ADVANCES IN PARASITOLOGY

Control of Human Parasitic Diseases

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Edited by D.H. MOLYNEUX

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Control of Human Parasitic Diseases

Guest Editor

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Foreword

Jeffrey D. Sachs

The parasitic diseases covered in this enormously useful and timely volume continue to inflict massive suffering, mortality, and economic distress throughout the low-income world, especially in the tropics. Thirteen high-quality and up-to-date chapters describe not only the epidemiology, complex life cycles, and pathogenesis of these diseases, but also the powerful technologies that make possible their effective control, if not eradication. The chapters also document that these strategies—many of them with extremely low cost and very high efficacy—are not reaching the poorest people who are afflicted with these diseases. This book is therefore not only a unique state-of-the-art sourcebook on parasitic disease control, but also a major prod to policy action.

Control of Human Parasitic Diseases comes at a time of potential policy breakthrough. After decades of substantial neglect by the wealthy countries, human parasitic diseases are back in policy focus. The major donor countries have in recent years repeatedly pledged to take stepped-up action against these diseases at G8 Summits, UN gatherings, World Health Assemblies, and other important venues. New financing is finally being mobilized through areas such as the Global Fund to Fight AIDS, TB, and Malaria, the World Bank, as well as from private foundations and bilateral donors. The threats of emerging diseases, such as SARS and avian flu, are drawing global attention to the urgency, possibility, and practical challenges of disease control.

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The Millennium Development Goals (MDGs) provide an important shared global framework and timetable for action. Several of the authors of this book have played a special role in promoting support for the MDGs, including Professor David Molyneux, whose lucid overview chapter provides an especially fitting introduction to the themes of the entire volume. This book comes at a crucial time, and through its excellent coverage, can play an important role in spurring science-based action.

Jeffrey D. Sachs is Director of the Earth Institute at Columbia University and Director of the UN Millennium Project. He is also Special Advisor to UN Secretary General Kofi Annan on the Millennium Development Goals.

Preface

This special volume of *Advances in Parasitology* is perhaps the most practical, covering the latest developments in methods of control of parasitic infections, including both prophylactic and curative chemotherapy and other preventive methods. The range of infections covered is wide—malaria, human trypanosomiasis (African and South American), leishmaniasis, dracunculiasis, soil-transmitted helminths, onchocerciasis, lymphatic filariasis, cystic echinococcosis, taeniasis and neurocysticercosis, and schistosomiasis.

The guest editor, David Molyneux of the Liverpool School of Tropical Medicine (UK), has brought together a panel of international experts from Europe, North and South America, Asia, and Africa to contribute to a volume which will surely prove to be an invaluable source of information on this most pressing of topics—the control of global parasitic disease.

John Baker
Ralph Muller
David Rollinson

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Control of Human Parasitic Diseases: Context and Overview

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ABSTRACT

The control of parasitic diseases of humans has been undertaken since the aetiology and natural history of the infections was recognized and the deleterious effects on human health and well-being appreciated by policy makers, medical practitioners and public health specialists. However, while some parasitic infections such as malaria

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have proved difficult to control, as defined by a sustained reduction in incidence, others, particularly helminth infections can be effectively controlled. The different approaches to control from diagnosis, to treatment and cure of the clinically sick patient, to control the transmission within the community by preventative chemotherapy and vector control are outlined. The concepts of eradication, elimination and control are defined and examples of success summarized. Overviews of the health policy and financing environment in which programmes to control or eliminate parasitic diseases are positioned and the development of public–private partnerships as vehicles for product development or access to drugs for parasite disease control are discussed. Failure to sustain control of parasites may be due to development of drug resistance or the failure to implement proven strategies as a result of decreased resources within the health system, decentralization of health management through health-sector reform and the lack of financial and human resources in settings where per capita government expenditure on health may be less than $US 5 per year. However, success has been achieved in several large-scale programmes through sustained national government investment and/or committed donor support. It is also widely accepted that the level of investment in drug development for the parasitic diseases of poor populations is an unattractive option for pharmaceutical companies. The development of partnerships to specifically address this need provides some hope that the intractable problems of the treatment regimens for the trypanosomiases and leishmaniases can be solved in the not too distant future. However, it will be difficult to implement and sustain such interventions in fragile health services often in settings where resources are limited but also in unstable, conflict-affected or post-conflict countries. Emphasis is placed on the importance of co-endemicity and polyparasitism and the opportunity to control parasites susceptible to cost-effective and proven chemotherapeutic interventions for a package of diseases which can be implemented at low cost and which would benefit the poorest and most marginalized groups. The ecology of parasitic diseases is discussed in the context of changing ecology, environment, sociopolitical developments and climate change. These drivers of global change will affect the epidemiology of parasites over the coming decades, while in

many of the most endemic and impoverished countries parasitic infections will be accorded lower priority as resourced stressed health systems cope with the burden of the higher-profile killing diseases viz., HIV/AIDS, TB and malaria. There is a need for more holistic thinking about the interactions between parasites and other infections. It is clear that as the prevalence and awareness of HIV has increased, there is a growing recognition of a host of complex interactions that determine disease outcome in individual patients. The competition for resources in the health as well as other social sectors will be a continuing challenge; effective parasite control will be dependent on how such resources are accessed and deployed to effectively address well-defined problems some of which are readily amenable to successful interventions with proven methods. In the health sector, the problems of the HIV/AIDS and TB pandemics and the problem of the emerging burden of chronic non-communicable diseases will be significant competitors for these limited resources as parasitic infections aside from malaria tend to be chronic disabling problems of the poorest who have limited access to scarce health services and are representative of the poorest quintile. Prioritization and advocacy for parasite control in the national and international political environments is the challenge.

1. CONTROL OF PARASITIC DISEASES

1.1. Concepts of Control, Elimination and Eradication

A distinction must be made between the terms 'control', 'elimination' and 'eradication'; the latter term is often used inappropriately and it should be employed with caution. The International Task Force for Disease Eradication (ITFDE) was established in 1988 to evaluate systematically the potential for eradication of candidate diseases and to identify specific barriers to eradication. The criteria used to assess the feasibility of eradication are provided in Table 1. The Task Force was reconstituted in 2001 to evaluate the current situation. The ITFDE defined eradication as 'reduction of the world-wide incidence of a disease to zero as a result of deliberate efforts obviating the

Table 1 Criteria for assessing eradicability of diseases or conditions (Dowdle and Hopkins, 1998)

Scientific feasibility
Epidemiologic vulnerability (e.g. absence of non-human reservoir; ease of spread; natural cyclical decline in prevalence; naturally induced immunity; ease of diagnosis; and duration of any relapse potential)
Effective, practical intervention available (e.g. vaccine or other primary preventive, curative treatment, and means of eliminating vector). Ideally, intervention should be effective, safe, inexpensive, long lasting and easily deployed
Demonstrated feasibility of elimination (e.g. documented elimination from island or other geographic unit)
Political will/popular support
Perceived burden of the disease (e.g. extent, deaths, other effects; true burden may not be perceived; the reverse of benefits expected to accrue from eradication; relevance to rich and poor countries)
Expected cost of elimination or eradication (especially in relation to perceived burden from the disease)
Synergy of eradication efforts with other interventions (e.g. potential for added benefits or savings or spin-off effects)

necessity for further control measures'. The original ITFDE reviewed more than 90 diseases, 30 of them in depth, and concluded that dracunculiasis, rubella, poliomyelitis, mumps, lymphatic filariasis and cysticercosis could probably be eradicated using existing technology. The term 'elimination' is increasingly being used to replace the term 'eradication', which should be only used in Global terms. The Dahlem conference held in Berlin in 1997 (Dowdle and Hopkins, 1998) also considered these issues in some detail and introduced the term extinction to classify an organism that did not exist on the planet contrasting with smallpox, which had been eradicated as a cause of disease but stocks had been retained in secure laboratories. The use of the term elimination is now regarded as referring to the removal of the organism from a defined geographical region ("local eradication"), which creates problems for quantification of achievement towards the goal. The accepted position being that the disease is not eradicated but no longer requires ongoing investment in control and is maintained at a level when the problem is no longer a significant health burden. A new concept has also been introduced through World Assembly Resolutions of the "Elimination of a disease as a Public Health problem". The definitions which will be used in this chapter are from Dowdle and Hopkins (1998), WHO (1998) and Molyneux *et al.* (2004):

Control reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts; continued intervention measures are required to maintain the reduction.

Elimination of disease reduction to zero of the incidence of a specified disease in a defined geographical area as a result of deliberate efforts; continued intervention measures are required.

Elimination of infection reduction to zero of the incidence of infection caused by a specified agent in a defined geographical area as a result of deliberate efforts; continued measures to prevent the re-establishment of transmission are required.

Eradication permanent reduction to zero of the worldwide incidence of infection caused by a specific agent as a result of deliberate efforts; intervention measures are no longer needed.

Extinction the specific infectious agent no longer exists in nature or the laboratory

1.2. Examples of Parasite Elimination and Vector "Eradication"

The classic eradication programme was that of smallpox which achieved its target in 1977. To date, no parasitic disease has been eradicated, although attempts to eradicate Guinea worm are underway (Hopkins *et al.*, 2002; Ruiz-Tiben and Hopkins, 2006). Nevertheless, successful "local eradication" (correctly elimination) has been achieved in some restricted geographical or epidemiological situations. For example, onchocerciasis has been eliminated from several parts of Kenya and from the Nile at Jinja in Uganda, by using DDT to remove the local vectors (*Simulium neavei* and *S. damnosum*, respectively) (Davies, 1994). The Onchocerciasis Control Programme (OCP) in West Africa has achieved the same goal eliminating particular cytoforms of the *S. damnosum* complex using aerial application of insecticides. Local elimination has also been achieved; the malaria vector *Anopheles gambiae* from Brazil in the late 1930s using larviciding measures and house spraying with pyrethrum, a success repeated in early 1940s after the same species had been introduced into Egypt; *Glossina palpalis,* the tsetse fly, the vector of human trypanosomiasis was eliminated from the Island of Principe in 1905 by trapping out flies using sticky back packs on plantation workers; animal trypanosomiasis from parts of North-East Nigeria by ground spraying of tsetse resting sites with persistent doses of DDT; *Aedes aegypti*, the vector of yellow fever, in parts of Central and South America. Local anti-mosquito spraying has eliminated lymphatic filariasis from the Solomon Islands with no evidence that over a 20-year period there has been any resurgence; filariasis due to *Brugia malayi* was eliminated from Sri Lanka through selective treatment with DEC, anti-larval measures (host plants killed by herbiciding), house spraying with DDT as part of the malaria eradication programme and environmental improvements. Chemotherapeutic approaches have eliminated filariasis (due to *Wuchereria bancrofti*) from Japan, South Korea and Taiwan in Asia and Suriname and Trinidad and Tobago in the Americas (WHO, 1992, 1994). Filariasis has also been eliminated as a public health problem in large areas of China where it seems transmission has been stopped for a period of over 10 years (WHO, 2003). Long-term "elimination" programmes have been successful against hydatid disease in Iceland, New Zealand and Cyprus; and malaria was eliminated from Sardinia by DDT spraying as well as in other marginal areas of distribution such as North Africa, Greece and parts of Turkey and the Middle East.

One noticeable feature of these successes is that many examples refer to islands or isolated populations or areas where the parasite is at the edge of its geographical range. Clearly, the advantages of isolation and a greater ability to control animal or human population movements are important. Elimination or global eradication of any disease is difficult to achieve and costs increase per case detected, controlled or averted as the end point is reached.

However, the high cost of eradication or local elimination programmes may be justified as they are time limited, whereas disease control implies a long-term commitment. Any control programme must be cost effective and should reduce the target disease to a level at which costs are sustainable by the local community or by public or private healthcare systems. Control seeks to bring the problems to a level at which the disease is no longer of public health importance with morbidity at an acceptable level within the community, an absence of mortality and, if appropriate, greatly reduced levels of disability. To translate the level of control achieved to eradication or elimination status requires a vastly increased cost per case treated or prevented which, for financial and ecological reasons, may never be feasible or the development of a more effective intervention.

1.3. Components of Control

1.3.1. The Range of Interventions

The spectrum of interventions against parasitic diseases, currently used against parasitic diseases, is summarized in Figure 1 and discussed in detail in the accompanying chapters in the volume.

1.3.2. Control of Animal Reservoir Hosts

Many parasitic diseases are zoonoses, defined as 'those diseases and infections (the agents of) which are naturally transmitted between (other) vertebrate animals and man' (WHO, 1979). A list of recognized parasitic zoonoses is provided by the WHO (1979). Ostfeld and Keesing (2000) provide an up-dated list of vector-borne infections of potential public health importance, while a recent analysis of all emergent and re-emergent infections (Taylor *et al.*, 2001) has identified that 75% of emerging pathogens are zoonotic and that such organisms are more than twice as likely to emerge as non-zoonotic ones. However, viruses and protozoa are more likely to emerge than the macroparasites such as helminths. The important zoonoses for which reservoir host control can have a cost-effective impact are

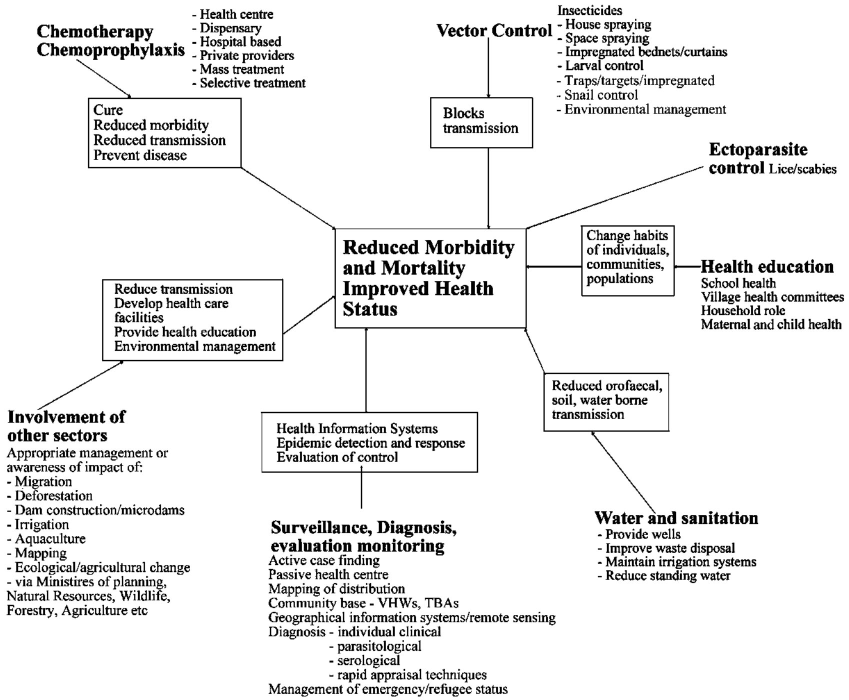

Figure 1 Interventions for the control of parasitic diseases.

leishmaniasis, echinococcosis and cysticercosis; while treatment of cattle with trypanocides in Uganda is a strategy used to reduce the role of cattle as a reservoir of *Trypanosoma rhodesiense* sleeping sickness (Fèvre *et al.*, 2005). However, the presence of an animal reservoir host may be a major impediment to control a disease particularly if the habits and habitats of the animal host prevent the intervention either on the grounds of practicality or for reasons such as protected status of host species e.g. primates or endangered species status. The ITFDE recognizes that the existence of an animal reservoir precludes the likelihood of the eradication of the infection.

1.3.3. Community Participation in Parasitic Disease Control

The drive towards primary healthcare following the Alma-Ata declaration of 1978 provoked a greater degree of involvement of communities in healthcare through (1) the use of community leaders to support various programmes; (2) the identification of personnel to undertake health activities on a voluntary basis; and (3) emphasizing the importance of such activities in community well-being. The topic of community participation has been reviewed by Curtis (1991) who provides a series of examples in vector-borne disease control. MacCormack (1991) provides an insight into the underlying principles of sustainable vector control in a community context emphasizing that success in small pilot projects depends on particular characteristics such as leadership; a responsive, well-motivated and well-educated community support; incentives from agencies and insecticide manufacturers; and ease of communication. Following initial success, there is a danger that a 'hot' project will fall into a steady state as enthusiasm and donor support wane while the project life cycle faces inevitable problems. The scaling up of pilot projects to national ones within a primary healthcare context presents additional challenges. For instance, the community may be affected by the replacement of local leaders with national bureaucracy. In establishing a functional link between the communities and the health systems, each group must be trained to understand the social role on the one hand and technical skills on the other. Communities' local knowledge about insects should be exploited to aid in vector control. Appropriate control methods, and the importance of maintaining them, must then be clearly explained to all those involved at the local level.

It must also be established whether unpaid community labour can be sustained over time; although it has been achieved in pilot programmes, doubts exist about longer-term sustainability (Walt, 1988). Much is likely to depend on the community structure and its relationship with those in authority, who are perceived as those most likely to benefit. If, for example, a cost recovery system operates, the volunteers are less able to collect fees from their social superiors. Professional interaction between technicians and volunteers can also fuel conflicts based on perceptions about status.

The outcome of community participation in any project will depend on the numerous complex social interactions existing within the community environment. The interaction between weak and strong groups, and the impact of participation on such group relationships, are of critical importance (Antia, 1988). It is valuable to define the boundaries of the community involved, as individuals tend to identify with a particular locale; this is despite the risk of inherent social instability of villages, resulting from factors such as migration, schooling and marriage. For practical reasons the community is usually defined by a geographical boundary such as an urban neighbourhood or an agricultural village while nomadic groups themselves represent a mobile community.

Communities differ in how they function and are stratified; for example, they may be democratic, autocratic or under military control. In a democratic environment, obtaining consensus may be a slow process, but the likelihood of sustainability will be high. MacCormack concludes that community participation in vector control will be sustainable only if the assessment of the costs to benefits ratio takes account of 'opportunity costs' (the value of activities people would undertake if they had not committed themselves to a particular control activity). Sustainability will be enhanced if activities are linked to the communities' priorities; skills training enhances the communities' well-being; and preventative work links to curative or care outcomes that increase income (Rajagopalan *et al.*, 1987).

Community-based treatments are usually better targeted and tend to involve volunteers, traditional birth attendants (TBAs) and primary healthcare workers. Increasingly, other types of groups are also becoming involved, such as women's groups, faith groups, civil society organizations (CSO) and non-governmental developmental organizations (NGDOs). The NGDO community has become increasingly involved in onchocerciasis control as the programmes in Africa and the Americas have expanded using the donated drug Mectizan® (ivermectin). The momentum for NDGO involvement came from the organizations committed to blindness control who recognized the value of ivermectin as a tool for reducing morbidity associated with onchocercal eye disease (Drameh *et al.*, 2002). NGDOs provide some 25% of the resources required for National Onchocerciasis programmes and 12 international as well as some local NGDOs are active in some 20 countries in Africa through the African Programme for Onchocerciasis Control (APOC) and the countries from the former OCP. The key element of the approach to control is community directed treatment with ivermectin (CDTI), which is regarded as the key driver in ensuring sustainabilitiy of this programme. The progress of the APOC programme is documented in a publication, which highlights the status of these programmes (*Annals of Tropical Medicine and Parasitology, 2002*). Amazigo *et al.* (2002) review the challenges presented by CDTI strategies with an approach based on the principle of community participation but also ensuring empowerment; allowing communities to decide on who should be distributors (CDDs) allowing the planning of ivermectin distribution to be decided by communities e.g. dates, location model of distribution. The replacement of the ‘‘Community-directed’’ approach from a ‘‘Community-based’’ treatment system has been encouraged as the former is likely to be more sustainable, provides community ownership and empowerment and reduces costs to the health system. CDTI enables communities to organize distribution in line with cultural norms and organizational structures—such as kinship and clan structures in Uganda (Katabarwa *et al.*, 2000) while stimulating basic healthcare infrastructure in remote areas (Hopkins, 1998). The experience of the Guinea Worm Eradication programme has led Seim (2005) to identify 10 components to bridge the divide between the systems approach and the disease-specific intervention. He also identifies the criteria for the effective use of volunteers, an approach described as the community-based catalyst to public health. The 10 elements can be summarized as the requirement for a few dedicated individuals, a data manager and a programme manager in each country, the role of a fast non-bureaucratic organization, resident technical advisers, international meetings, regular programme reviews, annual training and retraining of volunteers, network of supervisors, adequate transportation and continuous research for course correction.

1.3.4. Steps in a Control Programme

Components of control are listed under the following headings: (1) situation analysis; (2) definition of objectives and strategy; (3) roles and responsibilities at different levels of health system; (4) planning and resourcing; (5) monitoring and evaluation; and (6) implementation and integration of selected methods of control.

(1) Situation analysis

Stratification of parasitic diseases

Control programmes often involve specific approaches to arrest the transmission of infection (e.g. via vector control) or to prevent or cure a disease. Although such programmes have been successful in the past, integrated approaches are now recognized as being more appropriate for reducing prevalence and incidence. This is important if the strategy is aimed at alleviation of a disease problem in a community or population rather than in an individual. Integrated control is based on coordinated planning and detailed knowledge from many different areas: scientific, technical, inter-sectoral, financing and managerial. An approach termed 'stratification' has been used in malaria control; this means that the strategy is modified according to different epidemiological situations (WHO, 1993). Malaria stratification has been taken a step further by those with particular interests in different environments and geographical regions, a process known as 'microstratification' (Rubio-Palis and Zimmerman, 1997). While stratification has been most widely used in malaria control the concept is equally applicable to other parasitic diseases, for example leishmaniasis (WHO, 1990), onchocerciasis (Boatin *et al.*, 1997), filariasis (WHO, 1992), schistosomiasis and African trypanosomiasis. Molyneux (2005) details in a series of tables, examples of stratification of the epidemiology and its relevance to the planning of control in selected parasitic diseases.

Planning for Control

- Desk study of published and unpublished reports to assess problems in the context of country, region and district.
- Acquisition of information on prevalence and incidence.
- Appraisal of the validity of information.
- Evaluation of current epidemiological situation by passive surveillance at health centers or by use of questionnaires of health workers—for example using the postal system.
- Observation of changes over time and prediction of future change.

- Definition of the structure of health services and their existing capacity, human resources available and needs for training and capacity building.
- The priority afforded to the disease by the government, the MOH, the district management teams and the communities themselves.
- Establishment of linkages to other sectors or organizations in planning for control (e.g. other ministries, development organizations, NGOs).
- The influence of other activities such as development projects on planned programmes.
- Spot surveillance of local prevalence, vectors and, if applicable, animal reservoirs.
- Use of rapid assessment methodologies e.g. for schistosomiasis, onchocerciasis, filariasis or loiasis.
- Assess the available methods for prediction of epidemics using remote sensing or climate prediction available to other sectors, e.g. agriculture, natural resources, environment.
- Establishment of a National Task Force composed of various stakeholder groups to address the problem.

(2) Definition of objectives and strategy

- Analysis of cost effectiveness of different control approaches and options.
- Selection of appropriate methodology and definition of control requirements.
- Establishment of an inventory of personnel and facilities (including estimation of training needs and requirements for equipment and drugs).
- Establishment of feasibility in the context of other health needs.
- Contrasting epidemic (‘firefighting’) problems when rapid action is required to prevent further transmission (e.g. establish emergency response capacity to address predicted epidemic risk) compared with endemic situations for which a long-term approach and integration are required (Table 2).

(3) Roles and responsibilities of different levels of the health service

Table 2 Role of different levels of the health system in parasitic disease control

Community
Identification of suspects/patients
Follow-up of patients
Coordination of any appropriate vector control activities, e.g. bednet distribution to vulnerable groups/re-impregnation
Facilitation of cooperation, local logistics for community-directed treatment schemes, e.g. drug distribution of ivermectin and albendazole
Communication by Village Health Committees
District
Passive detection and treatment
Parasitological/serological diagnosis
Treatment and clinical care
Follow-up of microscopy
Regional
Active surveillance
Confirmatory diagnosis
Data collection
Technical supervision of vector control
Distribution of reagents and materials for vector control
Ministry and country level
Situation analysis/policy position
National strategy and plan
Establish stakeholder group/National Task Force
Financing
Training needs and responsibility
Health education
Distribution of technical information, equipment, drugs and materials
Purchase of equipment and supplies
Human resource management

(4) Planning and resourcing

- Define the expected contribution from the government.
- Develop national plan.
- Evaluate targeted approaches to donors in the context of donor priorities and prevailing national policy.
- Define appropriate timeframes for implementation of plans.
- Define the relationship of the action to overall health plans and budgets.
- Establishment of linkages with appropriate international reference centres for technical support; control of an epidemic may merit application for emergency status to provide rapid funding

(e.g. requests for therapeutic drugs and insecticides from international aid agencies and NGDOs).
- Establishment of drug supply line following identification of sources, initiate quality assurance mechanisms, define tax status of drugs (e.g. donated products).
- Definition of the role of the non-government sector (e.g. private providers, NGOs) in control policy.
- Ensure adequate information exchange about control policy between different bodies and individuals involved in healthcare provision.
- Undertake knowledge, attitudes and practice (KAP) studies as a basis to inform approaches to social mobilization strategies.
- Training (including management training) through courses, instruction of trainers, educational materials and health education programmes.
- Assessment of community acceptability and the perceived priority of any involvement that will require resource input from the communities (e.g. role and views of village health workers (VHWs), volunteers, TBAs, community leaders, school teachers).
- Definition of the management structure of the programme and its relationship with existing management structures.
- Assess capacity available (managerial, financial, technical) and ensure capacity building is embedded in planning.

(5) Monitoring and evaluation

- Assessment of progress towards objectives (prevalence distribution, vector status).
- Establish Sentinel site/baseline data in defined units.
- Definition of appropriate methods for epidemiological evaluation, e.g. parasitological, serological and vector-sampling methods.
- Longitudinal surveys or spot surveys at indicator villages.
- Adjustment of the programme in the light of results.
- Establish process indicators at national and sub-national level.

(6) Implementation and integration of selected methods of control
Chemotherapy and chemoprophylaxis

- Assessment of the availability and quality of drugs and the distribution system.

- Establish relationship between national bodies, donation programmes and NGDO community to define operational relationships, e.g. onchocerciasis, lymphatic filariasis, African trypanosomiasis, schistosomiasis, Trachoma programmes.
- Assessment of, or monitoring for, drug resistance (e.g. East-African network for antimalarial drug resistance).
- Assessment of the role of private providers and control of quality and price (e.g. malaria drug policy).
- Utilization of other systems for distribution (e.g. schools, agricultural extension workers, other health or government workers, NGOs, committees).

Vector and reservoir control

- Availability, cost and appropriateness of insecticides.
- Availability of skills to monitor insecticide resistance.
- Availability and effectiveness of alternative chemicals.
- Capacity for management of the control programme.
- Relationship to other sectors in providing support for environmental control measures.
- Acceptability and feasibility of reservoir control.
- Environmental acceptability of interventions.
- Personal protection, e.g. bednets, sustainability of a bednet programme/retreatment modalities.
- Policy in relation to bednet distribution—vulnerable groups, social marketing.
- Investigate opportunities for integration if appropriate, e.g. malaria and lymphatic filariasis in Africa; dengue and filariasis in the Pacific; leishmaniasis, Chagas disease and malaria via bednets in Latin America.

Environmental management

- Ensuring effective linkages between health and other sectors.
- Assessment of potential impact on other diseases.