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CONTENTS

	<u>Page</u>
1. Progress of the National Malaria Eradication Programme of India	2
2. O'nyong-nyong Fever	10
3. Selection of Drugs for Medicated Salt Projects	11
4. Engineering Staff in Malaria Eradication Programmes	14

1. PROGRESS OF THE NATIONAL MALARIA ERADICATION PROGRAMME OF INDIA

A report on the progress of the National Malaria Eradication Programme in India dated November 1960 has been received from the Health Division of the United States Technical Cooperation Mission to India, New Delhi. It was written by the three consultants, Dr Donald J. Pletsch, Dr F. E. Gartrell and Dr E. Harold Hinman. This review, although naturally applying to India, contains much of value and interest to workers in other programmes. Extracts from this report, including impressions and recommendations, have therefore been made.

The Government of India and the Technical Cooperation Mission undertook co-operation in a National Malaria Control Programme in 1953. In 1956, by mutual agreement, it was determined that an international team of three malariologist consultants would serve for a total period of three months on an evaluation of the National Malaria Control Programme and its conversion into a Malaria Eradication Programme. The report of this team was of great value to the Government of India and to TCM in evaluating the progress of the control programme and no doubt influenced its conversion to an eradication programme.

The Government of India and TCM early in 1960 mutually agreed that a team of three consultants from outside India should spend two to three months during the current spraying season evaluating the current status of the National Malaria Eradication Programme of India.

The team arrived in New Delhi early on 11 September for a nine weeks' programme. The members terminated their mission in India on 12 November 1960.

The team included Dr Donald Pletsch, Senior Malaria Adviser of the Pan American Health Organization (WHO) in Mexico; Dr F. E. Gartrell, Assistant Director of Health, Tennessee Valley Authority, Chattanooga, Tennessee; and Dr E. Harold Hinman, Chief, Technical Resources Division, Office of Public Health, International Cooperation Administration, Washington D.C.

The initiation of a programme of such stupendous magnitude as the complete eradication of the world's greatest health problem by a country of over 400 million inhabitants with the economic difficulties found in India reveals a courage that is

admirable; it also shows a full realization that India cannot afford to let malaria remain rampant or to attempt its control over an indefinite period of time. It was a logical decision that a large capital investment (of money and effort) be made over a restricted number of years rather than perpetuating smaller annual expenditures to prevent the continuing toll of illness and death due to this disease.

The team believes that Indian malariologists recognize the magnitude of the task of eradicating malaria, that they are cognizant that the programme demands a dedication unsurpassed in previous health undertakings; that problems not envisaged at the outset have arisen, that more such problems will arise. However, the country is committed to the eradication of malaria and there can be no turning back. A tremendous effort is required to meet this goal.

IMPRESSIONS AND RECOMMENDATIONS

1. The spraying operations carried out to date during the attack phase, constituting the principal pillar of the eradication structure, are impressive chiefly in their magnitude. Some units¹ - very limited in number - have demonstrated that complete and uniform applications of insecticides can be accomplished with the personnel and equipment available. However, the spraying operations have not generally attained the desired precision in (a) treatment of all existing houses, or (b) uniform coverage of sprayable surfaces in the individual houses and associated structures. The team believes that the benefits of residual insecticidal coverage can be more fully exploited by meticulous attention to all details of spraying operations.

2. Senior and junior assistant unit officers must personally ensure, through inspection of the spraying work in even the most remote parts of their jurisdiction, that all the houses in all the existing towns, villages and hamlets are being properly sprayed. Senior and junior malaria inspectors, in addition to the high academic qualifications which have been noted, must possess enthusiasm for, and exhibit dedication to, the painstaking overseeing of every aspect of the spraying operations.

¹ In the National Malaria Eradication Programme of India an operational unit deals with a population of approximately one million. Each state has a number of NMEP units according to its population and the type of area.

3. Less-than-complete coverage of many villages and less-than-complete treatment of sprayable surfaces within individual houses are frequently occurring because many houses are locked or because the householders, for many reasons, refuse to permit spraying. The team does not minimize the gravity of these problems, but feels that many field personnel are too inclined to accept them as excuses for superficial coverage of houses and villages. It is recommended that senior unit personnel intervene directly at the village level to distinguish between those refusals which can be resolved immediately and those which may require special or prolonged effort.
4. The NMEP has recognized that various units whose jurisdictions include one million inhabitants or more are working in terrain of highly variable difficulty. Sanction has been given to certain "difficult" units to reinforce the field staff by 50 per cent. or 100 per cent. so that total coverage may be achieved. The team has observed that a few units in several states are operating in such hilly terrain, with such dispersed housing, that the spraying rounds are not even being completed with the authorized increases in staff. In such territory the proper supervision of widely scattered spraying squads is also very difficult. The team recommends that such special situations be met by authorizing still further reinforcement of personnel, preferably through the increasing and re-definition of units, each with a full or increased complement of supervisory personnel. The same objectives might be achieved by limited extension of the spraying operational period in particular units concerned.
5. The spraying protocols for treatment of individual houses, while obviously varying from state to state according to local housing pattern(s), rather uniformly exclude the spraying of under surfaces of beds, fixed sleeping platforms, tables and shelves which may represent very favourable anopheline resting places. The team recommends a review of the probable benefits of spraying such surfaces, especially in areas where the newly-established surveillance casts any doubt on the interruption of transmission by residual insecticide application.
6. The team has observed that only limited use has been made of an extremely fruitful and sensitive source of epidemiological information, namely the examination of blood smears obtained from all fever cases encountered in hospitals, primary health centres

and other dispensaries. A master plan exists for future national exploitation of this so-called passive surveillance but the team believes that, in so far as possible, individual units or states should be directed to institute such service immediately.¹ Upon insistence that dispensaries obtain blood smears from all fever cases, the malaria service must recognize its obligation for immediate examination of these slides and furnishing of the results.

7. Active surveillance has, with few exceptions, been delayed by six or more months in its initiation (target date 1 April 1960) and no significant data will be available during the 1960 transmission season. This, together with failure to reach the spraying goals during the past three years, means that few units can be considered for withdrawal of spraying during calendar year 1961. The cost of these failures is enormous both in the unnecessary extension of spraying and in the fact that no significant data have been obtained during the last few months of calendar year 1960 when active surveillance was being slowly tooled up. States might well be informed that immediate initiation of complete active surveillance coverage constitutes one of the requisites for participation in the commodity programme from the centre.

8. State and unit malaria officers in a number of states, while conscientiously emphasizing spraying operations, have apparently not appreciated the surveillance programme, presently being implemented, as a refined criterion for safely interrupting insecticidal application or as the index demanding its continuation.

9. Paramount importance must be attached to the immediate and exhaustive investigation of malaria cases revealed by examination of fever case slides. A positive slide must be considered as prima facie evidence of transmission of malaria until actual proof can be acquired to the contrary, and no reluctance to classify it as indigenous is tenable just because no secondary case can be found.

10. The early accomplishment of malaria eradication has been stimulated in India, as in other countries, by the spectre of anopheline resistance to insecticides, a phenomenon which could greatly increase the technical and financial difficulties of the task. The susceptibility level to DDT of one of the principal vectors, Anopheles culicifacies, has declined seriously in very limited areas which are being increasingly well defined by national and international specialists.

¹ Steps have already been taken for dynamic initiation of this activity.

The geographical extension and the level of presently identified anopheline resistance in India do not currently call for any modification in malaria eradication strategy, but the danger signs should not be ignored. A plan for more widespread testing of susceptibility levels of this and other vectors is being implemented with high priority.

11. The team heartily supports the recent decision to abandon the system of routine house searches for anophelines in a limited number of villages in each malaria unit area. The procedures now being discarded provided no yardstick for measuring level of anopheline populations nor the adequacy of spraying operations in the villages not sampled, and may actually have accounted for the complacency of some unit officers with reference to the general situation in their areas.

12. With the initiation of the surveillance programme, house searches for anophelines by well-trained entomology technicians can aid the unit malaria officer in his investigations of parasite positive cases. However, failure to find anophelines in localities investigated some time after transmission may have taken place does not constitute proof that the case could not have been autochthonous.

13. Among reasons given by householders for refusal of house spraying, the team has noted the bedbug nuisance as one of the most serious. The studies confirming resistance of bedbugs to insecticides in some areas should be extended to all units reporting this problem. The more precise definition of this "refusal" problem might best be made by special teams including health educators as well as entomologists, to determine whether a much-needed programme of remedial action should emphasize persuasion or special insecticidal measures, or both.

14. Nomadism and movements of people within the country, along or across the border and the so-called "difficult areas" pose a potentially serious threat to the orderly achievement of malaria eradication and demand the institution of special measures to meet this threat.

15. The team is convinced that the future of malaria eradication in India is dependent almost entirely on the ability of the individual sprayman and the individual surveillance worker to carry out his duties in an acceptable manner and on his supervisors to provide the leadership and directions of eradication activities. If the

1961-62 spraying operations and epidemiological investigations are properly executed the team believes that during the following year there can be unit areas in India from which spraying may be withdrawn. This would permit increased attention to the remaining units.

16. The economic implications of this tremendous undertaking lead on to the conclusion that during a six year period from 1 April 1957 to 31 March 1963 (preparatory, attack and consolidation), a per capita investment of a little over Rs. 2.01 (or US\$ 0.44) will probably have reduced malaria to a focal disease which permits its walling off into well-defined pockets for the terminal attack.

17. Substantial quantities of insecticide will be carried over at the end of the current spraying season and shipments now pending from the United States would appear to be quite adequate for the next spraying season. As withdrawal of spraying in a substantial number of units may occur in calendar year 1962, attention needs to be directed to the special problems of logistics of insecticide storage and delivery.

18. The present fleet of vehicles, plus scheduled additions, should be fully adequate to meet the transport needs of the programme. Improvements in vehicle care and maintenance and utilization are needed to minimize operational problems.

19. The team is apprehensive concerning the diffuse responsibility which may result from the autonomy enjoyed by various official and other organizations which carry their own malaria eradication activities (railroads, coal-fields, tea-estates, defence establishments, public works departments and some urban corporations). Although most of these groups have had long experience in anti-malaria work, the national responsibility of the NMEP might be more firmly exercised if operational and epidemiological reports were received on a monthly rather than on an annual basis. It is further recommended that there be an exchange of monthly reports between any NMEP units and any other groups operating within the geographic limits of such units, thus facilitating a review to ensure total coverage.

20. The planning and execution of a malaria eradication programme ideally require a unified command and a near-military precision in the operations, admittedly difficult to achieve in a federation of states. The team believes that a mechanism to provide

a more frequent exchange of views, plus discussion of problems and their alternative solutions, will maintain the advantages of national unity of purpose and the adjustments necessary because of inherent differences in the states' administrative and technical conditions. This need might be satisfied by periodic meetings of key personnel from the Directorate of NMEP with all deputy directors of health (malaria) from the individual states.

21. The team is pleased to record its conviction that there is abundant evidence of dynamic leadership of the NMEP and that the management of the programme is fully appreciated and supported by the Ministry of Health, by the National Planning Commission and by the ministries of health of most of the individual states.

THE FUTURE

Malaria incidence is certainly at an all-time low level in India as a whole. The occurrence of a few isolated small outbreaks or epidemics emphasizes the persistence of a residuum but the conventional malarimetric indices provide too gross a measure to define exactly its occurrence in quantity and to pin-point its geographical distribution. If active and passive surveillance can be immediately made effective then a careful appraisal unit by unit or even sub-unit by sub-unit will permit a critical evaluation for decisions relative to withdrawal of spraying.

It may be anticipated that rather general spraying will be continued in India during the calendar year of 1961. The team believes that only under exceptional circumstances, approved by the Directorate of the NMEP, should more than one round of spraying be permitted in hypoendemic units. The current plan provides for two rounds in scattered foci in the 160 hypoendemic units. The population involved is approximately 20 million, the equivalent of 20 units. The team believes that some areas may be selected immediately for withdrawal of spraying. A careful review, at the end of the first round of spraying in 1961, of all surveillance data as well as any other recent information concerning malaria transmission should be done before any second round spraying is undertaken. It should be anticipated that substantial areas could be withdrawn from spraying at the end of the first round in 1961.

The quality of the supervision of the spraying operations should be improved from all points of view - better training of spray crews, investigation of refusals to permit spraying, more careful calibration of nozzle discharge and calculation of the quantity of insecticide applied to the structure, more uniform coverage of sprayable surface, more attention to the preparation of the dwellings for spraying, education of the public concerning the techniques and objectives of eradication and prevention of the destruction of the sprayed surface film of residual insecticide by mud plastering, whitewashing or otherwise interfering with the treated surface. In the closing stages of the attack phase, the provision of a high quality job of spraying is of maximum importance.

Surveillance, both active and passive, requires special emphasis. The newly recruited employees for this function are widely scattered over the entire country. They require constant supervision. The maintenance of a high morale and the institution of a more adequate reporting and assessment of their achievements is essential. They and their surveillance inspectors are the key to pin-pointing the occurrence of malaria and permitting a concentration of the "mopping-up" activities of malaria eradication in contrast to the broadcast approach during the attack phase.

An increase in the numbers of microscopes and laboratory technicians of the order of 75% of the present budgeted staff is forecast as the minimum need. This will not significantly increase the total costs of the programme (maximum increase of 600 technicians).

It is urgent that in 1961 there be much tighter supervision of the spraying operation, and at the same time maximum emphasis should be placed on surveillance.

In essence, India has 15 different malaria eradication programmes - one in each state. No one state can achieve eradication until each of its neighbouring states reaches the same point. This should lead to a federated programme with no place for jurisdictional problems. The cost is enormous and each year of extension can result in great hindrance to the ultimate achievement of eradication.

Appointment of personnel, purchase of small items, etc., must receive the highest priority. Unless the Minister of Health, the chief minister of each state, and persons in the highest echelons of the Central Government are willing to make reasonable concessions in the interest of expediting this programme, there can be no doubt that its success will be seriously jeopardized.

The team has confidence in the soundness of the plan for malaria eradication in India and the adequacy of resources for its execution. The team is concerned, however, by the possibility that the proven techniques may not be applied consistently over the entire country with the precision upon which the plan was based. A further concern is that complacency at vulnerable points in the attack may prevent the fullest exploitation of these resources. Both these possibilities present real threats to the timely achievement of the goal of malaria eradication in India and must be dealt with realistically during the ensuing year of the programme.

2. O'NYONG-NYONG FEVER

Among the numerous virus diseases which have been reported on in recent years o'nyong-nyong fever is of particular interest to malaria workers as it is reported to be the first known instance of an epidemic virus disease transmitted by anopheline mosquitos.

In February 1959 a major epidemic of a disease clinically resembling dengue broke out in north-western Uganda and spread on a wide front south-eastwards across the country invading Kenya and the Congo. Thus far there have been about a million cases, but no deaths directly attributable to the disease have been reported. It is characterized by fever, headache, agonizing joint and back pains, an itching rash and adenitis. (The name chosen for the disease, o'nyong-nyong, signifies "the joint breaker" in a Uganda dialect.)

From the first a puzzling feature had been the ready passage of the disease from one type of country to another; its rapid spread and high attack rate suggested transmission by droplet or faecal routes or by a winged vector, possibly an endophilous mosquito.

Initially, throat washings and stool samples as well as sera were collected, then it was suggested that mosquitos of the genus Mansonia might be the vectors; these, bedbugs and other mosquitos were collected in an attempt to isolate the virus from them. Eventually workers at the East African Virus Research Institute at Entebbe isolated the virus from A. funestus and A. gambiae, and a laboratory transmission using A. funestus was achieved. They found that the virus was a member of the Group A - arthropod-borne viruses, closely related to Chikungunya.

The finding that o'nyong-nyong virus was closely related to that of Chikungunya was of particular interest as, in the major epidemic in Tanganyika caused by the latter agent, while Aedes aegypti was the main vector, the virus was also isolated from anopheline species. In the case of o'nyong-nyong fever it was found that the virus did not persist in Aedes aegypti, usually considered the key species for virus transmission work in the laboratory.

In May 1960 o'nyong-nyong appeared in Masaka District on the west bank of Lake Victoria and views were expressed that there was perhaps some connexion between the appearance of this disease and the absence of malaria infection in the vector species which was noticed at this time. No malaria infection was found in 450 gland dissections and 100 stomach dissections of A. gambiae and A. funestus.

A paper on the possible effects of o'nyong-nyong fever on the transmission of malaria in Uganda has been prepared jointly by workers of the East African Virus Research Institute and the WHO Uganda Malaria Eradication Pilot Project and will be distributed as one of the forthcoming WHO/Mal documents.

3. SELECTION OF DRUGS FOR MEDICATED SALT PROJECTS

Consideration was given, at the Technical Meeting on Chemotherapy held in November 1960 at Geneva, to the available antimalarials which at present could be employed in medicated salt projects.

The three drugs which might be considered for mixing with common salt are chloroquine, pyrimethamine and amodiaquine.

1. Chloroquine

Chloroquine, in the form of diphosphate, is the drug most often used for preparation of medicated salt. Chloroquine sulfate can also be used for this purpose. The differences in the base content (62% for diphosphate and 76% for sulfate) and in the solubility in water of these two chloroquine salts are relatively unimportant for all practical purposes (chloroquine diphosphate 25 g per 100 ml; chloroquine sulfate 33 g per 100 ml, both at 20°C). Chloroquine diphosphate mixed with salt at the concentration of 0.3-0.4% with salt has no

discernible bitter taste; this taste begins to be perceptible when the drug concentration reaches 0.5%. Chloroquine is not excreted in human milk, and this precludes the possibility that breast-fed infants might be protected by the drug ingested by nursing mothers.

The simple early method of mixing an aqueous solution of chloroquine salt was soon replaced by more reliable methods of mixing powdered chloroquine with salt in a concrete mixer, and tests were developed for checking the correct concentration of the drug in the final product.

Several problems connected with the use of chloroquine in salt were encountered and one of them was the formation of an unpleasant taste and smell of iodoform when the drug mixed with iodized salt was stored in humid conditions. The addition of sodium thiosulfate prevents this undesirable occurrence.

The most important technical problem is the "leaching out" of chloroquine due to the considerable moisture content of crude, hygroscopic salt in areas of high relative humidity. This "leaching out" effect gradually decreases the concentration of the drug in the upper layers of the stocks of medicated salt and results in the fact that much of the stored salt is not fully effective, while some of it is too bitter for proper use. It has been estimated that in conditions of high humidity as much as 60% of the chloroquine may "leach out" in six weeks. The effect of leaching could be prevented either by using a less soluble salt than the diphosphate, or by coating the soluble salt with some sparingly soluble material in order to protect it against the action of humidity.

Some progress has been made in preparing a special "premix" chloroquine formulation coated with cetyl-stearyl alcohol, which protects for some time the active compound against moisture.

An additional means of reducing the leaching effect of chloroquine in medicated salt is the packaging in plastic bags of 1, 2 and 5 kg capacity. These bags are hermetically sealed and the final mixture so protected can probably withstand a prolonged storage, provided that it is dry when put into bags.

The less soluble and practically tasteless chloroquine salts (such as methylene-bis- β -hydroxynaphthoate) are not very regularly absorbed in the alimentary canal when given in relatively large single doses, but their absorption may be satisfactory when small daily doses are given in medicated salt. This point has not been properly investigated and deserves some attention.

2. Pyrimethamine

This drug would seem to have many potential advantages for use in medicated salt. It is tasteless, active at small doses and practically insoluble in water. It has the advantage of passing into mothers' milk when given at a normal dose, and it is possible that a smaller daily dose of this drug ingested by nursing mothers would be sufficient to afford some protection to infants.

Pyrimethamine base is not soluble in water and this excludes the problem of "leaching"; the use of pyrimethamine slightly complicates the operation of mixing the drug with salt. Pyrimethamine "premix" containing 10% of the drug has been prepared for this purpose. It should be added that the technique of mixing pyrimethamine with salt has not been standardized and a method different from that developed in the United States has been used with apparent success in Cambodia.

The main disadvantage of pyrimethamine is the hazard of resistance and the results of the Netherlands New Guinea and Cambodia medicated salt projects confirm the opinion that the use of pyrimethamine alone in common salt cannot be recommended.

Pyrimethamine in medicated salt might be used in conjunction with chloroquine, but it is unknown whether a daily dose of 1 to 4 mg of pyrimethamine in addition to 20 to 40 mg of chloroquine base would present any advantage. So far, no evidence is available showing that the regular intake of pyrimethaminized salt, providing a daily dose of the drug of about 5 mg or less, would result in a sporontocidal effect and in a sufficient excretion with mothers' milk to protect breast-fed infants. Until at least one of these effects can be demonstrated, the large-scale use of pyrimethamine together with chloroquine in medicated salt cannot be recommended. A small experimental field trial with a thorough parasitological, chemical and epidemiological appraisal should be carried out to elucidate the points mentioned before.

3. Amodiaquine

It has recently been proposed to use amodiaquine base, which is practically insoluble in water, for the preparation of medicated salt. The use of amodiaquine base in medicated salt projects may be of definite value; more information on the absorption of the drug when given in such form would be desirable. The information that amodiaquine excretion in urine cannot be easily estimated by means of simple tests now available may constitute a minor drawback in the use of this compound in medicated salt; a simple urinary test of the excretion of amodiaquine would be of value in the field.

4. Primaquine

Attempts to assess the value of this drug when used in medicated salt showed that the active compound is rapidly destroyed in the course of ordinary preparation of cooked food. Research on 8-aminoquinolines of value in chemotherapy of malaria and suitable for incorporation into common salt will be of much interest.

4. ENGINEERING STAFF IN MALARIA ERADICATION PROGRAMMES

At the end of 1960 an assessment was made by regions of the spraying operations in progress and still to be undertaken, and of the engineering strength in the malaria programmes, both national and international. The results are summarized in Tables 1 and 2.

It was seen that while 50 countries had programmes currently in the attack phase, 72 more countries had yet to start the attack phase. About 500 million persons lived in areas under attack, and nearly as many people lived in areas yet to come under attack. Of 74 countries either planning or engaged in spraying operations, only 28 (38%) had engineers engaged in this work. WHO had engineers or sanitarians assisting in 46 (62%) of these countries. Outside the American region only 22% of the 49 countries planning or engaged in spraying operations had engineers on their malaria staffs, and only 57% received engineering assistance from WHO. It is notable that of the eight largest spraying programmes outside the Americas, all of which have over 10 million persons being or planned to be covered, only three had the assistance of national engineers and only four of WHO engineers. These four WHO engineers were all posted during 1960 (see Table 3).

TABLE 1. SPRAYING OPERATIONS IN PROGRESS AND YET TO BE UNDERTAKEN^a

WHO Region	In attack phase, end-1958		In attack phase, end-1960		Not yet in attack phase end-1960	
	Countries	Population (millions)	Countries	Population (millions)	Countries ^b	Population (millions)
AFR	4	1	5	1	38	136
AMR	25	46	24	53	2	25
SEAR	6	245	8	432	2	93
EUR	8	23	5	16	1	16
EMR	4	10	5	12	13	142
WPR ^c	2	2	3	12	16	45
	49	327	50	526	72	457

^a Data from A12/P&B/10 and A14/P&B/2

^c Areas for which information is available

^b Countries with no areas in the attack phase

TABLE 2. REGIONAL COMPARISON OF ENGINEERING STRENGTH

WHO Region	Engineering Staff				Engineering coverage: Countries		
	National Engineers	WHO Engineers ^c		WHO Sanitarians	Number	With National Engineer	With WHO Engineer or Sanitarian
		RO, TC or IC	Country Project				
AFR	2	1	1	9	15	2	8
AMR	119	4	15	50	25	17	18
SEAR	1	1	1	6	8	1	5
EUR	1	1	1(1) ^a	1	6	1	2
EMR	65	2	3(1) ^a	9	12	4	10
WPR	24	1	3	1	8	3	3
IR ^c	-	1 ^b	-	1	-	-	-
	212	11	24	77	74	28 (38%)	46 (62%)

^a Training centre engineer assists also country programme

^b Consultant for sprayer evaluation

^c IR - Inter-regional; RO - Regional office; TC - Training centre; IC - Inter-country.

TABLE 3. ENGINEERING STRENGTH IN TEN LARGEST MALARIA ERADICATION PROGRAMMES

Country	Population (millions)	National Engineers	WHO Engineers	WHO Sanitarians
Brazil	14	37	2	3
Mexico	18	39	2	1
Burma	13	-	-	1
India	388	1	-	1
Indonesia	41	-	-	2
Thailand	24	-	-	-
Turkey	10	-	1	1
Pakistan	87	-	1	1
Utd Arab Rep. Egypt	18	31	1	-
Viet Nam	12	1	1	-