

WHO-EM/SCHIS/97-E
February 1987

**REGIONAL WORKSHOP ON RECENT ADVANCES IN
THE STRATEGIES FOR SCHISTOSOMIASIS CONTROL**

Wad Medani, Sudan, 12-24 October 1985

(Meeting Reference: INC.WKP.SCH.CNT/11)



**WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR THE EASTERN MEDITERRANEAN
1987**

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1. INTRODUCTION

A Regional Workshop on Recent Advances in the Strategies for Schistosomiasis Control was held in Wad Medani, Sudan, from 12 to 25 October 1985. The inaugural meeting of the Workshop took place in the Blue Nile Health Project Conference Hall, under the chairmanship of the Governor of the Central Province. The Director-General of the Blue Nile Health Project welcomed delegates from Member States, WHO staff members and observers.

The Regional Adviser, Parasitic Diseases, read the message of the Regional Director, Dr Hussein A Gezairy. In his message of welcome Dr Gezairy thanked the Government of Sudan for having kindly agreed to host the workshop, the staff of the Blue Nile Health Project for their collaboration and the participants for their efforts in preparing the workshop. He emphasized the importance of schistosomiasis, referring to its increase in prevalence and distribution in the Eastern Mediterranean Region in recent years. Reference was made to recent developments in the epidemiological strategies, improvements in diagnostic techniques and the development of more efficient, safe and easily administered drugs which made the control of schistosomiasis a more realistic and attainable target than heretofore. The Regional Director concluded his message by wishing the participants a pleasant stay in Wad Medani and a successful workshop.

The Agenda and Programme of Work of the workshop are presented in Annex I and II respectively. The Workshop was attended by delegates from Democratic Yemen, Egypt, Iraq, Jordan, Morocco, Saudi Arabia, Somalia, Syrian Arab Republic, Tunisia and Yemen. WHO staff from Headquarters and the Regional Office acted as Secretariat and resource personnel (Annex III)

At the first session of the Workshop, Dr Omar Tamim was elected Chairman and Dr M.R. Tawfik Rapporteur.

2. OBJECTIVES

The objectives of the workshop were: to gather up-to-date information on the epidemiological situation of schistosomiasis; to review applied and recent advances in control strategies; to develop appropriate methodologies for collection of information on schistosomiasis and its control; to identify the role of primary health care in schistosomiasis; and to assess training and research needs for schistosomiasis control in the Eastern Mediterranean Region (EMR).

3. SCHISTOSOMIASIS IN THE EASTERN MEDITERRANEAN REGION

Schistosomiasis remains one of the most important and serious public health problems in EMR due to its socio-economic impact and the toll it takes on health, ranking second only to malaria. The disease exists in a number of countries of the Region. Although endemicity varies from one country to another, the disease is of particular significance in Democratic Yemen, Egypt, Iraq, Somalia and Sudan.

Intervention techniques in attempts to control schistosomiasis by breaking transmission of the disease are beyond the financial, technical and personnel resources of some Member States with endemic schistosomiasis. On

the other hand, a technology and a strategy are now available to bring schistosomiasis under control; this augurs well for the future. The discovery of safe, well-tolerated and highly effective oral drugs and the low-cost diagnostic techniques used in rural areas have already produced dramatic results in several endemic countries through their primary health care (PHC) services at different levels, e.g. Egypt, Saudi Arabia and Sudan. Plans and PHC programmes are under way to improve schistosomiasis control activities in other Member States.

The main objective of the Regional programme is to reduce the incidence of schistosomiasis, utilizing the WHO new strategy, focused on people and their behaviour. This strategy is based on health education, widespread diagnosis and treatment, access to safe water and sanitation, environmental management and modification, snail control and intersectoral cooperation in agricultural and water resources development schemes. The Regional Office is continuing its trial of building up in each endemic country a core of national experts, through training of nationals at all levels, both locally and abroad, besides the provision of information and expertise

4. COUNTRY SITUATIONS

4.1. Democratic Yemen

Schistosomiasis is a recognized health problem in Democratic Yemen. Background information available on the problem and the programme planned for schistosomiasis control is very limited. However, from various surveys and studies conducted, it has been well established that schistosomiasis is more prevalent in Lahej, Abiyan and Hadhramaut Governorates than in the rest of the country. Case detection at present is only effected through hospitals, health centres and other health institutions

Both urinary and intestinal schistosomiasis exist, the predominant species being *S. haematobium*. The infection rates with *S. haematobium* found during limited studies were 17% in Dhala, 66% among schoolchildren and some adults in Al-Azarik, 34% in Battis and 12% in Dirgag. Infection with *S. mansoni* was 9% among schoolchildren in Mussaymir.

It is highly recommended to reestablish the schistosomiasis project in Democratic Yemen as soon as possible. It should start in a limited area and be gradually extended as facilities and trained personnel become available.

4.2. Egypt

Schistosomiasis, the most prevalent and serious endemic disease in Egypt, has always been ranking the first among public health problems in the country. The disease has acquired its endemicity through the construction of an enormous network of open canals and drains for perennial irrigation, leading to intensive human/water contact. The population living in endemic areas of the country is estimated to represent about 40%.

S. haematobium and *S. mansoni* co-exist in Egypt. The former is widespread throughout the country, with prevalence rates exceeding 50% in certain communities, while the latter is confined to the Nile Delta and northern parts of Giza Governorate. Recently sporadic cases of *S. mansoni* have been reported in almost all governorates in Upper Egypt.

Bulinus truncatus and *Biomphalaria alexandrina*, the intermediate hosts for *S. haematobium* and *S. mansoni* respectively, are commonly found in irrigation canals, drains etc. Male human subjects are more infected than females, while children and young adults harbour most infection.

For a long period the strategy of the national control programme was based on multiple approaches, i.e. chemotherapy with snail control, health education and, when feasible, improvement of sanitation in the environment. Recently the PHC approach was adopted; the infrastructure of health services in the rural sector of Egypt has been a great asset in the country's experience in schistosomiasis control. This has been further augmented by introducing the concept of outreach activities and community participation.

Lately, the Ministry of Health adopted a "National Bilharziasis Control Programme" aiming at control of transmission and eventual morbidity control, to be implemented in 10 areas sharing natural borders, similar environmental circumstances and/or common sources of irrigation. The strategy comprised selective population chemotherapy and area-wide mollusciciding besides enhancement of health education programmes, particularly among schoolchildren. The programme has been implemented, by priority, in the Middle Egypt Area since 1977, the Upper Egypt Area since 1980 and Giza Governorate since 1983. Chemotherapy has been integrated within PHC delivered through rural health units and centres available in almost all villages with a population of 4000 or more. Metrifonate was the regimen adopted for treatment; however, lately praziquantel has been employed for *S. mansoni* in villages where prevalence is higher than average for the district concerned.

There is strong evidence that, with the implementation of the new policy based on treatment and community participation, the prevalence of the disease and its endemicity have been substantially reduced over the last few years (8.5%) particularly with regard to morbidity.

4.3. Islamic Republic of Iran

In Islamic Republic of Iran, *S. haematobium* is found mainly in Khuzestan, the population of which was estimated in 1976 at 150 000, i.e. 0.4% of the total population. Other foci have also been discovered in the surrounding provinces where evidence of transmission exists. *S. mansoni* is extremely limited in its distribution.

Khuzestan is under an extensive development programme which includes the construction of several dams and the large-scale extension of new irrigation systems. The control of urinary schistosomiasis by a combination of mass chemotherapy using niridazole (Ambilhar) and focal treatment of different types of snail habitats with the molluscicide niclosamide (Bayluscide) against *B. truncatus*, the only intermediate host of *S. haematobium* in the area, has been under way since 1966.

Combined use of chemotherapy and mollusciciding were continued annually in all seasons but the main activities were concentrated in spring and autumn. Data collected on the prevalence rates of infection in the area indicated a gradual decline from 8-3% in 1970 to 1% in 1976 and 1977.

In parallel with mass chemotherapy, the number of Bulinus-infested habitats also decreased due to annual mollusciciding. The percentage of infested habitats declined gradually each year, from 10% in 1970 to 1.6% in 1977.

4.4. Iraq

In Iraq, in the middle and lower river valleys, schistosomiasis is highly prominent; prevalence was found to increase with increased irrigation. It was estimated that almost half-a-million individuals were infected with *S. haematobium* in 1972. The population at risk (living in endemic areas) was estimated at 5.31 million in 1976 (46.1% of total population).

Urinary schistosomiasis is considered to be an important public health problem in Iraq, second only to malaria. High prevalence of the disease is found in rural areas, especially in children. It is particularly common in the central and southern provinces, with one snail focus in the north.

Measures for environmental control in cooperation with the Ministries of Agriculture and Irrigation are being undertaken at present at this northern focus, which is being considered as an experimental and control area. The intermediate host *B. truncatus* disappeared from control and experimental areas during 1969 and 1972 respectively after sodium pentachlorophenate application. Primary schoolchildren in the most endemic experimental area which serves as an index have been showing a continuous decline in schistosomiasis prevalence, from 90% in 1960 to 0.4% in 1977. Schistosomiasis prevalence in the preschool children (2-6 years age group) fell from 67% in 1961 to nil in 1977. The project area was expanded during 1968 by addition of adjoining areas. Screening of Egyptian immigrants to Iraq (agricultural and manual labourers) with appropriate treatment has been carried out since 1976.

Fortunately all snails in Iraq have proved refractory to *S. mansoni* infection.

4.5 Jordan

Urinary schistosomiasis was recognized as a possible public health problem in Jordan only in 1975, following the discovery of a case which appeared to have been contracted in the country. The snail intermediate host *B. truncatus* was also detected for the first time in the same year, in Muthalath El Masri area in the Jordan Valley.

Transmission of schistosomiasis had never been proven to occur in Jordan until 1984 when 24 Jordanian citizens from El Berbita Springs area, most of whom had never travelled outside Jordan, were discovered to be infected with *S. haematobium*. In addition, more habitats infested with *B. truncatus* were detected. In 1979 a focus was discovered in two ancient Roman pools near Jerash and in 1980 snails were found in large numbers in King Talal Dam basin. Since then the snails have been discovered at many sites in the Jordan Valley and in Yarmouk River.

Every year thousands of agricultural workers enter Jordan from schistosomiasis endemic countries; the Ministry of Health estimates that 23% of these workers are infected with *S. haematobium*.

This, together with the emergence of a susceptible *B. truncatus* in the various water bodies, poses a potential for the establishment of schistosomiasis transmission in Jordan.

Surveillance and control activities are undertaken by the Malaria and Schistosomiasis Department, Ministry of Health. These activities consist mainly of urine examination of all expatriates coming to Jordan for employment in the Jordan Valley, with free treatment of all infected persons and follow-up for six months, and comprehensive search and destruction of intermediate hosts by means of molluscicides.

4.6. Saudi Arabia

In Saudi Arabia, schistosomiasis is focal in distribution, affecting widely scattered areas. The population at risk was estimated in 1976 at one million (14.2% of total population). Both *S. haematobium* and *S. mansoni* are endemic within the Kingdom. *S. haematobium* reaches its highest prevalence in the Gizan province, it is also present in various regions of the country, e.g. Najran, Riyadh, Mecca and Medina. The estimated prevalence was 60% in affected localities in the early seventies, however, it was brought down to 32% in Najran in 1977 as a result of the schistosomiasis control programme. *S. mansoni* is also present in some parts of the country.

The prevalence and intensity of infection with both intestinal and urinary schistosomiasis which are found in at least 12 areas have been declining, especially in the last three years. The strategy of schistosomiasis control consists mainly of case finding and treatment of all cases besides health education of the community. Snail control is carried out through environmental modification and proper focal mollusciciding. The success of the programme depends on the integration of all control activities into the widely and adequately distributed health care units throughout schistosomiasis-infested areas.

The strategy is to examine at least 80% of the population of each area and give treatment to all cases detected. Cooperation of the public was achieved to a remarkable extent through health education and participation of communities in their health matters, initiated through PHC.

Training programmes in the control of schistosomiasis had been included in the training of the personnel in the PHC units. WHO publications in Arabic on control operations of schistosomiasis and their integration into PHC are being distributed to all participants. The successful results of intersectoral cooperation and collaboration between various departments of the Ministries of Health, and other Ministries were most encouraging.

4.7. Somalia

Schistosomiasis is a significant public health problem in Somalia, particularly in the southern regions where the two perennial rivers Shabelli and Juba comprise the major water sources. The interriverine area is large and thickly populated; the most productive agricultural development scheme areas are located there. Schistosomiasis is mostly confined to six riverine areas with an estimated population of over 1.7 million people, i.e. Lower Shabelli, Middle Shabelli, Lower Juba, Middle Juba, Gedo and Hiran regions. In these endemic areas, the disease has shown a high prevalence rate, estimated at 50% overall. *S. haematobium* is the only species known up to

date, although *Biomphalaria*, the snail intermediate host of *S. mansoni*, is present in the northern part of the country.

Programme activities for the control of the disease started in 1976. The years which have elapsed since the beginning of the programme have not been conducive to the identification of an effective and practical strategy for the control and consequently the reduction of morbidity. The present structure and resources are not sufficient for a large scale vertical operation covering the six endemic areas. Therefore, for the time being, activities have been confined to the Lower and Middle Shabelli regions. As the PHC programme steadily expands its activities in rural areas in Somalia, it is advisable to integrate schistosomiasis control activities within this programme.

All confirmed cases are treated with either metrifonate or praziquantel.

Snail control is effected through both mollusciciding and environmental management operations. Health education is a major tool for community mobilization and is carried out routinely by the health staff at district and regional levels, in collaboration with the Health Education Unit at the Ministry of Health. Organization of refresher courses for in-service staff is a continuous process.

4.8. Sudan

Schistosomiasis has been known since the beginning of the century to exist in Sudan, in the North along the Nile, in the West in water pools and seasonal streams and in various regions of the South. Surveys showed that there was a steady increase of cases between 1954 and 1974. The population at risk living in endemic areas was estimated at 15 million in 1976 (93% of total population). The case:population ratio is highest in Khartoum, Darfur and Blue Nile provinces, the latter province is considered the centre of the problem with its huge irrigation schemes.

However, the history of the disease entered a new phase with the opening of the Sennar Dam in 1925 and the Gezira irrigated scheme. Due to the lack of an efficient strategy for schistosomiasis control the prevalence of infection in this area flared up to an average of 70-80%. Consequently the Blue Nile Health Project (BNHP) was established in 1979. This ten-year project was aimed at control of major diseases associated with irrigation in agricultural communities along the Blue Nile.

In the BNHP, which is the largest integrated disease control project in the Region, community participation was fostered through the establishment of village health committees composed of social and religious leaders. Volunteers were trained in the application of molluscicides and in the chemotherapy of schistosomiasis by the staff of the BNHP, and then took over these responsibilities in their respective villages. The BNHP has successfully attempted to control transmission of schistosomiasis by the screening of immigrants and chemotherapy of those found infected, plus focal snail control. The maintenance phase has continued and is being strengthened by the introduction of other interventions to maintain the low levels of disease achieved during the attack phase (9 9%); these include formation of village health committees, health education meetings, maintenance phase microscopy, follow-up chemotherapy, routine monthly water contact inspection for snails and focal mollusciciding.

4.9. Syrian Arab Republic

Schistosomiasis has a focal distribution in Syrian Arab Republic with comparatively low prevalence rates. Urinary schistosomiasis, which was endemic in the early 1950s in the Kamichly area in the north-east of the country, was effectively controlled by a specific WHO-assisted project and practically disappeared from the area. However, in the early 1970s it reappeared in the Balick river locality in endemic form. A WHO-assisted project has been in operation since 1975 but WHO technical assistance ceased in 1984. *S. haematobium* is the only human schistosomiasis parasite in Syrian Arab Republic and is transmitted by the snail *B. truncatus*.

Snail control operations started in 1977 with the use of Bayluscide, treatment of cases was by means of niridazole initially and more recently praziquantel.

The persistence of schistosomiasis transmission is attributed to environmental factors, in addition to lack of well-trained personnel. There is an urgent need to study the focality of schistosomiasis, bearing in mind that the absence of domestic water supplies in the affected villages is at the root of water/child contact involving mainly natural water courses or ponds. The focality study should provide guidance for the conduct of concurrent treatment of patients and foci of infection. The prevention of schistosomiasis should be seen as a combined intervention entailing concurrent health education of the public and provision of domiciliary water supply.

4.10. Tunisia

Urinary schistosomiasis was found to be endemic in Southern Tunisia, occurring in many localities (most of them oases) from the Governorates of Gabes and Gafsa, with an isolated focus in the Governorate of Kairouan. The population at risk (between 150 to 200 thousand) was submitted to a parasitological survey that identified 11 596 positive cases. Prevalence in endemic areas was 6.6% but many localities, e.g. Guettaya, Mansoura, Djidida and Ouled Tlihane, presented infection rates between 30 and 70%. The only molluscan vector was *B. truncatus*.

Control measures started in 1971 at the oasis of Guettaya and were extended step by step throughout the whole endemic area. The last transmission foci were identified at Nouail in 1975 and at M'naga/Gafsa oases and Ouled Majed (Degache) in 1976. The overall prevalence in these localities (14 000 inhabitants) fell from 34.1% in 1973 to 0.6% in 1978. Data suggest that, due to control measures and spontaneous cure of non-treated cases, human sources of schistosomiasis will tend to be exhausted in the years to come. The population at risk is estimated at 169 515, which represents 2.9% of the total population. However, relaxation in control measures recently resulted in the spread of the disease particularly in Gafsa area.

4.11. Yemen

Schistosomiasis is one of the main public health problems in Yemen. Over one million of the population are infected with either one or both types of the disease with the highest prevalence in the Governorates of Taiz and Ibb. The distribution of both types is focal and patchy over most of the country and follows the uneven distribution of the water sources.

Three species of freshwater snails of the genus *Bulinus*, *B. truncatus*, *B. wrighti* and *B. beccarii*, are responsible for transmission of *S. haematobium* while *Biomphalaria pfeifferi* is the sole snail intermediate host responsible for the transmission of *S. mansoni* in Yemen.

Most of the activities in the various units of the Schistosomiasis Control Project are concentrating on case-finding among referred cases from hospitals and private laboratories and treatment of infected cases. Diagnosis and treatment of schoolchildren are concentrated in the main urban centres and nearby villages. The drug used is praziquantel.

The prevalence rates of urinary schistosomiasis among various units in Sana'a, Hajjah and Saada were 4.44%, 39.18% and 2.73% respectively, while the rates for intestinal schistosomiasis were 48.15%, 68.83% and 41.24% respectively

Treatment of snail-infested habitats is carried out with both dripping and focal spraying methods twice a year by Bayluscide but reinfestation has often occurred. Moreover, the presence of many ponds in the main urban centres in the various provinces constitutes a major health hazard for the inhabitants who use them for recreational facilities. The new Maarib dam now under construction should also be considered as a possible health hazard. It is merely a matter of time for snails to find their way to the project area, especially since both schistosomiasis and the snail intermediate hosts are found in the catchment area.

Recently a plan of action for effective schistosomiasis control on a large scale was formulated. The proposed plan will be carried out in three operational phases in collaboration with WHO

5. RECENT ADVANCES IN CONTROL STRATEGY

5.1. A strategy of morbidity control

5.1.1. Definition

The primary objective of schistosomiasis control is the reduction or elimination of morbidity due to the infection. To achieve this objective a plan of action aimed at reducing the number of adult *Schistosoma* worms in the population should be established and carried out, since the reduction/control of the adult worms producing the eggs in man will consequently reduce the risk of the development of the disease. The number of worms present is evidenced by the number of *S. mansoni* eggs per gram of faeces or the number of *S. haematobium* eggs per 10 mL of urine. Quantitative parasitological diagnostic techniques now in common use permit the definition of reasonably precise reductions in prevalence and/or intensity of infection.

5.1.2. Background

In the past the objective of schistosomiasis control has been clearly stated as being the interruption of transmission. The idea inherent within this objective was that eradication of the disease was possible. After 30-40 years of experience in snail control in the major endemic areas of the world it became confirmed that this objective could rarely be attained with

the existing tools. In a few small foci with unusual epidemiological characteristics, such as a single waterbody as a source of transmission, the cessation of transmission has been achieved after a single intervention effort. In other areas, such as Japan, general economic development has been more responsible for the interruption of schistosomiasis transmission than any specific intervention

Public health workers tend to fear that unless schistosomiasis has been stopped, a control programme cannot be declared a success; whether this attitude is realistic is questionable. Perhaps it is a sign of our times that the strategy of control of schistosomiasis should change. By adopting a strategy of control of morbidity it becomes possible to define feasible and attainable objectives in realistic terms, and thus it is no longer necessary to pursue the unreachable goals which have frustrated schistosomiasis control efforts in the past. The government of the country concerned will have to realize that the requirements in financial and human resources will be higher than it can probably afford if the interruption of transmission is chosen as the primary objective of schistosomiasis control in an endemic area

Furthermore, as peripheral health services and primary health care activities are strengthened, diagnosis and treatment of schistosomiasis as well as of other parasitic diseases will be facilitated. Integration of schistosomiasis control into the health care system is necessary to assure maintenance and surveillance

The reduction of the disease caused by human *Schistosoma* infection in an endemic area is an objective based on sound epidemiological principles; also it is feasible and can be achieved within the limitations of each and every endemic country. Never before in the history of schistosomiasis have the prospects for its control been more optimistic. During the past 20 years, schistosomiasis control operations have profited from a better understanding of the epidemiology of the disease, simplified quantitative diagnostic techniques and the development and field use of new anti-schistosomal drugs.

5.2. Epidemiological basis

The epidemiology of schistosomiasis is not necessarily uniform within an endemic country nor it is comparable between countries. Water resource development projects for irrigation and agricultural purposes can modify an endemic area with seasonal and highly focal schistosomiasis transmission into one with intense, widespread and constant transmission.

Since the introduction of quantitative urine filtration techniques a large body of data from well-defined communities where *S. haematobium* is endemic has become available. The peak prevalence and intensity of infection generally occurs in children 10-14 years of age. In general, 60-70% of all infected persons are 5-14 years of age and, furthermore, about 75-80% of all persons who have more than 50 eggs per 10 mL of urine are also in this age group

In children and adults, increasing levels of haematuria and proteinuria are associated with increasingly heavy *S. haematobium* infections. Cytoscopic, renographic and radiological changes in the urinary tract are associated with heavy infections in children. In several studies, haematuria was detected by

reagent strips in nearly all children (98-100%) with more than 50 *S. haematobium* eggs per 10 mL of urine. Among all infected children, 80% had haematuria.

In *S. mansoni* endemic areas a small proportion (6%) of the infected population excretes at least 50% of the total number of eggs contaminating the environment. Most of these heavily infected persons are between 10 and 14 years of age. A high proportion of children with *S. mansoni* egg counts of over 100 eggs per gram of faeces have enlarged livers and spleens.

5.3. Parasitological diagnostic techniques

A strategy of morbidity control for schistosomiasis control programmes requires appropriate parasitological and epidemiological criteria. In the past the broad objective of schistosomiasis control was to stop transmission and qualitative parasitological techniques were generally used for assessing results.

Quantitative parasitological techniques have generally been considered to be simple, cheap and readily adapted to the needs of endemic countries. Simple urine sedimentation requires only the containers in which the urine is collected and a pipette to remove the sediment. Sedimentation techniques for faecal examination are more complicated. Some form of a sieve to remove large particles is necessary and sedimentation flasks and pipettes are essential. The current cost of glass sedimentation flasks is surprisingly high. While these techniques may be sensitive, if a large unmeasured volume is sedimented, the lack of reproducibility, especially between different examiners, and the lack of reliable estimation of the intensity of infection are serious limitations for control programmes.

The usefulness of quantitative techniques is now recognized by national control programmes which have achieved significant reduction in prevalence from double to single figures in large areas. As these programmes progressed, prevalence has been reduced to low levels; further reductions from year to year were minimal. Prevalence data alone without the support of data on intensity of infection are a useful but incomplete epidemiological indicator of the level of transmission.

All parasitological diagnostic techniques are relatively insensitive in the detection of low-level infections. This is an important consideration if incidence data, the most precise index of transmission, are to be calculated. Quantitative parasitological diagnostic techniques provide reproducible data which qualitative techniques cannot provide. Research on immunodiagnostic techniques continues but none are currently recommended for use in control programmes.

5.3.1. Advantages

These quantitative techniques have numerous advantages:

- (1) they are rapid;
- (2) their cost is low;
- (3) they give results which are reproducible among technical personnel;
- (4) they provide an estimate of the intensity of infection;

- (5) they give quantitative results which can be submitted to statistical analysis,
- (6) they provide results which can be compared between different endemic areas and by different observers;
- (7) samples obtained and prepared in the field may be examined microscopically later;
- (8) they facilitate quality control;
- (9) they are useful in the evaluation of morbidity related to Schistosoma infection;
- (10) they are important in the evaluation of schistosomiasis control activities devoted to reduction of morbidity.

5.3.2. Limitations

The major limitation of any diagnostic technique is the availability of equipment and supplies. The small samples used in quantitative techniques limit the sensitivity of the examinations. The recommended volume of urine to be examined is 10 mL. The actual volume of faeces examined in the cellophane faecal thick smear technique ranges between 10-125 mg. In public health laboratories and hospitals sensitivity may be increased by examining several thick smear slides prepared from the same stool specimen or by examining larger volumes of urine or stool.

In practice qualitative sedimentation techniques are widely used. If such techniques are used, a reasonable compromise would be to systematically use quantitative techniques for monitoring and evaluation.

5.3.3. The techniques

The microscope is essential for all parasitological diagnostic techniques. The microscopist should have specific training in the operation and maintenance of the instrument. All microscopes should have reflecting mirrors for use in daylight. If the microscope has only an electric light source, there may be problems with the electricity supply or its stability and with the replacement of light bulbs. Binocular microscopes may be relatively inexpensive and are being used more and more frequently. Regular cleaning of the microscope lens and stage with a soft cloth is recommended. Quantitative techniques require a fully operative mechanical stage to ensure accurate scanning of specimen. The stage should be regularly checked.

The microscope should have 10 oculars (wide angle if possible) and a 10 and a 40 objective.

Each quantitative parasitological diagnostic technique is discussed in detail in the annexes. Annex IV contains the description of the urine filtration technique as well as details on the material and supplies. Annex V comprises a description of the cellophane faecal thick smear technique and Annex VI refers to the glass sandwich faecal thick smear technique.

5.3.4. Egg count categories

Quantitative parasitological techniques permit the use of categories of egg counts in the assessment of control programmes. A new dimension of interpretation is added if such data are available. The units recommended for

reporting are: (1) the number of *S. haematobium* eggs per 10 mL of urine or (2) the number of *S. mansoni*, *S. japonicum* or *S. intercalatum* eggs per gram of faeces

(a) Urine examinations

The quantitative data from urine examinations by the syringe filtration technique for detection of *S. haematobium* infection may be reported according to egg count categories. Population based epidemiological and clinical studies have assessed the relationship between proteinuria or haematuria and *S. haematobium* infection. In most of these studies a high proportion of children excreting more than 50 eggs per 10 mL of urine were found to have haematuria and/or proteinuria as detected by chemical reagent strips. Limited experience is available on the use of the following egg count categories and modification may be required to include a third higher category:

<u>Level of infection</u>	<u>No. of eggs per 10 mL of urine</u>
Light	1 - 49
Heavy	50 +

Two additional reasons for selecting 50 eggs per 10 mL of urine as an upper limit for urinary egg counts are. (1) the lack of reproducibility of higher counts between microscopists or by the same microscopist, and (2) the length of time required to count more than 50 eggs. In training courses on quantitative parasitological techniques, it has been found that the accuracy of higher egg counts is low. Nytrex and Nuclepore filters (or even paper filters if staining is done quickly) may be examined immediately to identify a person for treatment.

A third category such as 500+ or 1000+ *S. haematobium* eggs per 10 mL of urine may be appropriate in areas where the intensity of infection (10%) frequently reaches this level. This decision should be based on a trial in which microscopists are trained to estimate accurately high egg counts by different methods. If the microscopist recognizes that the filter has more than 50 eggs, then he may (1) scan the entire filter or (2) scan only one quadrant of the filter to determine if more than 125 or 250 eggs are present in the quadrant and multiply his estimate in the quadrant by 4 to obtain the total number of estimated eggs on the filter. Other methods of estimating high egg counts may also be evaluated

Most control programmes using large-scale chemotherapy did not foresee that prevalence and intensity of infection could be reduced so rapidly. For this reason, the use of quantitative parasitological techniques from the outset is desirable in order to avoid the administrative difficulties of introducing a new parasitological technique and reporting methodology after the programme has expanded.

(b) Stool examinations

The quantitative data from stool examinations for detection of *S. mansoni* eggs may be reported according to egg count categories. These categories are derived from population based epidemiological studies which assess the relationship between intensity of infection and morbidity, i.e. liver and spleen size. In children liver and spleen enlargement correlate with the intensity of infection. Most epidemiological studies agree that the

correlation becomes statistically significant above 100 *S. mansoni* or *japonicum* eggs per gram of faeces. As an example, the egg counts obtained by the cellophane faecal thick smear technique (Kato-Katz) may be reported in the following categories:

<u>Level of infection</u>	<u>No of eggs per Kato-Katz slide</u>	<u>Range of eggs per gram of faeces</u>
Light	1 - 4	24 - 96
Moderate	5 - 33	120 - 792
Heavy	34+	816+

In some areas intermediate categories may be useful such as: 5-16 eggs per slide or 120-384 eggs per gram of faeces; 17-33 eggs per slide or 408-792 eggs per gram of faeces. These categories may have to be adapted according to the general intensity of infection in a given area. If few infections over 800 eggs per gram of faeces are present, the use of intermediate categories may be appropriate

In some areas the intensity of infection may be rarely over 100 eggs per gram of faeces either naturally or due to an advanced stage of control. In such areas the sensitivity of a single Kato slide is insufficient to detect all infected persons. In these areas multiple Kato slides may be prepared to increase the sensitivity or a more elaborate technique such as the quantitative modified formol-ether concentration technique may be used. The rates of morbidity due to schistosomiasis are low in these areas. Public health and hospital laboratories could maintain adequate monitoring and surveillance by using more sensitive techniques. Specialized schistosomiasis control activities in areas of low intensity of infection are probably not necessary unless there is a risk of spread of schistosomiasis due to migration or man-made water resource projects or if the control of transmission is desired. In such areas diagnosis and treatment should be available through the peripheral health services.

5.3.5. *Indirect diagnostic techniques*

Simple indirect diagnostic techniques to detect urinary blood or protein to identify heavily infected persons, particularly children, will aid the implementation of schistosomiasis control programmes. Such techniques may be used by minimally trained personnel. Rapid low cost diagnosis of heavily infected persons followed by treatment with new safe and highly effective antischistosomal drugs will reduce morbidity related to schistosomiasis at costs within the financial constraints of most endemic countries. The cost-effectiveness of indirect techniques has not yet been evaluated in large-scale programmes.

5.3.6. *Miracidial hatching technique*

The miracidial hatching technique is sensitive for the detection of schistosomal infection. However, in clinical trials of anti-schistosomal drugs, hatching techniques have not been well standardized and further improvements are needed.

5.4. Chemotherapy

Three anti-schistosomal drugs are now included in the WHO model list of "Essential Drugs": metrifonate, oxamniquine and praziquantel.

5.4.1. Chemotherapy delivery systems

The selection of a delivery system for antischistosomal chemotherapy should be based on a sound understanding of the epidemiology of schistosomiasis as well as the effectiveness of the drug. The basic elements of any chemotherapy delivery system are: personnel, diagnostic techniques and associated materials, drugs, logistical support and data management.

Mass treatment: Strictly speaking, this term refers to treatment of entire populations without prior individual diagnosis. The decision to employ mass treatment must be based on adequate epidemiological data indicating that a very high proportion of the population is infected. The sampling frame and design of this approach are critical and should be based on the smallest administrative units.

Case detection costs are minimal and restricted to preliminary sampling to establish the existence of a high prevalence; drug and delivery costs are maximal but maximum effects on morbidity and transmission can be expected.

Selective population chemotherapy (SPC): In this approach, urine and/or stool specimens from the entire population of an area are examined. Only persons excreting Schistosoma eggs are treated.

Case detection costs are high but drug costs are less than with mass treatment as only infected persons are treated. Delivery costs may be lower than with mass treatment. A high level of morbidity control can be expected and the effect on transmission will be only slightly less than with mass treatment if the diagnostic test used to identify infected persons is sensitive.

Selected group treatment: This approach is a variant of selective population chemotherapy. As peak prevalence, intensity and morbidity are generally found in the younger age groups, treatment can be given to these persons - either to all the group or to all those infected.

Table 1 Comparative costs and benefits of different chemotherapy delivery systems

Delivery system	Case detection	Drug	Delivery	Morbidity	Transmission
Mass treatment	+	++++	++++	++++	++++
SPC	+++	+++	+++	+++	+++
Selected group treatment					
(a) Total	+	+++	+++	+++	+++
(b) Infected	+++	++	+++	+++	++
Targeted	++++	+	++++	++	+

If a high proportion of children are attending school, this approach is probably the easiest to organize. When the whole group is treated, case detection costs are limited to the survey defining the epidemiological status of the area; drug delivery costs will be less than in the regimens described above and, although the overall effect on morbidity and transmission will be less than with mass therapy, it will be high in the age groups at greatest risk and responsible for a high proportion of environmental contamination.

On the other hand, if only infected persons in the group are treated, case detection costs will increase but drug costs will be less than when all are treated. These approaches probably have the greatest benefit relative to cost.

Targeted chemotherapy: This term has been suggested to be applied to the treatment of individuals with high levels of egg output and who are at greatest risk of developing disease. A small field trial of this approach revealed reduction of morbidity; however, this remains a theoretical approach which has not yet been adequately tested on a large scale.

Phased treatment The SPC approach has been more frequently applied than others, but in countries with prevalence varying from locality to locality a more flexible approach may be required. Thus mass treatment in areas of very high prevalence can be carried out, when prevalence and intensity of infection have been reduced, by selective population chemotherapy and subsequently by selective group treatment. This appears to entail the most economical use of drugs.

5.4.2. Treatment schedules

During the period when only toxic anti-schistosomal compounds were available, both curative (intensive) and suppressive treatment regimens were used extensively. In view of new advances in chemotherapy, the controversy about curative as opposed to suppressive treatment has subsided. Today, complete doses of oral anti-schistosomal drugs given to infected individuals have both curative and suppressive effects.

Praziquantel and oxamniquine are usually given in single oral doses. There is no justification to reduce the recommended dosages which have been determined by adequate clinical trials. On the other hand, there is indication that in some areas of Central and East Africa, the dosage of oxamniquine for *S. mansoni* infection should be up to twice that required in West Africa or in the Americas. Furthermore, in Egypt and Sudan the dosage required may be up to three or four times higher than that required in the Americas. This information is derived from several small-scale clinical trials and should be reconfirmed in each endemic country where use of oxamniquine is anticipated.

For metrifonate, it is recommended that it be given in three doses of 7.5 mg/kg at two week intervals. The 100 mg metrifonate tablets and the product's package insert instructions facilitate the administration of metrifonate at 10 mg/kg. The cure rates and reduction in *S. haematobium* egg counts are similar for both dose levels. In large-scale use, the amount of drug required would be less if a dosage of 7.5 mg/kg rather than 10 mg/kg could be more accurately and rapidly administered in the field.

Single dose regimens of metrifonate of 10 mg/kg or two doses of 7.5 mg/kg given at intervals of 4, 6 or 12 months have been suggested. The published results of clinical trials of these reduced doses of metrifonate are not conclusive. Some degree of reduction of excretion of S. haematobium eggs has been obtained in all reported trials. Single dose treatment appears to have little or no effect in endemic areas where the overall intensity of infection is high. At present single dose regimens cannot be recommended for operational control programmes. However, clinical trials comparing single dose to multiple dose metrifonate treatment under field conditions are encouraged.

The three-dose course of metrifonate may be administered by minimally trained health workers under medical supervision. Thus, the multiple dose regimen should not be a serious limitation to applicability in most endemic areas. The initial dose may be administered by the team undertaking the diagnostic procedures. Subsequent doses may be given by other health workers or minimally trained community personnel. Even so, compliance rates for a three-dose course are usually low.

5.4.3. *Evaluation of chemotherapy*

The importance of quantitative parasitological techniques cannot be over emphasized. The cure rates with available anti-schistosomal drugs are expected to be high. Prevalence rates at 6 months or one year should be at least 40% below the pre-treatment figures. If prevalence is not reduced to this extent, then the intensity of infection, either in terms of number of persons excreting more than 50 eggs per 10 mL of urine or more than 100 eggs per gram of faeces should be reduced. If the intensity of infection is not markedly changed, then the following should be taken into consideration:

(a) Drug failure

The anti-schistosomal drugs should be properly stored to avoid deterioration. Drugs in storage as well as those in the field should be checked periodically to assure that active drugs are being used. Metrifonate has a shelf life of 2 years under proper storage conditions. The shelf life of oxamniquine and praziquantel is at least that long. No drug should be used past the expiry date. Drugs should be stored in a cool dry storage area. Refrigeration is not necessary.

(b) Operational failure

Effective supervision of the distribution and administration of the drug is necessary in all control programmes. Supervision may include inspection; however, the supervisor's primary task is to accompany and support the operational teams. If specific objectives (i.e. population to be examined) are not set, then supervision and assessment of operations are difficult, if not impossible.

(c) Lack of compliance

If the community does not accept treatment, then the reasons should be identified, corrective action taken and attempts made to promote cooperation.

(d) "Resistance" of the parasite to the drug

Resistance of *S. mansoni* to oxamniquine has been observed in less than 1% of those treated. Resistance to treatment is not an "all or none" phenomenon. Treatment with oxamniquine will eliminate most if not all *S. mansoni* parasites. The parasites which remain after treatment may be resistant to repeated treatment with oxamniquine

No human schistosomes are resistant to praziquantel

No strains of *S. haematobium* resistant to metrifonate have been identified

5.4.4. *Retreatment schedules*

A single treatment with an anti-schistosomal drug should never be expected to achieve a permanent cure or to prevent reinfection. In general, within populations with high prevalence (50%) and high intensity of infection (this level must be defined in each area by assessing the data at the time of the first survey), a planned assessment of the treatment programme is required after 6 months or 1 year. If it is foreseen that no reexamination of the population or of a representative sample of it would be possible within one year of a treatment programme in areas of high prevalence, then the programme should be appropriately modified within the limits of available personnel and resources to assure a reliable evaluation. If experience in epidemiologically similar areas has shown that reexamination and retreatment of positive cases are feasible and satisfactory at 18 months or more, then a longer interval before retreatment may be justified.

Retreatment implies that reexamination of the target population is necessary. The data from careful, continuous and systematic surveillance in endemic areas will determine the appropriate reexamination and retreatment schedules. Periodic examination of school-age children, of selected adult populations such as agricultural workers at high risk or even of entire communities is in each case an optional approach.

The strategy of morbidity control anticipates that transmission will continue after large-scale treatment, although probably at a lower level than before, for some time. Further treatment will be required to maintain control of morbidity. The rate at which prevalence and intensity of infection increases depends on:

(a) The number of persons remaining infected after treatment, which is dependent on:

- (i) the pre-treatment level of endemicity;
- (ii) the operational approach used;
- (iii) the level of population participation in respect of providing specimens for case detection and of accepting full courses of treatment;
- (iv) the "cure" rate,
- (v) the numbers of deferred treatments due to pregnancy, ill health, etc.;
- (vi) the extent of population movement and immigration of infected persons.

(b) The rate of reinfection, which is dependent on:

- (i) the extent of water contact, which may be inversely proportional to the availability of a safe, adequate and reliable water supply;
- (ii) the extent of faecal and/or urine contamination in the environment;
- (iii) the extent of snail intermediate host populations and the seasonality of transmission,
- (iv) in areas where *S. mansoni* is endemic, the rates of infection among animal reservoirs, as these may be of epidemiological significance in maintaining transmission.

The availability of diagnosis and treatment at the first-level health delivery system would support intensive control efforts and would be essential during the maintenance phase of schistosomiasis control

5.4.5. Cost of treatment

Although there is great interest in anti-schistosomal drugs, there is also concern about their cost for large-scale use. Cost estimates should be weighted in favour of treatment of children, who comprise the greater part of the infected population. The cost of these drugs is calculated on the basis of actual direct bulk purchases by national schistosomiasis control programmes. The cost of anti-schistosomal drugs will vary from one country to another. Current prices must be confirmed from local and international suppliers and from the manufacturers

In most control programmes, in which the costs of operations have been carefully analysed, the cost of drugs comprises 10-30% of the total cost of delivery. The cost of drugs usually represents expenditure in hard currency, which may be restricted, in the country concerned. Special low prices may be negotiated with the manufacturer of praziquantel when it is used in large-scale national control programmes, this agreement has been extended to other United Nations agencies. The cost of drugs, however, should not be the ultimate factor in determining their proper use. If funds are restricted it may be appropriate to limit control operations to smaller geographical areas or affected communities rather than attempting to use a drug indiscriminately over a large area

As current anti-schistosomal drugs become available at a lower cost, it will be important that the endemic countries be prepared to use these drugs on a large scale.

5.5. Health education and community participation

5.5.1. Health education

In schistosomiasis control programmes health education has received the lowest priority in the past. It was not fully appreciated that each contact with the community provided an ideal opportunity to explain the reasons behind diagnostic techniques, treatment and snail control activities as well as to influence constructively the habits and behaviour of the community. All field workers and primary health care personnel should be given instructions on how the solution of the public health problem posed by schistosomiasis depends heavily on community awareness and participation.

The lack of appropriate educational material has been an important constraint; however it has not been the only one. In order to develop materials close collaboration should be encouraged between the national control programme of each country and the Ministry of Education

The inclusion of schistosomiasis and other parasitic diseases in the school curricula would be a positive contribution to community awareness. Schistosomiasis prevention, from an educational point of view, might be best taught if schoolchildren as well as the community in general recognize that control of parasitic disease is in part at least, their responsibility. Their role in causing and spreading the disease should be clearly explained. Posters and teaching folders based on the December 1984 issue of World Health (Arabic issue, 1985) are available from the Parasitic Disease Adviser, WHO Regional Office.

5.5.2. Community participation

The failure of sustained control of parasitic diseases in endemic countries where dramatic short-term results have been obtained should not be forgotten. All schistosomiasis control programmes in the course of each of their activities should inform, motivate, train and encourage the community and their leaders to take part in improving their health. If schistosomiasis control activities are the responsibility of the primary health care system, then community commitment is essential.

5.5.3. The primary health care (PHC)

The primary health care (PHC) worker will be the focal point of the health education process in the community. His/her role may be twofold, depending on the government's priority ranking of schistosomiasis control, viz:

- (a) if a specialized schistosomiasis control programme is operational, the PHC worker may be the most important liaison between the specialized team and the community;
- (b) if schistosomiasis control activities are within PHC responsibility, the PHC worker may educate the community:
 - on its role in transmission of schistosomiasis;
 - on the impact of schistosomiasis on its daily lifestyle; and
 - on the responsibility of all community members to eliminate the causes of schistosomiasis.

5.6. Environmental management

In agricultural development areas, the proper management of the environment will reap economic benefits. At the same time, the rate of transmission of vector-borne diseases such as malaria and schistosomiasis will be reduced. Intersectoral action in environmental management is encouraged within schistosomiasis control activities.

5.7. Snail control

The emphasis on the use of specific chemotherapy must not be misinterpreted to mean that there is no place for snail control in this strategy. On the contrary, snail control measures associated with or immediately preceding large-scale use of chemotherapy may bring about a dramatic reduction in transmission as well as the expected reduction in prevalence and intensity of infection in the human population. In some endemic areas, transmission is constant year round and at such a high level that specific chemotherapy must be combined with effective snail control measures to reduce the prevalence or intensity of infection. In other areas, if snail control measures are undertaken, the level of transmission is reduced so that the effect of the large-scale treatment, i.e. reduced prevalence and intensity of infection, is sustained for a much longer period.

The main constraints in this approach are:

- (1) the high cost of chemical molluscicides;
- (2) the availability of only one chemical molluscicide with acceptable toxicity;
- (3) the lack of trained field personnel with the expertise to determine the epidemiologically important transmission sites and to dispense the molluscicides;
- (4) the reproductive potential of the intermediate host which necessitates repeated chemical applications;
- (5) the lack of any immediate direct effect on human pathology.

5.8. Supervision and training activities

Supervision is an important component of a schistosomiasis control programme. The tasks of supervisors must be specified so that they can effectively carry out their responsibilities. Quality control of the work of microscopists requires patience and tact. A satisfactory procedure for quality control is for every 10th urine specimen, in case of *S. haematobium* surveys, to be given to someone who has completed treatment and request him to return in line for microscopic re-examination of the specimen. The microscopist will record the result usually without realizing that the specimen has been examined before. The supervisor can then verify if the two results of the specimen tally.

Other procedures for quality control may be used, such as systematic re-examination of every 10th-30th slide by an independent microscopist. It is important to maintain the interest of microscopists by having positive slides available to check the accuracy of egg counts. The faecal cellophane thick smear technique facilitates preservation of the specimen for subsequent quality control.

Training of staff for schistosomiasis control programmes is initiated at the beginning of the intervention phase. Training modules have been developed and experimentally tested using WHO/SCHISTO documents. The development of human resources is both a short-term and long-term component of disease control programmes.

5.9. Evaluation methodology

The primary objective of schistosomiasis control is the reduction or elimination of morbidity due to schistosomiasis. A schistosomiasis control programme which does not have specific activities for evaluating its impact on morbidity is inadequate. In these days of scarcity, both of financial resources and of trained manpower, it is important to be able to shift resources within programmes and among programmes, once the objectives have been determined.

This strategy emphasizes quantitative objectives. Each country where *S. haematobium* is endemic may establish its own quantitative goals of:

- (a) prevalence of infection;
- (b) prevalence of heavy infections of at least 5 eggs/10 mL of urine;
- (c) history of recent haematuria;
- (d) history of recent dysuria;
- (e) gross haematuria at the time of examination;
- (f) haematuria confirmed by chemical reagent strips at the time of examination;
- (g) hospital bed occupancy of patients with urinary schistosomiasis;
- (h) out-patient attendance related to urinary schistosomiasis at the PHC dispensary and hospital out-patient level.

In countries where *S. mansoni* is endemic, quantitative goals may be established according to:

- (a) prevalence of infection;
- (b) prevalence of heavy *S. mansoni* infections of at least 100 eggs/gram of faeces;
- (c) history of haematemesis;
- (d) hepatic and/or splenic enlargement in schoolchildren;
- (e) hospital bed occupancy by patients with *S. mansoni* infection;
- (f) out-patient attendance related to disease caused by *S. mansoni* infection at PHC dispensary and hospital out-patient level.

All these goals involve simple measurements and are within the capability of any schistosomiasis control programme and health delivery system.

5.10. Data management

A schistosomiasis control programme is a far-reaching undertaking whose preparation and execution, in all its phases, requires the possession of different quantitative information. Existing documentation must be used rationally by the personnel in each phase of operations. In addition, the technical and administrative needs demand the collection and analysis of appropriate supplementary data.

A single index used to characterize the status of schistosomiasis within a defined population, such as prevalence - the proportion of infected persons - is not adequate to monitor or modify the operations of a control programme. Other indices are needed, especially those relating to the reduction of morbidity due to schistosomiasis, in a treated population.

Statistical analysis should allow for the evaluation of the effectiveness of the campaign during its various phases and verification of whether the epidemiological evolution of the disease conforms to expectations.

5.10.1. The need for statistics

The planning, execution and monitoring of schistosomiasis control programmes should depend on objective judgements and not on personal expectations. The data from these programmes are derived from interactions between three living groups; man, snail (intermediate host) and worm (*Schistosoma*). Each of these groups may affect, and may be affected by, environmental factors known or unknown. The selection of operational approaches and their modification during the course of the programme therefore rely on the correct interpretation of interrelated data which are not only highly variable within themselves but may also be influenced by a multitude of other uncontrollable factors.

Modern statistical methods help to facilitate, to a large extent and on a purely objective basis, the interpretation of numerical data in which variations may be due to the simultaneous action of many factors. In particular, the correct interpretation of data implies the use of appropriate statistical techniques. For this reason, statistical methods are required in all phases of a schistosomiasis control programme, in the establishment of operational plans as well as in the monitoring of operations and the final evaluation of results

5.10.2. Analysis of schistosomiasis in the community

In contrast to the clinician whose major concern is the health of his patient on an individual basis, the epidemiologist in a control programme is concerned with the state of health of the community at large. In both cases, the actions to be taken will depend on the number of persons who are to be cared for and the measures of intervention which are available. However, the situation takes on a statistical nature because the epidemiologist may have to base his conclusions on the relevant observations from a selected number of individuals rather than from the whole population. He has to determine to what level the community is at risk with respect to schistosomiasis, to determine the type, prevalence and intensity of infection, to decide on intervention schemes and how best to reduce the risk of the disease within the community. Although data will be collected on an individual basis, analysis will be focused more on the community as a whole than on the individual. Appropriate statistical methods should then be applied in the analysis of the collected information.

5.10.3. The role of statistics in the control of schistosomiasis

Statistics are derived from data recorded for each event or on each individual. Only with great difficulty can one grasp all the information which can be obtained on an individual basis. The capacity of a control programme to accumulate data usually outstrips its ability to analyse it correctly and to use it in an informed manner. Statistical methodology is an indispensable tool for the correct interpretation of the collected data. In fact it comes directly into play in the various problems faced by a

schistosomiasis control programme Among the principal problems, we may note the following:

1. Rational planning, which implies:

- plans which are flexible and suited to local conditions,
- plans which are practicable within the limitations of available funds and trained personnel - data processing should be catered for;
- choosing the geographical area to be covered, the frequency of observations, and the methods and frequency of intervention;
- establishing reasonable targets for achievement.

2. The correct collection and processing of data, which includes:

- the establishment of definitions and the use of standardized classifications,
- the preparation of questionnaires and appropriate record forms with the provision of pre-testing data collecting procedures;
- the training of staff in data collection, their supervision and the establishment of quality control procedures;
- the establishment of appropriate sampling schemes where total population coverage is not feasible;
- the verification of data with regard to its accuracy, correctness and validity.

3. The analysis and interpretation of the collected material, i.e.:

- the sorting and classification of data into the required groups for tabular presentation;
- the estimation and comparison of the appropriate statistical indices and their errors;
- the evaluation of the campaign results, and the statistical significance of the conclusions;
- the timely preparation of reports on the progress of the campaign and their dissemination to those concerned including workers in the field.

It may be necessary to use advanced statistical methods for certain types of analysis and significance testing, and to have access to computer facilities for a more efficient processing of data.

5.10.4. The need for a central statistical service

Although the operational approach to be followed during a control programme should be clearly established, it will need to be continually adapted to the particular conditions which are met. Various changes may be necessary during the course of operations and sufficient knowledge of the situation is needed at all times.

The data to be used are of a varied nature, derived from different sources (demographic survey teams, mollusciciding teams, diagnostic teams, observers, doctors, epidemiologists, administrators responsible for material and equipment, etc.) It is therefore indispensable that all the information collected should be sent to a centralized service responsible for their collation. The responsibility for the analysis and interpretation of the data, however, should not rest solely with the central statistical service. The capability should be built in at each operational level of the programme to make specific judgements concerning the effectiveness and efficiency of the operations within its sector.

Among the functions of such a centralized service are the following:

- (1) Keeping a permanent control of the statistical documentation coming from the different sectors of the operation. Centralization may eventually be limited to the data necessary for the calculation of relevant fundamental indices:
 - the prevalence of schistosomiasis, i.e. the results of the parasitology examination;
 - the actual activities of the control programme (number of potential transmission sites treated with molluscicide, efficiency of the diagnostic teams, etc.)
- (2) Establishing plans for surveys which are appropriate to the local conditions for the estimation of indices which cannot be calculated from the current data;
- (3) Maintaining a centralized file for the classification of data by locality responsible officer, etc.
- (4) Establishing plans for registering the data on standardized forms so that they can be stored, retrieved and analysed by computer when available.
- (5) Liaising and collaborating with national health statistical services, in order to avoid any duplication of effort and to correct any eventual differences in the relative numbers of known schistosomiasis cases.
- (6) Verifying the accuracy of the information received and studying in collaboration with the administrative and technical personnel, the possibility of simplifying or making the registration of the data more economical.
- (7) Establishing effective lines of communication so that not only are the data from the operational units transmitted to the service but also aggregated information is led back and the use being made of the information is disseminated to all sectors

5.10.5. Statistics necessary for the preparation and the implementation of control schemes and their sources

The need for statistical information becomes apparent during the preparation of the preliminary investigations which precedes the actual control campaign, and is even more imperative in the phases which follow. A detailed study of schistosomiasis in each community is based on the knowledge of demographic, health, economic and social characteristics of the population itself. i.e. its dimension, its composition by sex and age, general health conditions, conditions of work, habits, knowledge of the disease, etc.

(a) Demographic statistics

Detailed reports on the status of the population are published periodically in most countries, usually at the time of census. Statistics relating to demographic events such as births, deaths, marriages, etc. are also published annually by national governments in publications on vital

statistics. Furthermore in certain countries statistics on causes of death are also compiled and published.

While these statistics may not be of great value in the implementation of control schemes they will serve as an indicator of the population size. In general the population census should be established at the outset of the operations. Each locality should be defined by careful mapping and the population size determined by a household census. In those instances where a census is not feasible, the best estimate which may be obtained through discussions with local officials community leaders may be used. This estimate should also give some indication of the distribution of the population by age.

(b) Statistics based on parasitological findings

In order to properly monitor and evaluate a schistosomiasis control programme it is necessary to calculate certain indices, both before and during the duration of the programme. The most appropriate indices are based on quantitative measurements made on the human population. Indices based on egg counts comprise:

- Prevalence of infection: the proportion of the population infected with schistosomiasis, i.e. the proportion of individuals with schistosome eggs in their urine or faeces.
- Prevalence of heavy infections: the proportion of individuals with at least 50 eggs/10 mL of urine for *S. haematobium* or with at least 100 eggs/gram of faeces for *S. mansoni* infections.
- Intensity of infection: this is estimated by the number of eggs per unit volume of urine or weight of faeces.
- Incidence: the rate at which uninfected persons who were never treated become infected during a given period of time.

All of these measurements are directly affected by the sensitivity of the diagnostic technique. In the analysis, these indices should not only be presented for the total population, but also by group, according to age and sex.

For most control programmes it will be sufficient to calculate only the first two of the above indices. The last two are more appropriate for special studies within the programme. For the intensity of infection, it is recommended that the geometric mean egg output among infected individuals be calculated.

(c) Statistics on morbidity due to schistosomiasis

Since the aims of control programmes are now directed towards a reduction in morbidity due to schistosomiasis, it is necessary that more up-to-date and reliable information be obtained in this area, both at the beginning of and during the programme.

Indices related to morbidity

- Within a stated time interval, the number of hospital beds occupied by patients with schistosomiasis infections.
- The number of outpatient visits related to schistosomiasis infections at dispensaries, health units and hospitals.

(i) for S. haematobium infections

- proportion of persons with recent history of haematuria and/or dysuria;
- prevalence of gross haematuria at time of examination;
- prevalence of haematuria as detected by chemical reagent strips.

(ii) for S. mansoni infections

- proportion of persons with recent history of haematemesis;
- prevalence of hepatic and/or splenic enlargement in schoolchildren (the presence or absence of meso- or hyperendemic malaria should be stated)

(d) Statistics on chemotherapy of schistosomiasis

Chemotherapy is a tool for both primary and secondary control of schistosomiasis. The aim of primary control of schistosomiasis is reduction in the excretion of eggs, particularly in those persons who are most likely to pollute transmission sites, and it is therefore beneficial for the entire community. The aim of secondary control of schistosomiasis, however, is to reduce the risk of morbidity and mortality among the treated individuals.

Indices related to chemotherapy

- Participation rate, i.e. the proportion of infected persons who have received treatment. A distinction should be made for individuals who are only partially treated in schemes using a drug regimen requiring more than one dose.
- Egg negative rate, i.e. the proportion of infected persons who were treated and who now show an absence of Schistosoma eggs. The diagnostic techniques used and the time after treatment should be stated.
- Reinfection rate, i.e. the proportion of people who had no Schistosoma eggs at the first examination at least 3 months after treatment but who were again found to be infected 6 months or later at a subsequent examination. The length of time between examinations should be stated. Usually reinfections are observed at about 4-6 months after treatment.

(e) Other assessment indices

Although the examination of the human population is essential for the evaluation of the programme, other indicators may also be taken into consideration, e.g.:

- reduction in the snail population;
- reduced human/water contact;
- reduced cercarial level at water contact sites;
- introduction/increase of sanitation and water supply.

In order to establish these indicators, information relating to the environment and man's relationship to it needs to be ascertained.

6. WORKSHOP PROGRAMME

6.1. The workshop programme was designed to give participants an opportunity to evaluate a training module on the epidemiology and control of schistosomiasis for field personnel. This activity has already been undertaken in many countries and in Egypt it has been repeated 30 times. It is an intensive course which combines a didactic with a practical programme.

Training programmes of this type have been modified or extended to include further discussions on operational approaches to be actually implemented in a specific control programme.

6.2. The programme of the workshop continued with a two-day presentation of activities by the Blue Nile Health Project (BNHP). The BNHP started in 1979 with an agreement between the Government of Sudan and the World Health Organization to control malaria, schistosomiasis and diarrhoeal diseases in the area irrigated by the Blue Nile. The BNHP has been operative in the Rahad zone (200 000 feddans), the study zone (50 000 feddans) and the Gezira/Managil zone (2 000 000 feddans). The participants observed schistosomiasis control activities in the study zone and in the Gezira/Managil zone. The field exercise took place in the Rahad zone. A large-scale chemotherapy campaign against schistosomiasis is now under way.

The water supply and sanitation programme, the production factory for concrete slabs and several villages with operative water supply by filtration systems were visited.

In the villages the intensive health education efforts designed to prepare the community for mass chemotherapy, were observed by the participants. Health committees are responsible for ensuring community participation in all aspects related to schistosomiasis control and to identify major health problems.

6.3. A planning exercise to develop a medium-term plan of action for schistosomiasis control was led by Mr Laaziri, Chief of Operations, Research and Evaluation, Ministry of Health, Rabat, Morocco, assisted by Dr K. Mott and Dr G. Farid.

Further background material is now available in publication WHO/SCHISTO 86.87

This was a practical exercise in planning for schistosomiasis control. It was composed of two sections:

- (a) A general description of the process of planning. This section includes (i) a flow diagram of the planning process; (ii) an outline of the planning process; and (iii) general information on the situation analysis and the development of a medium-term plan of action.
- (b) Data on a hypothetical situation of a province in an endemic country where schistosomiasis control is to be implemented.

The following WHO/SCHISTO documents provide further details:

- 83.68 - A strategy for morbidity reduction in schistosomiasis.
- 83.69 - Diagnostic techniques in schistosomiasis control
- 83.70 - The role of chemotherapy in schistosomiasis control.
- 83.71 - Schistosomiasis control. a PHC approach.
- 83.72 - The role of molluscicides in schistosomiasis control.
- 85.81 - Statistical methods applicable to schistosomiasis control programmes.

The objectives of this planning exercise were:

- (1) To introduce the methodology of a planning process which is applicable to control programmes.
- (2) To apply the planning methodology to a hypothetical situation.

The principle underlying the exercise was that:

The planning process requires time, effort and human resources. Investment in the planning process will pay off by means of an efficient, targeted and effective control programme to achieve control of morbidity due to schistosomiasis.

In the evaluation of the workshop this planning exercise was considered to be the workshop's outstanding activity.

7. RECOMMENDATIONS

7.1. General recommendations

7.1.1. The workshop endorsed the WHO strategy of control of morbidity due to schistosomiasis as a feasible, cost-effective strategy for the schistosomiasis-endemic countries of the Eastern Mediterranean Region

7.1.2. The workshop encouraged increased exchange of information and experience regarding control of morbidity due to schistosomiasis between the countries of the Region and other WHO Regions.

7.1.3. The workshop recognized the importance of health education, water supply and sanitation supported by organization and motivation of community participation to assure the effectiveness of control programmes, utilizing large-scale anti-schistosomal chemotherapy.

7.2. Technical recommendations

7.2.1. Each endemic country is encouraged to develop a medium/long-term plan of action for control of schistosomiasis. The preparation of a detailed situation analysis is the first step in the planning process efforts.

7.2.2. The workshop encourages the standardization if not yet adopted, of quantitative parasitological diagnostic techniques, the urine filtration technique for *S. haematobium* infection and the faecal thick smear technique for *S. mansoni* infection and intestinal helminths, either with cellophane or between glass slides using a standard stool measure.

7.2.3. The workshop recommended that reporting forms be standardized throughout the Region to facilitate evaluation and exchange of information.

7.2.4. To initiate national workshops to introduce the national medium-term plan of action and to train the trainers who will undertake local training courses in operation, supervision and the data management information system. WHO is encouraged to support these workshops and training courses with relevant documentation.

7.2.5. The national control programmes are encouraged to furnish periodic reports on general progress. In addition, short reports on positive and negative results are encouraged for submission for publication in the WHO surveillance reports

7.3. Research recommendations

7.3.1 The workshop endorsed the idea of collaboration between universities and national research institutes with the governmental agencies responsible for schistosomiasis control in carrying out research projects, to assist the planning process and the evaluation of operations

7.3.2. Research to assess the prevalence and range of morbidity due to schistosomiasis is encouraged. The effect of treatment on the status of morbidity is one measure of evaluation of control.

7.3.3. Operational research on different chemotherapy delivery systems may be useful in some endemic countries. In particular, the assessment of the cost-effectiveness of repeated single doses of metrifonate is desirable.

7.3.4 All those who participated in the workshop were impressed by the extensive information available through the Blue Nile Health Project. It was agreed that the Blue Nile Health Project is one of the best sites for research and training.

7.4. Other recommendations

7.4.1. Operation research into the feasibility of focal mollusciciding application technique is encouraged for endemic countries.

7.4.2 Monitoring the susceptibility to different anti-schistosomal drugs is necessary

Annex I

AGENDA

- 1 Opening of the Workshop.
2. Country situations.
3. Regional situation and distribution of the disease
4. Epidemiology of schistosomiasis
5. Methods of diagnosis.
- 6 Chemotherapy of schistosomiasis.
7. Malacology/snail control.
8. Sanitation/water supply.
- 9 Data management.
10. Health education.
11. Primary health care in schistosomiasis control.
12. Planning exercise (National Plans of Action)
13. Training and research needs.
14. Evaluation of the Workshop.
15. Closing Session

Annex II

PROGRAMME OF WORK

Saturday, 12 October 1985

- | | |
|--------------------------------------|--|
| 09.30 - 12.30 | - Registration of participants |
| <u>Formal Opening of the Meeting</u> | Chairman, Dr A.A. Gaddal |
| 10.30 - 10.35 | - Quotations from the Holy Quran |
| 10.35 - 10.50 | - Introduction by Dr A.A. Gaddal |
| 10.50 - 11.00 | - Message from Dr Hussein A. Gezairy,
Regional Director, WHO EMRO |
| 11.00 - 11.15 | - Inaugural address by
H.E. The Governor of the Central Region,
Brigadier Farouq A. El Buluk |
| 11.15 - 11.40 | - Recess |
| 11.40 - 12.00 | - Election of officers (Chairman and
Rapporteur)
- Adoption of the agenda
- Programme of work |
| 12.00 - 14.00 | - Country presentations |

Sunday, 13 October

- | | |
|---------------|---------------------------------------|
| 08.30 - 10.30 | Country presentations. |
| 10.30 - 11.00 | Recess |
| 11.00 - 13.00 | Continuation of country presentations |
| 13.00 - 14.00 | Regional Situation |

Monday, 14 October

- | | |
|---------------|---|
| 08.30 - 09.30 | Epidemiology of schistosomiasis by
Dr K. Mott |
| 09.30 - 10.30 | Chemotherapy of the disease by
Dr K. Mott and Dr S. Nassif |
| 10.30 - 11.00 | Recess |
| 11.00 - 14.00 | Data management by Mr Richard See |

Programme of work (continued)

Tuesday, 15 October

08.30 - 09.00	Malacology and snail control by Dr A. Daffallah
09.00 - 09.30	Sanitation and water supply by Dr A. Fenwick and Dr A. Daffallah
09.30 - 10.00	Health education by Miss Amira El-Mallatawi
10.00 - 10.30	Primary health care in schistosomiasis by Miss A. El-Mallatawi
10.30 - 11.00	Recess
11.00 - 13 00	Methods of diagnosis and practical session by Dr A Habash
13.00 - 14.00	Division of the participants into two groups and explanation of field exercise.

Wednesday, 16 October

Group A	- Diagnosis in schools
Group B	- Mapping, ecology and malacology transmission

Thursday, 17 October

Group A	- Mapping, ecology and malacology transmission
Group B	- Diagnosis in the schools

Friday, 18 October

Free

Saturday, 19 October

The two groups visited the Blue Nile Health Project for demonstration of activities in schistosomiasis control

Sunday, 20 October

Continuation of the visit to the Blue Nile Health Project

Evening : Demonstration of health education
Hamadab Village in Gezira

Programme of work (continued)

Monday, 21 October 1985

08 30 - 10.30	Report of groups A and B on field exercise
10 30 - 11.00	Recess
11.00 - 12 00	Introduction to planning by Mr Mohamed Laaziri
12.00 - 14.00	Preparation of plan of action by three groups and resource personnel
18 00 - 20.00	Continuation of planning exercise

Tuesday, 22 October 1985

08.30 - 14.00	Continuation of planning exercise
18 00 - 20.00	Preparation of the groups' reports

Wednesday, 23 October 1985

08.30 - 10.30	Presentation and discussions by each group
10.30 - 11.00	Recess
11.00 - 14.00	Evaluation of the workshop
14 00 - 15.00	Replies to participants' queries
18 00 - 20.00	Recommendations/Closing Session

Annex III

LIST OF PARTICIPANTS

DEMOCRATIC YEMEN	Dr Abdo Salem Saleh Director of Malaria and Schistosomiasis Control Ministry of Health <u>Aden</u>
EGYPT*	Dr Saleh El Hak* Director Endemic Disease Control Department Ministry of Health <u>Cairo</u>
IRAQ	Dr Hashim Abdul Jabbar Bilharziasis Endemic Diseases Institute <u>Baghdad</u>
JORDAN	Dr Mohammed Rida Tawfik Director of Malaria Department Ministry of Health <u>Amman</u>
SAUDI ARABIA	Dr Mohsen Al-Tobaigy Medical Officer Schistosomiasis Control Station <u>Gizan</u> Dr Abu Baker Abdo Al-Tobaigi Epidemiological Section Preventive Medicine Department Ministry of Health <u>Riyadh</u>
SOMALIA	Dr Ahmed Yusuf Alio Project Manager Schistosomiasis Control Project <u>Mogadishu</u>
SUDAN	Dr O. Tamim El Dar Blue Nile Health Project <u>Wad Medani</u> Dr Ahmed Babiker Mohammed Scientist/Malacologist Ministry of Health <u>Khartoum</u>

* did not attend

SYRIAN ARAB REPUBLIC

Dr Mohammad Rachid Al Taha
Head of Preventive Medical Department
Deir El Zor

Dr Turkey Said Salman
Deir El Zor

TUNISIA

Dr Moncef Ben Said
Ministry of Public Health
Tunis

YEMEN

Dr Abdullah Mohamed Mujally
In-Charge, Schistosomiasis Control in Hajja
Sana'a

WHO SECRETARIAT

Dr G.A. Farid	Regional Adviser on Malaria and Secretary of the Workshop	World Health Organization Regional Office
Dr K Mott	Chief, Schistosomiasis	World Health Organization Geneva
Dr F. Arfaa	WHO Team Leader	Schistosomiasis Project Riyadh, Saudi Arabia
Dr Ahmed Habash	Temporary Adviser	In-charge, Schistosomiasis Project, UNICEF, Beheira Governorate, Egypt
Miss Amira El-Mallatawi	Temporary Adviser	Health Programme Officer UNICEF Schistosomiasis Control Project, Abu-El-Matameer, Egypt
Mr Alan Fenwick	Temporary Adviser	In-charge, Research and Training Unit, Blue Nile Health Project, Khartoum, Sudan
Dr Samir Nassif	Temporary Adviser	In-charge, Endemic Diseases Control Department, Ministry of Health, Cairo, Egypt
Mr Mohammed Laaziri	Temporary Adviser	Chef du Bureau des Opérations de Recherche et d'Evaluation, Ministry of Public Health, Rabat, Morocco

Dr A. Daffallah	Temporary Adviser	Director, Research and Training Administration, Blue Nile Health Project, Wad Medani, Sudan
Mr Richard See	Statistician	USAID, BNHP
Mrs Mona A. Abbassy	Secretary	World Health Organization Regional Office

Annex IV

URINE FILTRATION TECHNIQUE FOR *S. HAEMATOBIIUM* INFECTION

The permanent equipment for this technique is (from left to right and upper to lower):

1. Urine collection containers of which a wide variety may be used including locally available bottles or jars.
2. A plastic extension tube to avoid dipping the syringe directly into the urine.
3. A plastic 10 mL syringe to facilitate examination of 10 mL specimens.
4. A plastic Swinnex type 13 mm diameter filter support with a silicone gasket.
5. A filter of nylon mesh or Nytre1^R (shown), polycarbonate or Nuclepore^R or filter-paper may be used.

The syringes with extension tubes and the mounted filter supports are ready for rapid use without delay of preparation of material. It can be envisaged that if 300-400 complete filtration units are available, rapid screening is possible with immediate quantitative diagnosis and specific treatment given to all persons infected with *S. haematobium*.

The urine specimen is thoroughly mixed by drawing 10 mL of urine into the syringe with the plastic extension and returning it back to the specimen container several times. Finally, a 10 mL specimen is withdrawn; the plastic extension tube is removed and placed in a container with water and a small amount of detergent or disinfectant; the plastic filter support with the filter inside is inserted on to the syringe. Then the 10 mL urine specimen is forced through the filter support containing the filter.

In large-scale surveys, the plastic filter support and the specimen container may be returned to the patient who carries these (one in each hand to the microscopist). The microscopist then opens the filter support. If a small number of specimens are to be examined the same person may filter the urine specimen and examine the nylon mesh filter microscopically.

After opening the filter support, the microscopist removes the filter with forceps.

The nylon mesh filter (Nytrel^R) is placed face up on the microscope slide. If necessary, the microscope slide should be labelled with a specimen identification number. The nylon mesh filter may dry rapidly and a drop of iodine or Lugol's solution should be placed on the edge of the filter to improve visualization of *S. haematobium* eggs under 10 x objective with a binocular microscope. The filter may be preserved for several days under the cellophane from the Kato technique (EL-ZOGABIE modification).

Preferably, the microscope will utilize sunlight and reflecting mirror as a light source. All eggs on the filter may be counted. In control programmes, it is necessary to count only up to 50 eggs. The actual egg count up to 50 eggs per 10 mL of urine is recorded. Higher egg counts are recorded as more than 50 eggs per 10 mL of urine. Prevalence may be recorded as (1) % of those infected among all persons examined and (2) % of those with more than 50 eggs/10 mL (heavy infections) among all persons examined. The

nylon mesh filter on the slide may also be stored carefully in horizontal slide boxes and can be examined up to 24 hours later. This method should be evaluated in each programme before implementation.

After microscopic reading the nylon filter (Nytrel^R) is removed from the slide and placed in a small container with water and detergent and washed between the fingers, dried and re-used later.

The polycarbonate (Nuclepore^R) filter is removed from the filter holder and placed face down on the slide. A drop of glycerine or collodion may be used to fix the filter to the microscope slide. The paper filters (Whatman No. 541 or No 1) are placed face up on the microscope slide and stained with ninhydrin, iodine or other stain. These two filters may be stored for long periods of time and are not re-usable.

EQUIPMENT: Any similar equipment from other suppliers is acceptable.

Plastic disposable syringes, 10 mL

Becton Dickinson
Division of Becton, Dickinson and Co.
Rutherford, New Jersey 07070, USA

Plastic tube extension

Arthur H. Thomas Co.
P.O.Box 779
Philadelphia, Pa. 19105, USA

Item: No. 9565-L42 Tubing, low density polyethylene
Tubing 1/8" x 1/16", 100 ft roll

Swinnex filter supports

Millipore Corporation
Bedford, Ma. 01730, USA

Items: SX 00 01300 - Swinnex 13 mm
SX 00 02500 - Swinnex 25 mm

Item. Packages of 500 Swinnex 13 mm filter supports are available at a special price by ordering directly from Specials Coordinator, Millipore Corporation.

Filters

Nytrel:

L'Union Gazes à Bluter
B P. 2, 42360 Panissières, France

Item: Nytrel TI HD 20 in rolls per m² or precut 12 mm diameter in packages of 500 filters.

Nuclepore:

Public sector or large volume purchases of Nuclepore filters should be directed to:

PATH
Program for Appropriate Technology in Health
Canal Place, 130 Nickerson Street,
Seattle, Washington 98109, USA

For further information write to: Chief, Schistosomiasis and other Snail-borne Trematode Infections, Parasitic Diseases Programme, World Health Organization, 1211 Geneva 27, Switzerland.

Annex V

CELLOPHANE FAECAL THICK SMEAR EXAMINATION TECHNIQUE FOR DIAGNOSIS
OF INTESTINAL SCHISTOSOMIASIS¹

The cellophane faecal thick smear examination technique was introduced by Kato and Miura in 1954 (see section 7). Subsequent to the first English publication of this technique by Komiya and Kobayashi in 1966 (see section 7), many modifications of the original technique have appeared. This technique has proved to be a useful and efficient means of diagnosis of intestinal helminthic infections, as well as of *Schistosoma mansoni* and *S. japonicum*.

1. Materials

- (a) Glass microscope slides. The ordinary slides (25 x 75 mm) are appropriate.
- (b) Flat-sided wooden applicator sticks or similar devices made of plastic or other material.
- (c) Cellophane, wettable, 40 to 50 microns in thickness in 22 (or 25) mm x 30 to 35 mm strips.
- (d) Glycerine-malachite green solution (50% solution).
 - 100 mL water
 - 100 mL glycerine
 - 1 mL 3% aqueous malachite green or 3% aqueous methylene blue
- (e) Screen. Made of either wire steel cloth (105 mesh, stainless steel, bolting cloth) or plastic (60 mesh per square inch or 250 μ mesh size). A stainless steel screen welded onto an oval steel ring with a handle is re-usable.
- (f) Template. Made of stainless steel (Peters et al., 1980, see References), plastic (Kato-Katz) or cardboard (Japanese Association of Parasite Control) templates of varying diameters have been used. The size (20 mg to 50 mg) may depend on local requirements; in any event, the template permits accurate delivery of a standard stool specimen and determination of quantitative egg counts.

2. Procedure

- (a) Soak the cellophane strips in the 50% glycerine-malachite green (methylene blue) solution for at least 24 hours before use.
- (b) Transfer a small amount of faeces onto a piece of scrap paper (newspaper is ideal).
- (c) Press the screen on top of the faecal sample.
- (d) Using the flat-sided wooden (or plastic) applicator, scrape across the upper surface of the screen to sieve the faecal sample.

¹ Description of the stool examination technique is available as a separate document issued by WHO Parasitic Diseases Programme (PDP) under the symbol PDP/83.3 (in English, French, Chinese, Spanish, Arabic and Portuguese). A teaching series of 24 colour slides on the stool and urine diagnostic techniques with an accompanying script in English is available directly from: Teaching Aids at Low Cost, P.O. Box 49, St Albans, Herts, AL1 4AX, United Kingdom (Price £1.80)

- (e) Place a template on a clean microscope slide.
- (f) Transfer a small amount of sieved faecal material into the hole of the template and carefully fill the hole. Level flat with the applicator stick.
- (g) Remove the template carefully so that all the faecal material is left on the slide and none is left sticking to the template
- (h) Cover the faecal sample on the slide with a glycerine-soaked cellophane strip.
- (i) If an excess of glycerine is present on the upper surface of the cellophane, wipe off the excess with a small piece of toilet paper or absorbent tissue.
- (j) Invert the microscope slide and press the faecal sample against the cellophane on a smooth surface (a piece of tile or flat polished stone is ideal) to spread the sample evenly.
- (k) Do not lift the slide straight up. The cellophane may separate. Gently slide the microscope slide sideways holding the cellophane.

Preparation of the slide is now complete. It may be necessary to wipe off excess glycerine with a piece of toilet paper to assure that the cellophane stays fixed. After practice you can obtain perfect preparations.

Several modifications have been developed in control programmes. In Malawi, metal sieves with 100 mesh screen are used and the specimen is forced through the screen. The sieve is rotated so that 20 specimens can be sieved consecutively. (Details may be obtained from: National Bilharzia Control Programme, P.O. Box 377, Lilongwe, Malawi.) In Burundi, small individual sieves have been manufactured and the specimen, on a small piece of plastic, is forced through the screen. (Details may be obtained from: Projet Bilharziose, B.P. 337, Bujumbura, Burundi.)

3. Proper reading of slides

The slide should be kept at ambient temperature for at least 24 hours before microscopic examination (see below regarding hookworm eggs). By placing the slide in an incubator (40°C) or under an intense fluorescent, incandescent light in the laboratory or in sunlight in the field, the slide may be read within minutes

To facilitate the microscopic reading, one or two drops of eosin in saline (1:100) may be placed on the upper surface of the cellophane, left for 3 to 5 minutes, then wiped off with a piece of toilet paper or absorbent paper. This method permits improved visualizaton of Schistosoma eggs.

Microscopic reading of the cellophane thick smear slides should be easily accomplished with 10X wide field oculars and 10X objectives. Confirmation of identification of *S. mansoni* and *S. japonicum* eggs may be required by the 40X objective. Eggs of *Ascaris lumbricoides*, *Trichuris trichuris* and *Fasciolopsis buski* are easily visualized by this technique. This technique has also been used to identify *Clonorchis sinensis*, *Metagonimus yokogawai*, *Opisthorchis viverrini*, *Fasciola hepatica*, *Hymenolepis nana* and *Taenia* spp. Hookworm eggs may be detected only immediately after preparation of the slide.

Many different recommendations have been made regarding reading of the slides. Ideally, each laboratory would review the reading procedure carefully to determine the optimal time for microscopic examination of the slides

All results should be recorded as number of *S. mansoni* or *S. japonicum* eggs per gram of faeces. According to the size of the template, the number of eggs counted on the slide will be multiplied by a correction factor to obtain the number of eggs per gram of faeces. The Kato-Katz template delivers 41.7 mg of faeces; the correction factor is 24.

4. Shipment and storage of the slides

Cellophane thick smear slides can be prepared in the field, stored in microscopic slide boxes and shipped great distances, which permits examination at a central laboratory if required.

Under most conditions, if the proper grade of cellophane and adequate concentration of glycerine are used, slides can be kept up to six months without deteriorating. If the cellophane curls or dries, it can be remoistened with a drop of water, glycerine or eosin in saline. Reconstitution is not perfect but at least practical. Again, each laboratory can adjust these recommendations for storage according to individual requirements.

5. Thick or hard stool specimens

The major complaint about the thick smear technique from most microscopists has been that it is impossible to visualize the helminth eggs in some hard (constipated) stool specimens. In such cases:

- (i) after preparation by the standard method, be sure to wait 24 or 48 hours before counting eggs on these slides. The slide may clear slowly;
- (ii) remake another pair of samples on a large (2 x 3 inches - 5 x 7.6 cm) microscope slide and use a slightly larger piece of cellophane (35 x 35 mm), then press very hard to flatten the specimen as much as possible.
- (iii) when the large slide is used, the stool may be softened with saline or glycerine before sieving.

6. Suppliers

6.1. *Nettable cellophane*

- (a) Description: Rhone Poulenc 500 P 601
- Bulk supplier: Rhone Poulenc S.A., France

Product supplier (in rolls of 50 meters x 22 mm):

Société Normande de Coupage (in lots of 1000 only)
72, rue des Chênaux, Ymare, 76520 Boos, France

6.2. *Screen*

- (a) Stainless steel
- Item characteristics: 105 mesh, stainless steel, bolting cloth
- Supplier: W.S. Tyler Inc., 8200 Tyler Boulevard,
Mentor, OH 44040, USA

- (b) Nylon screen
Item characteristics: TI250, HD 16243 A
Supplier: L'Union Gazes à Bluter, B.P. 2,
42360 Panissières, France
- (c) Plastic screen
Item characteristics: 60 mesh/sq inch (CS-5)
Supplier: Japanese Association of Parasite Control
c/o Hokenkaikan, 1-1 Ichigaya-Sadohara
Shinjuku-ku, Tokyo, Japan.

6.3. Complete kit including all necessary material

- (a) Japanese Association of Parasite Control c/o Hokenkaikan
1-1 Ichigaya-Sadohara
Shinjuku-ku, Tokyo, Japan
- (b) OVO-FEC kits (Kato-Katz) for 100 or 500 examinations
A-K Industria e Comercio Ltda.
Rua Goitacazes 43 - 80 andar
CEP 30 000 Belo Horizonte, Minas Gerais
Brazil

(Note: the glycerine/malachite green solutions of the kits may be defective and should be discarded and replaced by fresh solution.)

7. Bibliography

Kato, K. & Miura, M. Comparative examinations, Japanese journal of parasitology, 3: 35 (1954) (In Japanese)

Katz, N., Chaves, A. & Pellegrino J A simple device for quantitative stool thick smear technique in *Schistosoma mansoni*. Revista do Instituto de Medicina Tropical de Sao Paulo, 14: 397-400 (1972)

Komiya, Y. & Kobayashi, A. Evaluation of Kato's thick smear technique with a cellophane cover for helminth eggs in faeces. Japanese journal of medicine, science and biology, 19: 59-64 (1966)

Peters, P A., El Alamy, M., Warren, K.S. & Mahmoud, A A.F. Quick Kato smear for field quantification of *Schistosoma mansoni* eggs. American journal of tropical medicine and hygiene, 29: 217-219 (1980)

WHO Workshop. Quantitative aspects of the epidemiology of *Schistosoma japonicum* infection in a rural community of Luzon, Philippines. Bulletin of the World Health Organization, 58(4): 629-638 (1980).

Annex VI

THE GLASS SANDWICH FAECAL THICK SMEAR TECHNIQUE FOR DIAGNOSIS OF INTESTINAL SCHISTOSOMIASIS

The glass sandwich technique is a further modification of the glass coverslip thick smear technique first described by Teesdale and Amin in 1976. This technique and the cellophane thick smear technique may be compared under field conditions prior to selecting the most suitable technique.

The essence of the glass sandwich method is that, after sieving of the stool sample to remove large particles, the glass cover slide enables the investigator to press the stool sample into an even layer, in which the eggs can be seen clearly against a background of the rest of the stool matrix. No clearing is therefore required and the stool can be examined immediately. However, preservation of the slide for later reading is not possible.

There are three drawbacks to this rapid low-cost technique:

- (1) if the stool specimen contains small hard particles such as sand which are not removed by sieving, the slides will not stick together;
- (2) the large slide may be difficult to manipulate on a mechanical stage;
- (3) the performance of the microscopists requires intensive training and supervision. An experienced microscopist with a broad training in parasitology usually has no difficulty in identifying the eggs

1. Materials

- (a) Glass microscope slides 2 x 3 inches (5 x 7.6 cm) are most appropriate.
- (b) Squares of paper 5 x 5 cm.
- (c) Flat-sided applicator sticks (wood or plastic).
- (d) Metal frame sieves, 100 mesh (150 microns). Eight inch (20.3 cm) diameter sieves (obtainable from Endecotts Ltd, Lombard Road, London SW19 3VP, England) are very satisfactory, but any setting of 150 microns on a frame will suffice.
- (e) Templates of stainless steel (Peters et al., 1980) or plastic (Kato-Katz) can be used. The size of the hole will depend on local requirements. Templates enable an accurate amount of stool to be delivered so that quantitative egg counts can be made.
- (f) Counting grids (optional). These can be made of either transparent plastic or glass. Lines should be spaced 0.125 inches (0.357 cm) apart so that one complete square fills the microscopic field of view at 40x magnification. Grids enable accurate counting.

2. Procedure

- (a) Using an applicator stick, transfer a small sample of the stool to be examined (about the size of a maize kernel or large pea) onto a piece of paper 5 x 5 cm. A cut-off tuberculin syringe may be used as well.

- (b) Holding the sieve in one hand, press the piece of paper carrying the stool firmly against the mesh. Careful positioning of the sample on the mesh will enable up to 25 samples to be processed on one sieve, without danger of their mixing, before the sieve must be washed
- (c) Using a clean applicator stick, scrape the sieved stool of the mesh surface.
- (d) Place the template in the middle of a clean slide.
- (e) Transfer the sieved stool (on the applicator stick) into the hole of the template and level off, avoiding any air bubbles
- (f) Remove the template carefully, so that no stool is left in the hole of the template.
- (g) Upturn the slide onto another clean slide so as to make a sandwich with the stool in the middle.
- (h) With the slides remaining on the bench press down firmly with fingers or thumb to spread the sample in a slight rotating motion into an even, circular layer (Experience will determine the amount of pressure needed; too much pressure breaks the eggs and may force the stool from between the slides; too little pressure leaves the sample too thick, making observation of the eggs more difficult).
- (i) Place the slides on the microscope stage with the grid on top, and examine at low power (x40) for eggs.

3. Proper reading of slides and additional hints

- (a) The slide can be examined immediately it has been prepared and should not be left for more than 4 hours, as air bubbles form and the edges tend to dry up. Use of the large slides delays the drying and avoids stool being squeezed out of the "sandwich".
- (b) Adjustment of the light source is important. Contrast and intensity of light should be altered to suit the stool sample being examined. In general dry samples require greater light intensity, wet samples a reduced aperture on the condenser
- (c) Doubtful eggs can be confirmed by applying slight pressure to the upper slide while still in position on the microscope. This tends to roll the eggs over, thus revealing the spine clearly if it has been hidden
- (d) Viability of eggs may be checked by observation of flame cell movement. This can only be done using slightly thinner slides which enable the x100 objective to be used.
- (e) Other helminth eggs can be observed, but are more easily seen at x100 magnification. Hookworm eggs are best observed from day-old or older stools, where development of the larvae has passed the morula stage.
- (f) This technique is rapid. An experienced microscopist usually takes 2 minutes or less per slide. Preparation of 3 slides per stool sample can compensate, to a degree, for the inability to store slides.

- (g) Provided stool samples remain moist, they can be processed and examined several days after collection. Refrigeration of stools prolongs storage time.
- (h) For quantitative work the consistency of the stool sample is important. Up to 10 times the number of eggs per gram of stool in samples taken on separate days from the same patient have been observed. Dry stools give high counts, and diarrhoeal stools give low counts, compared with stools of medium consistency from the same patient.
- (i) Stools should not be processed in any way before sieving. Addition of formalin is unnecessary, and makes the sample difficult to sieve; glycerine kills and clears the miracidia, making the eggs more difficult to see; the addition of iodine to the sieved stool after sieving and before the "sandwich" is made, does not increase sensitivity.
- (j) To wash sieves, soak for several hours in water to loosen the stool, and then clean using a high-pressure jet of water from the tap on both sides of the screen. Dry before re-use. Scrubbing rapidly reduces the life span of a sieve. Two or three sieves used in rotation are appropriate.

Annex VII

PROCESS IN SCHISTOSOMIASIS PLANNING

