

EXPERT CONSULTATION TO ACCELERATE ELIMINATION OF ASIAN SCHISTOSOMIASIS



22–23 May 2017
Shanghai, China

WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR THE WESTERN PACIFIC

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MEETING REPORT

EXPERT CONSULTATION TO ACCELERATE ELIMINATION OF
ASIAN SCHISTOSOMIASIS

Convened by:

WORLD HEALTH ORGANIZATION
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NOTE

The views expressed in this report are those of the participants of the Expert Consultation to Accelerate Elimination of Asian Schistosomiasis and do not necessarily reflect the policies of the conveners.

This report has been prepared by the World Health Organization Regional Office for the Western Pacific for Member States in the Region and for those who participated in the Expert Consultation to Accelerate Elimination of Asian Schistosomiasis in Shanghai, China from 22 to 23 May 2017.

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Keywords:

Parasitic diseases / Schistosoma / Schistosomiasis – prevention and control

ACRONYMS

CAA	circulating anodic antigen
CCA	circulating cathodic antigen
CL-SWASH	community-led initiative to eliminate schistosomiasis with water, sanitation and hygiene interventions
COPT	circumoval precipitation test
ELISA	enzyme-linked immunosorbent assay
EPG	eggs per gram
GPS	Global Positioning System
IHA	immunohaemagglutination assay
LAMP	loop-mediated isothermal amplification
MDA	mass drug administration
NTD	neglected tropical disease
PCR	polymerase chain reaction
UCP-LF	up-converting phosphor lateral flow
WASH	water, sanitation and hygiene
WSP	water safety plan
WHO	World Health Organization

SUMMARY

Asian schistosomiasis is a parasitic disease caused by two species of blood flukes (trematode worms), *Schistosoma japonicum* and *Schistosoma mekongi*. These can cause serious morbidity such as liver dysfunction and cerebral symptoms, and sometimes death from complications. In the Western Pacific Region, *S. mekongi* is endemic in Cambodia and the Lao People's Democratic Republic, and *S. japonicum* is currently endemic in China and the Philippines.

The Western Pacific Region has a long history of the fight against Asian schistosomiasis. Significant progress has been made in recent decades in reducing the prevalence of schistosomiasis in many endemic areas in the Western Pacific Region by means of preventive chemotherapy. However, poor sanitation and animal reservoirs have contributed to rapid resurgence of infection and continuing transmission of schistosomiasis, and preventive chemotherapy alone has not sufficed to interrupt transmission of Asian schistosomiasis.

An Expert Consultation to Accelerate Elimination of Asian Schistosomiasis was held in Shanghai, China on 22-23 May 2017 to review the experience of various control interventions and the current status of schistosomiasis in the Western Pacific Region. Participants recommended that community empowerment through a One Health approach, composed of health promotion, improving water, sanitation and hygiene (WASH), preventive chemotherapy, treatment and management of domestic animals and livestock (buffalo and cattle, dogs, sheep, pigs, goats) and focal snail control (for *S. japonicum*), supported by high-level political advocacy, should be the core strategy to accelerate and sustain elimination of Asian schistosomiasis.

The Consultation participants also agreed on the provisional criteria, goals and indicators for the elimination of transmission (referred to as interruption of transmission) of Asian schistosomiasis in the Western Pacific Region, taking into consideration the zoonotic nature of the disease. All countries endemic for schistosomiasis in the Western Pacific Region will aim to achieve the aforementioned criteria by 2025 and be validated for elimination of transmission of schistosomiasis by 2030.

As prevalence goes down and countries accelerate their efforts to eliminate the disease, surveillance systems need to be improved by intensifying active surveillance, establishing passive surveillance and improving diagnostic techniques to be able to detect infected individuals in low-prevalence settings. WHO, with the support of WHO collaborating centres and other academic and research institutions, should support endemic countries to build capacity for effective active and passive surveillance systems.

1. INTRODUCTION

1.1 Meeting organization

The Expert Consultation to Accelerate Elimination of Asian Schistosomiasis was held on 22-23 May 2017 at the National Institute of Parasitic Diseases, a WHO Collaborating Centre for Tropical Diseases, in Shanghai, China. The meeting was attended by 13 experts and 12 representatives of stakeholder organizations. The full list of participants is in Annex 1. The meeting programme is in Annex 2.

1.2 Meeting objectives

The objectives of the meeting were:

- 1) to review the current endemicity of schistosomiasis and country experiences in control interventions, monitoring and research for the elimination of Asian schistosomiasis;
- 2) to discuss the goal, targets and process to verify elimination of Asian schistosomiasis;
- 3) to recommend strategic actions and an enhanced monitoring framework, and estimate resources needed to accelerate elimination of Asian schistosomiasis; and
- 4) to identify and discuss integration opportunities with other disease-control and surveillance activities that will contribute to acceleration of the elimination of Asian schistosomiasis in the Western Pacific Region.

2. PROCEEDINGS

2.1 Opening session

Dr Zheng-Long Lei, Deputy Director-General, Bureau of Disease Control, National Health and Family Planning Commission, China, delivered welcoming remarks. He said that elimination of schistosomiasis remained a high priority for the Government of China and significant progress had been made over several decades. The current goal was to have China free of schistosomiasis by 2030. China was willing to share lessons and challenges and collaborate with all other schistosomiasis-endemic countries to attain this goal.

Dr Rabindra Abeyasinghe delivered the opening remarks on behalf of Dr Shin Young-soo, WHO Regional Director for the Western Pacific. The Regional Director acknowledged the long history of the fight against Asian schistosomiasis in the Western Pacific Region, caused by *S. japonicum* and *S. mekongi*, and the progress being made in the reduction of the overall prevalence and intensity of the disease over recent decades. He noted that mass drug administration (MDA) was clearly not sufficient if elimination of the disease was to be achieved. Better guidance on multidisciplinary interventions to complement MDA, such as snail control, veterinary interventions to address animal reservoirs and water, sanitation and hygiene, improved diagnostics and enhanced monitoring, evaluation and surveillance towards interruption of transmission were needed, particularly in the settings where prevalence of infection was already very low. In closing, Dr Shin conveyed his appreciation to the participants for sharing their expertise and experience to guide the Region in the fight against neglected tropical diseases (NTDs).

2.2 Updates on progress of elimination of Asian schistosomiasis in the Western Pacific Region

2.2.1 Cambodia (*S. mekongi*)

Transmission of schistosomiasis in Cambodia is restricted to 114 villages along the Mekong River and its tributaries. The villages are located in two provinces (56 villages in two districts in Kratie province, and 58 villages in five districts in Stung Treng province). The population at risk is estimated at 80 000 people. Peak transmission season, from February to April, overlaps with fishing seasons, and attempting to dissuade people from standing in the infested river is thus unrealistic. A control programme, with MDA as a principle strategy, has been used in Cambodia for the past 20 years, and by 2016 it had reduced the prevalence of infection in all four sentinel sites to 0% based on the Kato-Katz method.

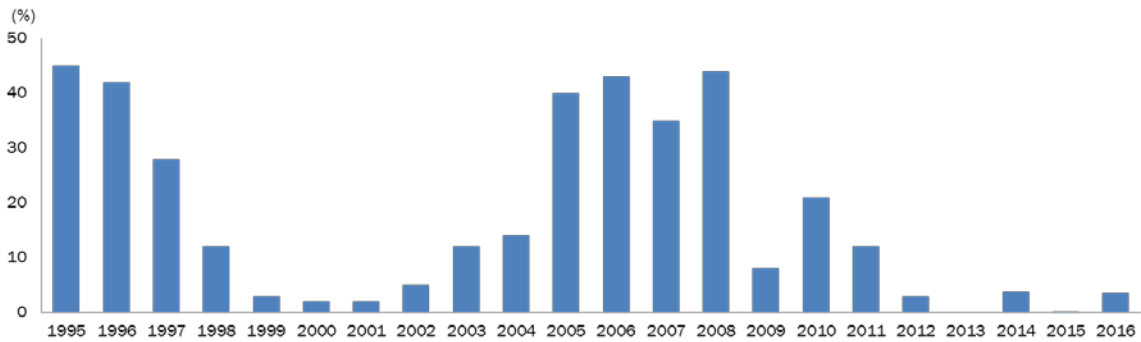
Realizing that improving access to safe water and eliminating open defecation is essential to interrupting transmission of schistosomiasis, the national NTD control programme, working closely with the Ministry of Rural Development and the Ministry of Education, Youth and Sports, and with technical support from WHO, rolled out a community-led initiative to eliminate schistosomiasis with water, sanitation and hygiene interventions (CL-SWASH) in several schistosomiasis-endemic villages in Cambodia. The initiative met with promising results. CL-SWASH builds on national efforts to improve sanitation and hygiene by developing water safety plans (WSPs) in endemic communities in Cambodia. The activity involves setting up a WSP team, adopting a comprehensive risk assessment and management approach to water supply from source to user, and deploying, monitoring and managing an improvement plan where necessary. The Ministry of Rural Development is now expanding community-level WSPs nationwide. CL-SWASH links WSPs with prevention and elimination of schistosomiasis in each endemic community. In the first five months of 2017, for example, 20 households constructed their own latrines immediately following participation in the CL-SWASH activities.

Attention was drawn to the urgent need for more sensitive diagnostic tools for *S. mekongi* infection to be developed and validated. Support is also needed for capacity-building in order to implement CL-SWASH in all schistosomiasis-endemic communities, and for joint monitoring of transmission of schistosomiasis with the Lao People's Democratic Republic along the common border.

2.2.2 Lao People's Democratic Republic (*S. mekongi*)

Transmission of schistosomiasis in the Lao People's Democratic Republic is restricted to 202 villages in Champasak province (152 villages in Khong district and 50 villages in Mounlapamok district). Champasak province and Stung Treng province in Cambodia share a contiguous border, part of which runs along the Mekong River. Preventive chemotherapy was initiated in 1989, and by 1999 it had successfully reduced the overall prevalence of infection. As a consequence, MDA was suspended, causing the infection prevalence to return almost immediately to pre-MDA levels (Fig. 1).

Fig. 1. Prevalence of *S. mekongi* infection in sentinel sites based on the Kato-Katz technique in the Lao People's Democratic Republic, 1995–2016



MDA was resumed in 2007 with support from WHO and various partner agencies. In 2016, the prevalence of infection in sentinel sites was 6.9% in Khong district and 0% in Mounlapamok district, and none of the infected individuals had a heavy-intensity infection. As in Cambodia, CL-SWASH was initiated in 10 schistosomiasis-endemic villages in 2016 through strong intersectoral cooperation, and its expansion is planned to all 202 endemic villages by 2020.

2.2.3 China (*S. japonicum*)

The first case of schistosomiasis in China was reported in 1908. National surveys conducted in the 1950s identified 12 provinces as endemic, mostly in the south. At that time, it was estimated that 12 million people were infected and 100 million people were at risk. In China, the endemic areas are classified as one of three types based on the habitat of the *Oncomelania* snail intermediate hosts: 1) marshland and lake areas; 2) mountain and hill areas; and 3) water network areas. Marshland and lake areas currently account for 95.06% of the snail habitat in the country, followed by mountain and hill areas (4.91%) and water network areas (0.03%), which are mainly located along the Yangtze River. Infection usually occurs in summer (May to October).

In 2004, control efforts were stepped up with the goal of reducing the overall prevalence of infection to 1% by 2015. The interventions used a multisectoral collaborative approach that embraced chemotherapy, snail control and health education. Between 2004 and 2015, five provinces achieved the national transmission interruption target (i.e. zero infections in humans, animals and snails), with seven provinces achieving the national transmission control target (i.e. infection prevalence of less than 1%). The reported number of cases in 2016 was 77 194, a 90.23% drop compared to 2014. No acute cases have been reported since 2015.

The Government of China continues to demonstrate its strong commitment to the elimination of schistosomiasis, and recently developed the new national schistosomiasis elimination plan for 2016–2020. However, further reducing the infection prevalence in livestock, management of faeces of fishermen in areas with persistent transmission, and the low sensitivity of current diagnostic and snail survey tools are all challenges still to be met.

2.2.4 Philippines (*S. japonicum*)

The occurrence of *S. japonicum* in the Philippines was first recorded in 1906. *S. japonicum* is currently endemic in 1592 barangays (communities) in 203 municipalities and 14 cities that are spread across 28 provinces of 12 regions. The estimated at-risk population is 12 million.

The national schistosomiasis control programme was established in 1961. Initially, it focused on active case finding, environmental sanitation, agro-engineering snail control and health education. In 1991, the Government launched its Philippines Health Development Project (PHDP), designed for communicable disease control, including schistosomiasis, and funded by the World Bank. With the

availability of a safe, effective and inexpensive drug (praziquantel), the programme used intensive case finding and mass treatment using praziquantel, along with WASH interventions and snail control as supplementary measures, to successfully reduce the overall prevalence of schistosomiasis in the country. However, the PHDP ended in 1995, leading to significant loss of the national and subnational capacity for schistosomiasis control and a subsequent rebound of infection prevalence in the Philippines.

MDA targeting high-prevalence areas was started again in 2007, and a nationwide prevalence survey was conducted in 2008. In 2009, MDA began targeting schoolchildren in all endemic areas. However, achieving and sustaining high treatment coverage remains a challenge. The year 2015 saw another nationwide prevalence survey, which identified one province with over 5% infection prevalence, 12 provinces with a prevalence of between 1% and 5%, and 14 provinces with a prevalence of less than 1%. Currently, *barangays* are being stratified in terms of the prevalence of infection in order to propose strategies by endemicity level, thus using resources more effectively.

Cooperation with the Department of Agriculture to address animal schistosomiasis is being strengthened. The Department of Health is providing financial assistance for capacity-building of veterinary health teams in priority areas, and joint planning and implementation of priority operational research. The next step will be to upgrade collaboration with the WASH programme. Recently, two endemic areas (Gonzaga municipality in Cagayan province, and Calatrava municipality in the province of Negros Occidental), which had not previously been classified as such, were reported through the local health department and confirmed using multiple tools, including the Kato-Katz technique, circumoval precipitation test (COPT), enzyme-linked immunosorbent assay (ELISA), and ultrasound. The emergence of schistosomiasis in areas previously identified as non-endemic has demonstrated the need to improve clinical and laboratory diagnosis and surveillance, along with an effective data reporting system for schistosomiasis cases, with clear clinical case definition to improve clinical diagnosis.

2.3 Preventive interventions for accelerating elimination of Asian schistosomiasis

2.3.1 Preventive chemotherapy targeting the human host

Preventive chemotherapy for morbidity management

Morbidity due to schistosomiasis, such as granuloma, periportal liver fibrosis and portal hypertension, is usually caused by egg deposition in the small vessels of the portal vein. Rapid disappearance of palpable hepatomegaly among children living in endemic areas in Cambodia and the Philippines has been observed following treatment with praziquantel. The number of eggs per gram of faeces (EPG) has thus served as a proxy to measure the morbidity burden of schistosomiasis. It is nonetheless recognized that clinical symptoms and signs become too subtle to monitor changes in morbidity, particularly due to *S. mekongi*, after a few rounds of treatment. In *S. japonicum* infection, liver and intestinal changes progress rapidly and there are sometimes cerebral symptoms, whereas neurological symptoms are rare in *S. mekongi* infection. It was recently reported in the Philippines that, following preventive chemotherapy, there were fewer patients with hepatosplenomegaly, but the proportion of cerebral cases had increased. Low ELISA titres were also frequently observed in patients with the cerebral type of *S. japonicum* infections in Japan. However, this epidemiological change has not been reported in China, and further epidemiological surveys following preventive chemotherapy will be necessary in the endemic areas of both countries.

In the morbidity control stage of Asian schistosomiasis, when the prevalence of infection is still high, preventive chemotherapy is highly effective in controlling morbidity by preventing progressive liver fibrosis and hepatosplenic symptoms. However, in the elimination stage, when the prevalence of infection has been significantly reduced and most of the infections are light, more sensitive diagnostic techniques such as ultrasonography are needed to monitor the change in morbidity.

Mass drug administration versus selective treatment

In China, where the overall prevalence of schistosomiasis in most endemic villages has been reduced to 1–3%, MDA is used twice a year only among communities of fishermen and boat people living less than 500 metres from waterbodies infested with infected snails. Otherwise, selective treatment is applied in high-risk populations using questionnaire surveys to screen people who have extensive contact with snail-infested waterbodies when the infection prevalence exceeds 10%, or using antibody-based serological testing in areas with above 1% prevalence. However, it is clear that preventive chemotherapy alone is not sufficient to interrupt transmission. Treatment of cattle and buffalo has been implemented six times per year, but this has not brought the prevalence below 6–8% in these animal hosts. More is being done to replace bovines with machines in farming, and this has proved effective in reducing transmission further.

China is looking for ways to stop preventive chemotherapy and move to post-MDA surveillance. However, because of the poor sensitivity of the Kato-Katz technique and the unavailability of more sensitive and specific diagnostic tools for field use, selective treatment using the Kato-Katz technique alone might only result in low treatment coverage among the true positives. Continuation of MDA in high-risk populations is therefore warranted, even in areas that have achieved the criteria for elimination of schistosomiasis as a public health problem, until more sensitive, specific, rapid and cost-effective diagnostic tools become available for active surveillance of Asian schistosomiasis.

2.3.2 Snail control

In Japan, there were formerly six endemic areas of *S. japonicum* infection. The life cycle of the snail intermediate host, *Oncomelania hupensis nosophora*, was understood by 1916, and a control programme was initiated in 1917. Injection of Stibnal (sodium antimonyl tartate) was the treatment of choice at that time, but the treatment regimen lasted two weeks and was associated with severe adverse events; thus, mass treatment was never implemented. Accordingly, snail control became the main strategy for elimination of schistosomiasis in Japan. Between 1957 and 1970, approximately 2000 km of concrete irrigation ditches were built under the Parasitic Disease Prevention Law. In Kofu basin, which had the highest number of snail colonies reported in Japan, much of the wet rice cultivation was converted to dry fruit farming. Molluscicidal agents and flamethrowers were used to kill snail colonies. Community participation in the snail-control activities was one of the key success factors for success. The distribution of snail colonies and the number of infected snails declined rapidly. No new indigenous cases of schistosomiasis have been found since 1977, and the elimination of schistosomiasis was declared in 1996.

Attempts were made to duplicate modified versions of these snail-control interventions in Bohol province in the Philippines. Here, where the intermediate host of *S. japonicum* is *Oncomelania hupensis quadrasi*, which is amphibious but generally prefers an aquatic environment (Table 1), annual, selective mass treatment with praziquantel has reduced the prevalence of infection to 4–8%. Integration of snail-control measures, such as grass cutting in swamps followed by use of molluscicides and land reformation from swamps to rice fields, combined with MDA, proved effective in reducing the prevalence of infection to less than 1%.

Table 1. Suitable living conditions and main habitats of snail intermediate hosts of schistosomes in the Western Pacific Region

Country	Schistosome species	Snail intermediate host	Suitable living conditions and main habitats
Japan	<i>S. japonicum</i>	<i>Oncomelania hupensis nosophora</i>	Amphibious but mostly found on land – banks of irrigation ditches, uncultivated rice beds, marshes, creeks
China	<i>S. japonicum</i>	<i>Oncomelania hupensis hupensis</i>	Amphibious and partially aquatic – banks of big rivers and irrigation ditches, uncultivated river beds, marshes and creeks
Philippines	<i>S. japonicum</i>	<i>Oncomelania hupensis quadrasi</i>	Amphibious but mostly aquatic – wet soil surfaces, wet swamps, wet rice fields, ponds, banks of streams
Cambodia, Lao People's Democratic Republic	<i>S. mekongi</i>	<i>Neotricula aperta</i>	Aquatic – shallow areas of the river and tributaries with a moderate current

China has implemented two main snail-control methods, ecological and chemical, over the past 60 years (Table 2). Ecological methods have included reclamation of snail habitats by building rice terraces on mountains instead of wet paddies and converting wet rice paddies to dry crop fields, submerging snail habitats in water by creating fish ponds, building cement water pipes and ditches, and constructing snail sedimentation pools. These actions required high initial investments but showed positive long-term effects. Another more innovative ecological method has been the use of black plastic film over the banks of ponds after molluscicide treatment in order to raise the temperature sufficiently to kill the snails. Chemical methods have included pasting mud with niclosamide (or other molluscicides) and lining ditches with molluscicides. Chemical methods were cheaper, effective immediately and could be reapplied as necessary. However, residual snails remained and easily spread to other areas through flooding, and more importantly, chemicals could be toxic to the fisheries and the environment. Overall, China has adopted a combination of ecological and chemical methods, which has proven to be the most effective for eliminating snails, and has limited snail control to upstream areas and to waterbodies close to human habitats in order to minimize environmental impacts.

Table 2. Major snail-control measures employed for elimination of *S. japonicum* infection in China and Japan

Methods		Specific snail-control measures
Ecological control	Agricultural measures	<ul style="list-style-type: none"> • Conversion of snail habitats to dry farms • Construction of fish ponds in low-elevation marshlands
	Water resource projects	<ul style="list-style-type: none"> • Cement lining of ditches and irrigation canals • Construction of snail sedimentation ponds to reduce water velocity and deposition of the snails
	Forestry projects	<ul style="list-style-type: none"> • Planting trees in high-elevation marshlands and lake areas
	Mechanical control	<ul style="list-style-type: none"> • Plastic film coverage for heat treatment
Chemical control	Molluscicide treatment	<ul style="list-style-type: none"> • Spraying, poudrage, immersion

WHO has recently published new guidance on field use of molluscicides in schistosomiasis control programmes,¹ as it recognized that snail control can be highly effective and feasible in small and

¹ Field use of molluscicides in schistosomiasis control programmes: an operational manual for programme managers. Geneva: World Health Organization; 2017.

confined waterbodies. In areas endemic for *S. mekongi*, snail control is not considered feasible because the snail host, *Neotricula aperta*, inhabits the flowing Mekong River and its tributaries. On the other hand, for the elimination of *S. japonicum*, snail control through ecological and, if necessary, chemical methods should be prioritized in the most high-risk areas such as confined waterbodies close to human habitats. It should be noted, however, that use of niclosamide is no longer allowed under the Clean Water Act in the Philippines. An option for exempted use of chemical methods in priority transmission foci might be explored.

2.3.3 One Health and multidisciplinary interventions

In China, bovines have been the major transmission agent for *S. japonicum*, and over 75% of schistosomiasis transmission has been attributed to water buffalo and cattle. In the Philippines, previous studies using stool examination showed that the prevalence of *S. japonicum* infection among water buffalo (carabao) was below 10%. However, recent studies using real-time polymerase chain reaction (PCR) have shown a significantly high prevalence of schistosomiasis (over 60%) in bovines. They also indicated that cattle and water buffalo are probably much more significant reservoir hosts than previously believed and may even be able to maintain the life cycle of *S. japonicum* without human hosts. This does not appear to be the case with *S. mekongi*. However, *S. mekongi* was first described as “*S. japonicum*-like” in dogs in 1971, based on post-mortem analysis, and was also found in some other animals such as bovines. However, the existing limited data based on convenience sampling of animals in a small area showed that the prevalence of *S. mekongi* in animals was low. This finding needs to be confirmed using more statistically robust studies before any decisions are made about whether to initiate or rule out interventions against animals.

Significant progress was achieved in China with the snail control strategy from the 1950s to the 1970s and chemotherapy in the 1980s. A comprehensive agricultural approach has been used by the Ministry of Agriculture in China since the 1950s to reduce the prevalence of schistosomiasis further and to develop the rural economy at the same time. Screening of all bovines and a proportion of sheep, goats and horses in highly endemic regions took place from May to July 2017 every year before 2011 in endemic regions using the miracidium hatching technique, or rapid diagnostic tests using soluble egg antigens, with praziquantel given to all positive animals. Mass treatment of bovines was carried out from October to November in the highly endemic areas.

The praziquantel dosages used in China for various animal hosts were as follows:

- Cattle: 30 mg/kg (orally), maximum of 10 g (orally)
- Buffalo: 25 mg/kg (orally), maximum of 10 g (orally)
- Pig: 60 mg/kg (orally)
- Horse: 25 mg/kg (orally).

Some agricultural measures were also combined with treatment. For example, farmers were encouraged with government subsidies to purchase farming equipment to replace their cattle, ruminants were replaced with poultry whenever possible, fences were built to cordon off cattle-grazing areas with warning signs posted where grazing was forbidden, biogas pools were constructed for dung management, and crops were rotated or converted from wet to dry varieties wherever possible. Such efforts reduced the infection rate in bovines from 10% to 3–5%, but further reduction proved impossible if only a single method was applied.

Mathematical modelling has been used to evaluate and compare the impacts of various control strategies employed for the elimination of schistosomiasis in China, such as preventive chemotherapy for humans and bovines, molluscicide treatment, sanitation and bovine vaccination.² The modelling clearly demonstrated that one intervention alone will not work to eliminate schistosomiasis and

² Williams G et al. Mathematical modelling of schistosomiasis japonica: comparison of control strategies in the People's Republic of China. *Acta Tropica*. 2002;82(2):253–62.

indicated that an approach integrating all such interventions was the most effective in bringing down transmission and sustaining the impact of control.

Any elimination programme should be mindful of long-term sustainability. Much of China's success can be attributed to strong government commitment and support. A comprehensive multi-faceted approach was found to be most effective; interventions need to be adapted to local conditions and be mindful of economic costs.

Other untapped control methods could also be used, such as the “field farmer school” approach initiated by the Food and Agriculture Organization of the United Nations, which educates farmers in detail about their pests and shows them how to control and manage pesticide use in agriculture. The ongoing efforts of CL-SWASH in Cambodia and the Lao People's Democratic Republic follow this approach, given that itinerant farmers and fishermen count among the major contributors to perpetuating the disease through indiscriminate defecation. Such effective health promotion activities were considered particularly important in many endemic areas in the Western Pacific Region where so-called MDA fatigue has been observed among the community members after a long history of annual MDA campaigns.

Finally, the best method will be one that creates a “win-win” for each sector, one that has clear and formalized roles and responsibilities for all partners, and where expert committees help to guide any partnership. The private sector, furthermore, should not be ignored when creating multisectoral partnerships. It was also emphasized that for any control method to be effective, both community involvement and quality control will need to be better established.

2.4 Monitoring, evaluation, surveillance and response

2.4.1 Evaluation of elimination of schistosomiasis as a public health problem in Cambodia and the Lao People's Democratic Republic

WHO classifies the intensity of schistosomiasis by the number of eggs per gram of faeces. It classifies the risk of infection by the prevalence of infection (Tables 3 and 4), and defines elimination of schistosomiasis as a public health problem as reaching a prevalence of heavy-intensity infection that is below 1% in all sentinel sites.

Table 3. WHO classification of intensity of schistosomiasis infection³

Intensity class	Intestinal schistosomiasis (infection with <i>S. mansoni</i> , <i>S. japonicum</i> and <i>S. mekongi</i>)	Urinary schistosomiasis (infection with <i>S. haematobium</i>)
Light-intensity infection	1–99 EPG	<50 eggs/10 ml urine
Moderate-intensity infection	100–399 EPG	-
Heavy-intensity infection	≥400 EPG	≥50 eggs/10 ml urine or visible haematuria

EPG: eggs per gram of faeces

³ Schistosomiasis: progress report 2001–2011, strategic plan 2012–2020. Geneva: World Health Organization; 2013.

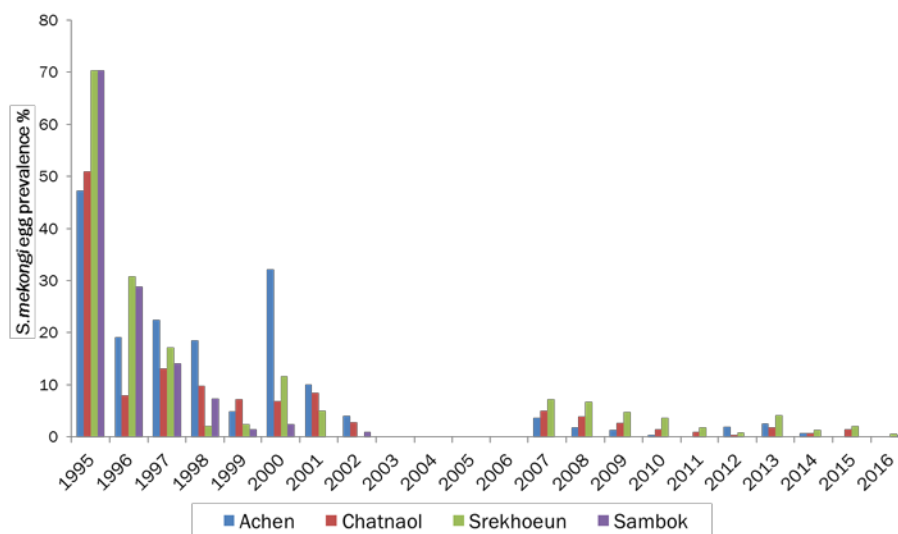
Table 4. WHO classification of prevalence of schistosomiasis infection³

Category	Baseline prevalence among school-age children
High-risk community	≥50% and above by parasitological methods (intestinal and urogenital schistosomiasis) or ≥30% and above by questionnaire for history of clinical symptoms
Moderate-risk community	≥10% and above but <50% by parasitological methods (intestinal and urogenital schistosomiasis) >1% and <30% by questionnaire for history of clinical symptoms
Low-risk community	<10% by parasitological methods (intestinal and urogenital schistosomiasis)

In 2016, the endemic situation regarding schistosomiasis in Cambodia and the Lao People's Democratic Republic was assessed using WHO's definition of elimination as a public health problem. Transmission of schistosomiasis along the Mekong River is considered to occur in dry seasons. Cambodia implements a monitoring and evaluation (M&E) survey (immediately followed by MDA) in April-May every year before the transmission season, whereas the Lao People's Democratic Republic implements an M&E survey (immediately followed by MDA) in September-October after the transmission season.

The monitoring survey in Cambodia has been conducted since 1995 in four sentinel sites and additional spot-check sites every year, with at least 200–300 samples at each site from all age groups. The prevalence in sentinel sites has been consistently below 3% based on the Kato-Katz technique and no cases of heavy-intensity infection have been found since 2014 (Fig. 2). To complement the monitoring of prevalence using the Kato-Katz technique, monitoring of prevalence using the formalin-detergent method and monitoring of sero-prevalence using the sodium metaperiodate (SMP) ELISA have been conducted in sentinel and spot-check sites since 1999 regularly with the support of Dokkyo Medical University, Japan. The results show that the prevalence of antibody-positives has been below 20% in all sentinel sites, with a steadily declining trend. Accordingly, it was concluded that elimination of schistosomiasis as a public health problem has been achieved in Cambodia. However, spot-check sites such as those at Kampong Krabei and Kbal Chuor still showed a prevalence of above 2% with cases of moderate-intensity infection using the Kato-Katz technique, and over 40% using the SMP-ELISA. This indicates that there are some moderate-risk villages surrounded by low-risk villages. It was consequently recommended to select a new set of sentinel and spot-check sites, based on the current risk of infection, in order to strengthen surveillance as elimination of schistosomiasis in Cambodia draws closer.

Fig. 2. Prevalence of *S. mekongi* infection in sentinel sites based on the Kato-Katz technique in Cambodia, 1995–2016



In the Lao People's Democratic Republic, *S. mekongi* infection data have been collected since 2003. However, there have been no fixed sentinel sites. Survey sites have been selected randomly every year, depending on the availability of budget and staff. The available data on intensity of infection are also limited. Longitudinal monitoring of epidemiological changes over time to determine whether the criteria for elimination of schistosomiasis as a public health problem have been met has not been possible. However, broad trends and data from the large amount of research conducted to date do suggest that elimination of schistosomiasis as a public health problem can be achieved in the Lao People's Democratic Republic in the near future. However, more surveys by random sampling are necessary to assess the current infection status, which will then provide the basis for future interventions and surveillance.

Accordingly, seven high-risk villages were newly redesignated as sentinel sites, drawing on historical data. It was agreed that in order to improve the sensitivity of the Kato-Katz technique, two stools would be collected per person and two smears per stool (i.e. four smears per person) would be tested in each survey, from at least 100 pupils in primary school and 100 adults above 15 years of age, and that serological monitoring and snail surveys would also be conducted regularly both at sentinel sites and spot-check sites with the support of collaborating research institutes. Using the new sentinel surveillance protocol, a monitoring survey was conducted in 2016 in the new set of sentinel sites. The results showed a schistosomiasis prevalence of 0–8.28% based on the Kato-Katz technique and no heavy-intensity infections. The Ministry of Health in the Lao People's Democratic Republic is making efforts to sustain this status and further reduce transmission.

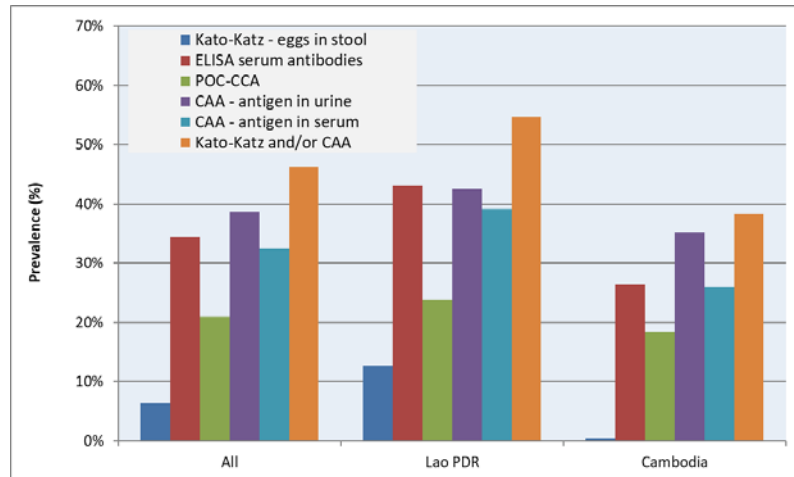
2.4.2 Evaluation of diagnostic tools for Asian schistosomiasis

Assays for the detection of circulating schistosome adult worm antigens (circulating anodic antigen [CAA] and circulating cathodic antigen [CCA]) released in the infected host's urine and serum are alternative and novel tools that could be used for the diagnosis of Asian schistosomiasis. The presence of CAA or CCA indicates active schistosome infections as they are excreted only by living worms and rapidly cleared from the host's circulation. The CAA up-converting phosphor technology based lateral flow (UCP-LF) assay is a test that makes use of a novel ultra-sensitive fluorescent label to detect CAA in serum and urine. The UCP-LF CAA assay is a laboratory-based diagnostic tool as it requires centrifugation and processing of samples, as well as a reader of strips. The POC-CCA™ rapid diagnostic test (Rapid Medical Diagnostics, Pretoria, South Africa) is an immunochromatographic lateral flow test that detects the presence of schistosome antigens released from adult worms in the infected host's urine and serum. It has been commercially available since 2004 and has been found to be more sensitive than the Kato-Katz technique for *S. mansoni* infection, which led WHO to recommend its use for mapping and monitoring programmes for the control of *S. mansoni* in 2015.

In parts of China, where recent control activities have resulted in a continuously diminishing rate of prevalence and intensity of *S. japonicum* infection, the UCP-LF CAA assay using both urine and serum samples has been compared with the Kato-Katz technique and immunohaemagglutination assay (IHA) for the detection of specific antibodies in serum. Using a composite reference standard based on positivity in triplicate Kato-Katz thick smear, or UCP-LF CAA assay, assuming 100% specificity of the CAA results (because of the highly specific monoclonal antibodies being used, the unique carbohydrate structure, the ultrasensitive UCP label, and the sample preparation procedure), the results showed sensitivity of 100% for CAA when urine and serum CAA were combined, 93% for urine CAA, 77% for serum CAA and 13 % for the Kato-Katz technique. These results indicate that classical microscopy largely underestimates the true number of active infections. UCP-LF CAA and POC-CCA also have been tested in the Lao People's Democratic Republic and Cambodia in comparison with other techniques such as the Kato-Katz technique and ELISA serum antibody test, with a composite reference standard based on positivity in triplicate Kato-Katz thick smear or UCP-LF CAA assay. This study also showed the highest prevalence by the composite reference standard, followed by ELISA and CAA, POC-CCA, and then the Kato-Katz technique alone (Fig. 3). However, considering the highly prevalent liver flukes in schistosomiasis-endemic areas in the Lao People's

Democratic Republic and Cambodia, it was recommended that proper validation of POC-CCA for possible cross-reactivity with liver flukes be done by comparing the results in areas where only liver flukes are known to be endemic, the results in areas where both *S. mekongi* and liver flukes are known to be endemic, and, preferably, the results in areas where only *S. mekongi* is known to be endemic.

Fig. 3. The prevalence of *S. mekongi* infection based on various diagnostic techniques/tools in Cambodia and the Lao People's Democratic Republic (presented by Dr Govert van Dam)



Although the CAA assay has not been designed for field use, the technique itself and reading of the test is straightforward in the laboratory setting, and reagents for the test are relatively inexpensive. The assay might be considered for use with a pooled sample, combined with Global Positioning System (GPS) technology, for rapid mapping of the schistosomiasis situation in all of the endemic areas of Asian schistosomiasis.

2.4.3 Surveillance indicators and criteria for interruption of transmission of Asian schistosomiasis

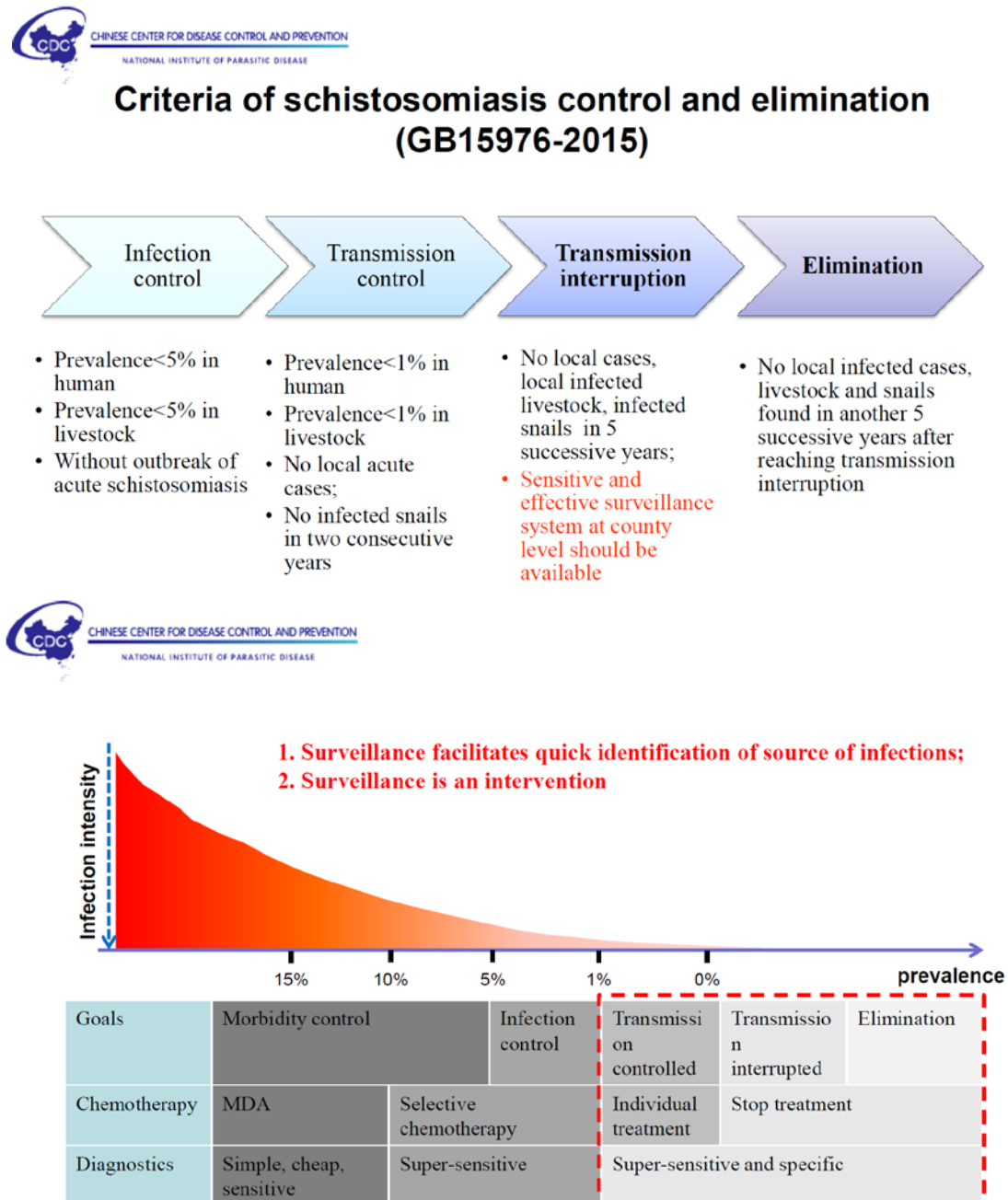
There were formerly six endemic areas of *S. japonicum* in Japan. The morbidity of infected patients was monitored through active surveillance using a collection of clinical records. The prevalence of infection in humans, animal hosts (cattle, dogs, horses and wild rats) and snails, as well as the distribution and density of snail hosts, were monitored by local governments, prefectural institutes of health and medical colleges. For stool examination, direct stool smears were used initially, but in 1965, there was a shift towards the merthiolate-iodine-formaldehyde concentration method (MIFC), which showed a significantly higher prevalence of infection (2.0% with direct smear in 1964 compared to 19.3% with MIFC in 1965). From 1967 to 1985, skin tests for antigen detection were also employed. Since 1983, an ELISA antibody test has been used among schoolchildren. In addition, the presence of ongoing transmission was monitored using mouse immersion, in which mice were immersed in the water of transmission sites for 2 hours per day for 3 days.

The final case of *S. japonicum* infection in Japan was found in 1977. Monitoring for the disease continued until 1995. By 1984, seven years after the final case report, no infection had been found in either humans or snails and animals, though the ELISA positivity rate was still 22.4% in local people. In 1995, 13 years after the final case, all ELISA antibody tests in schoolchildren, infection rates in snails, and immersion tests reached 0%. In 1996, the Government of Japan declared the country schistosomiasis-free, but post-elimination surveillance continued for another five years.

Japan's experience demonstrated that serological monitoring using the ELISA antibody test was highly effective in a low-transmission setting and that negative conversion can take 10 years or more. Even after the elimination of schistosomiasis, clinical case monitoring using ultrasound continued to detect cases of advanced liver fibrosis in formerly endemic areas. However, low ELISA titres indicated past infection. Such cases are irreversible without active infection.

In China, step-wise goals and indicators have been established (as shown in Fig. 4), and three modes of surveillance have been employed: 1) routine passive surveillance, 2) active sentinel site surveillance, and 3) active environmental risk surveillance. Firstly, routine passive surveillance involves monitoring of case reports from clinicians, confirmation of positive cases using parasitological tests, and response to acute infections. In 1995, 34 143 cases of schistosomiasis were reported, of which 1108 were confirmed positive by parasitological methods. Since 1995, however, no acute cases have been reported in the country.

Fig. 4. Step-wise goals and criteria for control and elimination of schistosomiasis in China
(presented by Professor Zhou Xiao Nong)



Secondly, sentinel site surveillance involves monitoring of infection prevalence in humans, animals and snails to assess changes in endemicity over time. The number of sentinel sites has been increased annually as the overall prevalence goes down. In areas where transmission control has been achieved,

at least 500 individuals from endemic villages are sero-screened followed by confirmation of infection using the miracidium hatching test. In areas that are considered to have achieved the criteria for transmission interruption, at least 200 individuals are sero-screened using the same procedure. In the Three Gorges Region, mobile populations such as fishermen are additionally tested using sero-screening and parasitological confirmation. In areas that are considered to have met the criteria for transmission control, over 100 domestic animals per site are also tested using the faecal hatching test. The distribution of infected snails is also monitored in areas where either transmission control or transmission interruption has been achieved using parasitological examination and the loop-mediated isothermal amplification (LAMP) method. The results of active sentinel surveillance in 2016 showed antigen positive rates of 2.96% in residents and 1.01% in the mobile population, egg positive rates of 0.02% in residents and 0.01% in the mobile population, an infection prevalence below 0.1% in local livestock, and an infection rate of 0% in collected *Onchomelania* snails at all designated surveillance sites.

Thirdly, environmental risk surveillance entails investigating infected mice in terms of the prevalence of infection and the worm burden, investigating animal faeces in snail habitats and the infection rate, and recording the intensity of snails in areas where transmission control or transmission interruption has been achieved using parasitological examination and the LAMP method. A snail survey conducted in four provinces in 2012 found no infected snails based on microscopy, but it detected five areas with positive snails using the LAMP method. A survey of wild animal faeces and snails conducted in seven provinces in 2017 found no infected faeces using the miracidium hatching method, but it detected two provinces with infected snails using the LAMP method. These findings indicate that the LAMP method is sensitive enough to be used in environmental risk surveillance to identify areas suitable for a targeted response or further investigation.

The experience in China indicated a declining surveillance capacity in transmission interruption areas, low sensitivity of classical parasitological tests, and the usefulness of serology and the LAMP method for screening and rapid environmental risk assessment.

2.5 Strategic actions and priority operational research to accelerate elimination of Asian schistosomiasis

2.5.1 Goals, targets and indicators

The WHO NTD roadmap, *Accelerating Work to Overcome the Global Impact of Neglected Tropical Diseases: A Roadmap for Implementation*, has set the following goals and targets for Asian schistosomiasis:

- elimination (interruption of transmission) of *S. mekongi* infections in the Mekong River basin by 2015;
- elimination (interruption of transmission) of *S. japonicum* infections in the Western Pacific Region by 2020; and
- elimination of schistosomiasis as a public health problem globally by 2025.

In a WHO (2011) report, *Schistosomiasis: Progress Report 2001–2011, Strategic Plan 2012–2020*, the elimination of schistosomiasis as a public health problem is defined as the “prevalence of heavy-intensity infection <1% in all sentinel sites”, whereas interruption of transmission of schistosomiasis is defined as the “reduction of incidence of infection to zero”.

On the basis of the experience of all four endemic countries in the Western Pacific Region, the meeting participants agreed that while “elimination as a public health problem” is an important milestone for endemic countries in the course of progression to the elimination phase, achievement of such status can be transient because positive cases can readily re-emerge as long as there is ongoing transmission. Therefore, all endemic countries in the Western Pacific Region should ultimately target

interruption of transmission of schistosomiasis. Official WHO verification and recognition should be awarded for attainment of transmission interruption.

The meeting participants also recognized that the definition of elimination – “reduction of incidence of infection to zero” – should specify the target hosts to which the zero incidence of infection refers. The criteria and indicators to verify interruption of transmission used in Japan and China, indicated in Section 2.4.3, were thoroughly discussed and the meeting participants agreed on the provisional criteria for elimination, referred to as interruption of transmission, of Asian schistosomiasis as follows:

- 1) reduction to zero of incidence of new indigenous infection in humans;
- 2) reduction to zero of incidence of new indigenous infection in animals; and
- 3) reduction to zero of infected snails.

The elimination of transmission of Asian schistosomiasis could be validated after a minimum period of five consecutive years of adequate post-intervention surveillance during which time no new infections are reported in humans, animals and snails.

The participants discussed at length the new regional goal and targets based on the current status of schistosomiasis in the Western Pacific Region. As mentioned in Section 2.4.1, Cambodia is considered to have achieved and maintained the status of elimination of schistosomiasis as a public health problem, defined as prevalence of heavy-intensity infection <1% in all sentinel sites, since 2014. The Lao People’s Democratic Republic also achieved the criterion of elimination of schistosomiasis as a public health problem for the first time in 2016, and is making efforts to sustain this status. In China, all 12 endemic provinces achieved the criterion of elimination of schistosomiasis as a public health problem by the end of 2015. In the Philippines, the endemicity situation varies from one region to another, and stratification of endemic areas in terms of the prevalence and intensity of infection at village level continues. Considering that the status of elimination of schistosomiasis as a public health problem can be easily reversed unless transmission is interrupted, and that interruption of transmission requires significant efforts to build strong multisectoral interventions, the meeting participants proposed that all countries in the Western Pacific Region in which schistosomiasis is endemic should aim to achieve the aforementioned criteria by 2025, and be validated for elimination of transmission of schistosomiasis by 2030.

2.5.2 Strategic actions

Preventive chemotherapy has proved to be highly effective in controlling morbidity, especially in areas with a relatively high prevalence of schistosomiasis, by preventing progressive liver fibrosis and hepatosplenic symptoms caused by Asian schistosomiasis. In the elimination stage, however, in which the prevalence of infection is significantly reduced and most cases have light infections, improvement in morbidity becomes too subtle to monitor progress.

Due to the poor sensitivity of the Kato-Katz test and the current non-availability of more sensitive and specific diagnostic tools for field use, selective treatment using the Kato-Katz technique alone for monitoring probably leads to low treatment coverage among the true positives. The participants accordingly agreed that continuation of MDA is warranted even in areas that have achieved the criteria for elimination of schistosomiasis as a public health problem until more sensitive and specific rapid diagnostic tools become available for active surveillance of Asian schistosomiasis. Implementation of MDA before the high transmission season, if logistically possible, is considered most effective in reducing transmission. For this reason, Cambodia and the Lao People’s Democratic Republic are encouraged to synchronize the timing of MDA.

Further, it is clear from the experience in Cambodia, China and the Lao People’s Democratic Republic that preventive chemotherapy as the sole intervention is not sufficient to interrupt transmission of Asian schistosomiasis.

In areas endemic for *S. japonicum* infection, One Health interventions should be given due priority. Large-scale bovine treatment at the end of the high-transmission season using oral administration or intramuscular injection of praziquantel is an option, where resources permit. Alternatively, consideration may be given to agricultural measures, such as building fences or containing animal hosts to prevent such animals from grazing or accessing snail-infested waterbodies, or to the replacement of ruminants with poultry or fish ponds in high-transmission areas.

In areas endemic for *S. mekongi* infection, on the other hand, existing data that indicate generally low prevalence of *S. mekongi* infection in animals such as dogs, pigs and bovines are based on limited studies using convenience sampling of readily available animals. Confirmatory studies based on randomized sampling should be undertaken before a decision to initiate canine and/or bovine treatment is made.

Controlling *Neotricula aperta*, the snail host of *S. mekongi*, which is found only in rivers and tributaries flowing with a moderate current, might not be practical. For *S. japonicum*, however, snail control has been one of the key strategies for the elimination of schistosomiasis in China and Japan. While extensive snail control in the Philippines might not be feasible, measures – preferably ecological and if necessary chemical – should be prioritized for the most high-risk areas such as confined waterbodies close to human habitats.

Because a lack of safe water and sanitation is the fundamental cause of the high prevalence of schistosomiasis, improving access to safe water and sanitation also merits greater focus, particularly in areas endemic for *S. mekongi* where annual MDA has been sustained for decades and snail control is not feasible.

Insufficient understanding of schistosomiasis among affected communities has been observed in many endemic areas in the Western Pacific Region, despite a long history of MDA campaigns. Moreover, in areas with persistent transmission despite a long history of MDA, so-called MDA fatigue has been observed within communities. In order to increase and sustain high MDA coverage, efforts should be made 1) to ensure directly observed treatment, 2) to assess true treatment coverage using WHO-recommended coverage evaluation tools, and 3) to empower communities through participatory health promotion activities such as CL-SWASH so that community members clearly understand the transmission cycle of schistosomiasis and drive elimination of schistosomiasis in their own communities.

In conclusion, the Consultation participants recommended that community empowerment through a multisectoral One Health approach composed of health promotion, improving water, sanitation and hygiene (WASH), preventive chemotherapy, treatment and management of domestic animals and livestock (buffalo and cattle, dogs, sheep, pigs, goats) and focal snail control (for *S. japonicum*), supported by high-level political advocacy, should be the core strategy to accelerate and sustain elimination of Asian schistosomiasis.

A vaccine for the prevention of *S. japonicum* infection of animals, notably bovines, would be valuable. Although efforts in this area continue, no commercial product for wide-scale application is so far available.

2.5.3 Monitoring, evaluation, surveillance and response

As prevalence goes down and countries accelerate their efforts to eliminate Asian schistosomiasis, the system of monitoring needs to be improved by intensifying active surveillance, establishing passive surveillance, and improving diagnostic techniques to be able to detect infected individuals in a low-prevalence setting.

Based on the provisionally agreed criteria for the elimination of Asian schistosomiasis, the following indicators will be monitored in both sentinel sites and spot-check sites in the Western Pacific Region:

- 1) prevalence and intensity of infection in humans;
- 2) prevalence and intensity of infection in animals; and
- 3) infection rate in snails.

While POC-CCA has the potential to serve as a sensitive field-level diagnostic tool for surveillance of infections in humans, it needs further validation for Asian schistosomiasis to ensure that it does not cross-react with other trematodes widely prevalent in the Western Pacific Region. In the meantime, the Kato-Katz technique will continue to be used as the standard technique in countries in the Western Pacific Region for routine active surveillance. To improve the outcomes and impose a standard across different countries and surveys for the purposes of data comparison, the Consultation participants recommended that a minimum of two stool samples be collected from each person, and that two slides be prepared from each stool sample. At least 200 people – primary school-age children and adults over 15 years of age – should be tested per sentinel site and/or spot-check site.

Countries with the support of collaborating academic and research institutes are encouraged to employ advanced diagnostic techniques such as CAA, ELISA, qPCR and PCR-LAMP, in addition to the standardized Kato-Katz technique, at sentinel and spot-check sites to generate supplementary epidemiological information. Considering the focal nature of schistosomiasis transmission, the aforementioned laboratory-based tools, in combination with data on snail distribution and local sanitation, can be used for rapid risk mapping and for determination of a representative number and locations of sentinel surveillance sites in each endemic country for long-term surveillance leading towards elimination. Further studies will be urgently needed to standardize and refine diagnostics for monitoring impacts in animal reservoirs and snail hosts that will lead to the development of clear guidance on surveillance for verification of the elimination of Asian schistosomiasis.

Partner agencies such as WHO collaborating centres and other academic and research institutions should also assist with diagnosis and laboratory capacity-building at all levels. The Consultation participants strongly recommended that WHO develop a definitive procedure and surveillance guideline to verify the aforementioned operational criteria and help establish a mechanism for quality assurance of laboratory diagnosis through the establishment of a regional reference laboratory network.

As discussed in Section 2.3.1, ultrasonography is needed to monitor changes in morbidity in the elimination stage, when the prevalence of infection has been significantly reduced and most infections are light. The Consultation participants recommended that WHO support endemic countries in establishing passive surveillance capacity and response systems in endemic areas to allow effective detection and treatment of cases within the primary health care system by establishing standard case definitions and reporting guidelines, and strengthening collaboration with clinicians and the private sector in efforts to eliminate Asian schistosomiasis.

2.5.4 Operational research

The following operational research agenda was identified as an immediate priority to generate further evidence, both to inform high-level advocacy and to further improve strategies for the elimination of Asian schistosomiasis:

- 1) refinement and standardization of diagnostics for monitoring impacts in humans;
- 2) refinement and standardization of diagnostics for monitoring impacts in animal reservoirs (sensitivity, quality control);

- 3) confirmation of the contribution of animal reservoirs to the transmission of *S. mekongi* based on randomized sampling;
- 4) further validation and application of CAA and POC-CCA for *S. mekongi* and *S. japonicum*;
- 5) mathematical modelling to identify an optimal integrated approach (e.g. preventive chemotherapy prevalence threshold, the required sanitation coverage for interruption of transmission);
- 6) identification of snail-control measures applicable in the Philippines;
- 7) cost–benefit analysis of different control strategies for interruption of transmission;
- 8) identification of impacts of climate change and environmental changes (e.g. caused by dams) on schistosomiasis endemicity and snail distribution and ecology;
- 9) study of co-morbidity of cerebral schistosomiasis and neurocysticercosis and development of treatment strategy;
- 10) understanding the pathogenesis of increased cerebral schistosomiasis in areas with light infections; and
- 11) development of animal vaccine.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

- 1) Significant progress has been made in recent decades in the reduction in prevalence of schistosomiasis in many endemic areas in the Western Pacific Region through preventive chemotherapy interventions.
- 2) Preventive chemotherapy using praziquantel has been effective in the control of morbidity by preventing progressive liver fibrosis and hepatosplenic symptoms due to Asian schistosomiasis.
- 3) Poor sanitation and the presence of animal reservoirs contribute to rapid resurgence of infection, and therefore preventive chemotherapy alone has proved to be insufficient to interrupt the transmission of Asian schistosomiasis.
- 4) Effective surveillance and response systems and coordinated operational research will be essential to accelerate elimination of Asian schistosomiasis in the Western Pacific Region.
- 5) Elimination will rely heavily on the continued and increased support of governments, and efforts must be made to increase governmental interest while focusing on integrating multisectoral responses and strategic partnerships.

3.2 Recommendations

- 1) Elimination of transmission (referred to as interruption of transmission) of Asian schistosomiasis should be operationally defined by the following criteria:
 - a) reduction to zero of incidence of new indigenous infection in humans;
 - b) reduction to zero of incidence of new indigenous infection in animals; and
 - c) reduction to zero of infected snails.
- 2) WHO should develop definitive procedures and surveillance guidelines to verify the aforementioned operational criteria.
- 3) Elimination of transmission of Asian schistosomiasis should be validated after a minimum period of five consecutive years of adequate post-intervention surveillance during which time no new infections are reported.
- 4) All countries endemic for schistosomiasis in the Western Pacific Region should aim to achieve the aforementioned criteria by 2025 and could be validated for elimination of transmission of schistosomiasis by 2030.
- 5) Community empowerment through a One Health approach, composed of health promotion, improved water, sanitation and hygiene (WASH), preventive chemotherapy, treatment and management of domestic animals and livestock (buffalo and cattle, dogs, sheep, pigs, goats) and focal snail control (for *S. japonicum*), supported by high-level political advocacy, should be the core strategy to accelerate and sustain elimination of Asian schistosomiasis.
- 6) In view of the current lack of sensitive and specific rapid diagnostic tools validated for Asian schistosomiasis and the reliance of most endemic countries on the Kato-Katz method with poor sensitivity for monitoring and evaluation, mass drug administration (MDA) should be continued.
- 7) MDA should be enhanced through directly observed therapy and reinforcement of coverage evaluation. Efforts should be made to implement MDA prior to high-transmission seasons to maximize its impact.
- 8) Considering the focal nature of transmission of Asian schistosomiasis, rapid risk mapping using serological tests, combined with data on snail distribution and sanitation situations, should be used to determine the representative number and locations of sentinel surveillance sites in each endemic country for long-term surveillance towards elimination.
- 9) WHO collaborating centres and other academic and research institutions should assist endemic countries in building capacity for active surveillance at sentinel and spot-check sites, and WHO should help establish a mechanism for quality assurance of laboratory diagnosis.
- 10) Snail control for interruption of transmission of *S. japonicum*, preferably through ecological and if necessary through chemical methods, should be prioritized in the most high-risk areas such as waterbodies close to human habitats in endemic areas.
- 11) WHO should support endemic countries in establishing passive surveillance and response systems in endemic areas to allow effective detection and treatment of cases within the primary health care system. This effort should involve collaboration with clinicians and the private sector.

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AGENDA

Day 1: Monday, 22 May 2017		
08:30 – 09:00	Registration	
Opening Session		
09:00 – 09:30	Welcome address	Dr Lei Zhenglong, Deputy Director General, Bureau of Disease Prevention and Control, NHFPC
		WHO WPRO
	Meeting objectives	Dr Rabindra Abeyasinghe Coordinator, WPRO/MVP
	Self-introduction of participants and observers	
	Nomination of the co-chairs and rapporteur	
	Administrative announcements	Dr Aya Yajima NTD focal point, WPRO/MVP
09:30 – 10:00	<i>Group photograph followed by coffee/tea break</i>	
Session 1:	<i>Updates on progress of elimination of Asian schistosomiasis in the Western Pacific Region</i>	
10:00 – 11:00	<ul style="list-style-type: none"> ○ Cambodia (<i>S. mekongi</i>) ○ Lao PDR (<i>S. mekongi</i>) ○ China (<i>S. japonicum</i>) ○ Philippines (<i>S. japonicum</i>) 	<ul style="list-style-type: none"> – Dr Virak Khieu, CNM, Cambodia – Dr Somphoe Sayasone NIOPH, Lao PDR – Prof Zhou Xiao Nong, Director, NIPD – Dr Winston Palasi Department of Health, Philippines
	Discussion	All
Session 2:	<i>Preventive interventions for elimination of Asian schistosomiasis</i>	
11:00 – 12:30	2.1 Preventive chemotherapy	
	<ul style="list-style-type: none"> ○ Preventive chemotherapy for morbidity management ○ Global challenges on schistosomiasis treatment ○ Moving from MDA to selective treatment in low transmission areas 	<ul style="list-style-type: none"> – Dr Hiroshi Omae NIID, Japan – Dr Jiagang Guo WHO/HQ – Prof Zhou Xiao Nong
	Discussion	All
12:30 – 13:30	LUNCH BREAK	
13:30 – 15:00	2.2 Snail control	
	<ul style="list-style-type: none"> ○ Methods, impacts and lessons learnt in: <ul style="list-style-type: none"> – Japan – China ○ The new WHO guidance on snail control 	<ul style="list-style-type: none"> – Dr Hiroshi Omae – Prof Zhou Xiao Nong – Dr Jiagang Guo
	Discussion	All
15:00 – 15:30	<i>Coffee/tea break</i>	

15:30 – 17:00	2.3 One Health and multi-disciplinary intervention <ul style="list-style-type: none"> ○ Contribution of animal reservoir in transmission of Asian schistosomiasis ○ Methods, impacts and lessons learnt from: <ul style="list-style-type: none"> – China – Philippines – Other zoonotic disease control ○ Evaluation of integrated interventions for the control and elimination of Asian schistosomiasis 	<ul style="list-style-type: none"> – Dr Jeff Gilbert – Dr Jin-ming Liu Shanghai Institute of Veterinary Institute, China – Dr Mario Jiz, RITM, Philippines – Dr Jeff Gilbert – Prof Donald McManus Queensland Institute of Medical Research, Australia
	Discussion	All
18:00 – 20:00	<i>Cocktail reception</i>	

Day 2: Tuesday, 23 May 2017		
09:00 – 09:10	Wrap-up of Day 1	Dr Aya Yajima
Session 3:	<i>M&E, surveillance and response</i>	
09:10 – 10:30	<ul style="list-style-type: none"> ○ Evaluation of elimination of schistosomiasis – findings and recommended enhanced surveillance protocol <ul style="list-style-type: none"> – Cambodia – Lao PDR ○ Evaluation of diagnostic tools (including CCA and CAA) for Asian schistosomiasis 	<ul style="list-style-type: none"> – Dr Hiroshi Omae – Dr Peter Odermatt Swiss TPH, Switzerland – Dr Govert van Dam Leiden University, Netherlands
	Discussion	All
10:30 – 11:00	<i>Coffee/tea break</i>	
11:00 – 12:30	<ul style="list-style-type: none"> ○ Surveillance indicators, method and criteria used for interruption of transmission <ul style="list-style-type: none"> – Japan – China ○ Newly found endemic areas and response ○ Integration of schistosomiasis elimination and surveillance in the health system 	<ul style="list-style-type: none"> – Dr Hiroshi Omae – Prof Zhou Xiao Nong – Prof Lydia Leonardo UPM, Philippines – Prof Vicente Belizario, Jr UPM, Philippines
	Discussion	All
12:30 – 13:30	<i>Lunch break</i>	
Session 4:	<i>Recommendations on intervention options, enhanced M&E protocol and priority operational research</i>	
13:30 – 14:15	Discussion: Goal, milestones, verification criteria and process for elimination of Asian schistosomiasis	All
14:15 – 15:00	Discussion: Strategic actions for acceleration of elimination of Asian schistosomiasis <ul style="list-style-type: none"> – Intervention options – Responsible parties and potential partners – Integration opportunities 	All
15:00 – 15:30	<i>Coffee /tea break</i>	

15:30 – 16:15	Discussion: Enhanced monitoring and surveillance strategy <ul style="list-style-type: none"> – Indicators – Protocols – Integration opportunities 	All
16:15 – 17:00	Discussion: Priority operational research <ul style="list-style-type: none"> – Research agenda – Potential partners 	All
17:00 – 17:20	Conclusions and recommendations	Dr Rabindra Abeyasinghe
17:20 – 17:30	Closing	Prof Zhou Xiao Nong

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