UNITED NATIONS
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NATIONS UNIES

WORLD HEALTH ORGANIZATION

ORGANISATION MONDIALE DE LA SANTÉ

INTERIM COMMISSION

COMMISSION INTERIMAIRE

WHO.IC/Mal./20

22 April 1948.

EXPERT COMMITTEE ON MALARIA

The Secretary of the Expert Committee, upon the suggestion of its Chairman, has the honour to communicate the following paper by

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PLANNING FOR MALARIA CONTROL

I. The Global Problem

The immense scope of the malaria problem arises from its global character, and the circumstance that during the past fifty years deliberately executed control measures have not appreciably diminished its magnitude, has, from time to time, resulted in expressions of pessimistic opinion regarding an ultimate solution. For our part, we believe such an attitude exemplifies the impossibility of appreciating the relative dimensions of any vast object from a position in its immediate vicinity, or an inability to see the forest because of the trees, since close contact with detail may make unattainable any concept of overall proportions.

It is believed that if in a position of sufficient detachment, an inspection will reveal that the global malaria problem, or any other problem of similar proportions, may be recognizable as the summation of a multiplicity of lesser problems each of which if distinguishable or definable, is probably capable of ultimate solution. Nor is it necessary to leave this planet for a position in space to attain this perspective.

In our opinion, any examination of the multifaceted malaria problem indicates its possible primary resolution into two series of lesser perplexities. The first includes those which, with a high degree of probability, possess a fundamental or world-wide significance and to a large degree constitute lacunae in our present array of knowledge; the second those which vary in character in different but nevertheless extensive regions, and are more directly related to eradication.

Within the first lie various questions pertaining to the host (human and anopheline) - parasite relationship. This includes such subjects as species and strains of parasites, complete details of their sexual and asexual cycles, their physiology and metabolism, the reactions they evoke in either host, immunity with the possibilities for its artificial enhancement, and the discovery of new parasiticidal drugs. It must be realized that the picture of autochthonous infections in hyperendemic areas is highly complex, due to the certainty that the clinical reaction is a summation of the effect of repeated inoculations with different species and strains of parasites.

A very real handicap to the elucidation of these questions from the standpoint of the human infections, arises from the highly limited host specificity which these parasites exhibit, which has made their transmission to laboratory animals impossible, while variations in the response of lower animals to their own specific infections make their interpretation in terms of reaction of the human host, exceedingly difficult. A further handicap arises from inability to conveniently propagate them in vitro, or reliably preserve viable parasites outside of the host for extended periods. These circumstances have prompted the prosecution of extensive studies on the malaria infections of lower animals, at first of the avian infections, more recently of the simian. Owing to limitations in the amount of experimental work that may be performed in human subjects, arising either from the inappropriateness of the objective or the scarcity of material, it is inevitable that a great deal of the exploratory work can as yet only be effected through the utilization of the infections of lower animals. Nevertheless, any significant results secured from studies of these infections must be repeated as far as possible with human subjects, before their implications in terms of human infections can be established.

The approach to these problems is laboratory and clinical. The former requires facilities in an institution equipped for experimental work on avian and simian infections, the latter in active malariatherapy services in a mental hospital with adequate laboratory facilities.

The second series of problems concern the host (human) - vector relationship. This series exhibits a remarkable aggregation of variables, as a consequence of which the epidemiology of malaria exhibits many contradictory aspects in different parts of the world. The complexity of the variables mentioned arises from (a) the circumstance that no species of anopheline vector has a world wide distribution, (b) that most anopheline species are confined to one of the well defined faunal regions of the world, and (c) that different anopheline species vary widely in their bionomics. Furthermore, included in this series are those phases in which, with our present knowledge, the broad problem appears most vulnerable to attack.

The faunal regions then constitute important secondary divisions of this series. While it has been justifiably and pardonably expedient in the past for political and administrative reasons to consider the malaria problems let us say, of Mexico and Guatemala, or of Peru and Bolivia, as individual entities, such grouping may cause sight to be lost of the fact that well defined sub-regions are discernible, and that hardly anywhere do faunal limits and political boundaries co-incide. In fact in anopheline circles political boundaries are non-existent. Thus in the neotropical region cited, the fauna of the Caribbean presents a different aggregation of species from that noted along the west coast and extreme south of South America, while the region from llanos to the pampas east of the Andes constitutes a third.

The nature of the problems presented by the vectors in different parts of the world are in a confused state. The European picture was tremendously clarified by the elucidation of the maculipennis complex, and there is reason to believe that similar complexes occur in other regions. Solid progress in this field requires more extensive and intensive taxonomic study of anophelines than this subject has hitherto received, for it constitutes the foundation on which all further work must be based. We must define the field problems which malaria presents in terms of faunal regions

or sub-regions, and finally in terms of anopheline species.

It is obvious that there is imperative necessity for an international organization to continue and extend the program initiated by the Malaria Commission of the defunct League of Nations. In the Americas at any rate, it is likely that this need can be adequately met by the Malaria Commission of the Panamerican Sanitary Conference. Such an organization should endeavour to stimulate and foster the creation and development of adequate antimalaria organizations in the health departments of all countries which experience a malaria problem.

It is highly desirable that the program of professional instruction in malariology be revived. One such school should be maintained at some point in each faunal region.

This program should also provide for the extensive collection of anophelines and the careful study of their taxonomy in one or more central laboratories or museums in each faunal region, by a limited number of competent entomologists. This possibility might be most effectively initiated at an international conference of taxonomic entomologists who are interested in the Culicidae, in an effort to effect agreement on ideas of species concepts, to be followed by a program of intensive collecting to thoroughly appraise the fauna. When the specific status of the regional fauna is clarified, systematic studies of host preference and susceptibility of the anopheline species to infection may be carried on with precision, and should be the logical sequel.

While there can be no valid objection to the continued performance of field studies or execution of control demonstrations on a national basis within politically defined geographical limits, yet if such were stimulated or sponsored by an international agency, the faunal significance of the location should not be overlooked in order that the data gathered may have the widest possible application.

The International Congresses of Malaria have afforded an invaluable opportunity for those interested in the scientific aspects of malaria to report their work and exchange ideas. The first was held in Rome in 1925, the second in Algeria in 1939, and the third was held jointly with the third Congress on Tropical Medicine at Amsterdam in 1938. Serious effort should be made to maintain the continuity of this series of international meetings.

II. Approach to a National Problem.

Organization. The control and eradication of malaria is the clear cut and unevadable responsibility of the health department of any political division within whose jurisdiction the disease exists. While the status and character of the administrative subdivision charged with the execution of this responsibility may conceivably vary with the magnitude of the malaria problem in relation to the problems afforded by the other communicable diseases it is our conviction that efficiency is promoted if this be organized along functional rather than professional lines. Thus within a national, state, or provincial health department, the personnel assigned to malaria investigations and control may well constitute a primary division of the department if the problem is of first magnitude, if of lesser consequence they might well constitute a subdivision of the primary division of epidemiology, communicable diseases or preventable diseases, depending upon the scope of the responsibilities of the latter. To ensure effective coordination and integration of the work of personnel with diverse professional backgrounds by the

director, it is imperative that all persons who participate in the program be assigned to the same division.

Since one of the fundamental responsibilities of a central health department is the promotion and establishment of health organizations in each subordinate or local political unit, with subsequent formulation and supervision of their activities, a large part of the malaria program should be relegated to these local departments, particularly insofar as it related to the execution and maintenance of control activities. In this circumstance the technical personnel of the general organization should maintain an advisory and supervisory relation to the malaria activities of the local department. In the period before local organizations are adequately or widely established, special circumstances may require the general organization to initiate and execute control measures in unorganized political units, as an operating agency per se. But the occurrence of such an emergency should be exploited to the utmost in effecting the establishment of the lacking local organization.

The personnel of the malaria organization of the central department should provide an adequate staff, including persons with reputable basic professional qualifications in medicine and public health, sanitary engineering and entomology, with special training and if possible experience, in malariology. This supplemental training should give all a keen appreciation of how important is the efficient integration of their individual professional activities with those of their colleagues of different disciplines, so that all work together as an effective team. The director of the service should be chosen with due regard for professional training and experience, a broad outlook and demonstrated executive and administrative ability. An adequate subordinate staff of personnel should provide secretaries, draftsmen and technicians for the offices and laboratories, and inspectors and foremen for the routine field work. While it is obvious that the employees in the latter categories will be engaged in field work, it should be stressed that the professional employees must realize as well as their principal duties and responsibilities can only be discharged in the field. Their full mobility should be assured by adequate arrangements for travel and field subsistence. It should go without saying that all personnel of whatever grade are employed on a whole-time basis.

An important part of the malaria service, is the education of the laity in the facts relating to the nature and prevention of malaria. In collaboration with the education department or department of public instruction, simple instruction should be provided for children in the primary schools. Visual education of both children and adults is facilitated by the use of the 16 mm. movie, particularly where illiteracy is high. By using a hand cranked projector with illumination from a storage battery, the films can be taken into remote situations. The effectiveness of this instruction is enhanced if the scenes have been photographed in the country in which they are exhibited.

The official organization to promote the extension of malaria control should be supplemented by the formulation of a national malaria society with membership open to any person with an active interest in the problems afforded by this disease. The annual meetings should afford a forum where relevant subjects are presented and disuussed, and it should provide continuous suitable publicity that will make the populace aware of the burden of the disease, of its preventable character and of the public and private measures by which they may be freed from this load.

Responsibilities of the Malaria Organization. In attempting to sketch a picture of the duties and responsibilities of the malaria organization of a general health department, it should be borne in mind that while obliged to discuss different phases seriatum, practical considerations require most of these to be effected concurrently.

All available data pertaining to malaria morbidity and mortality in the country or state should be assembled, and if not already analyzed, examined as soon as practicable from the standpoint of minor civil divisions. Arrangements should be effected whereby, through executive direction, information coming through official channels to other primary divisions, is promptly transmitted to the malaria service. This includes reports of morbidity and mortality, positive laboratory examinations and meteorological observations. These should be promptly posted to the credit of the minor civil division in which they originate, and monthly and annual rates computed as they accumulate.

As soon as possible, arrangements should be effected with the education department, for one or more epidemiological field parties to visit the primary schools of the country to examine samples of the children encountered at school, in order, through a reconnaissance, to delimit more accurately the distribution of malaria, and determine its relative intensity in different parts of its extension. The more quickly a reconnaissance can be executed, the greater will be the uniformity in the value of the data gathered. Most satisfactory results would be secured if these school visits could be completed within three or four months during or shortly after the malaria season, but scarcity of medical personnel and transportation usually make this incapable of realization. If possible these field parties should have an entomological assistant to make collections of anophelines.

The relative magnitude of the problem observed in different communities should afford the primary consideration in selecting localities where orientation studies are to be conducted or control work initiated. It is to be expected that eradication of the infection from the salient foci of high endemicity, may materially reduce the incidence of infection in wide circumjacent zones of lesser endemicity.

Many factors must be considered and weighed in the selection of localities for the initiation of a control program, normal among which may be mentioned: (a) an impression of the magnitude and type of program likely required and of its probable cost, (b) the capacity and experience of the available personnel to deal with a difficult situation, (c) the availability and source of the requisite funds, (d) the interest of the local population as expressed in promised material assistance, and (e) the existence of a local health department or the probability of its early establishment. Even though consideration of these points may indicate a probably adverse decision, at least from a standpoint of immediate practicability, it is not unknown for adverse recommendations to be disregarded by higher authority from a variety of possible motives.

If the malaria organization is a new creation, in a country where malaria has been little studied, two or more areas should be selected as centers for a program of orientation studies covering a period of at least 3 years, before any active effort is made to expand the control program. It is to be expected that the general information available as well as the results of the reconnaissance will reveal whether the country includes more than one faunal region,

In the latter event orientation studies by the program previously described should be carried on en each region. The later phases of the program of orientation studies, not only train the personnel in the techniques of surveys, and the application of the particular control measures selected, but in the event a satisfactory effect on malaria incidence is secured at a reasonable cost, certainly not materially greater than that which may conservatively be credited to the losses arising from the rampant prevalence of malaria, it is to be hoped that through judicious publicity the beneficial results will be brought to the attention of the general and local officials and of the public throughout the region. Only by conclusively showing that under local conditions malaria constitutes a practicably preventable hazard, can a demand for the extension of control measures be stimulated and developed.

As public interest arises, it is to be expected that requests for the initiation of control programs in different communities will rapidly increase, usually faster than competent personnel are trained, or appropriating bodies allocate funds. The points already mentioned must be weighed in orde' to determine the precedence with which these petitions will be considered. Certainly in those regions where the endemicity is of long standing, the situations do not partake of an emergency character. Not infeequently however epidemics of malaria in hitherto free areas or where the endemicity has been low, occur, and constitute emergencies. These considerations will naturally influence the measures utilized.

It is inexcusable to initiate control activities in any community without a prior survey to determine (a) the endemic level at which malaria is prevailing, and the extent of its localization, (b) the transmitting anophelines and their production areas, (c) the control procedure or procedures best adapted to the local elimination, from the standpoints of efficiency and economy, of the transmitting anopheline mosquito. The techniques for the execution of these procedures have been discussed, and we only refer to points requiring consideration on the formulation of the control program. Surveys should invariably be performed during the transmission season, when malaria incidence is highest, and the anophelines are most abundant. On the occasion when the technical personnel of the malaria service are detailed to a community for the purpose of prosecuting surveys, supervising the installation of projects, their subsequent maintenance, or checking the effectiveness of the results, they should operate as temporary agents of the local health department, regarding the local health officer as their pro-tem chief.

It should be ascertained whether the personnel have the legal right to enter upon private property to make the requisite inspections or distribute larvicides, of the necessary legal procedure to be observed in traversing private property with drainage lines, and whether the costs of construction can be assessed against the land owner.

Formulation of a Control Program. Excluding from present consideration any problem presented by a sparse and scattered rural population, we may limit discussion to areas where there is definite congregation of population. Whatever might be the conceivable cost for the protection of such a group, the required per capita outlay will usually vary inversely with the population density. Low per capita cost usually would imply a respectable aggregation of population, always an incentive to initiate work. Consideration may next be given to the source of the required funds. Will the initial outlay be defrayed wholly from central government appropriations, or

will some proportion be contributed from local sources , either public or private? To what extent will local sources indefinitely contribute to a co tinuing program, including maintenance? Local support is indicative of local interest, and where two communities are under alternative consideration, first attention will doubtless be given to the one exhibiting a substantial and material interest.

In this circumstance preference should be given to a permanent program as contrasted with one of a temporary character; to the fullest adoption of measures of the highest possible degree of permanency as compared with those which are frankly temporary in their effect and necessarily repetitious. While indefinite endurance is the implication of permanency and none of the measures of this category are strictly speaking permanent, yet their effectiveness nevertheless has an appreciable endurance. Measures of this character necessitate definite capital outlays, but the cost of subsequent maintenance is low and over a term of years will usually effect substantial economies. Furthermore they result in appreciable indirect benefits. It is expected that during the survey the engineer will have made a thorough topographic study of the areas the entomologist has indicated as productive of the incriminated anopheline, and had determined that the collection and partial or complete evacuation of the water is either possible at a reasonable cost, or for some reason is impracticable. The ideal would be to evacuate all standing surface water, and place excess ground water in underground channels. If drainage is practicable he has also determined the lines and levels required for the main drainage and its laterals and estimated the cost of construction in labor and materials, The latter, included in particular tubes for subsoil drains, inverts and slabs for the lining of open ditches to preserve their grades and cross sections, and of the necessary culverts and bridges and the preservation of outlets. If the evacuation of water is impracticable for any reason, some procedure for the handling of or manipulation of water may be indicated, and plans for the requisite installation prepared. If funds for the requisite work are immediately available, it is desirable to proceed expeditiously with construction during the ensuing dry season, to have the system ready for operation when the rains return. However inadequacy of immediate funds should not be a deterrent to the initiation of construction, providing a comprehensive project has been prepared, as work can be extended from year to year as funds are recurringly available. Meanwhile the entomologist should have selected an adequate number of stations for the regular catching of anophelines, and developed a program for the routine distribution of larvicides to the several production areas until they are successively eliminated by the extension of the drainage program to each.

It should be borne in mind that such programs are often, from a variety of reasons, not static. The reclamation of ground, and the elimination of the malaria hazard, frequently stimulate immigration into communities, promoting the construction of housing and the creation of new suburbs, thus gradually increasing the radius over which the control program must be extended. In view of this circumstance, it is often desirable to lay out the drainage program with the possibility in mind of a portion at least, being transferred at some time in the future into a storm water sewage system. This will probably involve in many instances substitution of large tubing for the inverts lining the open ditches, and the filling in of the ditch excavations. The inverts are then available for use in the expanding system of open ditches about the periphery of the growing community.

Drainage ditches which continuously carry a flow of water should be lined to preserve gradient and cross section, and those which traverse populous sections should be, in the interest of ready maintenance, similarly constructed. Those, particularly the laterals in open country, which only intermittently carry water and are not likely to scour, may be sodded. However, laterals which tap areas of ground water seepage should preferably be laid with tile.

No program involving either the elimination or manipulation of water should be installed without making adequate arrangement for subsequent inspection of the operation of the system and requisite care and maintenance.

This is necessary to ensure the prompt repair of storm damage, the removal of debris and other obstructions, and the clearing of vegetation so that the system continues to function unimpaired.

In our opinion, sanction to a community program exclusively involving the use of larvicides should be given reluctantly, if at all. In some instances residual collections of water may remain after all practicable drainage has been effected, so that in this circumstance, the continued use of larvicides is unavoidable. Their proper field is for temporary application during the period when drainage is under construction, so the scale of their employment will continuously decrease. Their application should be a responsibility of the entomologist.

Various circumstances, but more particularly undetected gaps in distribution, seldom make it possible to get a complete kill from any application of larvicides, so that some few insects commonly escape. Their effect is of short duration, necessitating frequent applications throughout the season, and for an indeterminate period in subsequent years, which makes extended and repetitious employment very expensive. In order to obtain the maximum effectiveness their application must be closely supervised and the efficiency closely checked. Furthermore, various circumstances, often unforeseen and unavoidable, may occasion interruptions in their applications of shorter or longer duration. Whatever benefits had previously accrued during the period of their efficient application are soon lost. In other words, as a result the expenditures for their indefinite application will not have made any permanent contribution to the relief of the community. On the other hand should similar circumstances cause an interruption in the maintenance of the drainage system, this may continue to function with appreciable efficiency for an extended period, and is hardly likely to become a total loss before its conservation is resumed.

Various considerations will govern the selection and application of larvicides. Of primary influence will be the availability of larvicidal substances and equipment for their distribution, and of their cost delivered to the locality where their use is required. Secondly will be the dependability and intelligence of the labor available for their distribution. The efficient application of Paris green necessitates labor of a high degree of integrity, and, if power equipment is to be used, of sufficient intelligence to use the equipment effectively. The application of petroleum oils is better adapted to less efficient types of labor, particularly those requiring closer supervision. In any case the efficienty of the distributors should be continuously checked by one or more inspectors under the general supervision of the entomologist. The larvicidal program must be based on a thorough knowledge of the entire extension of all breeding areas in permanent and temporary water, with which all the

distributors must be familiar. These should be examined by the inspector during intervals between the application of larvicides, to check both the effectiveness of the previous application, as well as to secure any especial data to be communicated to the distributors for their guidance at their next round.

In most rural areas the population is relatively sparse, and the lesser density would usually make prohibitive, from the standpoint of per capita outlay, the measures of water elimination so useful in urban or suburban settings. Nevertheless where reclamation of land for agricultural use is the prime motivation, many opportunities for minor extensions of drainage for anopheline control may be discovered, and those living adjacent can often be persuaded to effect their installation privately. If the prevailing types of houses are of reasonably tight construction, the correction of structural defects and the installation of screens to windows and doors will make them proof against the admission of mosquitoes. While local domestic conditions and abuse by the occupants will cause wide variations in the duration of their effectiveness in different localities, yet in general an installation will be effective for several seasons and with care may last for many years. Hence where applicable, mosquito proofing affords a high degree of permanency. It is a measure readily promoted by the personnel of a local health department, who can supervise its proper installation, while most householders can be persuaded to bear the larger part or all of the cost. However, in the tropics, where inclement temperatures do not make the construction of tight houses essential, the opportunities for mosquito proofing are much restricted. An unfortunate prejudice prevails in some parts of the tropics against mosquito proofing, so that many houses to which it is adapted, afford no protection to their occupants from mosquitoes. The usual objection urged in the support of this prejudice is the curtailment of natural ventilation, which should be vigorously combated as it has no really valid status, and the ready availability of electric fans provide an effective compensation.

When mosquito proofing is impracticable, the widest possible private use of bed nets and imagocidal sprays in the interior of dwellings should be encouraged.

Rural malaria control in the tropics presents two aspects. One is that experienced by the labor forces of large corporations exploiting some natural resource, the other that of the indigenous land owner or tenant. The former organizations usually command considerable capital, and from bitter experience have or will learn that the control of malaria and other endemic parasitic diseases, is essential to the economical execution of their projects. Numerous organizations of this character have maintained for extended periods, excellent medical organizations for the care of employees and their families, which are also concerned with the sanitation of the camps and villages. The better health or the company labor is usually noted by the community at large, and apart from reducing labor turnover, stimulates in the others a desire for local emulation. The situation presented by malaria as it involves the indigenous landowner or tenant is usually in marked contrast. Income is low and reserve or working capital is small or lacking, and the revenues of local governmental bodies are slender. Such communities cannot provide adequate reserves for the control of malaria by the heretofore conventional methods. Especial interest therefore attaches to the possibility that in such areas malaria may be controlled at costs previously unattainable, through the domiciliary use of imagocides. This is a practice that in some areas had already made appreciable headway among those householders most influenced by retail merchandising methods, but the value of which had not until recently been

appreciated by health departments, Pyrethrum sprays applied weekly on a public and systematic community basis in situations attractive to resting mosquitoes, have given surprising results, and the possibilities that the intervals between applications may be greatly extended through the substitution of DDT are being explored. The possibilities from their employment are very attractive, as the per capita costs per season are very low, bringing it within the reach of a vast number of poorer communities. If the residual effects of DDT are found to be sufficiently protracted so that its repetition perhaps not more than twice during a season will suffice, much of the force of an objection due to repetitousness will be lost, although it appears fairly obvious that once initiated the practice must likely become a permanent part of community routine. However the same is true of all other procedures, as malaria cannot be permanently banished by the waving of any wand.

While scarcity of medical practitioners and pharmacies may necessitate self medication, and oblige a health department to provide facilities for the gratuitous or cheap distribution of plasmodicidal drugs, it is useless to believe that such a program, although admitted that it may in some degree reduce malaria mortality, it will make any material contribution to the solution of the prevailing malaria problem. Such a program cannot be regarded as an acceptable substitute for sanitation.

Naturalistic methods of control will always have a highly local character, due to faunistic variations. Their possibilities will require careful local study.

Careful accounting of expenditures for all aspects of a program should be required. This requires careful gathering of cost data, which will subsequently be of inestimable value in estimating the approximate cost of subsequent projects and the preparation of budgets. This applies with equal force to construction, maintenance, and the application of larvicides and imagocides.

And finally, we may reiterate that the effect secured should be constantly checked. Insofar as checking relates to anopheline densities, this of necessity must vary directly in elaboration with the extent to which larvicidal and imagocidal measures constitutes the program. Annual surveys of the malaria incidence should be continued until it appears that local transmission has either been drastically suppressed, or endemicity is stabilized at a new low level. While elimination of transmission should always be the goal sought, various circumstances, perhaps more commonly the presence of uneradicable residual water may prevent the attainment of perfection, it is desirable to continue the surveys annually, although perhaps on a restricted scale, as long as available personnel permits. When the program has expanded to the point where the personnel must be kept in the expanding margin, further check on the older controlled areas may be maintained through morbidity reporting.

The malaria organization should use its influence, unofficially if possible, officially if necessary, with other organizations, public or private, whose activities may result in the creation of new malaria hazards, unless such possibilities are duly considered and avoided.

Regarding the malaria problem as most commonly chronic, not acute, as usually constituting an endemic, not an epidemic, it is our conviction that we will more economically utilize our available resources, more quickly attain our goal, and more firmly hold our position by the maximum utilization, other things being equal, of the practices with the highest degree of permanency. We should "build out" malaria.