

a 63232



29 December 1962

ORIGINAL: ENGLISH

Supplement to WHO/Mal/369

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1. PRE-ERADICATION PROGRAMME

The following paper was presented by Dr C. A. Alvarado, Director of the Division of Malaria Eradication, WHO, Geneva, to the Third African Malaria Conference in Yaoundé, 3-13 July 1962.

Introduction

Malaria eradication is "the ending of the transmission of malaria and the elimination of the reservoir of infective cases in a campaign limited in time and carried to such a degree of perfection that, when it comes to an end, there is no resumption of transmission".¹

"The criteria necessary for the establishment of a malaria eradication programme are that eradication should be technically, administratively and practically feasible, and that the programme should be planned with the object of eradication on a country-wide scale."²

"Technical feasibility" implies the possibility of interrupting transmission in any epidemiological circumstances that might be encountered.

"Administrative feasibility" implies the possibility of creating an organization that would deploy the skills and resources necessary to:

- (a) secure and maintain the interruption of transmission over the entire area of operations during the required length of time;
- (b) measure and assess the depletion of the parasite reservoir in order to establish the appropriate and safe time for the end of the attack phase;
- (c) trace and wipe out any foci of residual or resurgent transmission during the consolidation phase;
- (d) certify the achievement of eradication and keep the country free of any possible reintroduction and re-establishment of the disease.

¹ WHO Expert Committee on Malaria, Sixth Report, Wld Hlth Org. techn. Rep. Ser. 1957, 123

² WHO Expert Committee on Malaria, Eighth Report, Wld Hlth Org. techn. Rep. Ser. 1961, 205

"Practical feasibility" implies that the mechanisms required for the processes referred to above are within the material and financial resources available to the government; that there are adequate supporting legislation, good co-operation of the public, open communications and freedom of movement to ensure that the application of the insecticides and surveillance operations are accomplished in conformity with the criteria of total coverage and full effectiveness.

It is obvious that eradication procedures of the required standards cannot be envisaged in developing countries whose general administrative and rural health services have not yet attained the level and distribution required for the precisely defined and chronologically adjusted tasks of a malaria eradication campaign, and assuring the effective implementation of the consolidation and maintenance phases. Therefore, a promotional programme with the purpose of laying down the foundations for a future malaria eradication campaign should first be organized. This promotional operation is called a "Pre-eradication Programme".

Definition

A pre-eradication programme has been defined as follows: "A preliminary operation undertaken in a country whose general administrative and health services have not yet reached a level which would enable it to undertake a malaria eradication programme and in which therefore the necessary basic foundations for this kind of co-ordinated, thorough and time-limited activity have first to be laid. The operation must be planned and adapted to the socio-economic conditions and general developmental status of the country concerned.

Scope

The main purpose of a pre-eradication programme is, therefore, to promote and contribute to the building up of those "necessary basic foundations" which comprise two main components, usually referred to as "the two main objectives":

- (a) the national malaria service, and
- (b) the health infrastructure.

The national malaria service is that developing organization which will become, in due course, the "malaria eradication service", able to deploy the skill and resources necessary to secure and to maintain the interruption of transmission until eradication is achieved.

The national malaria service will need to grow up gradually but steadily, gathering information about the extent and conditions of the malaria problem of the country; acquiring consciousness of its present and future responsibilities; and developing the ability to manage country-wide operations.

The gradual but steady growing up would come after setting up a functional and realistic scheme for development; a close evaluation of the human element and its careful selection; and the establishment of adequate facilities for the training of personnel of the various categories needed.

The collection of information will be done through well-planned and methodical epidemiological and sociological surveys, and the keeping of adequate records.

Operational and management abilities will be assured furthermore when developing the four other specific activities of a pre-eradication programme:

- (a) organization of a reliable system for the distribution of antimalarial drugs;
- (b) organization of facilities for the microscopic diagnosis of malaria;
- (c) health education directed to stimulate and promote maximum co-operation from the public as well as from other private and governmental agencies; and
- (d) the organization of a pilot operations area for training and with the object of demonstrating the operational requirements of malaria eradication procedures and their administrative implications.

All the above expressed activities will give to the incipient national malaria service knowledge, experience, confidence and maturity.

The public health infrastructure

The second main objective of a pre-eradication programme is the development of a public health infrastructure, to which the last Expert Committee on Malaria referred in the following terms:¹

¹ WHO Expert Committee on Malaria, Ninth Report, Wld Hlth Org. techn. Rep. Ser. 1962, 243

"The health infrastructure is defined as the organized network of peripheral units capable of providing certain basic health services within the available local resources to cater for the most urgent health needs of the population."

From the point of view of malaria eradication, that definition can be expanded as follows:

"The public health infrastructure is the capillary network of public health services which, by the end of the attack phase and through the whole of the consolidation phase, should be able to provide efficient collaboration in the detection of malaria cases and their adequate treatment and which, during the maintenance phase, should be prepared to handle the responsibility of keeping a watch over the area and maintain it permanently free from the re-establishment of the disease."

Both in theory and in practice it has been shown that a malaria eradication programme can be executed by an independent or separate organization with great success during the attack phase, but with less success during the consolidation phase unless a highly expensive active case detection scheme is organized, which strains the finances and the manpower of the Ministry of Health. When coming to the maintenance phase, the risk of total failure becomes paramount because of the absence of any organization to ensure freedom from reinfection and to prevent the re-establishment of endemicity. Under such conditions a ruinous sine die prolongation of the consolidation phase would be required until the adequate health infrastructure is created.

That explains the need for a parallel development of the health services whose requirements to support a malaria eradication programme are explained in Chapter 2 of the ninth report of the Expert Committee on Malaria, "Minimum requirements of health services to support a malaria eradication programme".

Duration of a Pre-Eradication Programme

Contrary to malaria eradication programmes which are time-limited campaigns with tight schedules for each main phase (12-18 months for the preparatory phase; four years for the attack phase and three years for the consolidation phase) pre-eradication programmes do not have such strict timetables. There are no phases in pre-eradication programmes; the progress must be a continuous trend up - a consecution of gradual

fulfilment of the two main objectives until they have reached the organizational level which can guarantee the high standards of efficiency of the precisely planned and chronologically adjusted tasks of a malaria eradication campaign. That desired "organizational level" has been compared with, and commonly referred to as the "launching platform".

The duration of the pre-eradication programme in a given country will be contingent to:

- (a) the size of the gap between the initial conditions of the "necessary basic foundations" and the "launching platform";
- (b) the speed of development, or the rate of progress of the basic foundations towards the platform level.

Eligibility

Any country not having yet reached the "launching platform" is eligible for a pre-eradication programme, whatever the existing conditions of the "basic foundations"; in other words, it does not matter if either they are completely absent or are fairly developed and just approaching the platform level. From the point of view of the global strategy for malaria eradication, the choice for assistance between two countries with different grades of development of the "basic foundations" should favour the less advanced one.

Evaluation

In a malaria eradication programme the ultimate objective is the achievement of eradication with intermediate objectives such as the interruption of transmission, the depletion of the parasite reservoir and the proof of the absence of indigenous cases; evaluation must check results against these objectives.

In pre-eradication programmes, however, the objectives being quite different in nature and in immediate purpose, evaluation of progress and results cannot and must not be effected with the classical measurements used for other malaria eradication projects. Consequently the epidemiological assessment of what is happening in the "pilot operation area" - in spite of being of definite interest - is nevertheless of minimal importance. What is primarily important is the progress accomplished in the

development of the "basic foundations": the malaria service and the health infrastructure, and in the other activities such as the training of personnel, the organization of diagnostic services and drug distribution, health education of the community and improvement of the knowledge of the malaria situation. But this last point would be useless without constant progress in the attainment of the two main objectives.

Once all the objectives of the pre-eradication programme have been fulfilled, the country will have reached the required operational maturity for the implementation of a fully-fledged malaria eradication programme.

2. THE INDIAN CENTRAL INSTITUTE FOR COMMUNICABLE DISEASES

The Government of India have decided to expand the activities of the Malaria Institute of India, Delhi, and to make it a centre for studies on various problems connected with communicable diseases. The Institute has been renamed as the Central Institute for Communicable Diseases with effect from 21 August 1962.

The Malaria Institute of India founded 53 years ago as the Central Malaria Bureau, has been confining its activities exclusively to malaria. During the last ten years research and training, as well as a large-scale pilot control programme for filariasis, have also been included among the activities. The contributions of the Malaria Institute in the field of malaria and the training of personnel made it possible for India to undertake the National Malaria Eradication Programme. With this, the original objective of the Malaria Institute was fulfilled. In view of the enormity of the size of the eradication programme, a separate Directorate was formed in 1958 for the National Malaria Eradication Programme.

The objectives and functions of the Central Institute for Communicable Diseases will be to advise the Government on all matters relating to communicable diseases and initiate investigations in these diseases. It will also assist State organizations in carrying out investigations taken up by them. In view of the fact that national programmes already exist with reference to some of the communicable diseases, such as malaria, tuberculosis, leprosy and smallpox, the emphasis at the Institute to begin with would be on vector-borne diseases and infections of animals communicable to man.

The Institute will undertake research into all basic facts underlying the prevalence and spread of communicable diseases and their prevention and study of etiological agents, vectors, mechanism of infection, including endemic and epidemic phenomena, and any zoonotic reservoirs.

The Institute will conduct epidemiological investigations, including mapping of endemicity, study communicable disease statistics on modern lines, and generally elucidate the underlying principles of prevalence of communicable diseases in the country. It will advise and assist in the implementation of control measures and evaluate the results. Another aspect of the Institute's work will involve clinical investigations in communicable diseases, including treatment and study of early diagnostic techniques, relapse problems and effects of new drugs.¹

Arrangements will be made at the Institute for training research workers and teaching and training personnel in epidemiology, medical entomology and control of communicable diseases. The Institute will publish the results of its findings and bring out guides and bulletins for the use of the medical profession.

It is pleasant to record this advance which is tinged with nostalgic regret at the passing of the famous name of the Malaria Institute of India, but it is a welcome sign of the times and augurs well for the success of malaria eradication in that country. Editor

3. THE UGANDA MALARIA ERADICATION PILOT PROJECT

The following material has been obtained from a paper presented at the Third African Malaria Conference, held at Yaoundé in July 1962, by Dr J. de Zulueta, of the Division of Malaria Eradication, WHO, Geneva, who was formerly Project Leader of the Uganda Malaria Eradication Pilot Project.

In 1957 a preliminary malaria survey of the northern part of the Kigezi District of Uganda was carried out at the request of the Uganda Protectorate Government by a team of the World Health Organization. This was followed by a supplementary entomological survey of the same area in 1958. Based on the results of these two surveys, plans were laid down for the establishment of a Malaria Eradication Pilot Project in the north of Kigezi. Operations in the project area were started in January 1959 and

¹ The Central Institute of Communicable Diseases under its present Director Dr S. P. Ramakrishnan established a close scientific co-operation with the World Health Organization. Important research work on experimental chemotherapy of malaria and on immunity to this disease is being carried out with most encouraging results.

were soon extended to all the other malarious areas of Kigezi District. The activities of the pilot project lasted, as had been planned, for three years but were not restricted to Kigezi District - a considerable amount of survey work being carried out during this period of time in other parts of Uganda.

Operations of the project were based on the use of DDT house spraying and the administration of chloroquine-pyrimethamine tablets. The DDT used was a 75 per cent. wettable-dispersible powder and was applied to all the inner surfaces of all human dwellings and animal shelters in the protected areas. "Ingress surfaces", that is outside surfaces of dwellings such as doors, shutters and eaves through which mosquitos may gain access to the interior, were also sprayed. The DDT was used at a dosage of 2 g (technical) per square metre of treated surface and was applied twice a year with the exception of the hyperendemic area of North Kigezi where three annual sprayings were carried out.

DDT spraying was supplemented by mass single-dose treatment during each spraying cycle. Tablets containing 200 mg chloroquine base and 16.5 mg pyrimethamine were used. An adult received three tablets and children one or two, depending on their age. The drugs were administered, and not merely distributed, by the spraying personnel, care being taken to see that all the inhabitants present at the time of spraying actually took the drugs.

In the spraying operations great emphasis was laid on obtaining complete coverage and no effort was spared to reach and to spray every single dwelling in the protected areas. Refusals were practically non-existent but houses left locked by an absent owner were occasionally encountered. In all these cases care was taken to see that the houses were opened in the presence of the local chief and that they were duly sprayed.

Work in the North of Kigezi

After preliminary surveys carried out in 1957 and 1958, the Malaria Eradication Pilot Project was officially started in January 1959. The original project area was the north of Kigezi District where a Government resettlement scheme had met with difficulty due to the presence of malaria. The District of Kigezi has an area of 1969 square miles (5100 sq. km), and a population of 493 444 according to the 1959 census. Most of the Kigezi population lives in the highlands and mountains of the

south and central Kigezi, in areas usually free from malaria and, in spite of the population pressure felt in those parts of the District, the plains and hills of the north of Kigezi were until recently thinly inhabited, malaria acting as a deterrent to potential immigrants.

The project area in the north of Kigezi covers an area of approximately 500 square miles (1300 sq. km) and had in 1959 a population of 59 000 inhabitants. It covered all the malarious territory in the north of the district, from the shores of Lake Edward (altitude 2995 feet (813 metres) above sea level) to approximately the 4500 feet (1370 metres) contour line. Above that level malaria transmission ceased though several pockets of malaria were found further south in the highlands of Kigezi, well above 4500 feet (1370 metres). Altitude, therefore, was not the limiting factor for malaria in Northern Kigezi. It is the steepness of the hills and mountains and the almost complete lack of water collections which prevented the breeding of malaria vector species above 4500 feet (1370 metres).

The soil, in practically all the north of Kigezi, is alluvial, made up mostly of sands and gravels. Lateritic soils here are practically non-existent and this probably explains the long-lasting effects of DDT in the local huts, simple constructions made, with few exceptions, of mud walls and thatch roofs.

The annual rainfall in the north of Kigezi is between 40 and 50 inches (116-127 mm). Two short periods of dry weather are noticeable in June-July and December-January, but there is no proper dry season as in other parts of Uganda. Mean maximum/minimum temperature at the Malaria Station of Kihiki (altitude 3700 feet (1130 metres) above sea level) is approximately 72°F (22.2°C). Variations in temperature throughout the year are, as would be expected in an area only two degrees south of the equator, extremely small.

The country in the north of Kigezi is flat near Lake Edward and becomes hilly above 3700 feet (1130 metres). It is savanna country with some areas of forest near Lake Edward and along the main rivers. Game is very abundant in the area; most of the country below the 3700 feet level (1130 metres) belongs in fact to the Queen Elizabeth National Park or Kigezi Game Reserve.

Before the introduction of DDT in 1959, hyperendemic malaria was found in all the country between Lake Edward and approximately the 3700 feet contour line (1130 metres). Above that level and up to approximately the 4500 feet (1370 metres) contour line meso-endemic conditions prevailed. The main vector throughout the whole area was A. gambiae, only a small pocket of A. funestus being found near Lake Edward. Transmission, as judged by the results of dissections carried out during seven months prior to the introduction of DDT and by the prevailing meteorological conditions, was probably perennial. Vector densities of 50 females per hut were common below 3700 feet (1130 metres) and as many as 200 or 300 A. gambiae females per hut were found in certain localities; yet true holo-endemic conditions were not encountered, the infant parasite rate was comparatively low and immunity in adults, even among the settled population, was never complete.

The first DDT spraying in the north of Kigezi was carried out in May-July 1959 and spraying at four-monthly intervals in the hyperendemic area and six-monthly intervals in the meso-endemic area were continued during 1959-61. The reduction of vector densities after spraying to almost zero was immediate and no infection was found in infants born after the first spraying. The general effect of DDT and drugs on the malaria situation can be judged from the following results of periodical mass surveys carried out in the area.

Type of survey	Time of survey	Spleens			Parasites		
		Number examined	Number enlarged	Spleen rate %	Number examined	Number positive	Parasite rate %
Pre-operational	Apr./May 1959	943	371	39.3	958	159	16.6
First post-operational	Apr./May 1960	1 595	170	10.7	1 692	6	0.3
Second post-operational	April 1961	1 738	74	4.2	2 425	9	0.3
Third post-operational	October 1961	-	-	-	5 271	7	0.1

As can be seen the combination of DDT and drugs produced an extremely rapid reduction of the parasite rate. In no part of our area was DDT used alone so that it is difficult to know how much the reduction was due to the insecticide and how much to the drugs, but we believe that only a combination of the two could have produced the rapid effects observed.

Passive surveillance based on the examination for malaria parasites of any fever case coming to dispensaries and aid-posts in the protected area, began in 1959 and was well established by 1960. In 1961, active detection of cases in part of the protected area by Malaria Project scouts was also established. The following is a summary of the results obtained with the two methods in 1960-1961.

Year	Type of surveillance	No. of cases	Imported cases	Indigenous cases	Total positive cases	Parasite rate %
1960	Passive (dispensaries and aid-posts)	437	14	7*	22	5.0
1961	Passive (dispensaries and aid-posts)	646	9	12	21	3.3
1961	Active (case detection by scouts)	1 762	3	3	6	0.3

* There was also one unclassified case.

If these results are compared with the results of the mass surveys, it will be noticed that the search for malaria parasites in Kigezi is much more productive in fever case surveys than in general mass surveys, a thing which would be exceptional in many areas of Africa where overt attacks with fever are rare.

From the above results it is clear that malaria in the north of Kigezi after two and a half years of DDT spraying and distribution of drugs was reduced to an extremely low level but that malaria cases at the end of this period still existed. In 1961 a total of 10 104 slides were collected in the protected area in mass surveys as well as fever surveys. This is a large sample for an area with a 59 000 population

and although in some cases more than one blood film must have been taken from the same individual, at least 10 per cent. of the population in the area must have been examined for malaria parasites during the year. Of the 10 104 slides taken, 43 were positive (41 P. falciparum and 2 P. malariae) and of these 43, 23 were classified as indigenous and 20 as imported. This shows in the first place that the number of cases is well above the 0.5 per thousand per annum which has been considered as a safe level for discontinuation of spraying. Also that there must still be some foci of transmission in the area or alternatively that the P. falciparum infections must last longer than is generally accepted. We believe that some foci of transmission may still persist in the upper part of the protected area; in fact in 1960 it was necessary to include in the protected area some localities above the 4500 feet (1370 metres) level where there was evidence of transmission and it may well appear that other foci exist above what is considered to be the limit of the malarious territory. Indigenous cases, however, were found in 1961 in the lower part of the protected area in places where inhabitants had been duly treated and their houses regularly sprayed. Are these new infections or could they be relapses of long-lasting P. falciparum infections? More investigation is needed to answer this question but as will be shown later evidence from the south of Kigezi indicates that after all P. falciparum infections may last much longer than has been thought possible

Work in Central and South Kigezi

Spraying operations and distribution of drugs were extended in 1959-1961 to all the malarious territory in the highlands of Central and South Kigezi. Malaria there is usually found around lakes and with few exceptions (where the vector is A. gambiae) is transmitted by A. funestus. The total population in these pockets of malaria added up to 72 000 in 1961 and the spraying here was done to reduce the risk of new infections being brought into the protected area in the north of Kigezi and also to gain information on how rapidly these highland foci of malaria could be dealt with. In the Lake Bunyoni area, which was the first highland area protected, two sprayings (with drug distribution) proved sufficient not only to interrupt transmission but to eradicate the vector - A. funestus - from the area. Since September 1960, when it was last sprayed, no A. funestus has been found in this particular area. It was

interesting to find here one indigenous P. falciparum case 14 months after the second spraying (and 20 after the first), an indication that falciparum infections may last, at least in this part of Africa, more than the accepted 12 months.

Work in Other Parts of Uganda

During the three years operations of the Malaria Eradication Pilot Project a considerable amount of survey work has been carried out in the Districts of Acholi, Ankole, Busoga, Masaka, Toro and West Nile. From this preliminary work it appears that malaria conditions found in the north of Kigezi exemplify conditions in Uganda where hyperendemic or meso-endemic malaria prevails. Holo-endemic malaria has in fact not been found in any of our surveys.