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Vector control in primary health care

Report of a
WHO Scientific Group

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WHO SCIENTIFIC GROUP ON VECTOR CONTROL
IN PRIMARY HEALTH CARE

Geneva, 4-10 November 1986

*Members**

- Dr A. Beliaev, Associate Professor, Chair of Tropical Diseases, Central Post-graduate Medical Institution, Ministry of Health, Moscow, USSR
- Mr W. Brieger, Senior Lecturer, Acting Coordinator of Studies, Ibarapa Community Health Programme, Department of Preventive and Social Medicine, University of Ibadan, Ibadan, Nigeria
- Dr J.D. Charlwood, Research Fellow, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, England
- Professor W. Kilama, Director-General, National Institute for Medical Research, Dar es Salaam, United Republic of Tanzania (*Chairman*)
- Ms Lim Suat Jien, Deputy Head, Vector Control and Research Department, Ministry of the Environment, Singapore
- Dr J.C. Pinto Dias, Head of the National Chagas' Disease Programme, Ministry of Health, Brasilia, Brazil
- Dr T.K. Ruebush II, Chief, Protozoal Diseases Branch, Division of Parasitic Diseases, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA, USA (*Rapporteur*)
- Dr V.P. Sharma, Director, Malaria Research Centre, Indian Council of Medical Research, Delhi, India (*Vice-Chairman*)

Secretariat

- Dr N.G. Gratz, Division of Vector Biology and Control, WHO, Geneva, Switzerland (*Temporary Adviser*)
- Dr J. Mouchet, Medical Entomologist, ex Institut Français de Recherche scientifique pour le Développement et Coopération (ORSTOM), Paris, France (*Temporary Adviser*)
- Dr R. Slooff, Director, Division of Vector Biology and Control, WHO, Geneva, Switzerland
- Dr R.J. Tonn, Chief, Planning, Management and Operations, Division of Vector Biology and Control, WHO, Geneva, Switzerland (*Secretary*)

* Unable to attend: Professor Fereydoun Amini, Public Health Practice, School of Public Health, University of Teheran, Teheran, Iran

VECTOR CONTROL IN PRIMARY HEALTH CARE

Report of a WHO Scientific Group

The WHO Scientific Group on Vector Control in Primary Health Care met in Geneva from 4 to 10 November, 1986. The meeting was opened by Dr R. Slooff, Director, Division of Vector Biology and Control, on behalf of the Director-General. He emphasized that attention should be focused on the primary health care approach to vector control including involvement of the community and the health service infrastructure.¹ The Group was requested to review the technical aspects of vector control appropriate to primary health care, available resources, training needs of personnel involved in vector control, and the role of the professional core group and the district health management team as a technical resource for the control of vector-borne disease.

INTRODUCTION

Vector-borne diseases continue to result in high rates of morbidity and mortality and to place severe limitations on attempts to improve the quality of life. When exploring ways of reducing the transmission of these diseases through the use of effective and economically feasible vector control measures, it soon becomes evident that action by governments alone is no longer sufficient. Communities themselves should actively participate in their own protection. Government commitment will be necessary, including the provision and maintenance of technical resources as well as the assignment of greater responsibility to the community level. District health systems are an essential part of national health systems based on primary health care, and more responsibility must be transferred to the district level, including that of adapting vector control programmes to encourage community participation. The role of the district health officers must be strengthened so that they and their

¹ The term "vector" is used in a broad sense and includes primary and intermediate vertebrate and invertebrate hosts and animal reservoirs of human and animal diseases.

teams can provide the necessary technical guidance to achieve this goal.

It is still as important as ever to ensure that vector control methods are reliable, effective, affordable, and acceptable; several requirements will have to be met to achieve this. A well-trained and informed core group including vector control specialists must be available to provide expertise when needed and to promote or carry out the research that may be required to improve methods or solve specific problems. A district health system must be developed to provide the necessary assistance at the community level. District health officers must have a thorough understanding of different vector control measures including the way in which they can be applied in different epidemiological, ecological, and sociological situations. Sectors other than health should be encouraged to contribute to the improvement of health, as well as to limit any vector-borne disease problems that their programmes might create.

Control measures that are likely to be successful must be designed and evaluated; they must also be appropriate for the health delivery systems that will use them. Community health workers and the general population must be made aware of these measures and be trained/oriented to use them when practical. A single control measure may not effectively control vectors under all circumstances. Vector control approaches should be innovative and, when necessary, integrate different methods at the various levels of the health care system.

1. THE INTEGRATION OF VECTOR CONTROL INTO PRIMARY HEALTH CARE

1.1 The magnitude of disease vector problems and the potential for their control through primary health care

While data on the incidence, prevalence, and geographical distribution of vector- and rodent-borne diseases are not always available, the total number of cases of disease is certainly in the hundreds of millions. A large proportion of the rural populations in developing countries, and, to a lesser extent, the urban populations, are likely to suffer from one or more of these diseases during their lifetime. Among the arboviruses, those causing dengue and dengue haemorrhagic fever/dengue shock syndrome are already endemic in

areas where hundreds of millions of people live and these infections appear to be spreading to all regions where the vectors *Aedes aegypti* and *Aedes albopictus* are found, often causing major epidemics. Malaria remains endemic in areas where almost 2 200 million people live, and it is estimated that the number of new clinical cases each year may be as high as 90–100 million. Between 15 and 18 million people are thought to be affected by Chagas' disease, while perhaps 90 million have lymphatic filariasis, and another 200 million have schistosomiasis. Sleeping sickness, leishmaniasis, and onchocerciasis cause severe problems in focal areas in various parts of the world.

On the basis of the available information, health planners must decide whether the vector-borne diseases endemic in their country or district constitute a sufficiently serious public health problem or restraint on economic development to justify the costs of attempting to control them. While there are many factors that are likely to influence such a decision, the essential first step is the political decision whether to undertake control of a given disease. Adequate and accurate epidemiological, entomological, and economic information must be available to decision-makers to be used in their deliberations; they must also be aware of the financial and organizational consequences of any affirmative decision. Once the control programme has been created, it is the responsibility of the core professional group of vector-borne disease specialists to ensure that all the necessary technical and economic data are available to those responsible for planning health interventions.

Vector control is often expensive, and if more economical, effective methods are available such as the use of immunization, chemoprophylaxis, and/or chemotherapy, they should be considered. However, there are certain infections for which neither mass prophylactic measures nor any safe, reliable, and affordable chemotherapeutic agents are available. In such cases, control of the disease vector should be considered although such control may not always be feasible. Certain vector species neither rest nor feed indoors, while others have larval habitats so dispersed that it is impractical to attempt to eliminate them.

If the control of a disease vector is considered feasible, it must be decided at which level of the health system it is most appropriate to implement the control measures selected and whether or not the control measures can be performed by community health workers. Control of the vectors of onchocerciasis in West Africa has been found to be more effective and economical using aircraft to apply

larvicides rather than attempting to reach and treat the myriads of constantly changing and often inaccessible larval habitats. Nevertheless, even in this kind of situation community health workers do have a role to play in vector surveillance and in the evaluation of control. A dialogue between the core professional group and the district health officer on one the hand, and the district team and the community health workers and community leaders on the other should result in the definition of the role of the community health worker.

Field research may be needed to obtain information on the epidemiology of the disease and the bionomics of its vectors and reservoirs. It is the responsibility of the core professional group working together with the districts, communities, and other professional groups, to plan and carry out this research and to determine how it will be applied during control activities.

Every opportunity must be taken to involve the community in the planning, execution, and where possible, the evaluation of vector-borne disease control activities. It is also important that the community health worker and the community set goals that are attainable using reliable and affordable methods.

1.2 The present status of programmes at the country level

Considerable efforts are now being made to include vector control activities in primary health care in countries where vector-borne diseases are endemic. A number of examples from regions in which this has been achieved are described in this section.

1.2.1 The African Region

Vector-borne diseases constitute a severe health problem for all countries of the Region, particularly among rural populations. While all Member States have integrated their disease control programmes into primary health care, relatively few have included vector control activities in disease control, and even in those that have, the extent to which this has been done varies greatly depending upon the different political, economic, social, and cultural characteristics of each country and the epidemiology of the diseases targeted for control.

Eleven countries of the Region have reported community participation in the control of the vectors of malaria in rural, urban,

or periurban areas through environmental control, larviciding, house spraying, or a combination of such measures. In four other countries, the communities have participated in trials to test the effectiveness and public acceptance of the use of mosquito coils and insecticide impregnated bed-nets. Traps are an effective tool for the control of certain species of tsetse fly, and several thousand traps are now in use in Angola, Congo, Cote d'Ivoire, and Uganda. Many of them are maintained with considerable enthusiasm by members of the communities near which they are placed.

In several countries, communities have participated in the application of molluscicides for the control of the snail hosts of schistosomiasis and some communities are playing an important role in the control of dracunculiasis through the production and use of filters to remove the *Cyclops* intermediate hosts from drinking-water.

1.2.2 *The Region of the Americas*

Historically, disease vector control activities in the Americas have been carried out by ministries of health. During the 1930s and 1940s emphasis was placed mainly on environmental measures. With the initiation of the *Aedes aegypti* and malaria eradication campaigns, far more use was made of chemical pesticides for the control of the mosquito vectors of malaria, yellow fever, and dengue as well as for the control of the triatomid vectors of Chagas' disease. Very little effort was made to enlist the participation of communities in these activities, and the failure of the *A. aegypti* eradication campaign dramatically illustrates, among other things, the consequences of failing to obtain the necessary community-based environmental and behavioural support.

Today, vector control activities in the Caribbean are directed almost exclusively against *A. aegypti*, and a growing proportion of such programmes are based on improvements in sanitation carried out by the community. Promising beginnings have been made in St Lucia and Dominica, and vector control activities in Costa Rica and El Salvador in Central America are gradually becoming part of primary health care. In Costa Rica, local health committees have been active since 1973 in encouraging and implementing health education as well as the use of mosquito nets, repellents, and basic sanitation for the control of malaria vectors. Excellent progress has been made in El Salvador in promoting an intersectoral approach to

vector control, with considerable community participation in drainage projects.

In a number of Central and South American countries, vector control operations continue to be implemented as vertical programmes with little participation by the communities. However, community-based programmes are gradually being developed against the vectors of malaria and Chagas' disease; economic factors are important in encouraging a change from vertical programmes. Emphasis has been placed on educational efforts, on increasing the role of community health workers in health education and in the recognition and solution of local problems.

1.2.3 The Eastern Mediterranean Region

Among the 23 Member States of the Region, malaria and schistosomiasis are the most important vector-borne diseases. Leishmaniasis, filariasis, onchocerciasis, trypanosomiasis, Rift Valley fever, and Crimean-Congo haemorrhagic fever occur in several countries but the prevalence of these diseases varies.

Few countries have separate vector control programmes, other than for malaria, and most of the malaria control programmes have already been integrated into the general health services.

Encouraging results in community participation in vector control have been observed in Djibouti, Oman, Somalia, and Sudan. The Sudan Blue Nile Health Project, which includes all water-associated diseases and integrates a variety of vector control measures to achieve a reduction in the intensity of these diseases, makes full use of the local communities through village health committees composed of social and religious leaders. These committees enlist the aid of volunteers who are trained in the application of residual insecticides and molluscicides, in the chemotherapy of malaria and schistosomiasis, and in the management of diarrhoeal diseases.

In Djibouti, communities have cooperated in the reduction of vector breeding-places and the rearing and distribution of larvivorous fish. Village health committees of religious, administrative, social, and educational leaders have been formed for this purpose and for the recruitment of voluntary and paid labour.

In Oman, villagers have been involved in the reduction of mosquito breeding-sites, by means of drainage and other measures, as well as in the distribution of larvivorous fish. This programme was initiated with the cooperation of local tribal chiefs, village heads, and

at times with intersectoral cooperation involving the Ministry of Agriculture and others.

In Somalia, community participation was obtained in a pilot vector control project using indigenous larvivorous fish. This approach helped to interrupt malaria transmission, to eliminate mosquitos almost completely, to clear water reservoirs of scum, and to provide an additional source of protein. Villagers cooperated actively in the transport, distribution, and maintenance of fish colonies in their water tanks and reservoirs.

1.2.4 *The South-East Asia Region*

In the countries of this Region, vector control activities and entomological services have, for the most part, been provided as part of national or local control programmes for malaria, filariasis, dengue haemorrhagic fever, Japanese encephalitis, or leishmaniasis. However, operational structures have not been developed for most of these programmes in the same way as is the case for the malaria and dracunculiasis programmes in India.

Since 1982, seven workshops have been held in the Region on malaria control in primary health care and these have encouraged integrated vector control and community participation.

Control programmes for dengue haemorrhagic fever in Burma, Indonesia, and Thailand are examples of operational vector-borne disease control programmes in which interventions against the vector have been carried out by the community as part of primary health care. In Indonesia, source reduction and mass larviciding have been used to control *Aedes aegypti* since 1975 in localities with a high incidence of dengue haemorrhagic fever; this work has been carried out largely by volunteers from the various communities. In 1983–84, more than 86 000 volunteers visited 2.5 million dwellings in 22 provinces and used 111 tonnes of 1% temephos sand granules. Larviciding operations in the field were supervised by personnel from primary health care centres and source reduction activities were carried out by volunteers who made house-to-house visits in the communities.

Studies have been carried out on the use of source reduction for the prevention and control of dengue haemorrhagic fever in Indonesia, Central Java, and Thailand. In Central Java, source reduction was carried out in 23 000 premises by village and student volunteers trained at primary health centres and supervised by the

Municipal Health Officer. In Thailand the Department of Medical Sciences promoted health education campaigns involving larviciding with temephos sand granules by village volunteers.

In addition to the programmes described above, a number of large-scale research or pilot projects are being carried out in the Region related to community-oriented vector control, e.g., the studies for the integrated control of malaria that are being conducted in India. The project in Gujarat, carried out by the Malaria Research Centre of the Indian Council of Medical Research, was initiated in 1983 in seven villages with a population of 25 000 and now includes 100 villages and 350 000 people. A second community involvement project in 33 coastal villages near Pondicherry was undertaken by the Vector Control Research Centre. The breeding of mosquitos in brackish water containing algae was eliminated by clearing the algae and using the plant material for paper production. Mosquito breeding-sites in low-lying areas and irrigation ponds were converted into prawn and fish culture ponds. The Vector Control Research Centre is also involved in an integrated programme for the control of lymphatic filariasis in Pondicherry, covering a population of 272 000 and an area of 60 km². This project is directed by professional staff with the cooperation of community leaders and involves various departments of the local government.

An integrated approach to the prevention and control of dracunculiasis through health education has been successfully carried out in 12 tribal villages in the state of Rajasthan, India.

1.2.5 *The Western Pacific Region*

Malaria, dengue, dengue haemorrhagic fever, filariasis, and Japanese encephalitis remain the most important vector-borne diseases in this Region. Community involvement in vector control has been implemented in most countries. Good progress has been made through community participation in the control of the *Aedes* vectors of dengue haemorrhagic fever and of the vectors of sub-periodic bancroftian filariasis.

Malaria remains an important public health problem in many countries. Personal protection measures are receiving more attention and the use of permethrin-impregnated bed-nets has been introduced on a small scale in all countries where malaria is a major problem. The responses of both the malaria workers and the community have been very favourable. Pilot projects with treated bed-nets are now

being expanded to involve at least 5 000 people to permit epidemiological and entomological evaluation. Cost analyses carried out recently in Lao People's Democratic Republic have shown that the use of impregnated bed-nets is cheaper than DDT spraying if inexpensive bed-nets are used, such as those available in the Philippines. Women living in a rural village outside Manila can sew the pieces together and sell them at a cost of less than US\$3 each. In Guangdong Province in southern China, more than 100 000 bed-nets have been impregnated with deltamethrin by community members.

The port city of Dalian, in north-east China recently received national and international recognition for ridding itself of rat infestation. The city of 4 million inhabitants used 45 000 volunteers to distribute anticoagulant bait (0.025% diphacinone) to all households, restaurants, and warehouses.

Community involvement in filling canals and other snail habitats has been successful in controlling schistosomiasis in many parts of China. In the Philippines, health education is used to encourage community members to refrain from swimming in snail-infested streams.

The general public spends large sums of money on aerosols and mosquito coils to control mosquitos in their homes. This is a multimillion dollar industry in countries such as Japan, Malaysia, and the Philippines.

1.3 Target vector species for which control through primary health care is feasible

When considering which vector species might be suitable targets for control through primary health care, it is essential to select those against which the community health worker and the community have a reasonable chance of success. Failure for reasons beyond their control will discourage the community, and the professional programme planner has a responsibility to see that this does not occur. This implies that the control techniques and materials provided for community use must be of demonstrated efficacy and suitable for application by individuals who have only a limited background knowledge of vector control. If the community health workers wish to increase the level of participation, they should certainly be encouraged and provided with appropriate training facilities.

There are a number of vector species that are, generally speaking, suitable targets for community-based control efforts. Once the community has launched a control effort, the government should ensure that the community's accomplishments receive the continuous support and interest of the health team. If the community has been given pesticides for use in their control activities, it is essential that their safe use and handling be monitored, that supplies be replenished when needed, and that help be given on the maintenance of equipment.

1.3.1 *Malaria vectors*

Many malaria vectors can be successfully controlled by the community with the guidance and support of a professional core group or the district health management team. For example peridomestic breeding of several species including *Anopheles claviger* and *A. stephensi* can be reduced by eliminating their larval habitats. In South-East Asia and China, cutting back the bush around villages will eliminate the larval habitats of *Anopheles dirus* and *A. balabacensis*. There are other examples, but in each case the selection of control measures must be based on a knowledge of the ecology of the target species and on experience with effective control measures appropriate for use by community workers.

For the prevention of malaria, increasing use is also being made of personal protection methods to exclude man-vector contact; these include the use of bed-nets in general and the use of insecticide-impregnated bed-nets in particular, or the use of insecticide-treated cloth strips suspended in sleeping quarters. The local production of bed-nets should be encouraged whenever possible.

1.3.2 *Aedes aegypti* in urban areas as a vector of dengue, dengue haemorrhagic fever, and yellow fever

In those parts of the world where breeding of *Aedes aegypti* occurs mainly in domestic habitats, e. g., in the Americas, South-East Asia, the Western Pacific, and to a certain extent in Africa, this species could be an ideal target for community-based control. Its larval habitats are relatively limited and can be readily recognized, its population density is generally moderate, and its flight range is short. Apart from the feral habitats of *A. aegypti* in Africa, the breeding-sites of this species are virtually all man-made, including

containers for the storage of water, flower vases, ant traps, and discarded receptacles such as automobile tyres, tin cans, and bottles.

Unfortunately, these man-made containers are sometimes found in such large numbers in urban areas that even with active community participation, not enough of them can be destroyed or disposed of to interrupt the transmission of dengue. Several field trials of community participation against *A. aegypti* have been undertaken in Asia and the Americas but, regrettably, most of these have not achieved the level of success anticipated; the reasons for this will be considered elsewhere. Nevertheless this species does represent a feasible target for community participation under the guidance of enthusiastic and persistent community health workers who concentrate their efforts on controlling the creation of these breeding-sites.

1.3.3 *Tsetse vectors of African trypanosomiasis*

One of the most successful recent developments in community-based vector control is the use, in many parts of Africa, of highly effective and low-cost traps against tsetse flies. These traps, whether impregnated with insecticide or not, are enthusiastically used by villagers who experience for themselves the reduction in fly biting and are able to see the large number of tsetse flies trapped.

1.3.4 *Triatomid vectors of Chagas' disease*

In many areas of Latin America, the vectors of Chagas' disease are peridomestic bugs that find suitable conditions for their development in the thatched roofs and in the cracks in the mud walls of rural houses. Replacement of these roofs by tiles or corrugated iron will eliminate this breeding-site and will also mean that the roof does not have to be replaced periodically. If wall surfaces are properly smoothed or are constructed of alternative materials that do not crack, vector densities can be reduced so that transmission of the disease no longer occurs. In most cases financial aid must be given to the community for the repair or reconstruction of their houses. Although this aid may be beyond the resources of many governments it should be realized that such house improvements can eliminate the necessity for periodic residual applications of insecticides. Field trials have shown that insecticide added to paints also provides effective long-term protection. In Brazil and Argentina

community members carry out surveillance for triatomids and spray houses when infestations are found.

1.3.5 *Body lice*

Body lice and the diseases they transmit can still be found particularly among poor communities in highland areas where colder temperatures discourage the frequent changing of clothes. Since it has been shown that infested individuals will often use agricultural insecticides to control their own louse infestations, it is likely that such individuals will readily accept any appropriate help they are given. This help should include the selection of safe and effective insecticides. Any control effort carried out should include all infested members of the community so that reinfestation does not occur.

1.3.6 *Household and personal pests*

Although they are not vectors of disease, headlice, cockroaches, and bedbugs are annoying pests. Effective help given by the community health worker to members of the community to control these and other pests will often make people more receptive to other vector control activities.

Headlice infestations are widespread throughout both the industrialized and developing world. The only effective means of controlling such infestations is by the application of an appropriate insecticide. Parents can treat infested children with insecticides if shown how and when to do so. It will be necessary in most cases for the health services to provide the insecticide. Some individuals in the community might be prepared to buy the materials if they are affordable. To control headlice infestations it is essential that all members of the family are treated at the same time.

Bedbugs are almost always troublesome to the affected individuals and advice on their control will generally be welcomed and implemented if the advice concurs with the local customs and if it is within the means of the community to do so. The effective control of bedbug and cockroach infestations as a byproduct of the use of residual insecticides to control malaria or Chagas' disease will often promote acceptance of house spraying. However, the use of some insecticides to which bedbug populations have developed

resistance frequently impedes acceptance of house spraying in general.

1.3.7 *Rodents*

Rodents are the reservoirs of a number of serious human infections and they are frequently important predators on stored food and crops. Often, simple rodent-proofing can be carried out to prevent access of rodents to stored food. If provided with the necessary materials and instructions, rural farming communities will willingly participate in rodent-proofing activities as well as in the preparation and distribution of rodenticide baits.

1.3.8 *Cyclops*

While the most effective means of preventing guinea worm infestations is the provision of safe water supplies, other short-term measures can be taken. Monofilament, nylon-cloth water filters have been distributed by community health workers in Nigeria. Communities can also be involved in the periodic application of temephos to *Cyclops*-infested water supplies and in the conversion of stepwells to draw-wells. Such measures will allow communities and governments time to raise funds for water-supply projects while offering some protection against this disabling disease.

2. DELIVERY OF VECTOR CONTROL THROUGH PRIMARY HEALTH CARE

The primary health care approach has focused more attention on expanding the role of communities, including community health workers, the importance of intersectoral collaboration, and the need for a more equitable use of health resources. This emphasis has led to the review of organization and orientation of existing health systems at national, provincial, and district levels. In this section of the report these changes are discussed as they apply to vector control activities in primary health care. The following five points are considered:

- (1) Vector control priorities differ geographically, environmentally, and politically; these differences will affect vector control activities in primary health care.

- (2) Changes in priorities and vector control strategies involve economic issues related to delivery systems and the transfer of responsibilities to communities.
- (3) The role of community involvement in vector control needs definition in terms of mobilization, mechanisms, and constraining factors.
- (4) A vector control component need not overburden the primary health care system if local priorities and capabilities are considered.
- (5) Certain aspects of vector control such as the control of epidemics of vector-borne disease may require centralization and assistance from specialized services.

2.1 Vector control measures in primary health care

It is recognized that the nature and magnitude of vector control activities in primary health care will differ between countries and even between different geographical regions of the same country, depending upon technical feasibility and the priority given to vector-borne diseases. Historically, malaria has been a health priority within ministries of health, but this might not be true at the community level. Nevertheless, several major vector-borne diseases, including malaria, schistosomiasis, filariasis, and trypanosomiasis continue to cause concern for both governments and communities, and priorities for disease control should be determined and agreed upon by communities and the health services (1, 2).

In this context, a number of factors must be considered:

- existing control technology differs between vectors, for example, many malaria vectors can still be controlled using residual pesticides whereas the control of urban filariasis vectors may require a combination of approaches. Control strategies may differ between urban and rural areas as well as with climatic factors such as temperature and rainfall;
- control of certain vectors is beyond the capacity of health service activities and requires a more generalized approach that may not be amenable to primary health care; for example, extensive breeding of *Culex tritaeniorhynchus* in rice fields and *Simulium damnosum* control;
- vector control should not be isolated from other health-oriented tasks;

- in many circumstances vector control is the responsibility of individuals who do not have the time, training, or interest to fulfil the tasks involved properly. This situation highlights the need for a district health management team that has expertise in vector biology and control;
- all levels of government must share in the responsibility of providing adequate and appropriate guidance within the primary health care system. This will require professional vector control specialists to participate in the decision-making processes related to vector control;
- intersectoral collaboration is necessary at all levels and work involvement must be such that each individual will be encouraged and their initiative sustained.

Several approaches to vector control through primary health care will evolve naturally. These approaches will relate to the social and economic environment of each particular community and will differ between urban and rural areas. Initial steps in vector control might first be directed towards sanitary measures such as source reduction and measures that protect the individual and the family. A more technical approach might develop as interest and skills improve. Activities that require specialized equipment or insecticides may have to be entrusted to more highly trained individuals at the district or primary health centre.

Nongovernmental organizations should be encouraged to participate in promoting and implementing special vector control activities through primary health care and community involvement. Possible actions include clean-up campaigns, city beautification, and health promotion contests.

2.1.1 *The evolution of national policies, strategies, and organization*

Health policy at both national and international levels was defined in the concept of primary health care expressed in the Declaration of Alma-Ata in 1978. The World Health Assembly in 1981 adopted its Global Strategy for Health for All, and this was followed by the development of global and national plans of action. In support of national health policies and strategies, WHO's Seventh General Programme of Work (1984–1989) was developed to promote and support the appropriate organization and effective operation of comprehensive health systems that provide the essential elements of primary health care to entire populations, along with

referral and specialized support, when necessary, and that involve communities and health-related sectors in responsible and coordinated ways (3).

The evolution of policies and strategies is towards increased cooperation between different governmental and nongovernmental sectors at all levels in order to emphasize that health is important to all sectors and that only through a unified approach will the goal of health for all be achieved. The current emphasis on the district health system has arisen from the need for more leadership, coordination, and integration of health activities at this level. It also follows logically from the increasing decentralization of responsibilities and resources. The district is a particularly suitable area for managing the control of vector-borne diseases because they are focal in nature.

The district health management team can accommodate local differences in the design of health activities and react more rapidly to changes in disease prevalence than those at the central level. In this context, national strategies should be seen as guidelines to encourage district and local actions, not as directives.

It must be remembered that every level of a primary health care network has different responsibilities and authorities, and these must be clearly identified. The district health management team may require expert advice to obtain and maintain the interest and involvement of both the community and the health workers in vector control. Consequently, the team is important in referral, coordination, and supervision of primary health care activities; it is at the district level that optimum technical inputs can be made into the field. An important part of vector control will be knowledge of control measures that are feasible for the communities within the district.

2.1.2 Planning for vector control in primary health care

For the effective integration of vector control into primary health care, planning skills must be available and put into practice at the district and community levels. Members of regional and national vector control core groups should provide consultation during the development of district level plans. In turn, the composite of district plans should guide national planning.

The first task for district level planning is to involve representatives of the community, including community health workers, in a vector control planning committee. The planning

committee will then gather information and carry out the following activities or ensure that they are implemented:

- identify vector-borne diseases of public health importance;
- identify vectors and pests that can be controlled;
- gather baseline data on the nature and extent of vector/pest problems, breeding-sites, locations of human habitats, outbreaks of disease, and sociobehavioural data related to disease transmission;
- design a basic monitoring and surveillance system that can not only be used to collect the above-mentioned data, but will be also useful in evaluating ongoing programme activities;
- set feasible objectives and establish entomological, epidemiological, social, and economic indicators to measure progress and output;
- determine appropriate strategies and tools including those for community education and mobilization;
- detail resource needs (material, financial, equipment, supplies, expertise, etc.) and indicate those that can be satisfied locally and those that must be obtained from outside;
- pay particular attention to personnel needs, both professional and voluntary, since human resources are the most important asset for successful primary health care:
- clarify roles and responsibilities of all personnel;
- seek collaborative support and involvement from relevant agencies and voluntary organizations at district and community levels;
- draw up timetables for the implementation of actions and strategies that cover each community in the district;
- establish and test a format for programme evaluation that involves the community; and
- develop further plans to sustain vector control activities on a long-term basis.

2.1.3 *Approaches to vector control in primary health care*

As already discussed, the principles of primary health care stress planning at the local level. This ensures that consideration is given to existing priorities, possibilities, and personnel within a system that is appropriate for the particular locality. The decision that vector control will be part of local primary health care and the form that the control activities might take should not be decided at the

national level but may be endorsed at that level. Instead, the role of the national and international specialists is to offer guidelines, encouragement, and consultation.

Vector control should evolve as a natural part of the overall mixture of health services that a community chooses for itself. The actual process of integration will occur at the district and community levels. This should not involve the "adding on" of new tasks for the community health worker. During this process the community will have considered its resource capabilities and the type, number, and variety of primary health care personnel needed to achieve these aims. The issue of overburdening the community health workers will not arise, if the community is truly involved in planning.

2.1.4 Economic implications of vector control in primary health care

Considerable public and private resources are invested in vector control activities. In the current economic climate, the effectiveness and sustainability of such activities must be assessed. Before that can be done, the economic issues involved in vector control must first be identified and clarified. A distinction should be made between the cost-effectiveness of long-term strategies and short-term resource management issues. Although closely related, these activities differ in terms of time and information requirements as well as in the way in which they influence decision-making at the various levels.

The management of vector control activities is complex because control programmes may be fragmented such that both direct and hidden costs are difficult to estimate. Differences in accounting procedures aggravate management difficulties. Some costs (e.g., pesticides, equipment, and supplies) are less dependent on the organizational structure. However, all control operations will have high initial costs for equipment, staff recruitment, and training that are not related to efficiency. In addition, buildings, vehicles, and other costs are frequently covered by funds that are not assigned to a specific programme.

The identification of patterns of resource use is necessary for basic descriptive analysis to be made of programme costs, their composition and determinants, and their relationship to activity levels. Questions of efficiency cannot be tackled until adequate information is available. Answers to more ambitious questions related to assessing potential vector control strategies using a variety

of methods, the role of communities in financing vector control, district health programme relations, and the degree of integration with primary health care will require new methods of accounting, new data, and substantial skills.

New methods and additional information are especially needed for conducting cost-effectiveness and cost-benefit studies. For these studies, indicators of cost and of the effectiveness of given measures must be developed. These indicators must include more than vector-borne disease mortality and morbidity statistics and should use non-monetary measurements of benefit to provide a basis for selecting disease or intervention priorities.

Planners must not overlook the benefits from and the indirect investments made by other sectors. For example, improvements in basic public services (drinking-water, waste disposal) can have an impact on vector breeding. Consequently, the effect on vectors resulting from these development projects should be considered as part of the benefits accruing from the projects in these other sectors.

When considering the economic implications of integrating vector control into primary health care, it is necessary to determine which vector control services are needed (or are considered priorities) and to whom as well as by whom they will be provided. Four factors are involved: (1) available resources at all levels should be assessed as well as the competition for these resources from other sectors; (2) the cost of vector control will depend upon population densities and the terrain; (3) the efficiency of different control measures vary and are not always predictable; and (4) to be effective, a control measure should appreciably reduce disease load.

Governments must define their responsibilities in providing the financial, technical, and administrative support as well as improve the use of available funds. As district health systems based on primary health care evolve, the potential for generating additional financial support at the community level will require careful study (11). Vector and pest control operations have been supported at the individual level throughout the world. The challenge is to harness this support and make it more effective for the community as a whole.

2.1.5 The role of international, regional, and nongovernmental agencies in the support of control

Many agencies are involved in the support, promotion, and implementation of vector control activities throughout the world. Such support may include direct participation in the funding of vector control activities and in the provision of commodities, supplies, and advisors, as well as assistance in the training of national staff at all levels.

Although donor agencies are often reluctant to propose a given health delivery system to the recipient country, more and more donors are setting guidelines to ensure that health interventions are carried out through primary health care. In the case of vector control, it is believed that donor agencies have an obligation to consider the manner in which the country receiving the assistance proposes to organize and implement its vector control activities. Recipient countries should be encouraged to develop their vector control activities within the context of community participation, intersectoral collaboration, and using appropriate technology.

2.2 Community action in the delivery of vector control

Community participation in vector control is not simply cooperation between the community residents and vector control agencies, it entails the formation of an active partnership between community members and health workers to solve local problems related to vector-borne diseases. Community members are encouraged to discuss the problems or issues involved. They are helped to recognize their own knowledge and skills and to apply these both when assessing the local health situation and when determining the priority needs of the community. If necessary, they should be helped to acquire additional skills. With this knowledge, they may contribute actively to the prevention of disease and the promotion of health by (a) participating in the planning, implementation, and evaluation of vector control; (b) supporting these activities with labour, time, money, and materials; and (c) accepting and making use of the services provided. However, to ensure that community participation will be sustained, the real costs involved must be assessed, including the time spent by community members in these activities as well as the benefits obtained.

There are three kinds of community action: (a) action involving members of the community on a long-term basis to ensure their own

individual protection or to manage the domestic and peridomestic environment, e.g., cleaning drainage channels of vegetation; (b) mass activity involving groups of workers for a limited time, e.g., treating containers with temephos sand granules or removing containers to control *A. aegypti* breeding; and (c) paid or voluntary health care workers assigned specific vector control activities such as health education.

2.2.1 *The benefits of community participation*

The community and the government may derive many benefits from community involvement in vector control in addition to the control of disease vectors and pests.

Community participation makes people more aware of the causes of their ill health and general underdevelopment and of how they can overcome these problems.

Community participation also fosters a sense of responsibility. When individuals are involved in the planning and implementation of a project, they regard it as their own and are more likely to support it and see that it is properly managed.

With community participation, services can be extended to underserved areas and expanded in areas with existing minimal services. People naturally practice self-care activities, and with primary health care their skills for solving local problems can be enhanced.

Economic benefits also result. Although individual services may not be cheaper, the integrated nature of primary health care reduces duplication in personnel, spending, and other resources. In addition, community participation uses valuable indigenous expertise and resources. Vertical programmes often tend to “import” expertise and resources into the project area even though the necessary skills and knowledge may exist locally. When local expertise is used in a vector control programme, it can promote a rapport with the local community and even encourage the establishment of local cottage industries. Similarly, the use of local materials or equipment will foster self-reliance.

By focusing on the priorities perceived by the community, community participation ensures that the solutions developed and actions taken will be adapted to local needs and will be culturally acceptable. Participation by the community signifies a commitment

to action that will help propel the programme towards more certain success.

Vector control operations are very labour intensive. Community workers with some specialized training in vector control are capable of carrying out many vector control activities, but professional supervision may be required.

2.2.2 Conditions that foster or limit community participation

Although community participation can occur spontaneously around a topical or current issue, community organization is usually a carefully planned process. Organization for participation can only occur when certain conditions are present. When they are absent, the health worker will have to help develop them. The conditions for community participation can be grouped under several headings. First are considerations of the basic structure and organization of the community including:

- presence of dynamic leadership and functional community organizations and groups;
- a history of positive experiences in self-help projects;
- a general orientation towards action rather than passive acceptance;
- a strong sense of community identity;
- opportunities for all groups in the community to express their needs.

Other variables that may influence participation are community perceptions and attitudes, such as:

- knowledge of the influence of the vectors on their health, perception of the efficacy of proposed actions (weighing benefits and risks), and understanding of purposes and functions—the preventive value of vector control is often not immediately obvious, so people must either understand this concept or regard pest reduction as a criterion of the effectiveness of control;
- relationship between proposed actions and local values and the ability of these values to encourage sustained action;
- availability of simple tools and methods that community members or health workers can easily apply and of local resources (financial, material) to carry out the proposed activities;
- relationship of proposed actions to perceived needs and priorities;

- compatibility and convenience of proposed actions with the daily life pattern of the community members—in integrated control based on environmental management, the burden of each individual is often inversely proportional to the population density;
- efficacy of the methods not only in terms of reducing disease load but also visible reward of proposed actions.

The approach of the health workers is a key factor in fostering community participation; for example they should:

- show understanding and respect for local culture and ability to communicate in culturally relevant terms;
- reduce the social distance between themselves and the people served;
- provide feedback to the community on all aspects of programming to maintain trust and interest.

2.2.3 *Vector control using existing programmes and in emergency situations*

When vector control programmes cross national borders and in emergencies greater support or even more direct intervention is required from national, regional, and international agencies.

A number of countries have continued to maintain single-disease, vertical control programmes. Even where integration has occurred, some parts of vertical programmes have been preserved, such as in some malaria and *Aedes aegypti* control programmes. Such structures exist primarily where the disease constitutes a major health problem over an extended area, where the vertical programme has been successful, or in malaria programmes that are still in the attack phase. For economic reasons it is probable that many of these control activities will eventually become part of primary health care.

The Onchocerciasis Control Programme in West Africa uses the aerial application of larvicides directed against *Simulium damnosum* breeding-sites as a basic vector control approach. This programme functions more or less independently of the health care systems of the eleven participating countries and it uses highly sophisticated methods. As centralized control activities in some of the participating countries are discontinued, local governments may become more involved in these activities. Although the vector control approach in the Onchocerciasis Control Programme does

not fit well in primary health care, the process of devolution offers a good opportunity to encourage countries to develop their own health strategies and to apply them effectively through primary health care. The recent development of an effective drug treatment for onchocerciasis also increases the potential contribution of primary health care.

Emergency control of some vectors and vector-borne diseases, such as certain arboviral diseases, malaria, and leishmaniasis, may require action at the central or regional level to ensure that emergency supplies of pesticides and equipment are available and to mobilize them rapidly. Monitoring of epidemics and vector-borne disease surveillance may also be important functions of national core groups. Such information may be used to forecast outbreaks of vector-borne diseases and to implement preventive measures.

Other emergency conditions that might require more centralized involvement are large-scale human migrations, rapid rural and urban development, and the consequences of development projects that may have resulted in the creation of habitats favourable to increased vector propagation, or the introduction of new pathogens or vectors into the environment. Resource development projects with a resettlement component may disrupt communities and routine vector control may have to revert back to being the responsibility of a centralized authority until the concept of community involvement can be developed.

The role of vector surveillance at the ports of entry into a country is usually assigned to a specialized central government group and does not involve primary health care. However, it is important that areas adjacent to air and sea ports achieve good vector and rodent control through community cooperation. These activities are usually supported by appropriate legislation.

2.3 Intersectoral collaboration

Intersectoral collaboration is a key principle of primary health care and has been an important feature of many vector control programmes. To what degree its presence in the primary health care approach will change the planning, management, and operation of vector control needs to be explored. Primary health care requires flexibility in problem-solving that can only be obtained by involving many disciplines and agencies in the process.

Intersectoral collaboration in vector-borne disease control covers all relations and interactions between public health and other sectors of national development, both urban and rural. Consequently, those included are the health services and community members involved in health activities as well as a range of public and private bodies, such as ministries, local authorities, nongovernmental organizations, cooperatives and state farms, development agencies, and industries. It is well known that the activities of other sectors can contribute to the breeding and spread of vectors or can help limit and control vectors in both rural and urban areas. Examples are the use of irrigation to improve crop output, clearing forests for new agriculture, new landscapes resulting from hydraulic engineering works, and industrial development in urban areas. Collaboration will reduce the risk of the former and maximize the effectiveness of the latter.

Improved intersectoral collaboration requires that vector control be better integrated in the developmental plans of other sectors. Health development must not compete with the social and economic goals associated with rural, industrial, and urban development; it must evolve as an essential requirement. Although a health component is included at the planning stage of nearly every important development project, this component generally receives little attention when the project is implemented. Some disease prevention measures such as lining canals and providing drainage systems are also good engineering practices (4). The general weakness of the health sector and the low priority given to its programmes has impeded the formation of the relationships required for effective joint planning. Nevertheless, the prominence given to intersectoral collaboration as part of the primary health care approach needs to be exploited in vector control to the maximum. For example, the control of *A. aegypti* in urban areas is made easier by the construction of water supply systems and dependable refuse disposal facilities.

One starting point for intersectoral collaboration is the exchange of information between sectors to determine priorities. Since vector propagation is linked with planned activities such as road building, the opening up of new agricultural areas, and urban development, it is possible to evolve an information system that graphically depicts and forecasts important developments. High level intersectoral meetings (such as "Malaria Board" meetings) are useful in establishing the principle of intersectoral cooperation and the broad

lines along which it should proceed and be maintained. Improved analyses and portrayal of such problems should help in establishing a dialogue with other sectors.

The decentralizing thrust of primary health care, with its focus on integrated action at the district level, should speed up the implementation of plans of action (5). It will be necessary to identify priority areas for collaborative action since resources are too limited to engage in vector control on all fronts. As part of its responsibilities the core group will be required to facilitate information exchange and priority setting. Attention will need to be given to establishing permanent or semi-permanent committees that bring together staff from the sectors involved, such as agricultural extension services in rural areas and civic organizations in urban areas.

Examples do exist of effective intersectoral collaboration for vector control. In India biological and environmental control of malaria is being successfully carried out in a collaborative project involving the Malaria Research Centre, National Malaria Eradication Programme, State Health Department, and Departments of Environment, Forestry, Fishery, Non-conventional Energy Sources, Irrigation, and Rural Development; each agency shares in the financing of the measures implemented. As a result, the cost of malaria control is much reduced, and is in harmony with other development projects.

In the planning of vector control educational activities, intersectoral collaboration is an important aspect. There can be valuable collaboration with the educational system, with vector control becoming an integral part of the teaching of science, biology, geography, etc. Various nongovernmental organizations are open to the promotion of community development ideas and will use available and appropriate promotional materials. Those responsible for local radio, television, and the press will also respond positively if they can be actively involved in developing the necessary materials.

3. COMMUNICATION AND EPIDEMIOLOGY

3.1 Information flow and feedback in the planning and management of vector control activities

The successful implementation of vector control activities in primary health care depends on information flow, with an effective feedback to the community. Information is only useful for the planning and management of vector control if it is timely and readily available to decision-makers. As a rule, the simpler the information gathered the greater the flexibility possible within the administrative structure and the more rapid the information flow.

The idea that a community can collect its own primary health care information is developing rapidly. Some communities with well-designed social/administrative structures are able to provide a flow of information to higher levels of the health system concerning the health problems of the community.

The essential link in information flow to and from the community is the district health management team. This team should coordinate community-based activities with other groups. They will channel essential information to and from the core group in the central government and as statistical information and analysis improve, the possibility of developing models in health planning and decision-making should become more realistic.

Regular feedback to communities is extremely important. Feedback to the community residents and health workers needs to be informal and ideally through personal contact. The supervisor at the district level must show the community health care worker how his results are used by decision-makers and, at the same time, help him and the community make their own decisions.

The microcomputer may soon become an integral part of the communication process in ministries of health in the developing world. The use of simple flow charts or branch-bound algorithms, designed as simple decision-trees, will help to organize thought processes and improve the flow of information and subsequent decision-making. These algorithms can assign technical actions to different administrative levels and provide the community health worker with clear guidelines on how to act or how to seek assistance from a higher level.

3.2 Epidemiological support

The availability of epidemiological information is essential for the planning and evaluation of disease vector control programmes. The nature and amount of information required will depend on the objectives of the control programme as well as on the level of development of the basic health services and the primary health care system. The minimum information the community health worker will need will be the population characteristics of the area he serves.

3.2.1 *Epidemiology in the planning of disease vector control*

Epidemiological data on the incidence and prevalence of vector-borne diseases in the population served by the community health worker can be collected in a variety of ways. Review of local medical clinic and health post records may provide useful information on the incidence of the more severe cases of disease. Community surveys and active case-detection will help to define the frequency and severity of disease as well as provide data on the knowledge, attitudes, and behaviour of the residents concerning those diseases. Finally, passive case-detection is appropriate for use in primary health care and posts can be set up in clinics and health centres staffed by nurses and physicians or in private homes to provide continuous information on the occurrence of disease within the community.

To allow for comparisons to be made at different health service levels, the collection of epidemiological information should be standardized. Within the primary health care structure much epidemiological data can be collected by community health workers. Past experience with primary health care in Africa and malaria control programmes in Central America has shown that illiterate community health workers can function well in this activity. Such workers can collect data using patient report forms with simple stick-figure drawings representing the age, sex, residential status, and symptoms of the patient.

The preliminary study of epidemiological information in primary health care can and should take place at the community level. The community health worker should be made responsible for summarizing the data he/she collects. This data will be most readily understood by workers with a limited education if it is presented in the form of a simple table or graph showing the number of cases of disease reported per month. More detailed data analysis and planning for specific interventions will have to be carried out at the

district or regional level where health management teams can select the most appropriate control measures.

3.2.2 Epidemiological indicators for the evaluation of disease vector control activities

To monitor changes in the level of disease transmission, epidemiological indicators should be chosen that are closely associated with the transmission of that disease. Clinical symptoms can be used as epidemiological indicators in the case of acute disease. In contrast, clinical symptoms are of little value in following changes in disease incidence or prevalence for chronic conditions, such as Chagas' disease, onchocerciasis, and lymphatic filariasis, since characteristic symptoms usually only appear late in the course of infection. In these cases, laboratory examinations may be necessary.

For the community health worker, clinical symptoms are probably the most useful indicators of disease. Although many surveillance systems rely on the presence of a single symptom to identify a particular disease, the use of a combination of symptoms may increase the sensitivity and specificity of diagnosis. More specific epidemiological indicators, such as a symptom complex, are more suitable for use by physicians or nurses.

A disease surveillance system must be sufficiently flexible to meet the changing needs and objectives of disease vector control. In a region with only limited health facilities, the most useful indicator of the incidence or prevalence of a severe disease may be the number of deaths caused by that disease. After a vector control activity has been initiated and the mortality rate decreases, the surveillance system can begin to concentrate on morbidity and base the diagnosis of individual cases of the disease on its clinical features. If the control activity is successful and the number of cases continues to decline, the diagnosis of individual patients should probably be based on laboratory examination so as to reduce the risk of over- or under-diagnosis, assuming such facilities are available.

At the time a surveillance network for vector-borne diseases is established, provision should be made for the periodic evaluation of the sensitivity and specificity of the epidemiological data that is being collected. A periodic evaluation of the surveillance network will enable health planners to avoid having to make decisions on the basis of incomplete or faulty information, and it will also provide the impetus to improve and refine the surveillance system.

4. SUITABILITY OF VARIOUS VECTOR CONTROL MEASURES FOR PRIMARY HEALTH CARE

The selection of vector control techniques for use at the community level will depend on the priorities of the community, its manpower and financial resources, the bionomics of the vectors, as well as on the availability, effectiveness, safety, simplicity of use, cost, and social acceptability of the tools and control measures used. Such techniques also require the availability of a core group of vector control specialists and a district health management team to promote and popularize these measures.

As stated earlier, disease vector control should not be considered in isolation but should form part of a clearly planned scheme for the overall development of the community. In fact, as a community advances economically, its desires, demands, and tolerance towards vectors may change significantly.

Vector control methods for use in primary health care should meet the following criteria laid down in the seventh report of the WHO Expert Committee on Vector Biology and Control (6):

- (1) The equipment, materials, and agents needed for initiating and sustaining the vector control programme can readily be made available.
- (2) The skills involved in maintaining the vector control programme can be easily acquired.
- (3) The expenditure involved in the use of the particular method is within the means of the community.
- (4) The proposed approach benefits other local enterprises.
- (5) The vector control measure is without risk to the environment.
- (6) There are no unacceptable toxicity or other health hazards associated with the proposed measure.
- (7) The proposed method is compatible with local practices and attitudes.
- (8) The proposed technique is well tested and has proved efficient, so that minimum evaluation is needed.

4.1 Basic control measures

In this section vector control methods that are suitable for primary health care use will be discussed. In some cases, considerable evidence exists concerning the efficacy and feasibility of a

particular method at the community level. In other cases, only limited information is available.

4.1.1 *Bed-nets*

Bed-nets have been used in tropical Africa, America, and Asia for many years and when used correctly, they are an effective means of protection against mosquitos. Recently a simple method of treating bed-nets with pyrethroids has been described; this can be carried out by the inhabitants with only limited supervision. These treated bed-nets remain effective for 6–12 months and the cost of treatment per net is as low as US\$0.50.¹ One advantage of this method is that protection against mosquitos continues even if the bed-nets are damaged or are not used over the bed, since their presence in the sleeping area alone seems to reduce man–vector contact. When they are used on a community-wide basis, vector populations may be dramatically reduced.

4.1.2 *Repellents*

Repellents, such as diethyltoluamide (DEET), dimethyl phthalate, and ethyl hexanediol, are relatively inexpensive; their use is an effective way of reducing contact with biting insects, but may not reduce disease transmission. Various types of clothes treated with DEET have been tested for effectiveness against *Simulium damnosum* in Cameroon and have been shown to provide protection against biting midges and blackflies. Elsewhere, DEET-treated headbands and anklets are being tested to see if their use reduces the number of mosquito bites. This approach is most suitable for high-risk groups, such as fishermen and rubber-tappers. Soap containing permethrin and DEET is currently being evaluated for its repellent effect against biting insects, and soap containing permethrin alone is being evaluated for its insecticidal properties.

4.1.3 *Mosquito coils, fumigation mats, and hand aerosols*

Mosquito coils are extensively used in the Western Pacific area, and in South-East Asia, Central and South America, and Africa. They usually contain a pyrethroid insecticide and the repellent

¹ SCHRECK, C.E. & SELF, L.S. *Treating mosquito nets for better protection from bites and mosquito-borne diseases* (Unpublished WHO document WHO/VBC/85.914).

vapour they produce drives mosquitos away. Fumigation mats, that require electricity are gradually replacing mosquito coils in urban areas. Insecticide impregnated paints and the use of a fumigation canister against the triatomid vectors of Chagas' disease are being evaluated for use at the community level. Hand aerosols are extensively used worldwide. Most of these contain one or more pyrethroids, usually synergized with piperonyl butoxide.

4.1.4 *Aedes aegypti* control in the domestic environment

In most areas, the distribution and breeding habitats of *A. aegypti*, the principal vector of urban dengue, dengue haemorrhagic fever, and urban yellow fever are such that mosquito control can be carried out by community members; measures include cleaning containers, filling tree holes with sand or cement, regularly changing water in receptacles, destroying discarded containers, stocking large water tanks with larvivorous fish, fitting tight covers to water receptacles, and using temephos as a larvicide. Legislation can greatly improve compliance and performance (7).

4.1.5 *Tsetse fly* control using traps and screens

Tsetse fly traps originally designed for sampling purposes, have been successfully used in Côte d'Ivoire and the Congo as a means of reducing tsetse fly populations. The traps and screens available are more effective against riverine than savannah species. In the Congo, traps are provided by the Ministry of Health and villagers are responsible for their maintenance; traps have officially replaced drug prophylaxis as the control method for sleeping sickness. The use of these traps is readily accepted by the inhabitants because they can see the results for themselves. Impregnation of the trap material with a pyrethroid such as deltamethrin further improves their efficacy. The traps can also be impregnated with odours to make them more efficient.

4.1.6 *Control of guinea worm* through community participation

Community control efforts can be directed towards avoiding contamination of water, changing the design of the wells from stepwells to draw-wells, and the use of appropriate filters for drinking-water. These techniques are being used successfully in India and Nigeria.

4.1.7 *Income-linked approach for the control of malaria vectors*

Vector control linked to social and economic development has been used successfully for source reduction and modification in several areas. In India, lagoon areas have been converted to prawn culture. In China, vector control agencies have taken advantage of the practice of raising fish in rice fields as a means of reducing larval populations of mosquitos. The integrated control of malaria vectors through source reduction, minor engineering works, biological control, and environmental improvement such as community tree farming, has also been shown to be successful against *Anopheles culicifacies* in Gujarat, India. Health education has played an important role in this effort. Income from fish culture and forests has also provided an incentive to assure continued participation by villagers.

4.2 Appropriate pesticides and pesticide application equipment

In recent years, pesticides and pesticide formulations have been developed that are less hazardous to man and the environment and are therefore more appropriate for routine use in the context of primary health care. Pesticides for use in a community vector control programme should be selected based on their efficacy, safety, cost, availability, and acceptability to the population. Extensive information on this subject has been published in "*Chemical methods for the control of arthropod vectors and pests of public health importance*" (8).

For routine use in primary health care, portable hand-operated pesticide application equipment is the most appropriate. Such sprayers have already been used by community health workers to control the vectors of malaria and Chagas' disease. In agricultural communities, equipment already in use for agricultural purposes may be employed directly or modified for use in disease control.

4.3 Safe handling and storage of pesticides at the peripheral level

Since all pesticides are toxic to some extent to man and non-target animals, every precaution should be taken to ensure their safe use. This is even more critical in a community-based vector control programme where the individuals responsible for the handling of insecticides may be volunteers with limited training and experience. Moreover, at the community level supervision, protective clothing,

washing facilities, and treatment for poisoning may also be inadequate. The insecticides chosen for use in primary health care must therefore be of low toxicity to human beings, and to domestic animals, livestock, and other non-target organisms. As stated in the seventh report of the WHO Expert Committee on Vector Biology and Control, an insecticide used in primary health care “must not only be safe, but must be seen to be safe, and should ideally offer little possibility for generating rumours about its lack of safety.” (6).

A responsible, literate member of the community should be put in charge of spraying operations and be provided with training appropriate to his/her responsibilities. The same person should supervise all vector control activities involving pesticides in the area, whether it be a village, rural district, or sector of a large town.

All pesticides should be stored under lock and key. In general, weighing and bagging of chemical pesticides should not be carried out at the community level. Pesticide wrappers, unused mixes, and washings should be disposed of as described in a previous WHO publication (9; section 5.4). The reuse of pesticide containers for any other purpose should be discouraged, but, if reuse is a common practice, those responsible for pesticide use should ensure that containers are properly decontaminated or destroyed. A previous WHO publication provides information on the surveillance and treatment of insecticide poisoning (9; Annex 3).

4.4 Biological control agents for community use

The biological control agents available attack only the immature stages of vectors. For that reason they are most suitable for use in vector breeding habitats that are closely associated with human habitations. The biocontrol agents are, in general, safer for non-target aquatic fauna and higher organisms than chemicals and this makes them particularly suitable for community use with minimal or no supervision.

Although the effectiveness of biological control agents has been tested in the laboratory and the field against a variety of vector species, the operational use of this control method has been limited to the use of larvivorous fish against mosquito larvae and *Bacillus thuringiensis* serotype H-14 for *Simulium* control. In China, carp are bred in rice fields for food and they also provide good control of mosquito larvae. Grass carp eat some of the weeds in irrigation channels and in this way help to reduce mosquito populations.

Oreochromis spilurus spilurus has been successfully used in water reservoirs in Northern Somalia against *Anopheles* larvae and this has resulted in the suppression of malaria transmission.

Bacillus thuringiensis H-14 is being used successfully in mosquito abatement programmes in North America and Europe. There are as yet a number of improvements to be made in the use of both this agent and *Bacillus sphaericus*; however, this should not deter attempts to use them on a limited scale to increase the action of natural or introduced predators.

4.5 Environmental management for vector control by the community

The principles of environmental management for vector control were defined in the fourth report of the WHO Expert Committee on Vector Biology and Control (10). Environmental management measures are aimed at eliminating habitats for vector breeding or resting, thereby reducing vector density and disease transmission. Since this approach is safe and can be carried out using simple and readily available tools, it is within the economic reach of rural and marginal urban communities. The compatibility of this measure with agricultural practices makes it a suitable component of integrated rural development projects.

The *Manual on environmental management for mosquito control* (4) describes a wide range of measures. The following are particularly suitable for implementation at the primary health care level.

Environmental modification methods, such as filling, land-levelling, drainage, shading, and village siting, can at times be carried out by the community. Drainage structures such as soakaways, seepage pits, and soakage trenches can be constructed by the community. The drying of marshy land by afforestation has been successfully used as a method of source reduction; this practice has the added economic advantage of providing trees for use as timber or wood fuel. Tree planting along the side of a water body may be effective in reducing anopheline breeding by shading, as was shown in Malaysia in the 1940s for the control of *Anopheles maculatus*. The maintenance of irrigation and drainage canals and the removal of aquatic weeds along the edges of bodies of water require repeated efforts that may be difficult to sustain at the community level. On the other hand, some methods of environmental manipulation can be

introduced as part of overall agricultural practices, including intermittent irrigation, improvements in irrigation water management, crop rotation, and the selection of rice varieties with reduced water requirements. Such measures are obviously intended to increase crop yields, but vector control efforts may also benefit.

Community actions such as discarding unwanted water containers and putting screens over domestic water containers are essential for the control of *Aedes aegypti* populations. The selective clearing of trees in the vicinity of houses, removal of firewood and domestic animals from the home, and better construction of houses are measures that reduce triatomid populations. Siting domestic animals as a first-line buffer between human dwellings and mosquito breeding-sites can be effective in reducing vector-borne disease transmission by zoophilic mosquitos.

Innovative approaches in mosquito control include the use of expanded polystyrene beads in latrines to prevent oviposition and kill larvae, particularly *Culex* spp.; the use of monolayers to reduce the surface tension and make it difficult for larvae to remain on the surface; and the use of the aquatic fern *Azolla* which covers the water surface in irrigated rice fields and may prevent oviposition or larval growth.

4.6 Measures for enhancing vector control

Vector control measures for primary health care should be simple, easily understood, and effective when carried out. While there is a need for central coordination, each community's activities should be self-sustaining and independent of those in other communities. If a breakdown of activities occurs in one community, others should not be affected. However, where success is achieved, the information should be shared. Community awareness takes time to develop in widely dispersed rural areas and in new or rapidly developing urban areas. Health education and legislation may help as "top down" approach and a drive for personal and family protection through health education may enhance vector control.

4.6.1 Health education

The aim of health education is to help people solve their own problems. This approach differs markedly from many health activities that attempt to choose solutions for people. Assuming that

a community wishes to pursue vector control as part of its primary health care activities, one must consider what are the basic health education tasks that a primary health care centre or a community health worker can undertake. The first task, in collaboration with local leaders, is the organization of vector control activities in the community. Then the community health worker will be able to:

- mobilize support for self-help projects (such as providing a water supply);
- advise community members on how to find the most appropriate individual protection measures (such as screens, mosquito coils, bed-nets);
- organize short-term projects, e.g., sanitation campaigns, or suggest simple forms of sanitation such as proper disposal of refuse and construction of pit latrines;
- provide basic vector control information, making use of the local language, concepts, and methods (proverbs, stories);
- utilize modern educational media such as films and posters where these are available and culturally relevant;
- deliver practical educational programmes at local schools;
- sensitize community groups such as boy/girl scouts, parent-teacher associations, and trade unions to their health roles.

The importance of cultural relevance is exemplified in Singapore where posters concerning *Aedes aegypti* and *A. albopictus* were better received by the community, especially by mothers, when they depicted a child at risk rather than when they focused mainly on mosquitos (7).

Local health education activities can be reinforced at district, regional, and national levels by the development of appropriate educational materials, mass media programmes, and training opportunities.

4.6.2 Legislation

Legislation can serve as an important tool to support, promote, and sustain vector control activities at the community level particularly in urban areas. Laws should satisfy vector control requirements and, at the same time be compatible with the political, cultural, social, and economic situation of the country. This is essential because laws may antagonize the population and make the

community uncooperative, i.e., lead to refusal of entry into premises for vector control measures or the refusal to carry out preventive measures. Appropriate legislation can facilitate health education and, at the same time, motivate community participation by those residents who are reluctant or unwilling to comply with recommended control measures.

5. HUMAN RESOURCE NEEDS AND DEVELOPMENT

It is natural that human resources be mobilized to solve vector/disease problems. These resources include both the community residents and technical personnel within the health system infrastructure. It is the community members who are the most immediately affected by vector-borne diseases or arthropod and rodent pests and their active involvement in developing and implementing plans to solve these problems is the essential ingredient for the long-term success of control measures. Technical staff must be trained to apply the most up-to-date, culturally appropriate, and economically feasible strategies in vector control. They also require leadership skills that will enable them to understand and to mobilize the communities they serve.

5.1 Behaviour, motivation, incentives, and leadership in the promotion of vector control activities

There are several potential levels of intervention in control efforts for vector-borne diseases—the host, the vector, and the environment. In this section the influences of individual and collective human behaviour on vector control are discussed, together with the factors that may motivate human behaviour, and the roles that local leaders can play in encouraging positive behaviour. The focus is on the community as well as on the behaviour of health workers and the design of health services. These interrelated issues form the basis for planning health education and training programmes.

5.1.1 Human behaviour

An understanding of people's behaviour and the factors that influence it are essential when selecting appropriate vector control measures and appropriate health education strategies. Human

behaviour in relation to vector control can be considered in several ways: behaviour that affects vector breeding; behaviour that may encourage or prevent man–vector contact; and new types of behaviour related to the adoption and use of measures designed to control vectors.

The broad categories of factors that may influence individual and community health behaviour include: knowledge, beliefs, values, attitudes, skills, finance, materials, time, and the influence of family members, friends, coworkers, opinion leaders, and even health workers themselves. Serious consideration must also be given to the community or social context in which a given type of behaviour occurs. Pervasive issues such as norms, male/female roles, ethnic discrimination, poverty, unemployment, and educational opportunities may limit the ability of some of the major sections of the community to behave in a healthy manner.

Behaviour change for vector control often involves changing familiar habits or methods, for example, using latrines, replacing thatch roofs with metal ones, or using a piped water delivery system. An understanding of the local cultural, economic, and social characteristics, together with consultation with the community should make it possible to select and design measures that are easy to understand, use, and maintain, that are beneficial, inexpensive to implement and maintain, that conform with existing customs and practices, and that take no more time than the current alternatives.

The promotion of new vector control methods can have unexpected consequences. In some communities, the residents have been so impressed with the effect of insecticides that they have found other uses for them. One example of abuse is fishing through poisoning. Careful monitoring of new vector control measures is needed to identify the potential for abuse and to prevent it from occurring. Ideally, alternative methods should be available so that, for example, each individual and family can choose between bed-nets, insecticides, impregnated curtains, mosquito coils, and sprays, according to their own needs and interests.

Both qualitative and quantitative methods can be used for collecting information on human behaviour and community needs, but the former may be more efficient and appropriate for use at the community level. Examples of such qualitative methods include participant observation, in-depth interviewing, case studies, and information gathering from key informants. These methods foster

community participation in data gathering and greater understanding by the community of its own problems.

5.1.2 *Motivation*

Motivation is the desire to act in order to meet personal needs. If a person understands the role played by vectors in disease transmission and perceives that a certain course of action will help to meet a personal need, he or she may wish (i.e., be motivated) to take that action assuming that no major barriers or conflicting demands prevent him from doing so. Examples of such potential barriers are the competition among community and individual needs, differing perceptions of priorities between community members and health workers, low self-image of the community in its ability to solve problems, and the difficulty of sustaining interest in long-term programmes.

Although it is natural for individuals and communities to be motivated to protect themselves in life-threatening situations, perceptions about the dangers posed by vectors may be low, giving low credibility to motivational messages. Vector control must also compete with such basic needs as adequate food supply, shelter, and employment in vulnerable communities. To be successful, vector control must be a sustained activity, requiring motivation of, and action by, the whole community in partnership with programme planners. Achieving this level of motivation may prove to be particularly difficult when vector populations and disease prevalence begin to decline, for example it may be difficult to ensure the continued use of bed-nets in malarious areas when there is a low density of highly effective vectors.

The solution to these problems has three aspects. The first is the development of control methods that can be easily adopted. If truly appropriate, the methods will be perceived not only as culturally acceptable, but also as a desirable way to fulfil an existing motivation. Second, health workers must develop an in depth understanding of local culture and behaviour. This will foster constructive dialogue with the community so that common ground can be found between professionals and communities in their perceived priorities. Third, health staff must be willing to devote time and effort to intensive community organization in order to mobilize collective motivations and increase local problem-solving capabilities. An example is mapping to show suitable places for

tsetse fly traps in each village and provide training for trap maintenance.

Vector control staff and other health workers should be guided by professional ethics that emphasize respect for the communities they serve. The attitude and behaviour of health workers themselves can contribute to or jeopardize the success of a vector control programme. Their attitude may encourage participation or provoke resistance by inconveniencing people in their homes or even damaging property. Their own motivation to do their job conscientiously and correctly may relate to their training/knowledge, scheme of service, pay-scale, and opportunities to show initiative and participate in planning. These issues must be addressed through staff meetings and individual sessions so that the health worker will develop a positive relationship with the community. Not just the individual staff members but the local health team must collectively consider how the way it provides services affects the attitude and behaviour of the people it wishes to help.¹

5.1.3 *Incentives for action*

Incentives are among the factors that stimulate motivation and encourage specific behaviours. Incentives can be either intrinsic or extrinsic, material or psychological, self-determined or selected by others. An intrinsic incentive is the benefit that comes from solving one's own problems. Extrinsic incentives are rewards that do not relate directly to the goal toward which the desired behaviour is aimed, for example, giving more food to people who participate in environmental management activities in their neighbourhood. Material incentives are tangible goods or services; psychological incentives include the satisfaction, self-esteem, or enhanced capabilities gained through a proposed course of action.

Problems may arise because the provision of incentives must be continued over a long period if vector control activities are to be sustained. Financial and/or organizational support to sustain the incentive must be provided initially and continued at a level that guarantees equitable access to all members of a community.

¹ *Community participation in tropical disease control: social and economic research issues*. Report of the Scientific Working Group on Social and Economic Research, UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, 1983 (Unpublished WHO document TDR/SER-SWG(4)/CP/83.3).

Incentives must not be disproportional to the emotional and material needs of the community member. Irrational choices and false dependencies may disrupt the programme and its goals. In order to plan appropriate incentives in vector control, the community must be involved in identifying the intrinsic benefits of specific control actions that will motivate broad-based community acceptance.

5.1.4 *Leadership in vector control*

Leadership in vector control requires basic knowledge of the biology, ecology, and control of the vectors concerned, of harnessing existing motivations, and of encouraging healthy behaviour. Leadership should come from both the health professionals and the community. The leader of a local health team must be dedicated to primary health care concepts and must set a good example. He or she must recognize the value of collaboration and be able to encourage other team members to take the initiative and contribute their own special skills to any endeavour (11).

The leadership approach adopted by the health professional toward the community should take the form of encouragement and organizational assistance. The community should be seen as an equal partner and encouraged to accept as much responsibility for control activities as its members are willing and able to perform. The transfer of leadership to community members is a slow process that requires much cultural sensitivity and patience on the part of the local health team.

Leadership at the supervisory level will demand the provision of constructive feedback and counselling to the local health professional that may be used to solve motivational problems. Accessibility should be a key attribute of the supervisor, since constant monitoring and encouragement are ways to prevent technical mistakes and motivational lapses.

Many communities leave leadership in vector control entirely to the professionals. This does not mean that the community lacks health leadership. In fact, for primary health care to succeed, existing and potential leadership must be enhanced. Local health leadership may come from many sources, such as traditional healers and birth attendants, respected elders, and religious leaders as well as from the officers of the local community improvement society or cooperative.

Primary health care leadership roles can be formalized through the training of local volunteers (community health workers).

Leadership development in vector control requires that the health professional identify and collaborate with local leaders. The community health worker is an important link in this process. Local leaders, both formal and informal, should take part in the planning process so that their knowledge of the local culture and their experience in mobilizing community action can be used advantageously. Community level management systems for acquiring, monitoring, and distributing vector control supplies and equipment can grow from the development of local primary health care leadership.

5.2 The core concept in vector control

The seventh report of the WHO Expert Committee on Vector Biology and Control (6) suggested the establishment of technical core groups with responsibilities for the planning, implementation, and surveillance of vector control. These groups would provide technical support to primary health care services and would carry out activities requiring sophisticated knowledge and skills.

The core group should consist of individuals from more than one discipline although its make-up will depend upon the disease problems of the country and the resources available for their solution. As a minimum the core group should include an entomologist (vector control specialist), a sanitary engineer, an epidemiologist, a health educator, and an administrator. This nucleus could be strengthened by additional similar staff and/or by sanitarians, technicians, statisticians and, depending upon the problem, malariologists, arbovirologists, parasitologists, social scientists, economists, etc.

The core group at the central level should be strengthened by establishing similar groups at the regional, district, and other administrative levels. The managerial infrastructure should include job descriptions outlining objectives, qualifications, tasks, responsibilities, lines of authority, and remuneration. The objectives and targets of plans of action must be logical, feasible, and clearly defined. The leader of the core group should have managerial ability and should be given resources adequate to the responsibilities involved.

The core group should also establish links outside the ministry of health. When other sources of expertise, such as universities and research institutes, are available, the setting-up of advisory boards to the core group should be considered. This will facilitate the flow of research and development information into the infrastructure.

5.2.1 Orientation to the core concept

Particular attention must be given to the development of appropriate mechanisms for technical direction and support, as well as administrative control that will be integrated with health team functions at the district and other levels.

As core groups are formed, consideration should be given to in-service training of the staff as a unit. This would allow group members to learn the basic aspects of each other's disciplines and to recognize the needs and limitations of each. Moreover, a team concept could be developed thus increasing efficiency and avoiding the isolation of professionals.

The dynamic roles of the community and the community health worker require that some form of continuous education be built into the core system as well as an ability to adopt strategies to changing local needs and circumstances.

5.2.2 Qualifications for the core group entomologist

The core group entomologist should possess much of the knowledge and skills listed below or should know how to recruit other personnel who possess them.

- knowledge of basic and applied entomology, epidemiology, and ecology;
- knowledge of integrated vector control and its individual components;
- knowledge and ability to use reliable vector monitoring techniques, including statistical analysis methods;
- ability to assess equipment, material, and manpower requirements;
- ability to use and maintain various types of pesticide application equipment;
- ability to assess the environmental and health impact of control measures;

- knowledge of environmental management techniques and the ability to anticipate vector problems due to the mismanagement of the environment through land and water resource development and construction projects;
- knowledge and skills to determine the cost of operations and to monitor the cost-effectiveness of the various components of a control method;
- knowledge of the safe use of pesticides;
- knowledge of emergency vector control procedures;
- skill in basic communication methods that are necessary to carry out effective health education and to train vector control personnel;
- ability to collaborate with others at community and referral levels;
- knowledge of basic managerial tools needed to organize the control operation;
- knowledge of local health legislation and health administration structure.

5.2.3 *The core group as a support system*

The role of the core group as a support system in primary health care will depend upon the structure of the primary health care service and the priorities the community and the service place on vector control. It should be action-oriented having more than a mere advisory role. As a management team, the core group would be involved in defining the various control activities feasible in different situations, adapting these activities to the community and to the health infrastructure, training and mobilizing workers, designing and implementing appropriate technology for specific vector problems, and coordinating information gathering and decision-making. The core group would also be involved in the procurement of resources, development of referral mechanisms, and liaison with others involved. This group should encourage research in all aspects of vector biology and control, especially in the selection of technology that is appropriate to local situations.

5.2.4 *Organization of the core group*

Countries differ widely in the administrative structure of the ministries of health and in the range of functions assigned to the district and community health workers. The position of the core

group within the administrative structure should be such that it can function effectively. Decentralization does not diminish the need for national and regional core groups and may strengthen it by allowing a more comprehensive control approach against more than one vector.

The core group at the district level should be represented by a health inspector, a public health nurse, and a health educator. Relevant professionals from other sectors, such as agriculture and education, may be included as necessary.

5.3 Educational and training requirements

It is not possible to identify specific categories of personnel for vector control in primary health care for all countries and settings, but three broad groups can be outlined: specialist level, district level, and community level.

5.3.1 Specialist-level training

The specialist in the vector control core group will be responsible for the overall planning, implementation, and evaluation of activities at national or regional levels. In the past, training for this level was carried out at universities and academic institutions in the developed world; however, the students, on receiving their degrees, often lacked practical field experience relevant to vector population and ecology in their own countries. In order to provide training relevant to local situations as well as to address problems of shortage of funds, M.Sc. degree courses in entomology serving countries on a regional basis have now been initiated for specialist training at national institutions in Brazil, Côte d'Ivoire, India, Indonesia, Kenya, Nigeria, Panama, and Thailand, with the support of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, other divisions of WHO, and the WHO regional offices.

To ensure that these courses provide appropriate education and training it is important that: (a) the research project associated with each degree is directed towards solving practical problems and the testing of combinations of control methods with community involvement; (b) proper orientation is given to training activities in primary health care and management of vector control activities within this context; (c) the candidates are provided with up-to-date

information on integrated vector control methodology and ways and means of involving and educating the community in vector control activities; (d) practical field experiences are designed to emphasize intersectoral and interdisciplinary approaches to problem solving; (e) trainees are exposed to vector control activities at community, district, and national levels; and (f) trainees and teachers themselves have appropriate qualifications and adequate experience in medical entomology. Finally, training considerations should not be isolated from career structure considerations; in this way the knowledge and skills acquired can be effectively applied.

5.3.2 District-level training

A second level of training focuses on staff who work in vector control at the district level such as public health officers, sanitarians, and public health nurses. Appropriate vector control concepts and methods should be integrated into the curricula of basic courses for these staff and special, advanced in-service courses should be planned. On-the-job orientation to vector control can be undertaken with the district health management team to guarantee an interdisciplinary input into programme activities.

5.3.3 Training at the community level

Community health workers, teachers, and local leaders can benefit from training concerning their roles in vector control. This training should be integrated into wider primary health care training in order to be relevant to community needs. Potential trainees should be involved in the design of the training course to ensure that it is arranged at convenient times and places and deals with vector control issues in the context of the local situation. These workers will be in the best position to bridge gaps between the professional knowledge and goals of the core group and district health management team and community beliefs, experience, and needs. Health education of the community will be one of their major duties. Care must be taken not to overburden the community health workers, but a limited spectrum of feasible and appropriate tasks should be defined for them.

5.3.4 *Training modules and materials*

The curricula of most M.Sc. and Ph.D. courses in medical entomology and vector control would benefit greatly from the inclusion of practical experiences in integrating knowledge with real-life situations. Training modules in vector control based on local epidemiological situations, human ecology, and community participation need to be developed at all levels and in collaboration with other related disciplines within primary health care.

In the past, intermediate level courses have focused too heavily on the acquisition of technical knowledge and too lightly on the development of practical skills and the ability to be flexible regarding varying local situations. Technical institutions that train these personnel should be closely linked to practical, field programmes.

Training at the community level must be developed locally with input from the community and from a cross-section of health and development personnel who serve that community. Training should be conducted in the local language using traditional methods of teaching (proverbs, story telling, dramas) that can be directly used by the community health worker in carrying out his/her duties. Training should also help community workers develop leadership skills.

Informative and educational materials such as leaflets, posters, and slide/tape shows for the population at the periphery require greater attention and may prove less appropriate than traditional communication methods and practical demonstrations. Most residents of developing countries have a low level of literacy and little detailed knowledge of vector-borne diseases, of how they are transmitted, or on the biology of the vectors and their control, including personal protection and source reduction. To develop appropriate educational material for this population it is important to understand their beliefs about vectors, their attitudes towards illness in general, and their life-style. The materials developed should not be based only upon behavioural patterns, but also upon the knowledge of how different populations perceive visual material.

6. RESEARCH REQUIREMENTS FOR VECTOR CONTROL THROUGH PRIMARY HEALTH CARE

6.1 Research needs

The successful use of vector-borne disease control in primary health care requires research both for planning and operational application. This research includes the improvement and development of suitable tools and methods, their evaluation under local conditions, the facilitation of community motivation and participation under various social and economic conditions, the adoption of existing health systems, and the assessment of the cost-effectiveness of the various possible integrated vector control methods that may be employed.

Where a core professional group is not yet in a position to carry out those research tasks necessary for the preliminary planning of a programme, support may be requested from other government departments, research institutes, and universities through intersectoral cooperation. The opportunity for such cooperation is often welcomed, particularly by university departments that may be interested in carrying out practical research, such as studies on insecticide resistance, epidemiological surveys, and vector taxonomy. Further, such institutes and departments normally have facilities that the ministry of health does not. Even after the core group is formed, such cooperation should be maintained by encouraging these other agencies to undertake specific research in support of the vector-borne disease control activities.

6.1.1 *Stratification of vector-borne diseases at the district level*

The implementation of a decentralization vector control strategy based on an integrated approach with community involvement will require stratification of vector-borne diseases as well as the provision of a priority list for vector control at the district level. Such information should focus on more than one disease, since vector control operations can target several diseases, e.g., urban mosquito abatement will control the transmission of malaria, filariasis, and dengue haemorrhagic fever. A multidisciplinary team is usually required to gather data on vector bionomics, as well as epidemiological, social, and economic information. The selection of control measures and the evaluation of results, requires the development

of methodologies that take into account the integrated aspects of each operation as it relates to the local situation.

6.1.2 *Development of tools and methods for vector control*

The integrated approach does not discard existing tools and methods, but adapts them to local conditions and constraints when they are to be used by non-specialized workers or community members. Research is needed to determine better methods of adapting vector control technology for use at the community level. Many of the methods used in integrated control have been known for several years, but they have to be combined with new tools such as self-protection devices or biological control agents and adapted to local vector problems.

New, simple and efficient tools that can be made at the community level from local materials are urgently needed. Some of these tools have already been developed, such as tsetse fly traps, nylon water filters, and self-protection devices. Innovative thinking is required to find more such imaginative solutions.

Bearing in mind the requirements outlined above, the following avenues of research offer promise in the development of suitable tools and methods for community-based vector control. Evaluation of tools and methods should include an assessment of their cost-effectiveness and compatibility with economic development and cultural practices as well as an assessment of the capability of the community to carry out and finance the activity. Control tools and control methods should be tested in the laboratory and in the field on a scale such that their impact on both the disease and the vector can be evaluated. Field tests should include an assessment of acceptability by the population and an evaluation of the ability and willingness of community members to collaborate under various social and epidemiological conditions.

1. *Individual protection.* Research on methods of individual protection should include the following:

- optimum size of mesh of insecticide-impregnated bed-nets;
- impregnation of these bed-nets with a wider range of pyrethroids or of other new knock-down insecticides;
- use of insecticide-impregnated curtains and clothes;
- use of insecticidal and/or repellent soaps;

- appraisal of traditional and new repellents, self-protection devices, and other methods of vector control;
- improvement of mosquito coils, insecticide-impregnated paints, mats, and other fumigant methods;
- low-cost housing improvements, such as screening, building materials, or design.

2. *Siting and construction of villages and settlements.* There is already much evidence that the proper siting of a village and the type of construction used can influence disease transmission and further research on the following should be particularly productive:

- identification and avoidance of areas at high risk for the transmission of malaria, schistosomiasis, African trypanosomiasis, and onchocerciasis;
- improved house construction and design in areas where Chagas' disease is prevalent.

3. *Development of biological control agents.* Among the many priorities for research on biological control agents, the following are relevant:

- improvement of formulations of *Bacillus thuringiensis* and *B. sphaericus*;
- use of fish for mosquito control in different epidemiological and ecological settings;
- screening of indigenous biocontrol agents for their effect on vector populations.

4. *Environmental management.*

- rice field management aimed at mosquito and snail control;
- the positive or negative role of fish culture ponds in the control of mosquito breeding in different geographical areas;
- effectiveness of environmental management and sanitation in various epidemiological and ecological settings.

5. *Trapping methods.*

- improvement of existing traps for tsetse fly control;
- expansion of the concept of trapping as a control method for other vectors, and development of appropriate baits.

6.1.3 *Social/economic and educational conditions of community involvement*

Research is needed into the effects on disease and vector control of community organization, the behaviour of its members, methods of financing, and the development of human resources. Social scientists, health educators, and economists carrying out this type of research should have a sound knowledge of health and vector control problems.

Research to improve health education is required to determine relevant strategies for various populations and environments. This includes developing programmes for such target groups as school-children, housewives, community leaders, farmers, and development project engineers. The effects of available media (modern, traditional, social, and institutional) should also be evaluated.

Detailed evidence is needed that community participation will produce the desired benefits, without increasing the cost of vector control to the community. Information is also needed on how to evaluate the effectiveness of community participation in vector control activities, on how best to enhance the level of participation, and on the benefits of a participatory research approach in which the community is directly involved in gathering information for planning and evaluating vector control programmes. Ethical considerations for research on community participation have been defined.¹

Keeping in mind the need to find effective ways of promoting community participation in vector-borne disease control, four key research topics have been identified:

1. As new activities are established, systematic investigation of the structure and function of communities is needed to identify existing community resources (special knowledge, skills, leadership, etc.) and communication channels both to and within the community. Further research will be required to identify target groups or social categories (groups at risk, potential participatory groups, refugee and migrant populations, etc.) as

¹ *Community participation in tropical disease control: social and economic research issues*. Report of the Scientific Working Group on Social and Economic Research, UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, 1983 (Unpublished WHO document TDR/SER-SWG(4)/CP/83.3).

well as concepts and perceptions of health and disease that influence vector control measures.

2. Methods of encouraging community participation should be analysed, taking into account a variety of factors, such as training and other back-up services, type and degree of participation, and skills in planning, data collection, monitoring, accounting, and management. Using such information, the participatory process can be described. This would help to identify elements of the participatory process and to provide a basis for predicting results. Ways of integrating disease control programmes with other sectoral activities such as agricultural and water-supply projects and income-generating activities, should be investigated to ensure sustained participation.
3. Studies are needed to compare the impact on vector and vector-borne disease control of different types and degrees of community participation; they should focus on the extent to which a given approach enhances the effectiveness of control strategies, its impact on health, and the cost and benefits of the approach. Further research might investigate the influences of population movement and urbanization, the training and supervision of community health workers, and the effects of sponsorship on the community's response to vector control strategies.
4. Primary health care is not free health care and even simple vector control activities need financial support. Research on the cost-effectiveness of every control action whether integrated or a single method, must take into account the input of community work and direct and indirect costs to community members. Research on the economic aspects of vector control will facilitate decisions about strategic options as well as programme management. Innovative options for vector control strategies must be identified and the potential implications of alternative procedures be defined in terms of cost in time and money versus effect in disease reduction or improvement in the quality of life.

6.1.4 *Operational research*

Operational vector control research may be categorized in the following way: (a) the behavioural aspects of primary health workers and governmental agencies involved in vector control and their interaction with the community as well as community attitudes towards the workers; (b) the optimal organizational structure for the

delivery of community-based vector control measures; (c) the cost-effectiveness of vector control under different operational schemes; and (d) the productivity and optimal workload of workers involved in vector control under varying epidemiological and social circumstances.

7. RECOMMENDATIONS

1. New medical entomology courses in endemic countries should emphasize practical training relevant to disease control. The training of medical entomologists should provide them with a thorough knowledge of vector-borne diseases, integrated vector control, and interdisciplinary collaboration for the planning, implementation, and evaluation of disease control activities. Wherever possible training should involve intersectoral/interdisciplinary experiences integrated into practical field activities to ensure the intersectoral orientation of entomologists and vector control specialists. Elements of vector control should also be incorporated into the training curricula in the fields of medicine, public health, engineering, and other disciplines related to the core group.

2. The Group noted with concern the lack of training opportunities for district level vector control staff in some countries, and strongly recommended the initiation of task-oriented training for this level of staff, emphasizing the solution of practical problems. Countries providing in-service training should introduce some simple elements of vector control for nurses and other primary health care staff.

3. Every country with vector control programmes being implemented through primary health care programmes or every country planning such programmes should form a core group of professionals that is capable of providing all aspects of the necessary technical support to every level of the primary health care system. These countries should assess their existing manpower capabilities in this area and be prepared, where necessary, to train and recruit the professional staff required to form such core groups. Implementation of vector control activities as part of primary health care should take full advantage of the personnel and experience at present to be found in existing vertical vector control programmes.

4. Vector control activities should be planned so as to make better use of the medical entomologists already available. The medical

entomologists should be given a favourable career structure in the national health system of the country by the establishment of core groups and district health management teams that include entomologists. The core group should work actively with district health management teams to adapt and apply existing technology to the solution of priority vector control problems throughout the districts covered in order to develop and evaluate feasible approaches for wider application.

5. Although many community members may be aware of the role of vectors in disease transmission, this knowledge is not utilized in vector control. Sanitary and health education efforts should go beyond awareness and should include other underlying factors and constraints. Studies on human behaviour as it relates to vectors and the transmission of vector-borne disease are necessary.

6. Nongovernmental organizations may stimulate a high level of community involvement and their resources should be increasingly involved in the support of national or district vector control activities.

7. The activities of some non-health sectors may encourage the proliferation of vectors or play a positive role in vector control, therefore the promotion of intersectoral collaboration in the planning and implementation of vector control activities at all levels is essential.

8. Vector control activities must be monitored and periodically evaluated to determine whether progress is satisfactory or if any changes are required.

9. Vector control in primary health care involves new activities, tools, and methods, and the research activities listed in this report should receive full support from national, international, and other bodies involved in health promotion and development processes.

10. WHO should collect information on community involvement in vector control and encourage investigators to publish both positive and negative findings. WHO should promote the exchange of information and experience relating to the identification of vector control methods between and within countries.

11. Increasing human populations, resettlement and resource development projects, and the growth of urban and periurban areas, all pose new and special problems and attention should be paid to vector control in primary health care under these conditions.

12. Several biological control agents are now available for development and are being used in specific settings. Whenever

possible they should now be applied in the context of demonstration projects so as to encourage and promote their wider use in other appropriate ecological and epidemiological situations.

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