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GLOBAL PROGRAMMES FOR DISEASE VECTOR CONTROL

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Summary The prevention and control of many vector-borne diseases are based largely upon the use of chemical pesticides, due to the limitations of the immunization and chemotherapeutic tools, when available, as well as to the insufficient development of genetic and biological methods for controlling the vectors. The most important diseases affect rural communities in the developing countries, especially in the tropical zone. In spite of the problems encountered, malaria eradication and control programmes have given lasting results, except in Africa. Concerted international approaches are being undertaken, or considered, for control of onchocerciasis and trypanosomiasis in Africa, and schistosomiasis will probably be the next candidate to be considered for control. Urban pest control is probably, after malaria control, the next largest public health user of pesticides. With the trend towards the establishment of a new international economic order, increased resources for the control of vector-borne diseases in the tropical zone are foreseen.

Résumé La prévention et le contrôle de nombreuses maladies transmises par des vecteurs sont largement basés actuellement sur l'emploi de pesticides chimiques. Ceci est dû tant aux insuffisances des agents immunisants et chimiothérapeutiques, lorsqu'il en existe, qu'à l'état encore rudimentaire des méthodes de lutte biologique et génétique en voie de mise au point pour la lutte contre les vecteurs. Les plus importantes de ces maladies affectent les collectivités rurales des pays en voie de développement, notamment en zone tropicale. En dépit des difficultés rencontrées, le programme de contrôle et d'éradication du paludisme a donné des résultats durables, sauf en Afrique. Des actions internationales concertées sont entreprises ou envisagées, pour la lutte contre l'onchocercose et la trypanosomiase en Afrique, tandis que la lutte contre la bilharziose pourrait bien constituer le prochain objectif. La lutte contre les vecteurs et nuisances en zone urbaine constitue probablement, après la lutte antipaludique, le principal marché pour les insecticides employés à des fins de santé publique. La tendance à l'établissement d'un nouvel ordre économique international devrait résulter en l'accroissement des ressources consacrées à la lutte contre les maladies à vecteurs en zone tropicale.

INTRODUCTION

On a long-term basis it is hoped that the prevention and control of vector-borne diseases will increasingly rely upon immunization, chemotherapy, and appropriate modifications of the environment, complemented only by vector control in special instances. At present however, such an ideal approach is only technically and operationally feasible for a few of these diseases. Thus the prevention and control of most vector-borne diseases depends, and will continue to depend to a large extent for the foreseeable future, upon vector control. Although genetic and biological methods might offer promise for controlling vectors, they are in their early stages of development and present operations are almost exclusively based on pesticide applications and some health sanitation. It must be furthermore stressed that the most promising of the biological control agents are microorganisms which will probably be used in the same manner as chemicals, thus constituting biological pesticides (WHO 1973).

In its broad sense the term "vector-borne diseases" includes all diseases transmitted by a vector, having an intermediate host, or an animal reservoir. The most important of these diseases affect rural and sometimes urban communities of the developing countries, especially in the tropical zone. Some diseases can also sporadically constitute a serious threat for the health of the people of developed temperate countries, such as tick- and mosquito-borne encephalitis, tick-, flea- and louse-borne typhus, plague, etc. The list of those permanently affecting the tropical areas is much longer and includes, over and above the diseases already mentioned, malaria, lymphatic filariasis, African trypanosomiasis, Chagas' disease, onchocerciasis, schistosomiasis, yellow fever, dengue haemorrhagic fever, etc. Most of these diseases occur over large areas, a number of them are zoonoses with animal feral reservoirs. Prevention and control operations, to give lasting results, must be undertaken on a sub-regional, regional, or even global basis and thus require very large resources, often far exceeding those that the affected countries can provide. Inter-country co-ordination and co-operation must play a large role in the planning, funding and implementation of the control operations, as well as of the associated applied research activities. By its very nature WHO is closely associated with many of these control projects and programmes, starting with the planning phase (WHO 1975).

THE WHO ROLE

Although the Constitution of WHO stipulates that the Organization shall "act as the directing and co-ordinating authority on international health work" this does not imply any supranational authority. Thus WHO, while gathering technical information, developing methodology, proposing regulations and promoting co-operation, only assists governments on their formal request. Within this framework, global programmes for disease control and their vector control components are those whose implementation is recommended by the member countries through the World Health Assembly. These are then carried out at the national level by each country at its own will, and may be with or without any direct assistance or co-ordination from WHO. Similar situations can develop on a regional basis, as a consequence of recommendations made by the WHO Regional Committees.

The best known example of such a global disease control programme is the malaria eradication programme. It resulted from the implementation of many malaria control programmes all over the world, of which some achieved outstanding success within a few years, while some others were faced with immediate insecticide resistance problems. The unanimously agreed goal was therefore to eliminate the disease through simple

methods of vector control before insecticide resistance of the populations of vectors could become an insurmountable obstacle. Technical and other difficulties had been underestimated, slowing down the operations in many countries, allowing resistance to slowly develop. This has now jeopardized the programme over huge areas, inducing a redirection of the Organization's policy towards malaria control without time limits. Although eradication was not achieved on a world-wide basis, and maintenance of the present degree of control sometimes constitutes a problem, the concentrated effort made for a quarter of a century to fight this disease has, with Africa as the only exception, considerably reduced its socio-economic importance. Amongst the many activities related to the malaria control or eradication programme, WHO has developed control and application equipment, has trained specialists at all levels, has organized the purchase of supplies and equipment on behalf of some member countries, has channelled voluntary contributions towards developing countries needing them, has assigned WHO staff to national projects pending the training of national specialists, etc. This has resulted, except in Africa, in a rather well-co-ordinated global programme, having even evolved its own terminology and rules, with every national decision still being made on a purely voluntary basis (WHO 1974).

With a rather different, sub-regional approach, the Onchocerciasis Control Programme in the Volta River Basin area is another example of a large vector control operation for disease control. Onchocerciasis, the river blindness disease, constitutes one formidable obstacle to the economic development of the fertile river valleys in most countries of the African savanna belt, north of the Equator. In view of the enormous flight range of the vector, limited-scale control operations have failed, although an inter-country project covering 60,000 km^2 did show some promising results in the central and northern parts of the treated area. Thus seven countries decided to join efforts for implementing a 20-year 700,000 square kilometre control programme, with the assistance of agencies of the UN system (UNDP, FAO, IBRD and WHO) as well as of donor institutions and interested governments. For this control programme, of which WHO is the executing agency, a special fund was established under the custody of IBRD; UNDP, FAO and IBRD are responsible for the economic development projects made possible by the interruption of the transmission of the disease. The control operations are centrally managed from a headquarters in Ouagadougou, Upper Volta, and are carried out over the whole area by WHO teams on the behalf of the seven countries concerned. A joint co-ordination committee composed of all the parties to the special fund meets once a year to consider the results of the operations as well as the plans and budget proposed for the following year. If successful, this programme could constitute a model for most of the onchocerciasis-plagued areas of tropical Africa which represent over 20 times the size and population of the present control area (WHO 1973a).

Another ambitious programme is under advanced planning by FAO to control the animal trypanosomiasis, and possibly its vectors, from the entire savanna belt of tropical Africa, in association with UNDP, WHO, and other agencies; human sleeping sickness is endemic in the same areas and has the same vector. It will probably have its original planning, management and implementation structures. Many policy and administrative approaches will have to be considered once the control methodology, the specialized operators, and the appropriate long-term resources are available. From a purely socio-economic viewpoint, one of the most obvious targets for future control operations would be the vectors of lymphatic filariasis, the intermediate hosts of schistosomiasis, the vectors and reservoirs of Chagas' disease and body lice in louse-borne typhus areas, but many other targets could be justified upon socio-economic grounds on a sub-regional or inter-country basis (WHO 1973b, WHO 1966).

SOME OF THE OBVIOUS TARGETS AND THE TECHNICAL PROBLEMS INVOLVED

Malaria

Now that it is obvious that malaria eradication is not an attainable goal in a number of countries, anti-malarial vector control operations will probably be carried out for many years at a rather constant level, should the national and international resources permit. It is estimated at present that there are over 100 million people with malaria parasites, while the number of those at risk of infection should current control operations be interrupted, far exceed 1000 million. Although larvicides are increasingly used, and there is a renewal of interest in the use of larvivorous fish, the main vector control method continues to be the application of residual insecticide deposits inside houses and other premises to kill the mosquitos when they come to bite man, or soon after they have taken their blood meal. The most extensively used insecticide is DDT, with an annual average requirement of about 38,000 tons calculated as technical. However, due to the steady development of insecticide resistance to organochlorine insecticides, the use of malathion is increasing and this trend will probably continue. Propoxur is used in a few countries and fenitrothion is certainly another suitable alternative to DDT; a number of other insecticides have given promising results when tested in the WHO programme for the evaluation and testing of new insecticides and studied during large-scale trials under tropical conditions by the WHO Field Research Units. Unfortunately all suitable alternatives to DDT for residual house-spraying are more costly and less residual than DDT, which makes their operational use difficult if not impossible, for many developing countries (WHO 1974).

Onchocerciasis

Onchocerciasis, which occurs only in Africa, Latin America and the Yemen, affects about 20 million people and can induce blindness at a relatively early age in a large proportion of the heavily infected persons. The control of the blackfly vectors is carried out by the periodic application of specially developed larvicides to their breeding places, usually fast flowing streams and rivers. In the lowlands of the tropical zone the applications are made weekly and these control operations could be required for up to twenty years to allow for the natural elimination of the parasite through ageing. Thus only insecticide formulations which are very safe for non-target organisms and do not accumulate through food-chains can be considered. Progress in developing suitable chemotherapy would shorten the duration of the control operations, but any individual programme would probably last nevertheless many years. The present control operation requires only about 25 tons of the larvicide per year calculated on technical. In case of success, the requirement could be much larger as other areas are treated since the amount of larvicide used is related to the water flow of the treated rivers and many of the vector breeding places in other onchocerciasis foci are very large rivers (WHO 1973a).

Lymphatic filariasis

Lymphatic filariasis occurs in all tropical and subtropical regions of the world with widespread but uneven distribution. It affects at least 250 million people with acute and sub-acute illness as well as chronic incapacitation. In Polynesia it is transmitted by feral *Aedes* mosquito species against which, as yet, no sound control methodology has been developed. In some rural areas, especially in Africa, filariasis is transmitted by *Anopheles* mosquitos, like malaria; therefore the control methodology is also based on house-spraying. The prospects for successful control are much greater because the filariae do not multiply in the human body, while the malaria parasites do. The main filariasis foci, however, occur in areas where the disease is

transmitted by mosquitos belonging to the Culex pipiens complex. This mosquito breeds in polluted water and improvement in sanitation would be the ideal means of controlling it; since this can only be a long-term solution, the best means now is the periodic larviciding of the breeding places with an organophosphorus insecticide which is relatively stable in the polluted water; fenthion and chlorpyrifos have given excellent results in tropical areas, with weekly treatments at 1 ppm target dosage. Such treatment for filariasis control as part of pest mosquito abatement may indeed be a current procedure, as a preliminary survey carried out during 1974 by WHO showed that a large amount of larvicides were used to control urban pest mosquitos of the Culex pipiens complex (WHO 1974a).

African trypanosomiasis

Although only a few thousand new cases of this killing disease transmitted by tsetse flies are registered every year, the number of people at risk amounts to over 100 million and the cost of epidemiological surveillance, early detection and treatment is high. Animal trypanosomiasis is also transmitted by the tsetse fly and occurs in the same areas, thus control programmes for the animal disease allow the participation of the human disease control component. The only insecticides which have been proven fully effective for tsetse fly control and/or eradication operations are some organochlorine insecticides which are either rather acutely toxic to vertebrates, or environmentally objectionable, or both. They are applied to the vegetation of the tsetse fly resting sites, either at single high dosage or at repeated low or ultra-low dosages. An ambitious plan is under consideration by the UN Agencies to eliminate the tsetse fly from 7 million square kilometres of African savanna over a 40-year period, for veterinary purposes. Based on the existing methodology, it is estimated that this would require a few thousand tons of dieldrin, endosulfan and/or DDT a year. However, intensive research is now being started to develop better control methods and more environmentally acceptable insecticides for this control purpose.

Chagas' disease

The American trypanosomiasis is a zoonosis, with a large feral animal reservoir. The transmission from animal to man, and from man to man, is made by a few species of hematophagous triatomid bugs and occurs inside houses and in the surrounding environment. The disease occurs only in Latin America where it is very widespread and affects the cardiovascular system, the digestive tract, as well as other organs. Its prevalence and clinical severity are not well documented in the affected countries, but it undoubtedly constitutes one of the major public health problems of the Americas, with tens of millions of infected people and many more at risk. There is no safe and effective drug. Better housing conditions and environmental sanitation measures could reduce the man-vector-reservoir contacts, but pending this long-term solution, the main control approach is based on residual house-spraying similar to that for malaria control. However, for triatomid control most control operations were formerly carried out with dieldrin but now with benzenehexachloride, since DDT is not very effective. Certain vector species have developed resistance to the cyclodiene group of organochlorine insecticides and alternatives are under investigation; propoxur has given promising results.

Schistosomiasis

Schistosomiasis is caused by parasitic worms infecting the vascular system; the parasite has a complex life cycle involving water snails as intermediate hosts. One of the four species of schistosomes affecting man also has a large animal reservoir

and is thus a zoonosis. The disease exists in many tropical and subtropical countries of the world with an uneven distribution, but is especially widespread in Africa. Over 200 million people are infected and the disease has serious debilitating effects. Its spread is greatly favoured by the development of modern agricultural techniques involving irrigation, damming of rivers, fish pond culture, etc. The control of the intermediate snail hosts involves the application, several times a year, of molluscicides to the habitats of these snails. In view of the operational costs involved, as well as of certain unfavourable side effects of the treatments on non-target freshwater organisms, control operations to date have been mostly carried out in densely populated, or economically important areas of the developing countries, and systematic control operations have been implemented in the richest of the affected countries. There is a distinct trend towards the intensification of snail control operations as a consequence of the agricultural and economic development of tropical areas where the disease already occurs, and such development could increase its prevalence (WHO 1973b).

Arboviral diseases

Special mention must be made of a number of arboviral diseases having common epidemiological and control characteristics. Japanese B and American encephalitis, yellow fever and dengue haemorrhagic fever, are widespread mosquito-borne diseases with animal reservoirs (problematical for dengue) and cause outbreaks in human populations with relatively high fatality rates and permanent after-effects amongst a proportion of the affected people surviving the illness. The population at risk far exceeds 1000 million people and involves not only tropical and subtropical areas, but also some temperate countries, such as Japan and the USA. The most widely used vector control method is the ULV application of insecticides, either from the ground or by aircraft, to eliminate the adult mosquito population and stop the transmission of the generally short-lived viruses. Due to its very large safety margin for man and animals, malathion is the insecticide of choice, but a number of other insecticides have given very promising results during field trials, and their use is a matter of national regulations and cost-effectiveness analysis (WHO 1966, WHO 1971).

PRODUCING THE TOOLS AND TRAINING THE PEOPLE

Expressed in terms of vector control for disease control, over and above pest control and urban sanitation problems, the needs of the countries of the tropical and subtropical zone are considerable. However, sometimes the control tools do not exist or require major improvements, and qualified planners, managers and operators are very scarce in most of the countries concerned.

WHO, through its network of collaborating laboratories, field research units, disease and vector control projects and programmes, and in close co-operation with the industry, leading scientific institutions world-wide, and the other UN agencies, especially FAO and UNDP, has carried out for many years a global programme for the evaluation of chemical pesticides and the development of the associated appropriate vector control methods for disease vectors. This has sought to improve techniques with known materials, to find new materials more acceptable for use in developing countries, as well as to find materials and methods for vector control not now available. While these activities have given satisfactory results in terms of vector control methodology, much remains to be done, especially with regard to resistance and environmental problems. Although active efforts have been made for training for vector control, results have been less than satisfactory in terms of staff for actual implementation of large scale control programmes by the national authorities; partly

because the training programmes have not been ambitious enough and partly because the lack of vector control career openings at the national level has allowed most promising individuals to leave their countries or be diverted to other careers. Furthermore, health has not been considered as an important component of the economic development planning and implementation at the national and regional level. It is only now after years of costly acquired experience, that one can see an increasing trend to give health and social problems their due place from the planning stage onwards; this can only favour the development of large scale disease and vector control activities.

As part of its policy to solve some of the vector control problems occurring with pesticides, such as resistance and environmental problems, WHO is developing a programme for the evaluation and testing of biological control methods. The development of microorganisms for vector control will have to be very similar to that followed for the development of chemical pesticides.

PLANNING, FUNDING AND IMPLEMENTING CONTROL OPERATIONS

Once the appropriate tools and the trained operators are available for specific vector control problems, the decision to undertake national, inter-country and regional campaigns is with the respective governments. The first step is the identification of the diseases against which control operations should be organized, and the allocation of their priorities for control within the framework of a long-term country health programme; this has only just been undertaken by a handful of tropical developing countries. The second step is to make a cost-effectiveness analysis of some sort, to select the most promising control approach and then define the stages of planning, costing, staffing and implementing necessary to achieve the defined goal. Should the governments require, WHO can assist the national authorities concerned during each of these stages. The WHO Regional Committees, World Health Assembly, Expert Committees, Scientific Groups, etc. constitute excellent opportunities to compare experiences, exchange views, determine fields of common interest for subsequent joint actions, and to define global strategies and priorities for the control of vector-borne diseases. As such, WHO plays a catalytic and co-ordinating role which should not be underestimated. In addition, WHO sometimes assists, not infrequently, as a resources raising agency, inducing donor countries and institutions to assist other countries through the allocation of financial grants, the secondment of technical and scientific staff, the organization of training and research activities.

THE FUTURE

What has been done to-date for controlling vector-borne diseases in tropical countries, with due respect given to malaria control and eradication operations where they were successfully carried out, represents only a minor part of what should be done. The resources devoted to pesticides and equipment for that purpose thus represent only a very small part of what will be required in the future if vector-borne disease control is to keep pace with the socio-economic development now envisaged for developing countries.

Many of the countries affected by these diseases have had limited resources in the past, and this stands true for the present for most of them. The situation is rapidly changing with the increasing prices of certain prime materials, and implies a major re-allocation of the world financial resources and permits the progressive implementation of new more inclusive vector control operations.

The recent UN acceptance of the need for a new international economic order should facilitate and speed up such a redistribution of the resources. We can thus hope that the near future will see the planning, costing and successful implementation of an increasing number of global programmes for the control of vector-borne diseases.

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