REPORT OF THE
WHO INFORMAL CONSULTATION ON
SCHISTOSOMIASIS CONTROL

GENEVA
2-4 December 1998

Schistosomiasis and Intestinal Parasites Control
Planning and Technical Guidance
Communicable Diseases Prevention and Control
www.who.ch/cds
(Formerly: Schistosomiasis and Intestinal Parasites Unit of the
Division of Control of Tropical Diseases)

This Consultation was financially supported by:

Direzione Generale Cooperazione allo Sviluppo, Italian Ministry of Foreign Affairs
Ministry of Health and Welfare, Government of Japan

With additional contributions from:

Prince Leopold Institute of Tropical Medicine, Antwerp / Belgian Cooperation Agency, Belgium
Danish Bilharziasis Laboratory, Charlottenlund, Denmark
Partnership for Child Development, Oxford, United Kingdom
This document is not issued to the general public, and all rights are reserved by the World Health Organization (WHO). The document may not be reviewed, abstracted, quoted, reproduced or translated, in part or in whole, without the prior written permission of WHO. No part of this document may be stored in a retrieval system or transmitted in any form or by any means – electronic, mechanical or other – without the prior permission of WHO.

The views expressed in documents by named authors are solely the responsibility of those authors.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of participants</td>
<td>1</td>
</tr>
<tr>
<td>Introductory address</td>
<td>7</td>
</tr>
<tr>
<td>Purpose of the consultation</td>
<td>9</td>
</tr>
<tr>
<td>Executive summary</td>
<td>10</td>
</tr>
<tr>
<td>The global status of schistosomiasis and its control</td>
<td>13</td>
</tr>
<tr>
<td>Geographic distribution</td>
<td>13</td>
</tr>
<tr>
<td>Population increase and water development</td>
<td>14</td>
</tr>
<tr>
<td>Public health impact and control programmes</td>
<td>14</td>
</tr>
<tr>
<td>Political will and national resources</td>
<td>14</td>
</tr>
<tr>
<td>Morbidity control and programme costs</td>
<td>14</td>
</tr>
<tr>
<td>Conclusion</td>
<td>15</td>
</tr>
<tr>
<td>Schistosomiasis-related morbidity and its regression after control</td>
<td>16</td>
</tr>
<tr>
<td><em>Schistosoma mansoni</em> (Brazil)</td>
<td>16</td>
</tr>
<tr>
<td><em>Schistosoma japonicum</em> (China)</td>
<td>18</td>
</tr>
<tr>
<td><em>Schistosoma mekongi</em> (Laos and Cambodia)</td>
<td>19</td>
</tr>
<tr>
<td><em>Schistosoma haematobium</em> (United Republic of Tanzania)</td>
<td>19</td>
</tr>
<tr>
<td>Genital disease in <em>S. haematobium</em> infection</td>
<td>20</td>
</tr>
<tr>
<td>Update on chemotherapy in schistosomiasis control</td>
<td>21</td>
</tr>
<tr>
<td>Chemotherapy of schistosomiasis</td>
<td>21</td>
</tr>
<tr>
<td>Drug resistance</td>
<td>21</td>
</tr>
<tr>
<td>Drug quality</td>
<td>22</td>
</tr>
<tr>
<td>Recent developments in control tools and activities</td>
<td>23</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>23</td>
</tr>
<tr>
<td>Rapid assessment indicators</td>
<td>25</td>
</tr>
<tr>
<td>Cost-effectiveness in schistosomiasis control</td>
<td>26</td>
</tr>
<tr>
<td>GIS mapping</td>
<td>27</td>
</tr>
<tr>
<td>Combined control of geohelminths and schistosome infections</td>
<td>28</td>
</tr>
<tr>
<td>Monitoring and surveillance in schistosomiasis control</td>
<td>28</td>
</tr>
<tr>
<td>Evidence building</td>
<td>29</td>
</tr>
<tr>
<td>Operational research and capacity building</td>
<td>29</td>
</tr>
<tr>
<td>The Cochrane Collaboration</td>
<td>30</td>
</tr>
</tbody>
</table>
List of participants

Dr S. Adjei, Director, Health Research Unit, Department of Health, Ministry of Health, Accra, Ghana

**Dr M.A. Ageel, Director-General, Health Service, Gizan Province, Ministry of Health, P.O. Box 120, Gizan, Saudi Arabia**

Professor M.A. Amin, Bilharzia Department, Health Service - Gizan Province, P.O. Box 120, Gizan, Saudi Arabia

Dr M. Booth, Swiss Tropical Institute, Socinstrasse 57, Basel, Switzerland – email: booth@ubaclu.unibas.ch

Professor D.A.P. Bundy, Oxford, UK, WHO Collaborating Centre for the Epidemiology of Intestinal Parasitic Infections, The Wellcome Trust Centre for the Epidemiology of Infectious Disease, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom – e-mail: dbundy@zoology.oxford.ac.uk

Dr Chen Ming-gang, Institute of Parasitic Diseases, Chinese Academy of Preventive Medicine, 207, Rui Jin Er Lu, Shanghai 200025, People’s Republic of China – e-mail: mgchen@fudan.ac.cn

Dr M. Chimbari, WHO Collaborating Centre for Schistosomiasis Research and Control, Blair Research Institute, P.O. Box CY 573, Causeway - Harare, Zimbabwe – e-mail: chimbari@blair.gov.zw

Dr J.P. Chippaux, Directeur de Recherche ORSTOM, CERMES, B.P. 10887, Niamey, Niger - e-mail: chippaux@niamey-orstom.ne

Dr D. Cioli, Laboratory of Cell Biology, Istituto di Biologia Cellulare, 43, Viale Marx, 00137 Rome, Italy – e-mail: dcioli@ibc.rm.cnr.it (Rapporteur)

Dr J.A. Cook, The Edna McConnell Clark Foundation, 250 Park Avenue, New York, N.Y. 10177-0026, USA – e-mail: jcook@emcf.org (Rapporteur)

Dr A. Davis, “Pantiles”, 4, King William Rd., Catcott, Bridgwater, Somerset TA7 9HU, United Kingdom – e-mail: andrew@davis.md.demon.co.uk (Chairman)

Dr A. Deelder, Laboratory of Parasitology, Medical Faculty, University of Leiden, P.O. Box 9605, 2300 RC Leiden, The Netherlands – e-mail: parasito@rulif2.medfac.leidenuniv.nl

Dr B.E. Ducusin, Director III, Schistosomiasis Control Service, Office for Public Health Services, Department of Health, Manila, Republic of the Philippines
Dr T.A.G. El-Khoby, Under-Secretary, Endemic Diseases Section, Ministry of Health and Population Egypt, 3 Meglis El-Shaab Street, Garden City, Cairo, Giza, Egypt – e-mail: srp@frcu.eun.eg (Co-Chairman)

**Professor H. Feldmeier, Epidemiology Working Group, Faculty of Medicine, Free University of Berlin, Fabeckstrasse 60, 12203 Berlin, Germany – e-mail: feldmeier.fu.berlin@t-online.de

Dr A.B. Gaye, Service national des Grandes Endémies, Ministère de la Santé publique et de l’Action sociale, B.P. 5899, Dakar, Sénégal – e-mail: abeckr@telecomplus.sn

Dr B. Gryseels, Director, Prince Leopold Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium – e-mail: bgryseels@itg.be

**Dr H. Guyatt, The Wellcome Trust Centre for the Epidemiology of Infectious Diseases, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom – e-mail: helen.guyatt@zoology.oxford.ac.uk

Dr C. Hatz, Schweizerisches Tropeninstitut, Socinstrasse 57, Postfach, 4002 Basel, Switzerland – e-mail: hatz@keep.touch.ch

Ms S. Hinalulu, Health Inspector, Ministry of Health and Social Services, Private Bag 13198, Windhoek 9000, Namibia

Dr N. Kabatereine, Danish Bilharziasis Laboratory, Jaegersborg Allé 1D, 2920 Charlottenlund, Denmark – e-mail: dbl@bilharziasis.dk

Dr P. Korte, Director, Department of Health, Nutrition and Population Development, GTZ, Postfach 50180, Dag-Hammarskjold Weg,1, 6236 Eschborn 1, Germany – e-mail: rolf.korte@gtz.de

Dr El Idrissi A. Laamrani, Service des Maladies parasitaires, Division des Maladies transmissibles, Ministère de la Santé, 14, rue Alkalsadi, Aгадal, Rabat, Morocco – e-mail: c/o Jmahjour@sante.gov.ma

Dr J.R. Lambertucci, Faculty of Medicine, University of Minas Gerais, Belo Horizonte, Brazil – e-mail: lamber@net.em.com.br

Dr A. Ly, Région médicale de St. Louis, B.P. 394, St. Louis, Senegal – e-mail: espoir@sonatel.senet.net

Dr A. Mbaye, Région médicale St. Louis, B.P. 394, St. Louis, Senegal – e-mail: ambaye@telecomplus.sn

Dr O. Ndir, Service national des Grandes Endémies, Ministère de la Santé publique et de l’Action sociale, B.P. 5899, Dakar, Senegal – e-mail: ondir@ucad.refer.sn
Ms M. Nghatanga, Director, Primary Health Care & Nursing Services, Ministry of Health and Social Services, Private Bag 13198, Windhoek 9000, Namibia

Dr G.R. Olds, Chairman of Medicine, MetroHealth Medical Center and the Charles Rammelkamp Professor of Medicine, Case Western Reserve University, Cleveland, Ohio, USA – e-mail: gxo@po.cwru.edu

Dr R.M. Olveda, Department of Immunology, Research Institute for Tropical Medicine, FICC Compound – Alabang, 1770 Metro Manila – Muntinlupa, The Philippines – e-mail: Dohritm@gaia.psdn.org.ph

Dr N. Ornbjerg-Christensen, WHO Collaborating Centre for Applied Medical Malacology and Schistosomiasis Control, Danish Bilharziasis Laboratory, Jaegersborg Allé, 1D 2920 Charlottenlund, Denmark – e-mail: dbl@bilharziasis.dk

Dr J. Ouma, Head, Division of Vector Borne Diseases, P.O. Box 20750, Nairobi, Kenya – e-mail: schist@usa.healthnet.org

Dr V.E. Ravaoalimalala, Chef de la Division Bilharziose-Cysticercose, Institut Pasteur de Madagascar (IPM), B.P. 1274 Antananarivo 101, Madagascar

Dr V.R. Southgate, WHO Collaborating Centre for the Identification and Characterization of Schistosome Strains and their Snail Intermediate Hosts, Department of Zoology, The Natural History Museum, Cromwell Road - South Kensington, London SW7 5BD, United Kingdom – e-mail: V.Southgate@nhm.ac.uk

Dr S. Sulaiman, Director, Tropical Medicine Research Institute, P.O. Box 2371, Khartoum, Sudan – e-mail: c/o tropmed@sudanet.net

**Dr M. Tanner, Schweizerisches Tropeninstitut, Socinstrasse 57, Postfach, 4002 Basel, Switzerland – e-mail: tanner@ubaclu.Unibas

Dr M. Traore, Programme national de Lutte contre la Schistosomiase, INRSP, B.P. 1771, Bamako, Mali – e-mail: mstraore@malinet.ml

Dr C. Urbani, Department of Infectious Diseases, Ospedale Generale, Via S. Lucia 1, 6200 Macerata, Italy – e-mail: urbani@fastnet.it

**Dr Yahia Abdel Wahab Hassanein, Ministry of Health and Population, 3, Meglis El-Shaab Street, Garden City, Cairo, Egypt

Dr Zhou Xiaonong, Assistant Director, Jiangsu Institute of Parasitic Diseases, Meiyuan, Wuxi 214064, Jiangsu State, People’s Republic of China – e-mail: xnzhou@wx.js.cn
Observers

Dr S. Brooker, The Wellcome Trust Centre for the Epidemiology of Infectious Diseases, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom – e-mail: Simon.brooker@zoology.oxford.ac.uk

Dr H. Carabin, The Wellcome Trust Centre for the Epidemiology of Infectious Diseases, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom – e-mail: helene.carabin@zoology.oxford.ac.uk

Dr J. Carvalho-Parra, Hospital do Cancer, Sao Paulo, Brazil

Mr Chang Sung Han, General Manager, Shin Poong Pharmaceutical Co. Ltd., 733-23 Yoksam-Dong, Kangnam-Gu, C.P.O. Box 4491, Seoul, Korea

Dr S. De Vlas, Department of Public Health, Faculty of Medicine, Erasmus University Rotterdam, P.O. Box 1738, 3000 Rotterdam, The Netherlands – e-mail: devlas@mgz.fgg.eur.nl

Dr C. Emerick, Fundação Oswaldo Cruz - FIOCRUZ, Av. Brazil – 4365 Manguinhos, CEP 21045, Rio de Janeiro, Brazil

Dr J.A. Ernst, Head, Community Treatment and Institutional Relations, Bayer AG Business Group Pharma, 51368 Leverkusen, Germany – e-mail: JOACHIM.ERNST.JE@bayer-ag.de

Dr G. Hesse, Animal Health Marketing Overseas, Animal Health Vector Control & Consulting Group, Bayer AG, 51368 Leverkusen, Germany

Dr R. Jähnke, GPHF-Minilab Project Manager, German Pharma Health Fund (GPHF) e.V., Postfach 150123, 60061 Frankfurt/Main, Germany

Dr H. Kienzl, Chairman, German Pharma Health Fund (GPHF) e.V., Kennedyallee 111, 6059 Frankfurt am Main, Germany

Dr G. Küsters, Managing Director, German Pharma Health Fund (GPHF) e.V., Hoechst Marion Roussel, Frankfurt/Main, Germany

**Dr K. Kiikuni, Executive Managing Director, Sasakawa Memorial Health Foundation, Tokyo, Japan

Dr C. Laburte, Product Information Manager, Novartis Pharma AG, WSJ-27.4067, 4002 Basel, Switzerland – e-mail: chantal.laburte@pharma.novartis.com

Dr P. Magnussen, Danish Bilharziasis Laboratory, Jaegersborg Allé 1D, 2920 Charlottenlund, Denmark – e-mail: dbl@bilharziasis.dk
Dr S. McGarvey, International Heath Institute, Brown University, Box G-B497, Providence, RI 02912, USA – e-mail: StephenMcGarvey@Brown.edu

Dr O. Morin, International Federation of Pharmaceutical Manufacturers Associations, 30, rue de St.-Jean, P.O. Box 9, 1211 Geneva 18, Switzerland

**Dr L. Mungomba, Faculty of Science, University of Zambia, Lusaka, Zambia – e-mail: LMubila@natsci.unza.zm**

**Dr P. Nyendwa, Head, Epidemic Task Force, University Teaching Hospital, Lusaka, Zambia**

Dr O. Pieri, Schistosomiasis Programme, Fundaçao Oswaldo Cruz - FIOCRUZ, Av. Brazil – 4365 Manguinhos, CEP 21045, Rio de Janeiro, Brazil

Ms M. Rowlands, The Wellcome Trust Centre for the Epidemiology of Infectious Diseases, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom

Dr M. Tendler, Head, Helminthology Department, Fundaçao Oswaldo Cruz - FIOCRUZ, Av. Brazil – 4365 Manguinhos, CEP 21045, Rio de Janeiro, Brazil

Dr B. Vennervald, Danish Bilharziasis Laboratory, Jaegersborg Allé 1D, 2920 Charlottenlund, Denmark – e-mail: dbl@bilharziasis.dk

Dr A. Lee Willingham III, Senior Research Fellow, Danish Centre for Experimental Parasitology, Royal Veterinary & Agricultural University, Ridebanevej 3, 1870 Frederiksberg C, Denmark – e-mail: awi@kvl.dk

Dr A. Wyffels, Prince Leopold Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium – e-mail: awyffels@itg.be

Dr Y. Yamagata, Development Specialist, Japan International Cooperation Agency (JICA), Tokyo, Japan

**Specialized Agencies and related Organizations**

**Dr C. Ok Pannenborg, Sector Manager, Africa Regional Operations, World Bank, Washington, D.C., USA – e-mail: opannenborg@worlbank.org**

Professor D.A.P. Bundy, Representing the World Bank, Washington, D.C., USA – e-mail: dbundy@worldbank.org

**Dr V. Orinda, Health Section, UNICEF, New York**
WHO Secretariat

Dr D.L. Heymann, Executive Director CDS
Dr R. Henderson, Special Adviser to the DG
Dr A. Kochi, Director, CDS/CPC
Dr N.R. Bergquist, Chief, CDS/CRD
Dr N.R. Bos, SDE/PHE
Dr L. Chitsulo, CDS/CPC, e-mail: chitsulol@who.ch
Dr M.R. Couper, HTP/EDM
Dr D. Engels, CDS/CPC, e-mail: engelsd@who.ch
Dr C.M. Garcia-Moreno, EIP/GPE
Ms M.C. Gehner, HSC/HPR
Dr T. Gyorkos, CDS/CPC
Dr P. Hartigan, CDS/CDR
Dr J.E. Idanpaan-Heikkila, HTP/EDM
Dr A. Montresor, CDS/CPC, e-mail: montresora@who.ch
Dr C. Morel, Director, CDS/CRD
Dr P. Olliaro, CDS/CRD
Dr E. Renganathan, CDS/CPC
Dr L. Savioli, CDS/CPC, e-mail: saviolil@who.ch
**Dr M. Scholtz, EXD/HTP
**Dr O. Shisana, EXD/CHS
**Mrs P. Singh, EXD/SDE
Dr P. Tharmaphornpilas, CDS/CSR
Dr S. Wayling, CDS/CRD
Dr S.H. Yu, HSC/HPR

WHO Regions

AFRO:  **Dr D. Barakamfiteye, DDC
       **Dr J.B. Roungou, Conseiller régional pour la Lutte contre les Maladies tropicales autres que le Paludisme, abs. Programme OMS de l’Onchocercose, Ouagadougou, Burkina Faso – e-mail: roungou@ocp.who.bf
AMRO:  **Dr G. Schmunis, PC/HCT
EMRO:  **Dr M.H. Wahdan, ARD
SEARO: **Dr V.S. Orlov, Senior RA/MAL & VBC
WPRO: **Dr A. Schapira, Ag RA/MAL

**Unable to attend
Introductory address

Distinguished colleagues,

It is my pleasure to welcome you to this Informal Consultation on Schistosomiasis Control, which will be hosted by WHO from 2-4 December 1998. Over 50 participants from 22 countries, of which two thirds are supported by external agencies and governments, will review schistosomiasis control strategies and reset the schistosomiasis agenda.

Schistosomiasis is one of the major communicable diseases of public health and socio-economic importance in the developing world. Despite control efforts in a number of countries, still an estimated 200 million people are infected, of which 120 million are symptomatic and 20 million have severe debilitating disease. An estimated 85% of all cases, and most of the severely affected, are now concentrated in Africa. Water resources development projects in Africa have been often linked with an increase in schistosomiasis transmission. Sustainable agricultural development in Africa may be hampered if schistosomiasis is not brought under control.

In the 1970s and 1980s WHO played a leading role in the development of the strategy for the control of schistosomiasis. Praziquantel, the drug of choice for the disease, was developed in a collaborative effort between WHO and the private sector. WHO also invested in the evaluation and promotion of rapid, field applicable diagnostic methods and mobilised donor agencies to support large-scale schistosomiasis control activities, based primarily on selective chemotherapy for the reduction of morbidity.

There have been several success stories. Morocco, Puerto Rico, Saudi Arabia, Tunisia and Venezuela are nearing schistosomiasis elimination or have already achieved this goal. Brazil, China, Egypt and the Philippines have been able to sustain national control programmes for a prolonged period, and have reduced the burden of schistosomiasis disease.

In spite of these positive results, and of the fact that cost-effective control tools are now available, interest in schistosomiasis control in the most affected continent, Africa, has waned. Schistosomiasis control needs to be revived, primarily in Africa, where nearly all of the 20 million with severe disease are concentrated.

The core of the renewed strategy will be a simple morbidity control package which can easily be implemented within the existing health system. The actual trend towards district-based health systems makes it easier to rationally plan for local disease priorities such as schistosomiasis. In addition, new intersectoral partnerships show much promise in targeting control measures to high risk groups such as school-age children.

Research has shown that a single dose of 40 mg of praziquantel per kg of body weight can reverse 90% of urinary tract lesions in schoolchildren infected with *S. haematobium*, after only 6 months. Regular treatment given to children can prevent the chronic debilitating sequelae which appear in adulthood. In Brazil, 20 years of large-scale chemotherapy has brought mortality due to *S. mansoni* down by more than 40%, and severe hepatosplenic morbidity by more than 70%.
At present, praziquantel is the drug of choice for all forms of schistosomiasis. This drug has been on the market for several years but is not yet affordable to the millions infected in Africa. There is a desperate need to make it available to African communities. There is a need to develop new drugs and to test the schistosomicidal properties of alternative drugs. And there is also a great need for operational research at the field level, such as in developing algorithms for the clinical diagnosis of intestinal and genital schistosomiasis, in optimising rapid assessment methods, and in developing appropriate communication strategies for health education. We need to act now on both research and control fronts to ensure consolidation of gains and a renewed impetus in limiting the spread and suffering caused by schistosomiasis.

Thank you for sharing your time and expertise with us. We look forward to receiving your advice and recommendations.

Dr Arata Kochi
Director
Communicable Diseases Prevention and Control
Purpose of the consultation

This Informal Consultation on schistosomiasis control comes at a crucial moment. Interest in schistosomiasis control has waned over the last decade, particularly in sub-Saharan Africa, where an estimated 85% of the cases and most of the severely affected, are now concentrated.

The objective of this meeting is to revive interest in schistosomiasis control, both in the field and in WHO. In order to achieve this, current control strategies have to be reviewed and updated, and practical propositions, which can easily be adapted to the varying situations in the field, have to be made. The schistosomiasis agenda has to be set for the coming years.

The major challenges are different in the different endemic countries and continents. In sub-Saharan Africa, only a few countries have ongoing control programmes. Some of the challenges for schistosomiasis control in this continent are: how can we make praziquantel widely available to endemic communities at an affordable cost? How can we organize and finance in a sustainable way the distribution of this drug to those who need it? What are the priority strategies for schistosomiasis control in sub-Saharan Africa, where the problem can be diluted among so many other health problems? How can we adjust control measures to the varying distribution pattern and public health relevance of schistosomiasis?

A number of endemic countries such as Brazil, China, the Philippines and Egypt have been able to sustain national control programmes for a prolonged period, while others, such as Puerto Rico, Venezuela, Saudi Arabia, Tunisia and Morocco, are nearing eradication or may have already achieved this goal. These countries should also be able to continue to receive appropriate technical guidance from WHO and be guided further towards eventual elimination or eradication. Some of the challenges here are: what are the optimal screening and treatment procedures in situations where a further reduction in prevalence levels and intensities of infection is difficult to obtain? When should emphasis in control be shifted from case finding to more sustainable transmission control? How can we, in general, make control strategies more appropriate and cost-effective in these particular circumstances?

These are just a few of the questions you will be asked to answer in the next days. Your expertise is being called upon to review evidence accumulated to date, from research projects and from the field, and together with your personal experiences, to bring fresh insight into current opportunities for schistosomiasis control. We will be looking forward to your suggestions and recommendations.

Dr Lorenzo Savioli  
Coordinator, Planning and Technical Guidance
Executive Summary

From 2-4 December 1998, more than 50 control programme managers, scientists, and public health experts from 22 countries, met in Geneva in an Informal Consultation on Schistosomiasis Control.

Schistosomiasis continues to be a global public health problem in the developing world. Because it is a chronic insidious disease, it is poorly recognised at early ages, and becomes a threat to development as the disease disables men and women during their most productive years. It is particularly linked to agricultural and water development schemes. It is typically a disease of the poor who live in conditions which favour transmission and have no access to proper care or effective prevention measures.

While progress has been made in schistosomiasis control in some countries, the estimated 200 million people infected has not changed - in part because control has halted or has never begun in areas of Africa, where population increases have pushed up the total number of persons infected. About 85 percent of the cases and almost all of those severely affected are now to be found in sub-Saharan Africa. Yet, during the 1980's, a number of African countries implemented donor-funded, vertical control programmes, which have subsequently shown to be unsustainable. Schistosomiasis is a focal public health problem and therefore "diluted" at the national level. The deteriorating socio-economic situation, and the appearance or re-emergence of more visible health problems, have further contributed to the downgrading of schistosomiasis on the public health agenda and the decreasing commitment towards its control by national health authorities.

During the last decade, however, a number of parameters in schistosomiasis control have changed. The cost of treatment has dramatically decreased, and has become more affordable for national health budgets and/or individual purchasing. Evidence has become available that the control of morbidity due to schistosomiasis can be tailored to the focal epidemiology of the disease and can easily be implemented at the peripheral level in a cost-effective way. This latter aspect is further enhanced by the fact that it can also easily be combined with the control of other helminthiases of public health relevance, such as soil-transmitted helminths.

In many countries, particularly in sub-Saharan Africa, the epidemiology of the disease is only partially known. In these countries, in spite of efficient control tools being available, no clear control strategy is in place, and the drug praziquantel is only minimally or not available to most endemic communities. The group further noted that in countries where control has brought schistosomiasis to low levels, it is both difficult to sustain policymakers' interest in the battle against this disease and to maintain standards within the control programme itself to ensure that the level of infection remains low.

There is ample evidence from countries where the public health importance of schistosomiasis was recognised and schistosomiasis control implemented, that the WHO-recommended strategy for morbidity control is effective. Four national control programmes (Brazil, China, Egypt, and the Philippines) can be cited where concerted control efforts together with economic development has decreased morbidity to very low levels. Chemotherapy was largely responsible for these good
results. Praziquantel, the current drug of choice for schistosomiasis, reverses pathology – in as little
as six months after treatment in *S. haematobium* infections, significant changes in the urogenital tract
are reversed. Also, when used widely, morbidity can be substantially reduced, as has been the case
in Brazil, China, Egypt, and the Philippines. The potential for drug resistance has been carefully
monitored in the field as well as in the laboratory, and the existence of operationally relevant
resistance or tolerance to praziquantel has not been confirmed. The attendants at the meeting
therefore encouraged the wider use of praziquantel, particularly in sub-Saharan Africa, coupled with
on-going monitoring of drug efficacy.

It was noted that praziquantel is very often not available because it is perceived to be too
expensive. While the price of an average treatment has reached a level of approximately
0.35 $US\(^1\), many countries are unaware of this and have not seized the opportunity to obtain the
drug at this price level. Therefore, the drug is not available at the periphery of the health care system
where it is needed.

Participants recommended that the World Health Organization explore with pharmaceutical
producers, donors and development agencies, a coalition or partnership that would allow the price of
this drug to be further reduced. Within endemic countries, it was felt that drug supply gains in most
situations from a strong centralised purchasing system, with distribution through the existing health
services according to local needs. This would greatly facilitate decentralised planning and
implementation of control strategies, resulting in higher acceptability, efficiency and sustainability.
Many participants were of the opinion that the wide availability of praziquantel alone could
significantly lead to the control of morbidity due to schistosomiasis.

With regard to the implementation of schistosomiasis control, the attention of participants in
this Informal Consultation focused largely on sub-Saharan Africa and on recommendations related to
a better targeting of control interventions, and a more cost-effective and sustainable implementation
of control strategies.

There is first of all a need to review the epidemiological status of schistosomiasis, and the
participants recommended that WHO pursue the completion of an atlas of schistosomiasis, currently
being drawn up. In this atlas, mapping of schistosomiasis will be done down to the peripheral level,
in collaboration with endemic countries, using new GIS technology and local data. Efforts will be
made to bring GIS technology to the field. This will allow for the decentralised planning and targeting
of control interventions, and their monitoring, as well as for regular updating and sharing of data
between countries. It can also be used to highlight the focal public health importance of the disease
and convince national policy makers and health authorities to give the necessary support to
peripheral health services to deal with it.

Evidence suggested that vertical programmes, while initially successful, are largely not
sustainable. Therefore the group recommended that schistosomiasis control build upon and
strengthen the capacities of existing health services and national policies. Emphasis should be given to the integration of control and decentralisation of decision-making and delivery. National policy makers and health authorities should recognise the focal public health importance of the disease and give the necessary support to peripheral health services to deal with it. Primary health care services should be strengthened so that they are capable of dealing with control and maintaining their effort.

With regard to control strategies, it was felt that the provision of basic clinical care is an essential component of control within the existing health system. In addition, health services should ensure more active morbidity control and implement appropriate treatment strategies where this is required by the epidemiological situation. With the falling costs of praziquantel it may be possible to expand the use of the drug while saving on diagnosis.

Community-based treatment should first be targeted to school-age children. This high risk group can be reached through the primary school system, in collaboration with the educational sector. Even in areas where school enrolment rates are low, outreach activities can be designed to ensure good coverage. In school-based delivery systems, integration with geohelminth control, nutrition and/or other interventions as a package, should be aimed for.

In order to enhance the effect of regular chemotherapy, long-lasting improvement in hygiene and sanitation should be promoted. This includes the provision of safe water in sufficient amounts to cover all domestic needs, as well as sanitation and appropriate health education.

Vulnerable groups such as fishermen, irrigation workers or communities with exceptionally high prevalence rates, should also have access to regular treatment for schistosomiasis, and appropriate prevention measures promoted within their respective working environments. Integrated control activities with other sectors such as agriculture and water resource development programmes, including small-scale irrigation schemes, should therefore be planned from the beginning. In some instances, the use of snail control may also be indicated.

In countries where control efforts have brought schistosomiasis to low levels, the maintenance of adequate resources is essential in order to consolidate the benefits obtained by schistosomiasis control. Full attention should be given to the cost-effective use of available funds, and to maintaining high standards of quality in carrying out control interventions. Screening and treatment strategies should be adapted in view of changes in the epidemiological situation. Where prevalences are really low, an adequate surveillance system should be set up and the emphasis in control should change from chemotherapy towards sustainable transmission control. Domestic water supply, sanitation, health education, as well as environmental transmission and snail control measures must be implemented to ensure maintenance and eventual elimination.

Finally, while the great progress in some control programmes in the Caribbean, the Middle East and North Africa was recognised, the means and criteria of certifying schistosomiasis elimination have not yet been agreed upon.
The global status of schistosomiasis and its control

Schistosomiasis remains one of the world’s most prevalent parasitic infections and a significant global public health problem. While its distribution has changed over the last fifty years and there have been successful control projects, the number of people estimated to be infected or at risk of infection has not been reduced and may well be increasing (due to population growth and increased water development projects in endemic areas). Where control has been successful, the number of people infected and at risk of infection is very small. This is the situation in most formerly endemic countries in Asia and the Americas. On the other hand, in sub-Saharan Africa where there have been few attempts at control and the population has increased from 344 million in 1976 to 577 million in 1995, a greater number of people are infected or at risk of infection.

As there are few accurate data on country-specific prevalence, global estimates for the number of people infected and number at risk of infection must still be made based on extrapolations of limited prevalence survey data to country level. The most accurate data are normally those provided by national control programmes or from national surveys. National surveys have been conducted in only a few countries in Africa with estimates of national prevalence given. When national prevalence data were extrapolated from the world atlas of schistosomiasis and applied to 1995 population estimates, it was calculated that about 652 million people were at risk of infection from the five human schistosome species and that 193 million were infected. Based on these calculations, 85% of the estimated number of infected people are on the African continent.

Geographic distribution

Schistosomiasis is endemic in 76 countries and territories. With the introduction of *S. mansoni* into Djibouti, Mauritania, Senegal and Somalia, intestinal schistosomiasis is currently found in 55 countries, including the Arabian peninsula, Egypt, Libya, Sudan, most countries in sub-Saharan Africa, Brazil, some Caribbean islands, Suriname and Venezuela. *S. intercalatum* has been reported from 10 countries in Africa. Its reported presence in Mali, an atypical sahelian environment, requires confirmation. Transmission of this species in the Central African Republic, Chad, Congo and Nigeria should also be confirmed. *S. japonicum* is endemic in China, Indonesia and the Philippines and has been reported from Thailand. Another oriental schistosome is *S. mekongi* found in Cambodia and Laos. *S. haematobium* is endemic in 53 countries in the Middle East and most of the African continent including the islands of Madagascar and Mauritius. It may have been erroneously reported to be endemic in Sao Tome and Principe. There is an ill-defined focus of *S. haematobium* in India. It still has to be determined whether those countries that have successfully controlled schistosomiasis, such as Japan, St. Lucia and Montserrat should be considered endemic.

The most severely affected countries in Africa are Angola, Central African Republic, Chad, Egypt, Ghana, Madagascar, Malawi, Mali, Mozambique, Nigeria, Senegal, Sudan, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe. Brazil, with 25 million people living in the endemic areas and 3 million infected, is the most affected country in the Americas. China is the most affected country in Asia with an estimated 900 000 people infected. Yemen has the most infected people in the Middle East (up to 3 million).
Population increase and water development

The increase in population in endemic areas means that more people are at risk of infection. Population movement from north-east Brazil has extended transmission of \textit{S. mansoni} to new areas. Requirements of an increasing population and subsequent pressure in terms of development lead to large scale water impoundments for electricity and irrigation which can result in increased transmission of parasitic diseases. Building of dams introduced urinary schistosomiasis to new areas in Cameroon, Côte d'Ivoire, Ghana, Mali, Namibia, Senegal and Sudan. \textit{S. mansoni} has been introduced to new areas in Ghana, Mali, Uganda and Senegal. Ecological changes wrought by the Aswan High Dam resulted in \textit{S. mansoni} being more prevalent in the Nile Delta.

Public health impact and control programmes

Recognition of increasing transmission and the global importance of the problem did not result in implementation of control programmes in many countries. Up to 1976, only Brazil, China, the Dominican Republic, Egypt, Iran, Iraq, Morocco, the Philippines, Puerto Rico, St. Lucia, Tunisia and Venezuela had national control programmes. Control was initiated in countries where the public health importance of schistosomiasis was appreciated. In China and Japan, the high morbidity and mortality due to \textit{S. japonicum} leading to the disintegration of communities and consequent reduction in agricultural production justified control. In Brazil, schistosomiasis was among the three top public health problems. Control was initiated in Egypt because irrigation is the mainstay of agriculture and it was felt that morbidity due to schistosomiasis would reduce production.

There has been a perception that compared to Brazil, Egypt and Sudan, sub-Saharan Africa had generally less and more variable schistosomiasis-related morbidity. It was therefore argued that the special, vertical schistosomiasis control programmes were not justified and that morbidity should be controlled in a more integrated way. The presence of serious morbidity has recently been confirmed in a number of areas in sub-Saharan Africa.

Political will and national resources

Essential factors for initiating control are political commitment and willingness to use local resources. Thus, in China and Brazil, control programmes followed political directives. The availability of resources is a major issue, as the only countries with a low GNP \textit{per capita} who have control programmes are China, Egypt and Laos with annual per capita incomes of $620, $790 and $350, respectively, in 1995. Only two endemic countries with a \textit{per capita} income above $1 000, Gabon and Namibia, have no control programmes. Along with political support and resources, there is need for a public health infrastructure to undertake the control interventions.

Morbidity control and programme costs

The new strategy for morbidity control should have encouraged endemic countries to undertake control. Countries undertaking control started with available methods and resources, ranging from environmental modification to eliminate vector snails, to molluscicides and chemotherapy. With the new strategy for morbidity control, the availability of single-dose oral drugs
and the use of rapid, field-applicable diagnostic techniques, several control projects were initiated in sub-Saharan Africa with bilateral funding. There was short-term success in reducing prevalence and intensity of infection. Few of these projects are continuing as local authorities could not meet the costs of maintenance.

Studies have shown that the cost of schistosomiasis control was inordinately high compared to the *per capita* health expenditure in sub-Saharan Africa. The relative contribution of drug cost to the cost of control was variable, ranging from 8.5% to almost 89% of the cost of control. As the price of these single-dose oral drugs has fallen sharply over the past twenty years, the cost of control has become more affordable for health budgets of endemic countries.

However, the advent of the HIV/AIDS epidemic, with its heavy economic burden, the need to address other health issues and low economic performance in many countries have made it difficult for many countries to invest in schistosomiasis control.

**Conclusion**

Progress has been made in the control of schistosomiasis over the last twenty years. Elimination and/or eradication of the infection is within reach in the Caribbean islands, Iran, Japan, Mauritius and Tunisia. Morbidity and mortality control is being achieved in Brazil, Cambodia, China, Egypt, Laos and the Philippines. Control has also been successful in Botswana, Iran, and Morocco where prevalence of infection is low though transmission continues. In many areas of Brazil and Egypt, prevalence of infection has been reduced to lower levels but transmission continues at high level. There is thus a need, in these countries, to apply efficient methods for transmission control in conjunction with chemotherapy. Along with snail control, more permanent methods such as the provision of safe water and sanitary facilities are required to limit infective water contact and contamination of the environment.

The adoption of a strategy for morbidity control by the WHO Expert Committee in 1984 was a synthesis of the experience gained from many countries on effective operational components for schistosomiasis control. Easily applicable control tools are available, and the substantial decrease in the price of praziquantel over the last few years has made it easier for countries to apply this strategy within the limitations of resources. For most endemic situations, particularly in sub-Saharan Africa, chemotherapy will be the major operational component. Other operational components, such as water supply and sanitation, environmental management, and health education need to be integrated in an intersectoral manner for sustainable control.

Many of the control interventions undertaken over the last twenty years have been with donor funding. There are exceptions, such as Morocco and Saudi Arabia, where local resources were used. The World Bank has been a leading source of funds, providing sector credits to endemic countries. European Governments and the European Union have funded control projects in Burundi, Congo, Madagascar, Malawi, Mali, the United Republic of Tanzania and Yemen. These are but a few examples of bilateral and multilateral support for schistosomiasis control interventions.

Schistosomiasis remains a public health problem in sub-Saharan Africa because very few countries have undertaken sustainable control. The construction of water resources schemes to meet
the power and agricultural requirements for development have led to increasing transmission. The introduction of \textit{S. mansoni} to new areas may lead to much greater morbidity. All governments in endemic countries should be encouraged to undertake control interventions. A beginning would be the provision of anti-schistosomal drugs at the primary health care level so that those symptomatic can receive treatment. There has to be recognition of schistosomiasis as a focal public health problem by policy makers and a willingness to promote and support control where necessary. Functional general health services are crucial to implement schistosomiasis control in a sustainable way. If necessary, the PHC system must be reinforced before specific schistosomiasis control measures can be implemented. Community based interventions should be targeted to school age children and particular high risk groups. Application of the recommended strategy for morbidity control should be complemented by permanent measures to control transmission. There is thus also need for social sector investments to give alternatives to the population for avoiding use of contaminated water and for better management of the environment. It has to be recognized that schistosomiasis control is a long-term undertaking. Most of the countries on the verge of eliminating schistosomiasis have been implementing control for more than 20 years.

\textbf{Schistosomiasis-related morbidity and its regression after control}

\textit{Schistosoma mansoni} (Brazil)

Most of the available data on clinical pathology due to \textit{Schistosoma mansoni} and its occurrence come from Brazil, where this disease has been extensively investigated.

The acute phase of schistosomiasis due to \textit{S. mansoni} infection is often asymptomatic. However, the clinical syndrome (fever, chills, liver and spleen enlargement, and marked eosinophilia) originally described in \textit{S. japonicum} and still common in this species, is now being increasingly diagnosed in Brazil, in individuals with \textit{S. mansoni} infection. It occurs often in non-immune individuals, frequently from urban areas, who are exposed for the first time to a heavy infection in an endemic area. The ability to recognise and clinically evaluate acute schistosomiasis often depends on awareness of the syndrome by clinicians whose experience is based on the chronic forms.

The chronic forms of the disease are either intestinal or hepatosplenic. The intestinal form may have no symptoms, but blood in the stools is the most common complaint in the absence of hepatosplenic involvement. Most individuals with hepatosplenic schistosomiasis have splenomegaly. However, hepatosplenic schistosomiasis can occur without enlargement of the spleen. The “field definition” of hepatosplenic schistosomiasis in endemic areas as hepatosplenomegaly with \textit{S. mansoni} eggs in the stools is therefore not satisfactory. The use of ultrasound has made it possible to improve the accuracy of clinical investigation. In a recent field study in an endemic area of Brazil, four different types of hepatosplenic disease have been identified, not all of which was associated with marked periportal thickening.
Various other syndromes can be seen in chronic human schistosomiasis, but are frequently overlooked. Syndromes of schistosomiasis associated with the central nervous system, particularly those related to granuloma formation around eggs deposited in the veins around the spinal cord, have been noted in both Africa and South America. While clinical evidence has shown lesions in the brain itself, a more common syndrome is transverse myelopathy. The usual presentation of this syndrome is initial paresthesia of the lower limbs followed by progressive weakness and loss of function. Most cases of this syndrome have been reported from Brazil. However, with increased awareness and ability to diagnose the syndrome, it is expected to be increasingly diagnosed in Africa.

The chronic form of *S. mansoni* infection also includes syndromes of pulmonary hypertension and glomerulonephritis. The syndromes of cardiopulmonary schistosomiasis are related to hepatosplenic disease and increased portal pressure resulting in shunting and an increased number of eggs reaching the lungs through the right heart to cause fibrosis. Symptoms, clinical presentation and radiological findings are similar to those associated with other causes of pulmonary hypertension and cor pulmonale. While this syndrome is not often reported, a study of 246 individuals with echo-doppler-cardiography in a highly endemic area of Brazil found pulmonary hypertension in 16%. The association of schistosomiasis with glomerulonephritis continues to be seen in areas of high endemicity. In Brazil, it occurs in 12-15% of hepatosplenic patients who are admitted to general hospitals. Nine of 100 consecutive hepatosplenic patients admitted to a Brazilian hospital had nephrotic syndrome. Unfortunately, the response of this disease to treatment with antischistosomal drugs and other immunosuppressive agents is poor.

While there have been reports that hepatosplenic patients are more likely to be carriers of hepatitis B antigen than patients with other forms of the disease, these were usually based on hospital-based studies. Studies on populations in the field have not confirmed this association for *S. mansoni* (and this has been true for field studies in *S. japonicum* endemic areas as well). On the other hand, chronic persistent and often multi-species *Salmonella* bacteremia has been described in association with *S. mansoni* infection accompanied by an indolent febrile disease. Reports from Egypt have associated this syndrome with males aged 10-30 years, although these were not population-based samples. The organisms have been found in the tegument and/or the intestinal tract of adult schistosome worms, therefore suggesting either a source or reservoir of the infection. *Salmonella* pyelonephritis is not common in *S. mansoni* infection, but is a frequent finding in patients infected with *S. haematobium* and its response to antibiotic treatment followed by schistosomicides has been good. Another bacterial disease associated with *S. mansoni* infection is pyogenic liver abscess due to *Staphylococcus aureus*. A site of skin infection with the organism has been found in some cases but the exact mechanism of pathogenesis is not clearly defined.

Many aspects of *S. mansoni* related morbidity are expected to change due to control. Some are expected to change quickly (worm burden, *Salmonella* bacteremia, hepatosplenic schistosomiasis in children), whereas others will not be affected for some years (pulmonary hypertension, glomerulonephritis, neuroschistosomiasis).
Progress in the control of *S. mansoni* and its related morbidity has been greatest in the Americas. In Brazil, the national control programme began in 1975, using first oxamniquine and later praziquantel as a single dose treatment. After more than 20 years, there is clear evidence of a reduction in severe morbidity. The mortality due to *S. mansoni* disease has decreased by 47 percent from 1977 to 1994. The percentage of patients with schistosomiasis admitted to the hospital for this disease declined by 50 percent between 1984 and 1997. These two indices have been accompanied by a decrease in the number of patients operated on for portal hypertension due to schistosomiasis as well as the number of people seen at autopsy with hepatosplenic schistosomiasis. This has been attributed mainly to the widespread use of chemotherapy as the primary control measure in Brazil.

*Schistosoma japonicum* (China)

Schistosomiasis has caused serious morbidity in the early days of the control programme in China, where 10 million people were infected out of a population of 100 million at risk, in 12 of the country’s provinces. This control programme, begun in 1955, was based initially on environmental alteration of the habitat of the intermediate snail host and treatment with antimonial drugs. After praziquantel became available for large-scale use in the 1980s, emphasis was placed on chemotherapy.

During the early stages of the programme, more than 50% of the infected patients were found to have signs or symptoms of the disease and up to 10% were cases with advanced hepatosplenic disease. Mortality (usually as a result of exsanguination from esophageal varices) was known to be high in certain areas where transmission was extremely intense. Men were especially affected because of their frequent water contact (which led to the designation of widows’ or no-man’s villages). Animal husbandry and agricultural production were also seriously affected. There have been several reports of high mortality due to acute schistosomiasis as well. In 1950, in Xinning Township, Jiangsu, 1 335 out of 4 019 individuals with acute infection died. Between 1956 and 1966, 2 311 people died from acute schistosomiasis in Xinzhou County, Hubei, and in 1962, 61 out of 1 762 individuals died due to this syndrome in Yuanjiang County, Hunan.

Some other particular aspects of morbidity due to *S. japonicum* infection include the fact that hepatic fibrosis can progress in infections which are below the detection level of a single Kato smear, the marked impact on growth, anemia, functional work capacity, and cognition, and the higher frequency of neurological disease. The presence of large animal reservoirs also makes control strategies different from *S. mansoni*.

While China relies heavily on chemotherapy, it has not abandoned methods of control directed towards the snail intermediate host. It continues to use both chemical snail control and environmental modification which, though more expensive, has a permanent effect.

The prevalence and morbidity of the disease in China is quite low today. In 1995, the population at risk had been reduced to 40 million and endemic areas included only 7 provinces, the others (Guangdong, Shanghai, Guangzxi, Fujin, and Zhejiang) having succeeded in eliminating the disease. In the endemic areas, prevalence has been reduced to 5% in humans and 9% in cattle.
more striking feature is that the proportion of symptomatic patients among those infected has also decreased (only 20-30% having symptoms). The intensity of infection is now low, with a geometric mean usually below 20 eggs per gram of faeces. However, acute schistosomiasis is still seen, but timely treatment with praziquantel has reduced mortality to zero in these cases.

As the morbidity due to schistosomiasis is induced mainly by the eggs laid by mature worms, killing the juvenile worms before they become mature, can prevent the pathological lesions of the disease. During recent years, two new chemicals, artemether and artesunate - both Qinghaosu derivatives - have been investigated and shown to have a high efficacy in killing *S. japonicum* schistosomula and juvenile worms, from 5 to 21 days old. They have been used in the field to prevent infection in high risk populations and rescue workers during the heavy flooding period in China in 1998. Although flooding along the Yangtze River was particularly important in that year, and a large number of people have been in contact with schistosome cercariae-infested waters, the number of cases of acute schistosomiasis has not been very high because of preventive treatment with artemether and artesunate and early treatment with praziquantel (4-5 weeks after water contact, without preliminary screening).

Schistosoma mekongi (Laos and Cambodia)

Of all human schistosome species, *S. mekongi* is the least common. It was nevertheless a public health problem in Laos and in Cambodia. The prevalence in Laos (Khong District) decreased from 40% in 1989 to only 1% in 1997. In Cambodia, it is endemic in the provinces of Kratie and Stung Treng. Morbidity due to *S. mekongi* infection is similar to that of *S. japonicum*, resulting in severe hepatosplenic disease. It has also been noted that growth retardation and delay in sexual development occur in heavy infections.

In remote areas where the disease is known to be endemic, a unique rapid assessment technique has been described by which sites of transmission are detected simply by asking for the presence of rocks in the river. The presence of the snail host is indeed related to the presence of rocks. A positive response to questioning about blood and mucus in the stool has also been associated with the presence of the disease. Community-based chemotherapy has been successful in bringing morbidity under control in a number of areas.

Schistosoma haematobium (United Republic of Tanzania)

Pathology due to *S. haematobium* infection in endemic areas has been found to be quite specific. Few diseases mimic the typical lesions seen in the urinary tract. The association between pathological lesions detected by ultrasound and measures of infection has also been documented. However, there is little published information on the extent to which different pathological lesions associated with schistosomiasis can be attributed to infection intensity as determined by egg output or haematuria measurements. Recent work has demonstrated the usefulness of calculating such attributable fraction estimates.

A study to assess the rate of clearance and reappearance of pathological lesions due to *S. haematobium* using ultrasound has now been carried out in two schools in South-Eastern
Tanzania, in an area of moderate to high transmission. Baseline data collection found urinary tract pathology in 67% of 533 children. Lesions of the bladder were highly significantly associated with egg positivity and microhaematuria. The attributable fraction estimate of major bladder lesions due to \textit{S. haematobium} was 75\%. A cohort of 224 infected children was followed after treatment with praziquantel. Before treatment, 76\% of them had pathological lesions of the urinary tract. The proportion showing lesions dropped sharply during the first months after treatment, to 11\% at 6 months (or a reduction of more than 85\%). Reappearance of positive egg counts between 6-12 months after treatment was followed by the reappearance of pathological lesions another six months later. At 24 months, lesions were again detected in 57\%, and 11\% had developed new severe pathology. Visual haematuria had a high sensitivity in detecting bladder pathology both at the beginning of the study and towards the end. It may thus prove a reliable, though crude indicator of pathological lesions of the urinary tract if ultrasound is not available.

The appropriate treatment and re-treatment schedules in any given endemic setting will be influenced by a variety of factors, including duration and intensity of exposure. The time intervals when re-treatment becomes necessary depend ultimately on the transmission pattern in a given endemic setting. However, this study carried out in an area of moderate to high transmission of \textit{S. haematobium}, suggests that regular treatment of schoolchildren at the standard dose of praziquantel at intervals of two years may be appropriate to prevent substantial urinary tract pathology and therefore control morbidity.

**Genital disease in \textit{S. haematobium} infection**

Genital disease manifestations in schistosomiasis haematobia occur frequently in women and men. Community-based studies from various countries in sub-Saharan Africa indicate that between 32\% and 75\% of women infected with \textit{S. haematobium} have infection-associated lesions in the lower reproductive tract. The prevalence of lesions in the upper reproductive tract could be lower, but precise figures are not known. Lesions in males occur more commonly in the seminal vesicles and ultrasound studies may reveal abnormalities in the prostate glands as well as in seminal vesicles. A community-based study in an \textit{S. haematobium} endemic area in Madagascar showed the presence of eggs in the ejaculate of 43 percent of boys and men aged 15-49 years.

There is circumstantial evidence that genital schistosomiasis in women is a risk factor for the bi-directional transmission of HIV, and that schistosomiasis of the cervix, with or without human papilloma virus infection, predisposes to the development of cervical cancer.

Genital disease occurs in the presence of light to moderate egg excretion in urine, and even in the absence of any egg excretion. A negative urine sample therefore does not exclude the existence of pathology in the genital tract. Since many of the women with eggs detected in a cervical biopsy were not passing eggs in their urine, control programmes aimed at morbidity reduction will need to pay particular attention to this type of disease manifestation.
Update on chemotherapy in schistosomiasis control

Chemotherapy of schistosomiasis

After the recent withdrawal of metrifonate from the market, only two drugs are currently available for the treatment of schistosomiasis: oxamniquine and praziquantel.

Oxamniquine has been the drug of choice for the Brazilian national control programme over the last 20 years, and several million people have been treated both in Brazil and elsewhere with an overall good record regarding both efficacy and safety. In more recent years, the price of oxamniquine has not undergone the substantial decrease as seen for praziquantel, so that the latter drug is now less expensive and is likely to replace oxamniquine even in Brazil. It is thus possible that, due to its decreased demand, the production of oxamniquine may come to an end, much as has happened with metrifonate. This would be a dangerous situation, because it would leave praziquantel as the only available antischistosomal drug, with very serious consequences in the event that the parasite developed resistance to praziquantel. Considerable progress has been made in the elucidation of the mechanism of action of oxamniquine, but this is unlikely to be exploited for the development of improved analogs, due to the lack of incentives for research on novel antischistosomal compounds.

Praziquantel is today the preferred treatment for schistosomiasis, a preference due mainly to its reasonable price and to its activity against all schistosome species. A single oral dose of 40 mg/kg is generally sufficient to give cure rates of between 60-90% and reductions of 90-95% in the average number of excreted eggs. In addition to the original German producer E. Merck/Bayer, praziquantel is now also produced in Korea and China, and is formulated in several countries, including Egypt and Brazil. In spite of the recent price reductions, praziquantel is far from being available in the field, and in several African countries, people with schistosomiasis have no access to treatment in the early stages of the disease, with the ensuing risk of subsequent serious morbidity.

Drug resistance

Resistance to oxamniquine has been documented in the field since 1973 and the characteristics of drug-resistant schistosomes have attracted attention, since up to 1 000 times the standard dose of oxamniquine may be ineffective against these parasites. The resistant schistosomes have been shown to be lacking one specific enzymatic activity and have been demonstrated to have a slightly lower fitness and lower vitality than their sensitive counterpart. This is probably the reason why oxamniquine resistance did not tend to spread in the population and never became a public health problem in Brazil.

Alarming very low cure rates with praziquantel were reported from Senegal in the early 1990s. This occurred in a recently established S. mansoni focus of unusually high intensity and high transmission. Increasing the dose to 60 mg/kg did not appreciably improve cure rates, while oxamniquine was effective at the expected levels. Subsequent studies from the same area have stressed the fact that low cure rates can indeed be expected when the number of parasites is particularly high, so that even at 90-95% drug efficacy some schistosomes will survive and continue
egg production. At the same time, the extremely high rate of transmission increases the probability
that any patient may have been infected 1-5 weeks before treatment and may thus harbour immature
parasites that are known to be largely insensitive to praziquantel. Indeed, a single drug dose gave a
low cure rate in a nearby area, but a second dose given 40 days later (when any immature worms
would have grown to sensitive adults) produced the expected high percentage of cure. More
recently, field studies (assessment of cure rates among infected children going to school in a
non-transmission area / assessment of cure rates in the endemic area after two doses of praziquatet,
two weeks apart, in order to kill the immature parasites having survived the first treatment) have
added strong evidence to the fact that the observed low cure rates in Northern Senegal are caused
by the very high transmission in the area. The efficacy of praziquantet can therefore be considered as
equivalent to what has been observed elsewhere.

However, in contrast to the above “epidemiological” considerations, it cannot be excluded that
the particular parasite strain may possess some intrinsic insusceptibility to praziquantet, since infected
snails collected in the area of the Senegalese focus gave origin to schistosomes that were somewhat
refractory to treatment. It was later shown that such a “refractoriness” was largely due to a slow
maturation rate of the Senegalese isolate, but even when treatment was delayed to allow for
complete maturation, the dose of praziquantet that killed 90% of the controls, killed only 50% of the
field-derived schistosomes. Similarly, an isolate showing decreased susceptibility to praziquantet was
produced in the laboratory upon repeated passages under drug pressure. It should be noted that,
even in this case, the degree of decreased susceptibility was limited and did not increase under
further drug pressure.

In an extensive study carried out in Egypt, 2% of patients were still excreting eggs after three
praziquantet treatments. Isolates from these patients were tested in mice: about 20% of these
isolates showed a normal susceptibility to praziquantel, while the remaining isolates required 2-6
times the normal dose of drug to achieve a 50% reduction of worm numbers. Again, this reduced
susceptibility was not increased upon repeated passages under drug pressure.

Thus, some evidence exists that certain schistosome isolates may be less susceptible to
praziquantel. Should this reduced susceptibility tend to spread or increase in magnitude, some action
would be required. A recent meeting sponsored by the European Commission (Concerted Action:
"Patterns of praziquantel usage and monitoring of possible resistance in Africa") concluded that
"while no compelling evidence exists to recommend any reduction of praziquantel use, persistent
vigilance is required to monitor the possible emergence of drug resistance”.

Drug quality

A recurrent problem in developing countries is the circulation of generic drugs of substandard
quality. According to different estimates, up to 5-7% of the pharmaceutical world market may
consist of counterfeit drugs. This may have serious health consequences, it is an obvious waste of
resources, and it may contribute to lower confidence in medical intervention. The problem is often
encountered in developing countries, where low drug costs are a priority, while quality controls are
difficult to perform.
Some recent novel initiatives aiming at facilitating developing countries to assure drug quality, deserve to be mentioned. An NGO, the German Pharma Health Fund (GPHF), has developed a now commercially available package of simple chemical assays to test the quality of 15 essential drugs in a portable and field-adapted format (essentially two suitcases). Using simple step-by-step schemes, the tests can be used to permit an evaluation of the packaging condition, to determine disintegration and dissolution characteristics, and to assess the identity and the quantity of the active ingredient of each drug. Only a minimum of lab equipment and of pharmaceutical knowledge is required, while availability of electric power is not a prerequisite. Tests are available for a few essential antibiotics and anti-parasitic agents, as well as for some analgesic and anti-inflammatory compounds. Praziquantel is not yet included, but is scheduled for addition in the near future. The whole set costs 2 570 $US and allows about 3 000 colour reactions and 1 000 Thin Layer Chromatography (TLC) runs.

**Recent developments in control tools and activities**

**Diagnosis**

For the diagnosis of schistosomiasis, many different techniques and approaches may be used both at the individual and population level. Diagnosis can be based on clinical symptoms, on the detection of morbidity markers (e.g. microhaematuria in schistosomiasis haematobia), on specific pathological changes using ultrasonography, on measurement of specific cellular immune responses and on immunohistochemical demonstration of specific schistosome antigens. The latter two measures are often grouped together as “immunodiagnosis”.

A diagnosis based on the demonstration of eggs in excreta of the host (faeces, urine) provides the most common technique to demonstrate the presence of adult worms, and remains the gold standard for all other diagnostic techniques. The main advantages of this approach are the fact that a parasitological diagnosis has approximately 100% specificity, that it can be quantitative, and that it is relatively simple to perform, even under field conditions. It also is inexpensive.

Despite its obvious advantages, parasitological diagnosis also has a number of drawbacks. The collection of samples is tedious and, especially for stool samples, not always culturally accepted. As a result, compliance in populations may be low. Egg output also strongly fluctuates. This has been extensively demonstrated for *S. mansoni*, *S. japonicum* and *S. haematobium* infection. Especially in areas with low intensities of infection, repeated examinations are needed to obtain reliable quantitative and qualitative data. In order to better guide policy makers, mathematical modelling has been used to develop tools (e.g. pocket charts) to derive the ‘true’ prevalence in a population from estimates obtained by single sample surveys. At the individual level, where a reliable qualitative diagnosis is required, repeated measurements are necessary.

A parasitological diagnosis based on a single examination is also poorly related to morbidity, especially at the individual level. In view of morbidity control, a clinical diagnosis therefore remains of value. This type of diagnosis is more specific in the case of urinary schistosomiasis as compared to the intestinal form. But it has recently been demonstrated in a primary health care based study in Burundi, that under certain circumstances (depending on the endemic level and the drug price), it
may be justified and economical to base diagnostic approaches on the presence of clinical signs only. In areas of low endemicity, however, it is usually more cost-effective to confirm the clinical diagnosis of schistosomiasis with a parasitological examination, even at the current price of praziquantel (0.35 $US per average treatment).

Ultrasound scanning provides visible evidence of pathology. It is a safe tool that can be used in the field and is reliable and specific, especially in detecting significant pathology. It is therefore useful in morbidity studies, to study the dynamics of clearance of pathological lesions after treatment and to improve the clinical case definition of schistosomiasis in its more advanced stages. As a result of WHO-sponsored workshops in Cairo in 1990 and Niamey in 1996, standardised protocols have been developed for the recording of pathology in the three main human schistosome species. The protocols designed in Niamey attempt to respond better to field requirements by taking into account the differential diagnostic aspect. The disadvantage of ultrasound is that it needs a specific expertise and that variation (especially inter-observer) is considerable.

Based on the use of a vast number of different antigen preparations and on an equally impressive number of different assay formats, many studies have documented the applicability of antibody detection for the diagnosis of schistosome infections both at the level of the individual and in sero-epidemiological studies. Although it is difficult to directly compare such studies because of the various technical approaches, a few general conclusions can be drawn. Light infections may rapidly stimulate high antibody levels. As such, they provide an excellent qualitative technique to demonstrate new cases of infection with a very high sensitivity and specificity. On the other hand, antibody levels - with the relative exception of IgG4 levels against egg antigens - are not quantitative indicators of the intensity of infection. Antibody assays are therefore not well-suited for the diagnosis of active infection in endemic areas or for the follow-up of chemotherapy. Certainly in those cases where after therapy a few worms remain alive, antibody levels may remain elevated for prolonged periods. On the whole, antibody assays have, at the population level, proven to be more useful for measuring the serological status than for diagnosis.

Like a parasitological diagnosis, and in contrast to antibody detection, a diagnosis based on antigen detection directly reflects the parasite burden and thus provides quantitative information. It is in this field of diagnosis that during the last decade major progress has been made. Although several research groups have now described assays for the detection of circulating antigens, the best studied and most evaluated assays are those based on the detection of two gut-associated glycoconjugate antigens: CAA (circulating anodic antigen) and CCA (circulating cathodic antigen). CAA and CCA are Schistosoma genus-specific antigens and can be detected in serum and urine of infected individuals with very high specificity (98%) and a satisfactory sensitivity. However, the sensitivity is - like in parasitological diagnosis - influenced by the intensity of infection. The main advantage of antigen detection, and particularly of CAA detection in serum, is the fact that antigen levels show little fluctuation. A one-point determination therefore provides more reliable quantitative data than in the case of a parasitological diagnosis. Many studies have now documented the fact that serum-CAA measurement currently provides the most direct and reliable marker to quantify the worm burden. It has shown its particular value in the follow-up of chemotherapy. The main disadvantages of antigen detection are related to the availability and cost of the reagents, and to the relatively time-consuming and expensive (ELISA) assay, which also does not lend itself well to use outside a laboratory setting.
To respond to future needs and increase the field applicability of antigen detection, recent research has on one hand focused on the development of rapid, field-applicable assays, and on the other hand on the development of high-throughput applications for use in central laboratories and quality control studies. Recently, the prototype of a one-step reagent strip assay for the detection of CCA in urine was developed, allowing a diagnosis of schistosome infection in a few minutes. Based on a further improvement and rigorous standardisation of assay reagents, the sensitivity of the serum-CAA ELISA test has been improved. It now also appears realistic to develop new, homogeneous assay formats which would allow fully-automated screening of about 10 000 samples/day using either capillary blood or a drop of urine.

Rapid assessment indicators

In view of cost-effectiveness of interventions, valuable information can often be obtained using non-invasive methods like questionnaires, interviews, visual inspection of stools and urines, and simple dipstick tests in the identification of communities at risk and in the assessment of endemic levels. Such methods are often used in school-based interventions. Their main advantage is that they are inexpensive and easy to use.

Rapid assessment indicators are particularly useful in evaluating the prevalence of *S. haematobium* infections, where even the simplest methods show good correlation with urinary egg counts. Macro- and microhaematuria have proven to be of great utility in the rapid diagnosis of urinary schistosomiasis. Very good sensitivity has also been obtained using simple interview methods. Results of the WHO-supported Red Urine Study (1990-92) and other studies have shown the validity of using a simple oral questionnaire for history of blood in the urine to estimate prevalences of infection among school children.

The identification of morbidity indicators is more difficult, although macroscopic haematuria and the presence of cloudy urine are correlated with benign ultrasound lesions. More recently, directed interviews have been demonstrated to be reliable and reproducible means of identifying children who have significant clinical infections.

Rapid assessment indicators in *S. haematobium* infection can also be used to measure the impact of control activities. However, accurate detection of reinfection remains problematic and these approaches need further refinement before they can be applied to determine the appropriate frequency of treatment.

In intestinal schistosomiasis, the use of rapid assessment indicators has been less extensively studied and their usefulness is more controversial. Data were recently reviewed from 9 studies conducted in 8 countries on the use of school/community questionnaires for the rapid diagnosis of intestinal schistosomiasis. Studies were carried out in China, Congo, Côte d'Ivoire, Ethiopia, Mali, Senegal, Tanzania and Zambia. Only studies from Congo and Ethiopia showed the utility of questionnaires at the community level. Data from the other countries were equivocal in this respect. For almost all of the studies the signs "blood in stool" and "bloody diarrhoea" were diagnostic at the individual patient level. A drawback was that different diagnostic protocols and recall periods were
used in the studies so that comparison of the results was difficult. In urinary schistosomiasis, the link between "blood in urine" and infection is straightforward, in intestinal schistosomiasis the equivalent is more difficult to determine.

**Cost-effectiveness in schistosomiasis control**

Because of the chronic lack of resources and the increasing number of health problems, cost-effective implementation of schistosomiasis control is imperative. Cost-effectiveness analysis is therefore becoming an increasingly useful and important tool to guide decision makers in allocating scarce resources for this purpose.

A cost-effectiveness study involves assessing the gains (effectiveness) and resource input requirements (costs) of alternative ways of achieving a given objective. In this type of analysis, costs can be divided into financial and opportunity costs (the latter comprising all kinds of human investments in addition to financial costs). Effectiveness can be evaluated according to a static model, i.e. immediate effects such as coverage, cure rates, etc., or according to dynamic models that can be based either on prevalence or on morbidity. Cost-effectiveness analysis is useful for comparing several control strategies either in isolation or in combination (e.g. snail control, education, chemotherapy). Cost-effectiveness analysis can also be used to health benefits of public health intervention in different fields.

For schistosomiasis control, cost-effectiveness analyses have mostly focused on comparing drug delivery strategies, generally considered to be the most cost-effective control option, in communities. One approach has been to target primary school children using the well-established educational system to reduce the costs associated with drug delivery. In fact, there is ample evidence from the field that this method of delivery is relatively inexpensive and easy to implement. However, cost-effectiveness analysis based on empirical data is limited to a situation with particular characteristics (e.g. endemic level, demography, economy), where only one or a limited number of strategies can be evaluated. In addition, collecting empirical data implies long-term, demanding and expensive projects. For this reason, the development of theoretical models, both static and dynamic, has been useful in assessing the impact of different delivery strategies for chemotherapy. One of the advantages of static and dynamic modelling approaches is their flexibility in conducting sensitivity analysis by varying the value of the parameters included in cost-effectiveness models.

A morbidity-based dynamic model has been used to estimate the cost-effectiveness of various frequencies of targeted treatment of school-aged children in Tanzania. An increase in the frequency of interventions from 3-years to 6-month intervals produces a negligible gain in the number of fibrosis cases prevented, a moderate gain in the number of hepatomegalies prevented and a more substantial gain in the number of infections prevented. However, the extra cost for each unit gain increases dramatically with more frequent interventions.

The WHO recommends mass treatment of children in schools where the prevalence of schistosomiasis exceeds 50%. This recommendation implies the use of a screening method to assess the prevalence of infection in each school. A study conducted in Tanzania has assessed the accuracy and cost-effectiveness of different screening methods for the diagnosis of *S. haematobium* infection.
Using the urine filtration method as a gold standard for diagnosis, the cost per infected/treated child of urine filtration, self-reported schistosomiasis, reagent strip test and visible blood in urine, was 1.59 $US, 0.72 $US, 2.17 $US and 0.45 $US, respectively. Even though visible blood in urine was the least expensive option, its sensitivity in identifying infected individuals was very low (16%). Self-reported schistosomiasis was an interesting alternative since it consistently underestimated the prevalence of schistosomiasis in the school by approximately 20%. Therefore, self-reported schistosomiasis may be a cost-effective strategy to identify schools for mass treatment using a threshold prevalence of 30%.

Cost-effectiveness analysis can also be used to evaluate different diagnostic approaches and treatment strategies in health services. In Burundi, a primary health care programme was implemented in the Rusizi Plain between 1990 and 1991. At that time, the overall prevalence of 
S. mansoni infection was 9.5%. Advertisements were made in the community to encourage individuals with symptoms suggestive of 
S. mansoni infection (vague chronic and non-intestinal symptoms, persisting mild diarrhoea, bloody diarrhoea, hepatomegaly) to consult their local health centre. The health centre staff was asked to perform a direct slide and a 25 mg Kato-Katz smear on a stool sample from all patients with these symptoms. The cost-effectiveness of presumptive treatment of individuals with any of the above symptoms in comparison to screening based on the presence of eggs in the smear was evaluated. Using the latter as a gold standard for infection, the cost per infected person treated was 4.10 $US for selective treatment based on a positive smear compared to 12.43 $US for mass treatment of patients with any symptoms. Screening with a 25 mg Kato-Katz smear was therefore found to be the most cost-effective approach in all age groups and health centres, considering the prevailing cost of praziquantel in 1991 (1 $US per average dose). Low drug prices, however, increase the cost-effectiveness of presumptive treatment compared to Kato-Katz screening. Overall, if the price of the drug would have been reduced to less than 0.20 $US per person treated, would the presumptive treatment option have become more cost-effective than the screening approach. At the actual cost of praziquantel of 0.35 $US per treatment, presumptive treatment would have been more cost-effective in health centres with detection rates of over 35%.

**Geographical Information System (GIS) mapping**

In view of a rational planning of control interventions, it is essential to adequately know the epidemiological distribution of a disease. The information contained in the "Atlas of the global distribution of schistosomiasis" (Doumenge et al., 1987) is largely outdated. A recent joint initiative of WHO and the University of Oxford has the objective of updating and expanding the available information on schistosome epidemiology, as the basis for a new atlas of the spatial distribution of both schistosomiasis and soil-transmitted nematodes. Schistosomiasis is often a local priority which is "diluted" at the national level and therefore not recognised as a health priority. As the decision level in most health sector reforms has now become the district level, the goal is to have information on the distribution of schistosomiasis within districts. Sources of information used for the new atlas range from official records to the 'gray' literature and epidemiological data consisting of community-based surveys collected after 1970. The new atlas is using new, user friendly GIS mapping software and is intended as a dynamic 'open' project that can be expanded and revised at any time in the future, and used for the planning, targeting and monitoring of control interventions.
Combined control of geohelminths and schistosome infections

Several features of geohelminth and schistosome infection epidemiology and treatment make combined control attractive. The two types of infection are both strongly related to poverty, and are therefore often endemic in the same communities. Both types of parasite are mainly infections of school-age children. Only two drugs, which can safely be administered at the same time, are required to treat several species of schistosome and geohelminth infections, which simplifies treatment schedules.

Recent analysis of data from Africa has shown however that, although geohelminth and schistosome infections are often endemic in the same communities, they are independently distributed within these communities. The prevalence of one cannot therefore be used to predict the prevalence of the other. This indicates that a more refined approach to combined control is required, whereby communities are identified for intervention against schistosomes and geohelminths separately and the most appropriate control strategies determined specifically for each of them.

Monitoring and surveillance in schistosomiasis control

It is important to periodically document the progress of control interventions. The World Health Organization sees monitoring as an integral component of control. This aspect is essential in ensuring that the programmes are run efficiently and that maximal benefit is attained by the beneficiaries. At the same time monitoring should be carried out at a minimal cost, in order not to divert resources from the intervention itself.

Progress can be measured by different types of indicators. Process indicators document the practical organisation of the interventions. They may include, among many others, the number of cases detected in health services, the degree of correct application of algorithms, the percentage of school age children covered by a school based intervention. Parasitological indicators monitor the impact of control on the occurrence of the parasite infections. If the aim of control is to reduce morbidity, morbidity indicators most specifically document the impact of the interventions. They are, however, more difficult to check.

In the past, the prevalence of infection has often been used to monitor the impact of community based chemotherapy. This type of intervention usually results in an immediate drop in the prevalence followed by a gradual return to the original levels if transmission is not substantially reduced. This gradual return to original levels after drug treatment is to be expected and should not be considered as a failure of control, particularly if morbidity control is aimed at. Periodical treatment results in a significant reduction in short and long-term morbidity, even without important changes in prevalence. Therefore, prevalence alone is not an adequate indicator to measure the impact of control based on chemotherapy. If parasitological indicators are used, other measures (e.g. prevalence of heavy infection) need to be considered in order to more correctly ascertain the benefits of the programme.
WHO is developing a manual (available September 1999) to guide health managers in the monitoring of control activities. A list of indicators is provided together with discussion on which indicators should be selected for what purpose and how data on indicators should be collected and analysed. The indicators have been grouped into process indicators, parasitological indicators, and morbidity indicators, which monitor more specifically the impact on the sequelae of the infection.

Evidence building

Operational research and capacity building

Schistosomiasis control must be seen in a broad context. Only in a few situations can control efforts be of a disease-specific nature, i.e. schistosomiasis control needs to be integrated in a more holistic approach for improved health. It is thus insufficient to focus on schistosomiasis alone, both when it comes to operational research and to capacity building efforts.

Available resources, endemic levels, functions of health systems, priority settings and other variables determine the approach and type of control operations. Three levels exist, namely morbidity control at the individual level involving peripheral health systems, morbidity control at the community level involving the health and/or other systems, and transmission control. The need for operational research and capacity building is different with each level.

Long-term and sustainable improvement in health conditions in developing countries requires building relevant and sufficient capacity at different levels. Effective disease control requires competence from the ministerial level down to the peripheral health unit level. Improved capacity of the health system at all levels is essential for disease control, including control of schistosomiasis. Strengthening of the health system is thus essential for the first level of control, namely morbidity control at the individual level. This requires availability of drugs at the peripheral health system level in sufficient amounts, a capacity to diagnose, either presumptively or using appropriate low technology techniques, and a capacity to treat.

Extending control to morbidity control at the community level requires building additional capacity at other levels. Creating community awareness about the schistosomiasis problem is an essential part of capacity building. The possible involvement of schools in such community-based morbidity control efforts requires relevant capacity building among school teachers, and, more globally, in the educational sector.

Transmission control requires a multisectoral approach, and requires capacity in many sectors and at many levels. The schistosomiasis problem is often linked to environmental change caused by development programmes. Dam construction and establishment of irrigation schemes often lead to schistosomiasis becoming a major problem. Thus, other sectors need to be made aware of health consequences of their policies and activities. Capacity building as related to schistosomiasis control should therefore start with strengthening the capacity for intersectoral collaboration. Disease problems should be forecasted and mitigating action incorporated early in the planning phase.
Building operational research capacity at the individual and institutional level in endemic areas is considered crucial for achieving sustainable schistosomiasis control. A capacity for operational research, monitoring and evaluation needs to be available in local institutions. Indeed, presently advocated strategies for schistosomiasis control still require much local operational research to achieve maximum effects and efficiency. Strong emphasis needs to be given to operational health systems research in a given context. Intervention methods must be culturally compatible and should be based on active participation by the affected communities. Solid social science research is therefore required. Knowledge regarding local perceptions, relevant practices, health care seeking behaviour, occupational and leisure risk behaviour, cultural explanations of illness categories and causality is a precondition for appropriate health education activities. Ideally, schistosomiasis control requires an integrated approach with chemotherapy being backed up by a range of supplementary interventions, including the provision of water and sanitation, and snail control where appropriate. The need for operational research in terms of cost-effectiveness and acceptance of these types of interventions is still great.

The Cochrane Collaboration

Health policy decisions should be based on sound scientific evidence usually obtained from the scientific literature. This can be supplemented with evidence from other sources such as surveillance reports, hospitalisation data and various other non-published material. However, available data are often insufficient or have not been critically and objectively reviewed. The “Cochrane Infectious Diseases Group” has been commissioned to undertake a series of systematic reviews on vaccines, drugs and other health interventions, that consist essentially of meta-analyses of available data with a critical assessment of the resulting options. In the field of schistosomiasis, praziquantel treatment has been compared with metrifonate and oxamniquine. In the future, other themes, in different fields of schistosomiasis control, can be proposed to this group for thorough and comprehensive analysis.

Schistosomiasis control in sub-Saharan Africa

Past experiences

Up until the 1970’s, efforts to control schistosomiasis were based on a combination of snail control with niclosamide, chemotherapy with metrifonate or niridazole, and educational and sanitary measures. With the introduction of praziquantel, a powerful single-dose treatment tool became available. This has changed the emphasis in schistosomiasis control in favour of large-scale chemotherapy, with the primary aim of reducing morbidity.

In 1978, the principles of Primary Health Care (PHC) were adopted by most countries in the developing world as a new strategy to bring health especially to under-served areas. This gave rise to hopes that coverage with essential health services was feasible and achievable in the foreseeable future.

In this context, the German Agency for Technical Cooperation (GTZ) implemented a number of schistosomiasis control projects in the 1980’s, first in Mali, and thereafter in the People’s Republic of Congo, Malawi and Madagascar. Special vertical programmes appeared justifiable for several
reasons. The safety of large-scale use of praziquantel still had to be established, and therefore
treatment was carefully supervised by professionals. Only later, praziquantel was given to
lay-workers and used for blanket mass chemotherapy (universal treatment). Because of the high
price of praziquantel and the availability of inexpensive and reliable diagnostic field methods such as
urine filtration and the Kato-Katz faecal thick smear, screen-and-treat campaigns were also a more
cost-effective strategy than blanket mass treatment in most endemic countries. Finally, it was hoped
that once a successful strategy was established, it could be integrated into evolving primary health
care systems.

The impressive impact of chemotherapy on the reduction of prevalences and intensities of
infection made this type of intervention the dominant theme of schistosomiasis control and probably
pushed traditional efforts like sanitation and health education to the background. However,
re-infection imposed regular re-treatment, and because of the limitations of diagnostic tools, it was
difficult to target interventions according to the severity of disease. The cost of interventions was
high by our present day standards. Integration in PHC was limited, as the development of the health
services was slower than expected during the economic crisis in the mid-1980’s. At the same time,
the vertical control programmes had established their own organisational structures and were
reluctant to dissolve, fearing the loss of quality in the services. The support of control programmes
was finally phased out, because sustainability could not be demonstrated.

Lessons

Some important lessons can be learned with regard to schistosomiasis control in Africa, both
from these control experiences and results achieved in other continents. Certainly, severe morbidity
has been substantially reduced in most countries or areas where antischistosomal drugs have become
widely available, either through special programmes or via existing drug distribution channels.
Another important lesson is that integration in existing, sustainable health services is essential from the
beginning of control interventions. If the existing structures do not have the capacity to ensure
specific programmes, then the first priority is the general reinforcement of the health system. This is
not only sound general health policy, but also essential for the long term sustainability of any specific
disease control programme and in line with the current overall strategy of WHO. The objectives of
control and the ensuing strategy should be more precisely and narrowly defined. Morbidity control,
infection control, and transmission control are distinct, although overlapping objectives, implying not
only different strategies, but also addressing different systems, and requiring different expertise and
research needs. The level of complexity of collaborative needs, cost-effectiveness, required
commitment and sustainability, increases substantially at every step.

New prospects

It is clear that schistosomiasis control needs to be revived in sub-Saharan Africa. The first
challenge is to make praziquantel widely available to health services in endemic communities.
Despite the fact that the price of praziquantel on the international market has now dropped to about
one quarter of its initial price, there is still a striking discrepancy between need and availability. Some
of the presently available products are expensive, and their quality has not been tested or is in doubt.
Very few health services have access to praziquantel at the best prevailing price of approximately
0.35 $US per average treatment of 3 tablets. The second challenge is to target schistosomiasis control to problem areas. In this respect, the actual trend towards district-based health systems makes it easier to rationally plan for local disease priorities. During the last decade, a lot of research has been carried out to make tools and strategies more cost-effective. These tools and strategies have to be brought to the field. The third challenge is therefore to have them implemented in an integrated way at the district level.

As a first step, the case management of schistosomiasis should be improved at the different levels of health care. The clinical case definition of schistosomiasis must be extended beyond an early clinical diagnosis of urinary schistosomiasis (haematuria) and the detection of late complications of all types of schistosome infections. Diagnostic algorithms and treatment strategies at the primary health care level should take into account the varying importance of schistosomiasis in the different endemic settings.

School health programmes are particularly useful in the control of schistosomiasis. Not only is the 5-19 year age-group always most at risk for the disease, but this type of programme can be easily implemented at the peripheral level, and tailored to the varying epidemiological disease distribution in a cost-effective manner, and combined with a range of other health promoting interventions, of which health education, the systematic treatment of soil-transmitted nematodes and nutritional supplementation are the most obvious. Other high-risk groups, such as fishing communities or families living in irrigation schemes, may need particular attention as well.

Environmental management and sustainable transmission control should by all means be promoted. These measures aim at reducing people's contact with infested water by supplying safe domestic water and sanitation, and/or at reducing snail breeding by environmental measures. They should particularly be incorporated at the planning stage in water resource development projects. It may appear that the installation costs of this type of measures are high, but the impact on schistosomiasis transmission is long-lasting, and there are other health and social benefits which justify the investment.

In health education, there is a great need to adapt communication strategies to the local realities. Messages should be simple and realistic. Promotion of health care seeking behaviour could be a message to start with. Health education messages should always be in pace with the implemented control interventions and the proposed preventive measures. There is a need for more involvement of (local) social scientists to adapt messages to local traditional paradigms.

**Elements of successful and sustainable control**

In reviewing the current state of schistosomiasis control in the various WHO regions, some elements determining successful schistosomiasis control can be highlighted and extrapolated to the situation in sub-Saharan Africa. The absence or weakness of any of these leads to a weak or unsustainable control effort. Countries that have succeeded in controlling schistosomiasis in the past have had most of these elements in place in one form or another.
Epidemiology/public health importance. The first prerequisite for the implementation of control is the recognition of schistosomiasis as a public health priority. In sub-Saharan Africa, although many aspects of schistosomiasis morbidity still have been poorly investigated due to a generalised lack of diagnostic potential, and the controversy whether it should be considered as a national health priority in a number of countries is still ongoing, its public health importance at the local level is generally well perceived in the peripheral health system. However, an adequate appraisal of the local epidemiological situation is necessary in order to develop a sound strategy.

Strategy/planning. A coherent control strategy must be developed that takes into account the local epidemiology and the severity of the disease as a public health problem. The strategy for morbidity control can be tailored to the focal epidemiology of the disease and can easily be implemented at the peripheral level in a cost-effective way. This latter aspect is further enhanced by the fact that it can also easily be combined with the control of other helminthiases of public health relevance, such as soil-transmitted helminths. While vertical campaigns are now inappropriate, some of the factors that made them successful need to be incorporated in strategies within a primary health care setting: a clear strategy and objectives, good monitoring, a real sense of mission, and feedback on progress to the field. Because of the decreasing price of praziquantel, the limitations of current diagnostic tests, and the lack of praziquantel toxicity after extensive use and experience, the actual tendency in community-based interventions is to move away from selective chemotherapy to more cost-effective targeted mass treatment of high risk groups such as school age children. This is also easier to implement within the existing health system.

Public health infrastructure and management. Functional general health services are crucial to implement schistosomiasis control in a sustainable way. Adequate health financing, available logistics starting with drugs, and good management of resources and personnel, are all crucial elements for integrated disease control.

Central support and political will. National policy makers and health authorities should recognise the public health importance of the disease within their country and give the necessary support to peripheral health services to deal with it. Anti-schistosomal drugs have to be made available at the primary health care level in schistosomiasis endemic areas, through the existing public health channels and at the lowest possible cost. National expertise should be available to teach peripheral health authorities how to efficiently implement schistosomiasis control and to supervise and evaluate control activities. Central support includes operational research capability to undertake studies to optimise the implementation of a control strategy in a particular context.

Community awareness and consumer demand. Because the actual damage in schistosomiasis is done in childhood with the disease presenting usually at adult age, the community must understand the natural history of the disease and the need for early treatment to prevent damage in the future. The tools of social marketing can be used to provide health education, and to increase demand as well as participation in services.

Monitoring and feedback. Unless those persons who are actually doing the work of control in the field have feedback on the success or failure of their work, their efforts will lag and goals are unlikely to be met. A simple monitoring programme should be in place that can provide feedback and reinforcement to those who are actually doing the work. At the same time, a summation of the
results can be provided to the policymakers who are necessary for continuing support for the control effort.

**Country examples**

**Ghana**

The “Ghana Partnership for Child Development” has recently started to carry out an intervention study to examine the feasibility and cost of using the school system to deliver a package of interventions to children aged 5-14 years who are in the educational system. The intervention was based on an average 70% school enrolment in Ghana and concerns three districts. Two districts are used as a comparison (non-intervention) area. An estimated 85 000 school children are targeted in the intervention districts.

The programme is implemented within the framework of a national School Health Education Programme, which is decentralised down to the sub-district level ("circuit officers", who are supervising 10-12 schools each). The intervention consists of the delivery of albendazole and praziquantel using teachers. The teachers receive a one-day orientation in the administration of the drugs. Albendazole is given to all children. For schistosomiasis, the programme makes use of questionnaires for a rapid assessment of prevalence. In schools with prevalences higher than 30% all children receive praziquantel, which is administered by the teachers using a calibrated height pole to calculate the drug dose. The rapid assessment is done by the circuit officers, who also supervise the drug distribution by the teachers and are in direct contact with the local health services for the supply of drugs. Health education is provided by the teachers as part of their classroom teaching.

Data on prevalence and intensity reduction has validated the effectiveness of this approach, while a study of costs has indicated that the total cost per child treated was 3.21 $US in this programme, with 1.22 $US as the average cost of praziquantel per child, and 0.24 $US the average cost of albendazole.

**Mali**

In Mali, a donor assisted (GTZ) schistosomiasis control project started in 1978 as a component of a small dam building project on the Plateau Dogon. The dams had significantly increased the agricultural potential, but had also significantly increased the prevalence of *S. haematobium* infections. A schistosomiasis control team was created in Bandiagara. Emphasis was put on sanitation improvement and snail control using chemical molluscicides. Efforts were made to change the design of the dams in order to minimise transmission.

In 1982, the schistosomiasis control programme on the Plateau Dogon was extended to other areas with irrigation and dams (Office du Niger, Baguineda and Selingue) and became a national programme. Schistosomiasis control was then considered by the Ministry of Health as one of the 10 top priority programmes to be implemented in the ongoing 10-year plan (1981-1990).
As strategy, a combination of mass chemotherapy with praziquantel, chemical mollusciciding and environmental hygiene was adopted. The schistosomiasis control team moved to Bamako and was placed under the joint supervision of a GTZ co-ordinator and his Malian counterpart. Population-based chemotherapy was initiated in all districts with a prevalence of either type of schistosomiasis (S. haematobium or S. mansoni) of 20% or above, or a prevalence of heavy infection (≥50 eggs/100 ml of urine, or >400 eggs/g of stool) above 5%. This was implemented initially in a vertical way by the central team, with the aim of bringing the prevalence to below the defined threshold, and then to hand over to the district team for the maintenance phase. During this latter phase, schistosomiasis control activities were meant to be integrated into the routine work of the district health services. As strategy, a combination of individual case management in health centres, health education and water and sanitation improvement through intersectoral collaboration, was used.

In 1988, at the start of this integration process, many problems became apparent. The vertical intervention by the central team based in Bamako had not been able to cover a great deal of high prevalence villages in endemic districts. The primary health care delivery system in most districts did not permit a satisfactory development and integration of schistosomiasis control activities in the routine work. The district health teams were neither sufficiently prepared nor motivated to undertake responsibility for the maintenance phase. The local communities had not been sufficiently involved in the decision-making process and continued to take for granted that free treatment should be given to them. The programme had been entirely funded by external support during 10 years and the financial means of the Malian government were insufficient to take over.

Since then, the Malian government has substantially increased its financial effort to fund schistosomiasis control, although the external donor continued to supply praziquantel for free community-based treatment. Regional training workshops have been organised to build the capacities at the regional and district level to conduct schistosomiasis control activities. The district health teams have started to involve the local authorities and communities in decision-making. Mechanisms for the payment of recurrent cost of mass chemotherapy and to enhance the motivation of health personnel, have been initiated. This has led to a 10-fold increase in the number of individuals treated in endemic areas between 1988 and 1989.

The integration of schistosomiasis control in the routine work of basic health services is progressing in Mali, despite the many difficulties specific for each endemic area. Nevertheless, the experience of the past ten years showed that secondary integration is a very long process which in particular needs a clear definition of the role of each level of the health care system in the planning, implementation, evaluation and monitoring of the programme, as well as a clear definition of funding mechanisms. It also has to be a flexible and dynamic process, as many countries are going through major health sector reforms. In Mali, with the creation of Community Health Centres, the implementation of the Bamako Initiative and the cost recovery schemes, one of the crucial problems is the definition of mechanisms for the payment and delivery of praziquantel both for individual case management and community-based treatment.

Morocco
Urinary schistosomiasis has been present in Morocco since 1914, but was not given much attention by public health authorities until the 1970's. From that time onwards, large irrigation schemes were implemented in the centre and the north of the country, attracting many workers from the endemic areas in the south. This resulted in an extension and increase of the disease and the recognition of schistosomiasis as a public health priority.

The preparatory phase of the national schistosomiasis control programme was started in 1976 and the programme was progressively implemented in the endemic provinces (20 out of the 50 provinces) from 1982 onwards. It was a vertically structured programme, but integrated in the well-developed health system, and combined with other disease control programmes (e.g. malaria). It was funded by the national budget. From 1982 to 1986, metrifonate was used as the drug of choice, but was replaced by praziquantel in 1987.

In 1993, after ten years of implementation, the perspectives and goals of the programme were reconsidered and it was decided to attempt elimination of the disease by 2004. The process for the elimination of schistosomiasis in Morocco was officially launched in 1994.

The cornerstone of the programme is case detection and treatment of positive cases. Case detection is done in several ways: passive case detection in health services, more active case detection (but still on the basis of reported symptoms) during public health outreach activities, and systematic parasitological examination in schools and populations in endemic areas. As diagnostic method, the sedimentation technique is used. Positive cases are to be systematically checked 3 and 6 months after treatment.

Selective chemotherapy is supplemented by snail control (both physical and chemical) and health education. Much attention is also paid to intersectoral collaboration.

The programme is carried out by local health personnel. The provincial level provides some assistance for the large-scale screen-and-treat campaigns. A provincial coordinator monitors the programme yearly by checking a number of indicators: the exposed population, the number of performed urine examinations and the number of cases (including breakdown by type of detection), the coverage rate (number of urine examinations/exposed population x 100), the detection rate (number of cases/number of urine examinations x 100), the cumulative incidence (yearly number of cases/exposed population x 1 000), the case distribution per age group, and the number of sectors and villages affected. A schedule for elimination has been set for each province individually.

During the first 5 years (1994-1998) of the programme, the overall number of detected cases decreased from 1 108 to 359. Schistosomiasis was eliminated from 7 of the 20 endemic provinces and from 156 of the 210 endemic villages. The elimination process is progressing according to schedule in another 9 provinces. In the 4 remaining provinces, each with a particular ecological setting, there is still active transmission and their schedule for elimination may have to be revised.

Senegal
Urinary schistosomiasis has long been known to be endemic in Senegal. In the 1980's, a dam was constructed on the Senegal River to prevent the annual inland flow of sea water. With the subsequent water resources development, the endemic level of urinary schistosomiasis has increased in the Senegal River Basin. In addition to this, a real epidemic of intestinal schistosomiasis due to *Schistosoma mansoni* has occurred in the St. Louis area (districts of Richard-Toll and Dagana). The first cases of *S. mansoni*-related schistosomiasis were discovered in Richard-Toll in 1988. Since then, the prevalences of infection in and around that town have gradually climbed from 42% in 1989 to 80-90% in 1997. In the rest of the area, recent surveys have given average prevalence rates of 90% around the Lake de Guiers (an inland lake connected to the Senegal River), 60% in the villages near the Senegal River, and 30% in villages more distant from the river. These surveys also have indicated very high intensities of infection. The extreme rapidity and the intensity of the epidemic's progression are due not only to the widespread propagation of the intermediate host, but also to the very significant compatibility between the intermediate host and the parasite, resulting in extremely high transmission levels.

Because of the rapid expansion of schistosomiasis in Northern Senegal, a control programme was funded and implemented in this area by the European Development Fund. This programme has a strong research component, through the ESPOIR project (European Special Programme for Operational and Integrated Research). The main component of the control programme is chemotherapy, which is delivered through case management in health services (use of clinical algorithms and systematic treatment of patients under 20 years old where intestinal schistosomiasis is a problem, active search for cases of haematuria where this is the case for urinary schistosomiasis) and targeted treatment of schoolchildren. This is actively supported by health education, using locally designed tools. Considerable attention is given to cost-recovery mechanisms. Vector control (malacological surveillance and cleaning of transmission sites), and the promotion of safe water supply and sanitation, are considered secondary strategies. Special emphasis is placed on supportive strategies, such as the strengthening of health services (training, logistic support, use of tools for self-evaluation and monitoring) and intersectoral collaboration.

Although recent surveys have indicated that intestinal schistosomiasis has also started to spread southwards, urinary schistosomiasis is still the dominant type in most of the country. A national survey has been carried out in 1996, and a national control programme, funded by the World Bank, was initiated in 1997. As in the St. Louis region, case management in health services is the key component of this programme. Community-based treatment is implemented according to the endemic level: universal treatment in communities where the prevalence in school age children is 50% or more, targeted treatment of school age children in communities where the prevalence is 20-49%. Malacological surveillance and snail control is carried out in the temporary pools which are the main sites of transmission in the central part of the country. These interventions are also supported by health education, using locally designed tools.

**Zimbabwe**

While having implemented morbidity control within the primary health care structure, Zimbabwe has also focused on environmental management and on modifying people's lifestyles and practices to control schistosomiasis. The results of three Zimbabwean pilot studies are particularly
interesting in this respect: the Mushandike project where environmental engineering was used to reduce transmission of schistosomiasis in an irrigation scheme, and two projects, in the Madziwa communal land and in a sugar irrigation scheme in the south-eastern lowlands, where the impact of safe water supply and sanitation was evaluated.

Environmental management for schistosomiasis control has had a great impact on water development projects which generally aggravate or introduce the schistosomiasis problem. There is vast experience of control of schistosomiasis in irrigation schemes using environmental management. The strategies that have been used vary but the most common approaches were: lining of canals, reducing conditions that favour the damming of water in the field, good water management to allow periodic drying of some parts of the irrigation system, canal maintenance, good management of night storage ponds by including by-pass canals in the design and appropriate siting of villages (far from irrigation water). A 6-year pilot project conducted at Mushandike, Zimbabwe, showed that inclusion of environmental considerations at the design stage plays a major role in controlling schistosomiasis. Most of the irrigation schemes which have adopted the Mushandike design have lower incidences of schistosomiasis compared to schemes without schistosomiasis preventive measures as part of their design.

Most of the studies on the role of water and sanitation in schistosomiasis control have demonstrated that, while prevalence is marginally affected, incidence and intensity of infection is significantly reduced. A pilot study conducted in Madziwa showed that prevalence, intensity and incidence of schistosomiasis significantly decreased in an area where Blair latrines and safe water were provided compared to an area with inadequate water and sanitation facilities. In an agricultural setting in the lowlands of Zimbabwe, both prevalence and incidence have gradually declined over a 20 year period. It must, however, be noted that water and sanitation as a means of controlling schistosomiasis is not used in isolation. It has to be used in combination with chemotherapy, snail control and health education. However, where the water and sanitation component has not been included, the effects have been short-lived, indicating the importance of water and sanitation in consolidating and sustaining control programmes.

On the basis of experiences from the Madziwa, Mushandike and lowlands irrigation scheme, water and sanitation has been made one of the major components of the national control programme in Zimbabwe. Furthermore, all new irrigation schemes constructed are required to have Blair latrines as an integral part of the field structures design and homesteads for the farmers must have household latrines. The 1997/98 Zimbabwe National Sanitation Inventory shows that the household coverage for Blair and Flush toilets is 32% while that of schools stands at 96%. The coverage of safe water units was reported as 80% compared to a coverage of 15% for unprotected water supply points.

In order to improve the water and sanitation situation in rural areas in a cost effective and sustainable way, several water supply technologies affordable to the communities have been developed. These include the Blair pump, the bucket pump, the tube well, the bush pump, upgraded wells and rainwater harvesting (still under experimentation). The standard Blair latrine and its brick version are recommended for basic sanitation. With such a good coverage for latrines and safe water supply points, it is believed that the benefits of using measures such as chemotherapy and snail control will be realised sooner.
The contribution of environmental management, and improved water and sanitation towards the control of schistosomiasis and other water-borne diseases cannot be underestimated. Programme managers are eager to see results, and are in some cases discouraged both by the time span within which results of implementing an environmental management, water and sanitation strategy are realised and the necessary capital investment. However, analysis of situations where a long-term commitment was made, such as in the lowlands of Zimbabwe, clearly indicate that the returns outweigh the initial capital investment. The frequency of chemotherapy and mollusciciding has decreased over the years, as the benefits of the long-term measures have gradually surfaced. It must also be realised that, in special cases such as water development projects, inclusion of environmental management, water and sanitation at the project design stage would not be very expensive, if there was effective intersectoral consultation. Moreover, the benefits of bearing the additional costs would be the overall improvement of health and the quality of life of people. The Mushandike project is a good example of a situation where all interested parties were consulted at all stages of project development, resulting in reductions of schistosomiasis transmission at reasonable costs.
Recommendations

Schistosomiasis control in sub-Saharan Africa

It was understood by the participants that these recommendations were formulated primarily with sub-Saharan Africa in mind. However, these recommendations are also applicable to endemic countries in other parts of the world where no control programmes exist.

1. Participants identified the availability of antischistosomal drugs, particularly praziquantel, as the major factor in reducing morbidity in countries that have had successful control programmes. The existence of operationally relevant resistance or tolerance to praziquantel has not been confirmed. Therefore, ways must be found to make praziquantel widely available in countries where schistosomiasis is endemic, and the following recommendations were given:

* A coalition or partnership should be explored with pharmaceutical producers, donors and development agencies, that would allow the price of praziquantel to be further reduced.
* The creation of drug distribution networks for all essential drugs, including anthelminthics, to the most peripheral areas should be facilitated. Within endemic countries, it was felt that drug supply gains in most situations from a strong centralised purchasing system, with PHC-integrated peripheral distribution according to the local needs, in order to allow decentralised planning and implementation of control strategies.
* Praziquantel should be part of the essential drug package in endemic countries at all levels of health care.
* WHO should collaborate with national governments and other agencies to assure the quality of praziquantel that is made available.

2. As there is a need to review the global epidemiological status of schistosomiasis, the participants recommended that WHO pursue the completion of an atlas of schistosomiasis (currently being drawn up with Oxford University), down to the peripheral level, within a system that employs the new computer technology of geographical information systems (GIS). This process should not be top-down. Drafts of the atlas, based on available information, have to be circulated to countries where the disease is endemic, soliciting feedback and using this as a stimulus to collect additional data at the district level. The information gathered should be useful for decision-making and should not be limited entirely to schistosomiasis but combined with other parasitic and endemic disease surveys or other health data. Because of the GIS technology, it would be possible to update these disease maps regularly using national health statistics and survey results.

3. Evidence suggests that vertical programmes, while initially successful, are largely not sustainable. Therefore the group recommended that schistosomiasis control always build upon and strengthen the capacities of existing health services and national health policies, and that emphasis should be given to the integration of control into the health services delivery system and to a decentralisation of decision-making. Health services should be empowered to ensure
morbidity control at all levels, and maintain their efforts. Participants gave the following specific recommendations concerning control strategies:

* The provision of adequate clinical care is an essential component of control within the existing health system. In addition, health services should ensure more active morbidity control and implement appropriate treatment strategies where this is required by the epidemiological situation. With the falling costs of praziquantel it may be possible to expand the use of the drug while saving on diagnosis.

* Community-based treatment should first be targeted to school-age children. This high risk group can be reached through the primary school system, in collaboration with the educational sector. Even in areas where school enrolment rates are low, outreach activities can be designed to ensure good coverage. In school-based delivery systems, integration with geohelminth control, nutrition and/or other interventions as a package, should be aimed for.

* In order to enhance the effect of regular chemotherapy, long-lasting improvement in hygiene and sanitation should be promoted. This includes the provision of safe water, in sufficient quantities to cover all domestic water needs, sanitation, and appropriate health education.

* Other vulnerable groups such as fishermen, irrigation workers or communities with exceptionally high prevalence rates, should also have access to regular treatment for schistosomiasis, and appropriate prevention measures promoted within their respective working environments.

* Integrated control activities with other sectors such as agriculture and water resource development programmes, including small-scale irrigation schemes, should be planned from the beginning. Environmental management, including water supply and sanitation, should complement chemotherapy-based control programmes. In some instances, the use of snail control may also be indicated.

4. The group identified the need to strengthen WHO capacity to provide technical assistance and training to countries where schistosomiasis is endemic. In carrying out this work of technical assistance and training, the role of the WHO Collaborating Centres should be strengthened and utilised. Technical assistance and training can be carried out through other sectors as well – the private sector / universities / non-governmental organisations, as well as the use of South-to-South technical assistance by countries who have successful control programmes already in place. Participants also called for special attention to the need for building partnerships among private enterprises, universities, and non-governmental organisations to support efforts of control in endemic countries.
Schistosomiasis control in the Americas, Middle East, and Asia

In these regions, a number of countries have been able to sustain national control programmes for a prolonged period, whereas in others the epidemiological situation and status of control is comparable to sub-Saharan Africa. The participants therefore made the following recommendations:

1. Epidemiological assessment must be encouraged and carried out in countries where there is currently no programme of control (Iraq, Somalia, Sudan, Yemen). Technical support should be given to these countries in order to implement control.

2. In countries which have been able to sustain control programmes for a prolonged period, the benefits of control should be consolidated. It is therefore essential that adequate resources be maintained and that full attention is given to the cost-effective use of available funds. In the technical field, the following recommendations were made:

* High standards of quality should be maintained in carrying out control interventions. The World Health Organization should develop policy/technical manuals in recommended techniques of quality control for parasitological examinations, mollusciciding, and mass chemotherapy.

* Ideal screening tests are not yet available. Therefore, in order to be efficient, screening and treatment strategies should be adapted in view of changes in the epidemiological situation.

* Where prevalence is really low, an adequate surveillance system should be set up and the emphasis in control should change from chemotherapy towards sustainable transmission control. WHO should provide technical assistance in order to develop an adequate surveillance system in these countries. In this regard, the monitoring of infection at school entry or of a young age group may be appropriate.

3. Certification: the great progress that has been made in some control programmes from these three WHO regions was recognised. However, the means and criteria of certifying schistosomiasis elimination have not yet been agreed upon.

Operational research

Recognising that operational research is a necessary part of successful control efforts, the participants encouraged national capacity building in endemic countries to carry out this research, and made recommendations in the following areas:

1. Special capability in epidemiological assessments will be needed and easy, field applicable methods (including rapid assessment) should be further developed.

2. With regard to the investigation of schistosomiasis morbidity, several needs were noted:

* Monitoring morbidity longitudinally in order to assess the impact of control efforts.
* Further definition and assessment of subtle morbidity (effects on anaemia, growth, development and cognition), and of the extent and impact of other neglected aspects of morbidity, such as genital schistosomiasis, neurological involvement, ectopic schistosomiasis, … .

* Further standardisation of measurements of morbidity (e.g. through ultrasound).

3. Clinical algorithms and appropriate treatment strategies should be developed for use in health services in different endemic situations.

4. The safety of praziquantel use in pregnant and lactating women should be established.

5. Social and economic studies are needed to establish the cost-effectiveness of drug distribution and environmental management, and to determine the impact of health education programmes on behavioural change and transmission.

6. Research in sustainable transmission control (reduction of water contact and/or snail breeding by environmental measures and health education) has to be continued. The use of competitor snail hosts should be explored in the Americas where reports indicate some success.

7. Numerous reservoir hosts of *S. japonicum* remain a significant cause of continued transmission. Therefore collaboration between health and agricultural sectors is essential. Further research should be encouraged in the veterinary community.

8. Further development of immuno-assays for diagnosis, particularly of low intensity, and yet active infections, should be encouraged.
**Selected references**


Nuttall I, O'Neill K and Meert J.P. Systèmes d'information géographique et lutte contre les maladies tropicales. Médecine Tropicale, 1998, 58: 221-227


