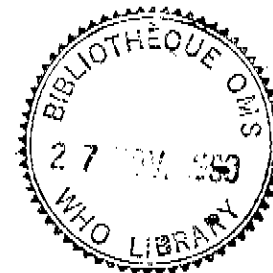




INFORMAL CONSULTATION ON INTESTINAL HELMINTH INFECTIONS\*  
Geneva, 9-12 July 1990

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Annex 1. List of Participants

- \* Footnote: Due to the new opportunities for positive action in helminth control, and to the special range of expertise available at the meeting, it was decided to focus primarily on intestinal helminthiasis. It was considered that the important issues in the control of intestinal protozoa would be better dealt with by a subsequent meeting on this specific topic. Infections due to protozoa are widespread and are of public health importance. As one example, cryptosporidiosis has recently been recognized as a significant cause of diarrhoea. This parasite and other protozoa are causes of opportunistic infections in immuno-suppressed patients and AIDS.

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## 1. INTRODUCTION

Over the last decade, intestinal helminth infection has become increasingly recognised to be an important and soluble public health problem. The availability of broad spectrum anthelmintics has been a major contributor to this perception, not only because they have made single dose cure a reality but also because the broad spectrum of activity allows infection with all the major intestinal helminths to be tackled. From this perspective, the disease caused by the 200 million infections due to schistosomes and the 1 000 million infections due to geohelminth species is difficult to ignore. On this scale of infection even mortality, which is a rare consequence of helminth infection, assumes substantial proportions: current estimates suggest that 100s of thousands of avoidable deaths occur each year due to helminthiasis. The large burden of geohelminthiasis has even more profound public health consequences in terms of morbidity. Careful clinical and epidemiological studies have demonstrated that chronic infection with the major geohelminths persists, and is most intense, throughout the vulnerable years of childhood, with insidious effects on growth, nutrition and development. More importantly, they have demonstrated that these effects are largely reversible by simple therapy. The claim that therapy is irrelevant to the control of helminth disease because children become reinfected, cannot be sustained in the face of the remarkable improvement in health achieved after a single treatment.

## 2. STATEMENTS

- 2.1 Intestinal helminth infections are most prevalent and intense in the poorest communities and in children.
- 2.2 Chronic intestinal worm infection during childhood has negative effects on the growth, nutrition and fitness of children. These effects are readily reversible by simple treatment.
- 2.3 In endemic areas there is often a social stigma associated with worm infection, analogous to the social perception of infection with lice or scabies in other societies.
- 2.4 Death is a rare consequence of intestinal helminth infection, but because of the very high prevalence of infection a substantial number of people die as a result of worm infection each year.
- 2.5 The current tools for the control of intestinal helminth infections are adequate to achieve a substantial impact on health both through parasite specific control programmes and through integration with existing health programmes (e.g. sanitation, primary health care, maternal and child health, occupational health, nutrition, health education).

- 2.6 The delivery of anthelmintics as part of parasite control programmes can, together with other public health programmes, provide a focus for the development of health care systems.
- 2.7 The control of intestinal helminths can serve as a focus (point of entry) for public health programmes due to community acceptance of the need for parasite control and because of the visible consequences of successful therapy. (This has been demonstrated by the Japanese Organization for International Cooperation in Family Planning (JOICFP)).

### 3. BACKGROUND TO THE PROBLEM OF INTESTINAL HELMINTH INFECTION

Humans are known to serve as host for more than 300 species of helminth<sup>7</sup> about 200 of which have been reported from the alimentary tract and its associated ducts and organs. By far the most abundant and widely distributed species of human helminth are the roundworm (Ascaris lumbricoides), hookworms (Ancylostoma duodenale and Necator americanus), and whipworm (Trichuris trichiura). These four species have a direct life history pattern; transmission depends on faecal contamination of the soil and environment. They are known collectively as the major geohelminths or soil-transmitted helminths.

Estimates suggest that about a billion humans are currently infected with A. lumbricoides and a similar figure may apply to T. trichiura<sup>5</sup> and the hookworms. The estimated number of cases of some of the common helminths are given in Table 1. There is general agreement that there are many more cases of infection with N. americanus than A. duodenale and individuals may be concurrently infected with two and sometimes three of these species. A. lumbricoides has been reported during the last few years from over 150 of the 208 states and countries of the world, and hookworms and whipworm are likely to be equally widely distributed<sup>9,10,25</sup>.

Table 1  
Estimated global number of infections with some common  
intestinal helminths<sup>22</sup>

Helminths	Number of Infections (thousands)
Ascaris	785-1150
Trichuris	750-1000
Hookworm	750-1000
Enterobius	400
Strongyloides	80-100
Schistosoma	200
Taenia	70

A large amount of theoretical and practical epidemiological work has established that the prevalences of A. lumbricoides and T. trichiura infections reach peak values in early life and then generally remain steady, while the prevalence peaks for A. duodenale and N. americanus are achieved in adolescence. In infections with A. lumbricoides, T. trichiura and schistosomes the largest worm burdens are found in children of primary-school age.<sup>2,3,4</sup> The maximum intensity of hookworm infection is achieved in young adults and tends to remain high throughout adulthood.

The frequency distribution of numbers of worms per host has been demonstrated to be highly aggregated or overdispersed such that a few individuals have disproportionately large worm burdens.<sup>2</sup> This distribution applies to all species of human helminth that have been studied. In practice, this type of distribution means that in any community approximately 15% of the human population will harbour more than 65% of the worms. Since morbidity is usually related to intensity (see below) it follows that the heavily infected children and adults will be most at risk of disease from the infection, and that heavily infected individuals will make a disproportionate contribution to contamination of the environment with infective stages. Further work has demonstrated that individuals with heavy worm burdens are more likely to reacquire heavy infection after treatment.<sup>1,5</sup> An individual who is heavily infected with A. lumbricoides is also more likely to be heavily infected with T. trichiura; these associations are not generated by random events and appear to result from predisposition to helminth infections in general.<sup>1,5</sup> So far as is known, there is no convincing evidence of protective immune responses against the major geohelminths in humans.

Although not necessarily of global health significance several other species of intestinal helminth require attention because of their regional or national importance. These species include the nematodes Capilaria philippineosis, Enterobius vermicularis and Strongyloides stercoralis, the cestodes Hymenolepis nana, Taenia saginata, T. solium and Diphyllobothrium latum and the trematode Fasciolopsis buski. There are other less-well known species of helminth that are likely to have some public health significance at a local level. A full list of helminth species of importance to humans is given in the WHO Expert Committee Report.<sup>25</sup>

After at least a decade of research and debate there is now a general acceptance of the view that the growth and nutrition of children is impaired to differing degrees by infections of both A. lumbricoides and T. trichiura.<sup>8,21</sup> Appetite and food intake, digestion and absorption and growth, as assessed by such anthropometric variables as height and weight for age and skinfold thickness have been demonstrated to improve in children who were dewormed using anthelmintic drugs and then kept free for a period from infection with A. lumbricoides.<sup>20</sup> Children with intense trichuriasis exhibit remarkable catch-up growth after anthelmintic therapy.<sup>8</sup> Hookworm infection is a major causative factor in the etiology of iron deficiency anaemia.<sup>11,12,14</sup> Such anaemia complicates the course and outcome of pregnancy, reduces worker productivity and may even impair mental functioning and cognitive performance in children. Overall, it now appears that the major species of geohelminth

cause significant morbidity, particularly in children to the extent that "WHO recommends that in areas where the prevalence of mild-moderate underweight in children is greater than 25%, or where [intestinal] parasites are known to be widespread, high priority should be given to deworming programmes for treatment of parasites".<sup>21</sup> The same report supports treatment of intestinal parasites in vitamin A deficient areas and in cases of acute protein energy malnutrition.

#### 4. CURRENT ACTIVITIES IN THE RESEARCH AND CONTROL OF INTESTINAL HELMINTHS

##### 4.1 Activities of WHO

WHO has supported control of intestinal helminths since its inception. The first WHO Expert Committee on Control of Ascariasis met in Geneva in 1967 (WHO, 1967) and at the same time, WHO and UNICEF issued a joint statement on Ascariasis and its control.<sup>23</sup> The WHO Parasitic Diseases Programme initiated increased efforts in the area of intestinal parasitic infection in 1979 with the posting of a full time medical officer. A WHO Scientific Group met in 1980 and published the first comprehensive WHO document on intestinal protozoan and helminthic infections.<sup>24</sup> More recently, the WHO strategies have been articulated in a WHO Expert Committee Report entitled "Prevention and Control of Intestinal Parasitic Infections".<sup>25</sup> This document, in conjunction with a series of WHO/PDP documents<sup>26,27,28,29,30</sup> has provided guidelines for development of national control programmes for intestinal parasites which are being implemented today.

Regional activity has involved the development of national programmes, training support and resource mobilization in all the WHO regions. Collaboration at WHO Headquarters has included the Programmes of Nutrition, Pharmaceuticals, Health Laboratory Technology, Control of Diarrhoeal Diseases, Community Water Supply and Sanitation and Veterinary Public Health.

##### 4.2 Activities of Other Agencies

World Bank. Situating disease, including parasitic disease, control within a broader health context was one of the aims of a recent Health Sector Priorities review undertaken by the World Bank.<sup>16</sup> One important conclusion was that school-based chemotherapy for intestinal helminths compared favourably in cost-effectiveness terms with DPT/Polio immunization and ORT for diarrhoeal disease, relative to conservative assumptions of morbidity (days of healthy life lost). The review concluded that large-scale mass treatment, perhaps involving more than one therapeutic agent, could represent an important and cost-effective health strategy in those many parts of the world where improved sanitation is not presently feasible, particularly if conducted in concert with other community-based programmes.<sup>22</sup>

The Subcommittee on Nutrition of the Administrative Committee on Coordination of the United Nations. The ACC/SCN, which harmonizes policy throughout the UN system, has recently reassessed the interaction between malnutrition and infection.<sup>21</sup> The Subcommittee's conclusion that "treatment of intestinal parasites may often be a desirable accompaniment to food supplementation programmes" has far reaching implications, not least in respect of the global activities of the World Food Programme. High priority should be given to de-worming programmes for the treatment of parasites because of the potentiating effects on food supplementation programmes.

The UNICEF International Child Development Centre. The UNICEF Child Survival and Development Revolution and the WHO EPI have made remarkable progress in reducing the avoidable mortality of children under the age of five years. With an estimated 5 000 child deaths avoided daily, attention is now turning to methods for promoting the quality of life of the children who have been saved. UNICEF ICDC has implemented programmes to promote National Capacity Building in African countries.<sup>17</sup> The control of geohelminth infection and schistosomiasis has a dual role in such programmes. Firstly, it provides a focus for the health activities of the community, government agencies and national institutions. The Japanese Organization for International Cooperation in Family Planning (JOICFP), for example, has demonstrated in cooperative programmes involving more than 31 countries that parasite control can be used as a means of promoting health education in general, although there are concerns about the sustainability of such programmes. The second relevance of parasite control to programmes focussing on child development is the particular importance of worm infection for children: the most serious consequences of geohelminths arise from chronic infection during the vulnerable years of childhood. It has been agreed, in the context of the rights of the child, that it is imperative to foster the development of children who have survived the onslaught of acute disease in infancy.

The UNESCO International Project to Improve Primary School Performance, Nutrition and Health. The theme of child development is also taken up in a recent statement by the Director of the United Nations Educational, Scientific and Cultural Organization (UNESCO): "the struggle to save children's lives must go hand in hand with an effort to change the lives thus saved". Recognition that efforts to provide learning opportunities for children are hindered by health factors which determine educational participation and performance,<sup>19</sup> has led to a broadening of the traditional emphasis on the provision of basic education to include the promotion of health interventions. This approach has been endorsed by the World Conference on Education for All, held in Jomtien, Thailand, and by the United Nations ACC/SCN. Geohelminthiasis has particular relevance for the "teachability" of school-age children because two consequences of infection - anaemia and growth retardation - are both linked with poor school performance, and because the most intense infections with the major geohelminths and schistosomes occur in the school-age group.<sup>15</sup> Delivery of treatment through the school system has been shown to be logistically feasible in Korea and in Montserrat,<sup>6</sup> and has the capacity for integration with existing programmes that address school nutrition and health needs.

The activities of other agencies are also relevant to intestinal parasite control. The InterAmerican Development Bank is currently exploring collaboration with PAHO in implementing sanitation and clean water programmes. Operational research and control on intestinal helminths are components of programmes being supported by the EEC in

Mexico, IDRC in Dominica and Zimbabwe, COMICON in Vietnam, UNRWA in the West Bank, SIDA in Zimbabwe and Thailand, ODA in India and USAID in Cameroon and Myanmar. Rotary International funds control programmes in a number of countries.

Governments have supported their own long-term national control programmes, notably in Venezuela, Malaysia, the Philippines and the Republic of Korea.

#### 4.3 Activities of Industry

The research and development activities of pharmaceutical companies have resulted in the safe and effective anthelmintics available today. Major contributors to this include; Bayer; ICI Pharmaceuticals; Janssen; Merck, Sharpe and Dohme; E. Merck; Pfizer; and Smith Kline Beecham (SKB).

In addition to these activities, several companies have actively supported research into the health impact of intestinal parasites: SKB has funded programmes in Kenya, Jamaica, Malaysia, Mexico, Montserrat, Nigeria and Zimbabwe; ICI Pharmaceuticals in Indonesia, Kenya, Myanmar, Nigeria, Panama and Sierra Leone. Global Health Partners, a group supported by a venture capital company, is currently supporting investigations into the pharmacodynamics of multiple drug interactions.

These are only some of the activities currently undertaken by the commercial sector, and a more detailed inventory of the health research activities of the private sector is required.

### 5. STRATEGIES FOR REDUCTION IN MORBIDITY AND MORTALITY

The primary and achievable aim of intestinal parasite control programmes is the reduction of morbidity and the avoidance of mortality. The secondary aim is the reduction of transmission. A range of strategies for the control of intestinal helminths is given in the WHO Expert Committee Report.<sup>25</sup>

#### 5.1 Survey Methods

The gathering of information on the prevalence of infection and morbidity is an essential pre-requisite for control implementation. Pre-control data are necessary for both the design and evaluation of control programmes (see below). It is recognized that both the quality and quantity of available data will vary considerably between regions and that it may be necessary to undertake specific surveys before implementing control. Appropriate survey methods are described in PDP/85.4, "Surveillance and Survey Methodology for Intestinal Parasitic Infections".<sup>30</sup>

## 5.2 Diagnosis

Diagnostic methods are required for evaluation and monitoring, as well as for those control programmes which involve screening individuals for the presence of infection. Appropriate methods are described in "Diagnostic Techniques for Intestinal Parasitic Infections Applicable to PHC".<sup>28</sup>

## 5.3 Chemotherapy

## (a) Anthelmintics

The major anthelmintics in common use for the treatment and community control of geohelminth infections are listed in Table 2.<sup>25</sup> It should be noted that albendazole and mebendazole are effective for all the major geohelminth infections. Albendazole is currently on the WHO Model List of Essential Drugs only for the treatment of larval cestodiasis. It is recognized that the choice of anthelmintic will vary with region, depending on local availability, cost and infection pattern. Indication and contraindications are given in the WHO Model Prescribing Information.

Table 2  
Anthelmintic activity of selected drugs in frequent  
use at the community level

	Therapy Activity				
	Ascaris	Hookworms	Trichuris	Strongyloides	Enterobius
Albendazole	+	+	+	+	+
Levamisole	+	+	+/-	+/-	+/-
Mebendazole	+	+	+	+/-	+
Piperazine	+	-	-	-	+
Pyrantel	+	+	-	-	+

(Therapeutic activity based on cure rates: + => 60% activity; +/- = 20-59% activity; - = 0-19% activity which is indistinguishable from technical errors associated with the techniques of examination). Mebendazole results for hookworm and trichuris are with multiple (3 day) treatment. All other results are for single treatment.

## (b) Treatment Schedules and Doses

Treatment of geohelminth infection should be more frequent during the early phase of a programme, with up to 3 treatments in the first year in areas of high endemicity. Annual treatments should thereafter be maintained. Longer intervals of 18 months to 2 years may be acceptable in areas where hookworm is the major infection.

All programmes should be monitored to ensure the adequacy of the treatment schedule.

Programmes should use anthelmintics at the doses recommended in the WHO Model Prescribing Information. It is recognized, however, that lower doses may have similar efficacy and have the advantages of reducing side-effects and costs. Options for dose reduction are currently being considered.

(c) Pharmacodynamics and Drug Interactions

The use of more than one anthelmintic to provide treatment for a broader range of infections has been reviewed by TDR/CTD in document TDR/STAC12/90.5, "Use of multi-disease chemotherapy for control of human helminth infections" and by an Informal Consultation on Multi-Drug Chemotherapy held in Geneva, 14-16 May 1990. The present group noted the recommendations of the consultation report (p.8, para 9), and adds the following comments:

- (i) After completion of the proposed studies on albendazole with praziquantel, similar studies should be conducted to examine combinations involving other drugs for geohelminths (e.g. pyrantel and levamisole) which are used and accepted in some areas.
- (ii) In vitro toxicity studies, perhaps leading to acute toxicity studies in laboratory hosts, should be initiated for the combination of ivermectin, praziquantel and albendazole.
- (iii) When appropriate, clinical studies should be undertaken to determine the optimal sequence for treatment with albendazole and praziquantel, with the aim of determining whether it is necessary to treat first for ascariasis.

5.4 Approaches to Treatment Delivery

"General strategies for prevention and control of intestinal parasitic infections within PHC"<sup>27</sup> provides guidelines for a broad range of control options. The selection of a particular option will depend on the epidemiological situation, as well as local logistic and economic resources.

Chemotherapy offers the major advantage of immediate morbidity reduction and achieves a rapid improvement in public health. However, in order to sustain these gains it is essential that chemotherapy programmes are situated within the context of health education programmes (see 5.7) which promote improvements in sanitation (see 5.5).

The selection of appropriate treatment delivery approaches will depend on local circumstances, but specific options are considered below:

(a) School-Based Control Programmes

Since the school-age child harbours the most intense infections with Ascaris, Trichuris and some other helminth infections, treatment of this age group achieves the maximum return per treatment in terms of morbidity and transmission reduction. In addition, children in school are one of the most accessible groups for treatment.

It is, therefore, recommended that school-based control programmes be implemented in areas where school enrolment is appropriate (greater than 60% of the school-age population). It is recognized that enrolment varies both between and within countries, and thus flexibility must be adopted in implementing school-based programmes. In all areas, treatment of children who do not attend school should be encouraged.

In developing such programmes the potential role of teachers, and other non-traditional participants in the health delivery system, should be given active consideration.

Treatment without prior screening offers significant logistic and economic advantages. It is recommended that treatment without prior screening be used where coprological surveys of school-age children indicate the prevalence of geohelminth or schistosome infection exceeds 50%. This guideline is based on current estimates of morbidity relative to prevalence<sup>13</sup> and is subject to revision and reassessment, particularly with respect to procedures being developed by the Parasite Epidemiology Research Group, Imperial College, London.

In deciding on the use of treatment, the following factors may indicate that rates of prevalence below 50% would also justify the use of treatment without prior screening:

- (i) the common presence of multiple infections which may potentiate morbidity;
- (ii) the existence of 25% mild - moderate underweight (see ACC/SCN guidelines);
- (iii) perceived need for treatment based on the existence of chronic or acute morbidity;
- (iv) inadequate standards of sanitation;

- (v) vitamin A deficiency or iron deficiency anaemia (see guidelines)<sup>21</sup>;
- (vi) where other approaches are impractical for socioeconomic reasons.

(b) Other Community Orientated Programmes

In areas where both geohelminths and schistosomiasis infections are endemic it will be necessary to deliver two treatments: an anthelmintic for geohelminths, and another for schistosomiasis. Details of doses and schedules for treatment of schistosomiasis are given in the Report of the WHO Committee.<sup>25</sup>

The nature of the interaction (if any) between these drugs is unknown (see 5.3 (c) above). The treatments should, therefore, be given sufficiently far apart to avoid any possibility of interaction. It is recommended that they be given on two separate occasions not less than one week apart. These guidelines will be reviewed in the light of the current studies of TDR/GTD on drug interactions.

In areas of high endemicity of hookworm, and where this is the predominant infection, it is necessary to include adults in the treatment programme since the most intense infections with this parasite occur in the adult population. The adult programme should be additional to the school programme and developed as an extension of it. Treatment may be delivered to adults: using schools as the focus of delivery; through PHC programmes, including MCH activities; and through existing occupational structures.

#### 5.5 Sanitation and Safe Water

The provision of safe water supplies and the sanitary disposal of faecal waste has health and sociological implications far beyond the control of intestinal parasites. These activities are an essential component of health development and are promoted within existing PHC structures. Programmes to control intestinal helminths can provide a potentially important focus for the promotion and monitoring of sanitation programmes, due to the strong community perception of the need for parasite control. Integration of these two areas should be considered in the development of any public health initiatives aimed at reducing morbidity due to intestinal helminthiasis.

When developing school-based treatment programmes consideration should be given to the importance of providing adequate sanitation in schools in order to promote hygienic practices in children.

## 5.6 Vaccines

No vaccines are currently available for human helminthiases. Vaccines have been developed for two veterinary helminthiases, lung worm in cattle and hookworm in dogs. Current research activity for human helminth vaccines is focussed on schistosomiasis and filariasis, with some work on human hookworm infections, cysticercosis and echinococcosis. All these studies are currently confined to laboratory models and it seems unlikely that any vaccine will be available for human use in the foreseeable future. Were a successful vaccine to be developed it would be of use in enhancing control approaches.

## 5.7 Health Education & Community Involvement

A linkage between education programmes and anthelmintic delivery programmes offers an opportunity for synergism leading to mutual reinforcement. The necessarily regular visits to deliver treatment can serve as foci for re-addressing health issues within the community. These activities are likely to be particularly closely linked in the case of school-based programmes.

The development and promotion of messages should involve a broad range of expertise drawn inside and outside WHO. Most importantly, the messages should be developed by and with the community to which they are addressed. Particular attention should also be paid in implementation to the defining of the responsibilities of the whole educational team, and to encouraging a multisectoral approach.

The new initiative by UNESCO into the school health area is recognized as an important development within the UN System, and as a recognition of the multiple linkages that are involved between health and education.

## 5.8 Cost-Effectiveness

With regard to the control of a specific disease or groups of diseases, their importance relative to other diseases must be determined in terms of prevalence, morbidity and mortality. The effectiveness of the control measures available must then be considered ranging from ineffective to highly effective. If certain measures are deemed effective enough, their costs and benefit must be determined. In the overall decision to initiate control measures the importance of the problem and the costs and benefits of the measures must be considered relative to all other health problems.

## 6. CONTROL OF TAENIASIS-CYSTICERCOSIS

Neurocysticercosis in humans has a considerable impact on human health and is a life-threatening condition in specific foci, particularly in Latin America. Taeniasis is the only source of cysticercosis for both man and the intermediate host, pig, and hence treatment of humans can potentially remove the source of infection. Effective and practical intervention is available through chemotherapy with a single low dose of praziquantel. Cysticercosis diagnosed in pigs can be used to identify foci for community treatment. The infection rate in pigs can also be used for monitoring the actual transmission in the endemic area.

Such control interventions involve relatively low cost as they use existing veterinary and medical services for delivery, and have the advantage that they may be very effective in strengthening the veterinary and medical cooperation in the field.

National and international commitment for implementation of the control measures is already developed in Latin America.

## 7. OPPORTUNISTIC HELMINTH INFECTIONS IN AIDS

Disseminated strongyloidiasis was at first considered to be a potentially major problem in individuals with HIV infection, and indeed was considered to be a criterion for the definition of AIDS. Subsequent experience, however, has shown little evidence to support this - only 6 cases of extra-intestinal strongyloidiasis have been reported from AIDS patients<sup>18</sup> - and it has been deleted from the AIDS Criteria.

## 8. SURVEILLANCE, MONITORING AND EVALUATION

Two documents are available on these issues: "Planning, Implementation, Monitoring and Evaluation of the Control of Intestinal Parasitic Infections Programmes";<sup>29</sup> and "Surveillance and Survey Methodology for Intestinal Parasitic Infections".<sup>30</sup> They provide valuable guidelines, but they require revision and updating (see 10. below), particularly with regard to evaluation of health education programmes. Evaluation of socioeconomic factors is an area in which more specific guidance is required, and further research in this area is encouraged.

Evaluation of control requires special skills which are rarely provided by existing training programmes. This issue is addressed in section 10. "Training", below.

## 9. IMPLEMENTATION WITHIN OTHER PROGRAMMES

There are significant advantages in cost and sustainability of linking parasite disease control programmes with other health sector activities. Such linkages may also be mutually reinforcing.

The most obvious linkage is between parasite control programmes. The schistosomiasis control activities of CTD/SCH, for example, have provided a vehicle for training in helminth control in general. In Botswana and Mauritius following schistosomiasis control activity, there has been a transition to intestinal helminth control during the maintenance phase.

Anthelmintic delivery programmes may also form mutually reinforcing linkages with sanitation programmes. The immediate benefits of chemotherapy can be reinforced with sanitation, while the visible consequences of treatment enhance acceptance of the sanitation programmes.

There may also be areas of collaboration between human health and Veterinary Public Health (VPH) programmes, such as the control of taeniasis in 8 countries of Latin America, as is being currently considered by PAHO.

Perhaps the most important area of potential collaboration at present is within the UN System. The new initiatives of UNESCO and UNICEF signal important new directions within these organizations and cooperation and communication should be encouraged.

## 10. TRAINING

### 10.1 Programmes

The major training need is to strengthen local skills in evaluation and programme management. This requires training at a senior level, and is additional and complementary to current programmes focussing on training at the field implementation level. Diagnostic laboratory work is important in providing the data for evaluation, but an additional managerial structure is required to collate, analyse and interpret the data produced.

In identifying training programme requirements it should be recognized that there is a potential role for several government agencies, including those concerned with education as well as health. This may be particularly important where the approach involves treatment delivery through the school system.

### 10.2 Documentation

The content of the existing WHO unpublished documents is of considerable value to personnel concerned with field implementation of control programmes and every effort should be made to increase access. A reduction in length might allow the various documents to be brought together in a single field manual. Consideration should also be given to translation, particularly with respect to increasing access for health workers in Latin America.

The current range of documents should be extended to include information on chemotherapy and procedures for assessment of health education interventions. Consideration should be given to preparing documents in each of these areas.

## 11. RESEARCH

The implementation of control programmes provides a unique opportunity for operational research. The results of such research can be used to modify existing programmes and to enhance the development of future programmes. The linkage of research to control activity has the additional economic advantage of being supported at the margins of control costs.

Important areas that require further or additional investigation include:

- (i) assessment of the effects of intestinal helminth control on the cognitive development of children, and on other factors influencing educational attainment and access;
- (ii) identification and quantification of the morbidity associated with intestinal helminth infections and the health benefits that accrue following control actions;
- (iii) comparative studies on the effectiveness and costs of control programmes, including those advocated in this Consultation;
- (iv) assessment of the socioeconomic consequences of control activity in endemic communities and the role of health education in control;
- (v) assessment of the contribution of intestinal helminth infection to malnutrition in communities, especially those where there are other social and environmental causes of malnutrition;
- (vi) investigation of the mechanisms of malnutrition and anorexia, the cultural determinants of food intake, and the development of diarrhoeal and respiratory disease associated with intestinal helminth infection;
- (vii) evaluation of the effects of control programmes on physical work capacity and production, particularly with respect to hookworm infection.
- (viii) mathematical epidemiological studies to quantify the relationship between infection prevalence and morbidity;
- (ix) assessment of the pathogenesis of disease, in particular the relevance of nutrition to growth stunting in intestinal helminth infection;
- (x) studies of the interaction between anthelmintics in vitro and, if ethically appropriate, in vivo to assess safety, efficacy and synergy.

These research aims, some of which coincide with those identified<sup>21</sup>, can be satisfied through integration of studies with control activities. The latter research areas are of direct relevance to control, but do not require a direct linkage with control activity.

## 12. RECOMMENDATIONS

1. The tools for the control of intestinal helminth infections are adequate to achieve a substantial impact on health both through parasite specific control programmes and through integration with existing health programmes (e.g. sanitation, PHC, occupational health, health education) and funding for such programmes should be actively sought.
2. Further development of cost-effectiveness analyses is considered a major priority.
3. The planning and evaluation of control activity should be developed or strengthened to include the training of programme planners and evaluators, and the regional offices should play a more active role in evaluation.
4. There is an urgent need for epidemiological studies of the relationship between infection and morbidity, especially clarification of the levels which justify intervention.
5. There is a need for more understanding of the effects of intestinal helminths on nutrition, growth and development. The research recommendations<sup>21</sup> are endorsed, and extended to include all major helminths.
6. Research is required into the effects of helminth infection on cognitive development and educational attainment and access.
7. There is a need to increase the availability to decision-makers of standardized data on the morbidity and nutritional consequences of intestinal helminth infection.
8. In order to improve control programmes, every effort should be made to incorporate operational research in such programmes.
9. A detailed inventory of the health research activities of industry, relating to helminths, should be established and maintained.
10. The current activities of TDR/CTD in developing a multiple disease control approach should be extended to examine additional anthelmintic combinations. In vitro pharmacological studies on a broader range of multiple-drug combinations should be implemented.
11. Every effort should be made to encourage collaboration between parasite control activities within WHO, and between WHO and the initiatives of other UN Agencies, such as UNICEF and UNESCO.

12. The existing PDP unpublished documentation on intestinal helminths requires up-dating and revision. New documents on chemotherapy and the assessment of health education are required. Incorporation of the documents into a field manual would be desirable.
13. A specific consultation on control procedures for intestinal protozoan infections is required.
14. Where ivermectin is used observations should be made on the effects of the anthelmintic on intestinal helminth parasites.

Annex 1  
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