharply increased.)

If the necessary measures are not taken, sporadic outbreaks of malaria occur both in old "smouldering" foci and in new foci. Usually such outbreaks can be dealt with speedily and successfully.

It is thus obvious that there is much scope for epidemiological studies on the following problems related to the late stages of malaria eradication:

1. Occurrence of new foci of malaria and reasons for the maintenance of old (residual) foci.
2. Course of eradication in countries with various types of malaria.
3. Features of the natural evolution of malaria.
4. Characteristics of malaria transmission related to various malaria vectors.

1. Occurrence of new foci of malaria and reasons for the maintenance of old (residual) foci

The term "malaria focus" signifies in the USSR an inhabited locality where natural conditions for transmission exist and in which one or more local or imported cases of malaria was recorded.

The following types of malarial foci are distinguished, on the basis of the presence or absence of active malaria transmission and its nature, in localities where natural conditions for malaria transmission are present.

(1) Cleared foci without transmission of malaria (where there are no malaria patients or parasite carriers or where there are only cases of malaria introduced from outside).

(2) Active foci, where the process of malaria transmission continues or has recommenced, or has begun for the first time; these are divided into:

(a) old (residual) foci, where every year local cases of malaria or parasite carriers are discovered. These are further sub-divided into: intensely active¹ or subsiding foci;

(b) new foci, where local cases of malaria or parasite carriers have newly appeared. These are further sub-divided into foci with slight activity (where only sporadic cases, and no further transmission have occurred), and intensely active foci, where a succession of local cases has been found.

All active foci, whether old (residual) or new, are also divided into two groups:

(a) single, scattered foci, distant from an inhabited site, in which malaria cases are occurring;

(b) conglomerations of foci - several foci either connected with each other, i.e. situated near the same vector breeding place, or unconnected although situated near to each other.

¹ In the USSR in 1959 there were no intensely active foci.

During the implementation of a malaria eradication programme it is advisable to classify all foci into these types to facilitate their study and to plan for the establishment of a rational system of antimalaria measures whenever natural conditions for the transmission of malaria are present.

The main problem requiring further research is that of the causes of the re-occurrence of new malaria foci in areas where malaria had been eliminated.

It has been established that the occurrence of new foci may be due to the importation of a source of infection from outside - the arrival of a person suffering from malaria or carrying the parasite and, in individual cases, the natural or accidental introduction of infected malaria vectors.

Attention should be drawn to the possibility of error by including, among places where the transmission process has ceased, inhabited sites where malaria cases are not being recorded; in fact such a focus is not a new one but an old "smouldering" focus.

In individual cases the source of infection may originate with:

- (a) blood donors and people infected with malaria from blood donors. This refers particularly to infections with quartan malaria, the parasites of which are maintained for a long time in the organism of subjects who have previously suffered from the disease;
- (b) persons who have undergone malaria therapy; and
- (c) those who have had a delayed relapse of their malaria.

Presence of the last-named group has not been recorded in the Soviet Union. Although in the past millions of people in the USSR suffered from malaria, the cases observed during the last few years are primary infections found in persons living in conditions where there is a possibility of transmission of malaria.

In some countries (in Italy, Czechoslovakia and France), however, reports were published of sporadic cases of delayed relapses of quartan malaria occurring after several years.

It is most important to discover: (a) the origin of the source of infection appearing in the cleared focus, (b) among what group of people the source was detected, and (c) what was the clinical course of malaria in the patient and whether he had been a parasite carrier. It is particularly necessary to define the role of parasite carriers importing the infection from the outside, and this includes also the people returning from abroad after travelling in countries where malaria is still rife.

It is also of interest to find out why in some instances, after the appearance of sporadic local cases of malaria, the malaria transmission ends there and then without any further spread of the disease, while elsewhere under apparently identical natural conditions a new active focus (or foci) arises, and a local outbreak of malaria may even take place. The dynamics of occurrence of malaria cases should also be studied in order to elucidate the factors which affect the spread of malaria.

There is little doubt that early detection of the source of infection, and speed in carrying out all the necessary protective measures, are of primary importance.

In what zones do new foci arise - in formerly intensely active foci, or in places where malaria was not so rife in the past and had less favourable conditions for transmission? According to information from the Soviet Union and other countries, new foci occur in all zones and are due as a rule to the premature cessation or reduction of vector control activities, combined with the absence of careful epidemiological evaluation. It is usually impossible to discover the source of infection of the Anopheles and the reason for the occurrence of local cases. Special surveys should be carried out to study this problem, as has been done, for example, in California. In some instances (as for example, in the Netherlands), the appearance of new malaria cases was related to large-scale migrations among the population, and local malaria cases and parasite carriers have appeared near the localities where the groups of newcomers have settled.

The problem of the speed of elimination of new foci of malaria should also be studied. In the Soviet Union as a rule new foci easily respond to appropriate measures and providing that adequate anti-mosquito and chemotherapeutic methods were used, any focus of malaria transmission in the South was eliminated during the same year. Occasionally, when only mass drug prophylaxis is undertaken in order to suppress an outbreak, some of the cases occur during the following year. In areas where P. vivax malaria with long incubation period is common, single cases have been recorded in the following year in the spring.

There is need for research on old (residual) foci, and particularly on the causes of their slow elimination. Among such causes the following have been observed in the Soviet Union: delayed implementation of mass antimalaria measures, incomplete or faulty execution, erroneous epidemiological basis for action in conditions where exophilic vectors are present, and the possibility of an influx of malaria mosquitos from neighbouring countries where malaria has still not been eradicated. Thus study of foci of malaria in frontier areas, discovery of the reasons for their existence, and the planning of appropriate methods for their elimination, can be recommended. The part played by parasite carriers in the maintenance of old malaria foci should also be studied.

In studying the reasons for the occurrence and maintenance of malarious foci it is very important to analyse fully the local data on environmental changes (changes in the size of anopheline breeding water surface, in the vector density and its species composition, in the atmospheric humidity and temperature etc.). Changes of social and economic conditions such as migrations of population, construction of settlements and reservoirs, changes in numbers of cattle and in the place where they are kept, must also be studied.

Research is also needed on some special problems connected with the spread of malaria related to the population groups concerned.

It is important to find out: (a) the place where malaria cases were possibly infected and whether infection occurred inside or outside centres of population; (b) the date of occurrence of the disease (coincidence with the periods of vector activity); (c) the relationship between the number of malaria cases and parasite carriers in the various age-groups of the population; (d) the occurrence of cases in families or among neighbours; (e) occurrence of cases in population groups as a result of travel inside the country and abroad.

2. Course of eradication in countries
with various types of malaria

The prevalence of the different types and degrees of malaria endemicity should be studied during the progress of eradication. The information obtained should be compared with the parasitological data available during the period when malaria was widespread.

The later phase of malaria eradication is characterized (according to data from the USSR) by the almost exclusive occurrence of vivax malaria. In the temperate zone of the USSR and in some other countries, vivax malaria with a long incubation period continues to predominate, while in the sub-tropical zone vivax malaria with a short incubation period is more common. As a rule, single cases of quartan and falciparum malaria are found only in old foci, although some instances can be quoted of the occurrence of a new focus of falciparum malaria through the introduction of a source of infection into a locality where malaria had been eliminated. Sporadic cases of quartan and falciparum malaria, and also a few cases resulting from blood transfusion, have also been recorded in the Soviet Union.

The relationship between the species of malaria parasites deserve some investigation. All cases of discovered quartan and falciparum malaria should be studied from the clinical, parasitological, and epidemiological angle. Changes of the density of malaria parasitaemia in clinical cases of malaria and in parasite carriers are of interest. It would be useful to describe in detail all cases of malaria occurring in areas where malaria had been eliminated, and particularly any local cases connected with the introduction of new species and strains of malaria parasites.

3. Features of the natural evolution of malaria

In studying the features of the epidemiology of malaria during the later phase of eradication, attention must also be paid to the clinical course of malaria, since several organizational measures of malaria control and prevention will depend on it.

The terminal phase of malaria eradication is marked by the absence of deaths from malaria, the exceptional occurrence of severe clinical course of disease, the predominance of relatively mild symptoms, very small proportion of parasite carriers, and the almost complete absence of re-infections.

The mild course of the disease and the absence of re-infection are possibly the result of a single quantum of infection, and the absence of the infection of mosquitos from primary cases and the re-infection of those subjects who have already had the disease. The almost universal use of quinocide for treatment of vivax malaria and the virtual elimination of relapses, has been of great importance in the USSR.

The prevalence of parasite carriers is very low according to data obtained in mass surveys. It is somewhat higher in old and new intensely active foci and this problem needs more detailed study.

The severe course of malaria noted in some rare cases may be due to the following factors:

- (a) introduction of a strain of malaria parasites from tropical or sub-tropical countries;
- (b) the loss of immunity left by a previous infection and reduced resistance in the organism.

The study of the clinical picture of cases in new foci of malaria is of interest. In view of the almost complete absence of any risk of re-infection with malaria, it is possible to follow these cases for a longer time, and particularly to study the duration of parasitaemia in carriers after attacks; it would also be of value to

elucidate whether the reasons for this phenomenon are due to some particular species and strains of malaria parasite, to the ineffectiveness of treatment, reduced resistance of the organism, or other factors which favour the attacks of malaria.

As soon as parasitologically confirmed cases of malaria are detected among suspected cases, a study of the characteristics of such cases and their relative proportion is of practical importance. Such a study would prevent the overlooking of sources of infection among persons suspected of malaria and guide the proper epidemiological surveillance.

4. Characteristics of malaria transmission
related to various malaria vectors

During the last few years the distribution of various vector species and their density have been affected by the residual spraying of premises in centres of population, the wide use of insecticides in agriculture, large-scale land improvement and hydraulic works, town planning schemes, the creation of reservoirs, improvements in the system of irrigated agriculture, etc. The exophilic species of Anopheles and also part of the population of endophilic vectors found in nature have assumed greater epidemiological importance in areas where active foci of malaria are still to be found.

The general reduction of the DDT and BHC spraying has led to a recovery of the numbers of vectors, but according to preliminary data the rate of recovery of the various species varies. In a number of countries mosquito resistance to insecticides has been found. This has not been observed in the USSR.

The ecology and phenology of exophilic species of malaria mosquitos, the planning of control methods, and the effect of cessation of complete DDT coverage on the population of various species of Anopheles in different types of malarial foci should be studied.