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Editorial

A new global strategy for the elimination of schistosomiasis

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ABSTRACT

Mass drug administration utilising a single oral dose of 40 mg/kg of praziquantel (PZQ) has been endorsed and advocated by the World Health Organisation (WHO) for the global control and elimination of schistosomiasis. However, this strategy is failing primarily because the drugs are not getting to the people who need them the most. The current global coverage is 20%, the drug compliance rate is less than 50%, and the drug efficacy is approximately 50%. Thus in reality, only about 5% of the reservoir human population is actually receiving intermittent chemotherapy. Despite claims that more of the drug will soon be made available the current strategy is inherently flawed and will not lead to disease elimination. We discuss the many practical issues related to this global strategy, and advocate for an integrated control strategy targeting the life cycle and the most at-risk. Moreover, we discuss how an integrated control package for schistosomiasis should fit within a larger integrated health package for rural and remote villages in the developing world. A holistic health system approach is required to achieve sustainable control and ultimately disease elimination.

1. Introduction

Schistosomiasis is a neglected tropical disease caused by blood flukes of the genus *Schistosoma*. It afflicts approximately 240 million individuals in the tropics and subtropics, causing roughly 70 million disability-adjusted life years.[1,2] Schistosomiasis is the third most devastating tropical disease globally and is a major cause of morbidity and mortality in Africa, South America, the Caribbean, the Middle East, and Asia. [1,2] More than 78 countries are affected, and nearly 800 million people are exposed to the disease.[1,2]

We are presently conducting a clinical trial in Northern Samar, the Philippines, on the integrated control of schistosomiasis.[3] During the course of the trial, we have been treating patients with a single oral dose of 40 mg/kg PZQ, but noted rapid reinfection rates in an area of moderate zoonotic transmission. In the Philippines, the National Department of Health is utilizing a single oral dose of 40 mg/kg of PZQ to treat endemic communities empirically for schistosomiasis, during annual mass drug administration (MDA) campaigns. This approach has been endorsed and advocated by the WHO for the global control of schistosomiasis.[4] However, this strategy is not working due to poor drug coverage, poor drug compliance, and many other factors.[5] We discuss the many practical issues related to this global strategy and advocate for an integrated control program targeting the life cycle and the most at risk. Moreover, we discuss in detail the practical steps required to achieve sustainable control.

2. Current Global Strategy–MDA with single oral dose of 40 mg/kg of PZQ

Numerous studies have claimed that 'preventive chemotherapy' utilising 40 mg/kg of PZQ given annually can significantly reduce the prevalence and intensity of infection, and control morbidity in the long term.[6,7] However, PZQ is not 100% curative in killing adult worms, cannot kill migrating schistosomulae or the early stages of the disease, and does not prevent reinfection.[8,9] It has been stated that MDA may reduce population immunity in the long term and if stopped can lead to large rebounds in egg counts.[10,11] Moreover, multiple rounds of MDA among school children have resulted in a reduced efficacy of PZQ which poses a threat to global MDA programs.[12]

Parasitological cure depends on the treatment dose. In the early 1980s and again in 2011, WHO, in an attempt to optimize PZQ use for the treatment of schistsomiasis, launched a series of multi-country trials, comparing the efficacy and safety of 40 mg/kg versus 60 mg/kg in schistosome infected patients in Asia, Africa and the Americas.[13] In these clinical trials, the 40 mg/kg dose was found to be effective (92% cure rate) and better tolerated than the higher 60 mg/kg dose.[13] However, a recent systematic review and meta-analysis of 52 clinical trials showed that, when compared with placebo, a dosage of 30-60 mg/kg PZQ produced a cure rate of 76% (range from 67-83%) for human schistosomiasis.[14] No significant differences in cure rates were found among subjects infected with *S. haematobium*, *S. japonicum* or *S. mansoni*. The cure rate of the drug at 40 mg/kg (which is the current dose recommended by the WHO) was 52% (range from 49-55%), compared with 91% (range from 88%-92%) when dosages were increased to 60, 80, 100 mg/kg, divided into two or more doses.[14] A recent pharmacokinetic study, on a paediatric population in Africa, has recommended a higher dosage (>60 mg/kg) to achieve therapeutic cure in young children.[15]

Inadequate treatment coverage is a serious obstacle for MDA implementation. In 2001, the 54th World Health Assembly

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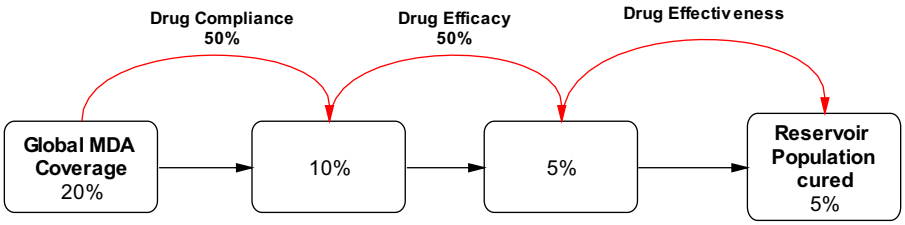

Figure 1. Percentage of global target population reached with 'preventive chemotherapy' for schistosomiasis control. The WHO reported that the global MDA coverage was approximately 20% in 2014.[17] It is assumed the compliance to free treatment is 50% and that the efficacy of PZQ at the single oral dose of 40 mg/kg is 50%.[14]

officially endorsed chemotherapy as the key public health strategy to combat schistosomiasis with the goal of achieving a drug coverage rate of 75-100% among school-aged children at risk of morbidity by 2010.[7,16] However, the target coverage was not attained according to the 65th World Health Assembly[7,16] In 2014, the global coverage was reported to be 20.74%.[17] Clearly such a coverage rate will not halt the transmission of the disease or lead to disease elimination (Figure 1). Much has been written about the benefits of MDA in order to secure large amounts of donor funding, but the operationalization of such programs has been grossly underestimated. In some of the poorest countries in the world, where MDA is taking place, the health systems are weak, understaffed and poorly resourced.[16,17] Is it, therefore, realistic to expect such countries to achieve >75% drug coverage rates? Most donors are willing to donate the drugs but few are willing to ensure safe delivery and consumption (e.g. directly observed treatment - DOT). Unless we do a better job 'on the ground' with the coordination of local control activities this strategy will surely falter. WHO and international agencies must take a more active role in operational management of MDA delivery.

Low patient compliance for free medication is another MDA impediment. Drug compliance is very low with many countries reporting <50% compliance.[5,17] It has been reported that up to 80% of those who ultimately take the drug suffer from transient side-effects such as dizziness, syncope, vomiting and diarrhoea.[5] Once the side-effects are observed and reported by others in the community, compliance quickly drops. Again if treatment is left in the hands of local untrained medical staff, compliance will surely reduce. Many of the current MDA programs in Africa utilise unpaid volunteers with no health background to deliver MDA to patients for schistosomiasis.[5,17] If such a person came to your door, would you take a drug from someone you do not know, who is untrained, for a disease you are not familiar with, with no confirmation of your infection status? Clearly not, thus the poor compliance rate globally. Getting the drugs from the pharmaceutical industry is one issue, but ensuring safe delivery and consumption is another issue, that to date has been grossly underestimated and uncoordinated.[17] The reported coverage and compliance rates are questionable given they are derived from internal evaluation reports. International and national control teams involved in MDA campaigns are under enormous pressure to show tangible results for the millions of dollars invested. Thus, they are clearly biased in the reporting of their coverage rates. Moreover, there is typically a mismatch in what is reported by the service providers for successful treatment (coverage) and who actually swallows the drug (compliance). It is well known that many who are offered the drug (e.g. put in their hands or mouth) simply throw it away or keep for later use when they feel sick. Moreover, it is not uncommon for service providers to rely on family members to administer drugs to their relatives who miss the MDA.

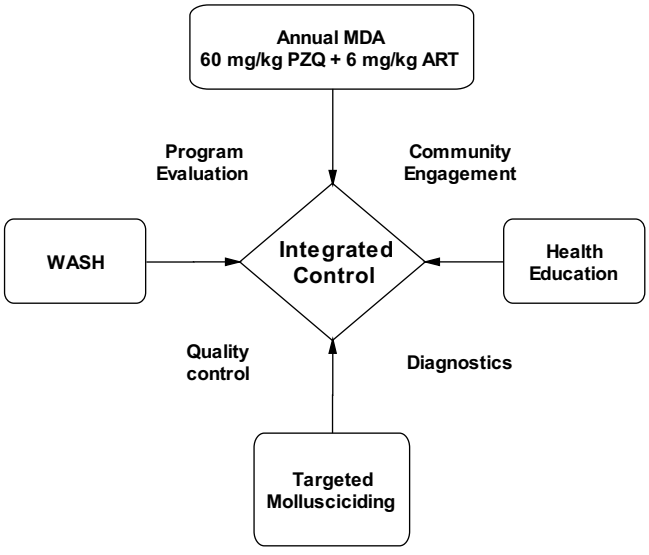

Figure 2. Key elements of an integrated control strategy required for the global sustainable control of schistosomiasis leading to disease elimination. Note: PZQ = praziquantel; ART = artemether.

3. New global strategy–split oral dose of 60 mg/kg PZQ + integrated control

What is the new global strategy based on? The new global strategy is not based on theoretical modelling but on our practical firsthand experience in participating in field-based schistosomiasis control programs over the past thirty years. What is outlined can only be achieved if members of the core control team (e.g., national and international healthcare providers) are committed to live and work in the endemic area for extended periods of time (months). On the ground planning, coordination, and daily supervision are vital to ensure local support, community engagement, drug coverage and patient compliance.[5] Key elements of the integrated control strategy required to achieve disease elimination are illustrated in Figure 2. There are two major transmission pathways in the schistosome life cycle that can be targeted by control programs: the parasites' path from humans (the definitive hosts) to snails (the intermediate hosts), and their path from snails to humans.[18] Mass PZQ treatment acts only on the transmission pathway from humans to snails and only for as long as treatment is given. A multifaceted integrated approach targets both pathways: complementing treatment with snail control, health education and water, sanitation and hygiene (WASH).

3.1. Target population

Who should be targeted for integrated control? Presently MDA campaigns are largely given to school children.[7] The advantage of this strategy is that a segment of the at-risk population can easily be reached for annual mass treatment. The disadvantage is that remote communities, and other at-risk populations are largely left untreated.[7] Given the clumped distribution of the disease these 'wormy' individuals are responsible for continued transmission. Thus, 'preventive chemotherapy' has limited impact on reducing the reservoir of infection. Future control efforts need to focus on

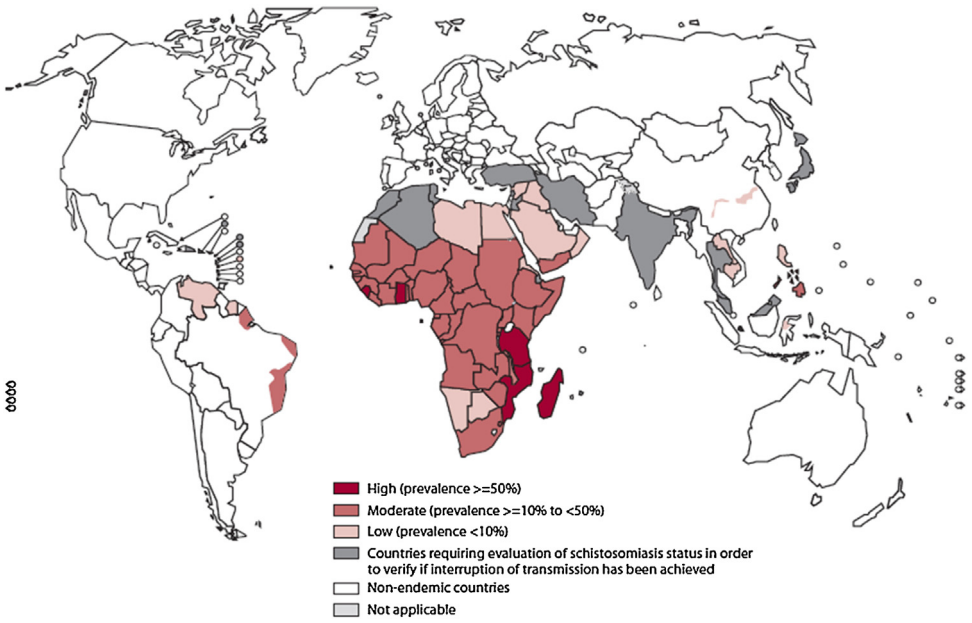

Figure 3. Global distribution of schistosomiasis showing the most at-risk populations within Africa. Highly endemic countries (dark red) are proposed to be the focus of future integrated control efforts.[2]

high-risk communities with a human prevalence of greater than 50% and high-risk individuals (e.g. fishermen, farmers) within those communities. Is trying to achieve disease elimination in a low endemic area (e.g. SCORE project[7] in Zanzibar with a human prevalence <10%) a wise investment of limited donor funding? We believe donor funding should go to those who need it the most. However, the caveat is that those who need it the most, live in areas that are very poor and hard to reach. Moreover, they are typically less educated and are less likely to comply to health education and treatment. These are also precisely the areas where control staff do not want to visit for annual MDA. Figure 3 below shows the endemic countries in Africa where the human prevalence is greater than 50%.[2] One of the highly endemic countries is Mozambique. To date this country has largely been ignored by donor agencies and the obvious question is why?

3.2. Political support & Community engagement

In order for integrated control to be successful, there must be support at the national, regional, and provincial level, but this is not enough.[5,18] The rate limiting step in global control is at the district/municipal level. Typically there is a district doctor/clinical officer who is responsible for coordinating control activities with a team of community health workers (e.g., 10-30 female nurses and/or midwifes). They are typically responsible for 30-50 villages and an overall population of approximately 30,000-50,000 residents. If the district doctor is active and well respected in the community it is likely that they will be able to convince the village chiefs/captains of the importance of the work, with the assistance of members of the control team (e.g., national and international staff). However, if there is no district physician/clinical officer or the doctor is not engaged with the community, then it is unlikely at the onset that the proposed integrated control work will be possible. Building relationships at the grassroots level is fundamental for the sustainability of any community-based activity and this is well documented.[17] Most global MDA programs currently do not have such a relationship, thus, are unlikely to be sustainable. Integrated control requires fostering long term community relationships.[5]

If communities agree to support the integrated control initiative they will want to know what else they will get out of it. Will free treatment be provided? If so, how often will it be provided and who will get it? Will they be paid for their work if required to work on the project? What other health services will be provided in addition to schistosomiasis control? The use of unpaid volunteers with little or no training is common practise in current MDA programs in Africa.[7] However, in the integrated control model, proposed trained staff must be paid a part-time salary for typically 2-3 three months per year depending on the activities they are involved in (e.g., driver, stool/urine collector, slide reader, molluscide sprayer, nurse, data entry etc.).

3.3. Diagnostics

In order to achieve a high compliance rate for treatment, patients will want to know if they are egg positive or not (e.g., infected). This is absolutely critical for sustainable control leading to elimination. We realise the cost, time, and technological skills required to read the stool and/or urine slides, but this is a non-negotiable component of integrated control. 'Preventive chemotherapy' is failing globally due in part to poor drug compliance rates for free treatment. With appropriate community engagement most residents will provide at least one stool or urine sample for diagnostic assessment, and if found positive are more likely to comply with treatment.[17]

Several advances (e.g., antibody/antigen/DNA tests) have been made for the diagnosis of schistosomiasis. However, the technology that can be deployed in rural and remote communities is limited given many communities struggle to have regular power supply and water. In Northern Samar, where we are presently working, there are scheduled power outages every week lasting an entire day and typically 1-2 unexpected outages per week.[3] Thus, the diagnostic strategy selected and deployed, must use low technology and be able to be administered by an unskilled local labour force. For intestinal schistosomiasis the Kato-Katz thick smear stool examination (Figure 4), and urine samples for detection of *S. haematobium*, are still the gold standard for field application. It cannot be taken for granted that local microscopists are able to read stool and/or urine slides even after receiving the appropriate training. Quality control measures (e.g., 10% of all slides read blindly by an experienced microscopist),[3] are vital to ensure a

Figure 4. National and local staff members preparing Kato-Katz thick smear stool slides for microscopic examination in the field.

reliable diagnosis and reported prevalence/cure rates. Through our work, we noticed considerable inter/intra-examiner bias in the reading of Kato-Katz stool slides.[3] Staff that are recruited for this purpose must be tested and if their skills are insufficient, must not be hired, or retrained. Daily supervision is required by the head microscopist and quality assurance protocols must be in place.

3.4. Treatment–Annual 60 mg/kg PZQ + 6 mg/kg ART

Preventive chemotherapy with a single oral dose of 40 mg/kg of PZQ is inadequate to control and eliminate schistosomisis.[16,17,19] Rapid reinfection rates are occurring globally and there is now evidence of drug resistance.[17] As mentioned, the efficacy of the drug is approximately 50% due to the drugs inability to kill migrating schistosomula and the early stages of the disease. Thus, we recommend annual DOT treatment with a split dose of 60 mg/kg of PZQ to kill existing adult worms and 6 mg/kg of artemether to kill the early stages of the disease in those who have a confirmed diagnosis. However, to do this on a large scale repeat visits to a single village in the same year is logistically impossible, given the total number of villages to be treated and the associated logistical cost.

Artemether (ART) (and other artemisinin derivatives), which comes from the leaves of the Chinese medicinal plant *Artemisia annua*, is effective against juvenile schistosomes during the first 21 days of infection in both animals and humans.[20–22] The dose required (i.e., 6 mg/kg) is lower than that required to treat malaria, thus given once per year with PZQ, it is unlikely to lead to the selection of ART-resistant *Plasmodium falciparum*. The combination of PZQ-ART given once per year should improve cure rates, thus reducing the reservoir pool of infected individuals needed to halt transmission.[20–22] It is noteworthy that to date no clinical trial has specifically looked at using PZQ-ART once per annum, but other treatment regimens using this drug combination have proven to be safe and effective, leading to higher cure rates.[20–22] Thus, what is now proposed would appear appropriate as part of an integrated control package. Our overall goal would be to have an annual drug compliance rate (e.g., DOT for diagnosed confirmed cases) of at least 80%, in over 90% of the villages with a human prevalence over 50%, within the next ten years. We believe this is a realistic goal if appropriate funding can be secured from national governments and international donors.

Advanced cases for the disease need appropriate medical and/or surgical follow-up (Figure 5). No mention of this is stated in current MDA campaigns and this raises serious ethical considerations.[23] Clearly we have a moral and ethical duty to assist such patients (e.g. <5% of total cases) that will be encountered in the community.[24] Prior to the commencement of integrated control, it is proposed that the Ministry of Health would sign a written agreement that indigent patients can be sent for appropriate referral, and that all medical expenses will be covered by the government's health-care scheme.[23] The state/provincial government should be lobbied to provide for local travel, and a modest living allowance for the spouse or guardian while the patient is undergoing treatment and recovery.[23] This requires planning before entering communities, as the needs are often overwhelming for physicians. If the control team are committed to such humanitarian efforts, this will strengthen relationships with the community, which will likely improve patient and community compliance, and aid in the sustainability of the control program. In Northern Samar we have provided care not only for those with advanced schistosomiasis but for many other surgical conditions.[23] This was recognised and well received by both the provincial government and the community residents, which contributed to solidifying grass roots relationships. Moreover, as a service to the communities under study, we provided primary-care during our annual follow-up visits.[23] The impact of such a service in terms of community wellness and building community rapport, cannot be underestimated. Unfortunately, this essential service is rarely, if ever provided as a part of global health programs.[23]

Figure 5. A. Mass drug administration in Northern Samar, The Philippines. B. Young patient who required surgery (splenectomy) for advanced schistosomiasis.[24]

3.5. Snail control- focal spraying of 'hotspots'

Schistosomes have coevolved with their molluscan intermediate hosts resulting in a well-balanced and highly efficient means of transmission. Each schistosome species infects a specific freshwater snail intermediate host - e.g., with *S. mansoni* this is generally *Biomphalaria glabrata* (Americas) or *B. pfeifferi* (Africa); with *S. japonicum*, it is *Oncomelania hupensis hupensis* in China and *Oncomelania hupensis quadrasi* in the Philippines.[25] The intermediate snail host has been targeted for control in order to break the life-cycle of the disease. However, molluscicide using niclosamide has proven challenging given it is a known pollutant.[25] As a consequence, in Asia, targeted molluscicide of identified 'snail hotspots' (cercarial positive snail sites) have now become an integral part of the national control program in China.[25]

It has recently been stated that the control of the snail intermediate host is the missing link for elimination efforts in Africa.[26] However, we recently attended a Gates Foundation meeting and were informed that the reason why it was not part of current 'preventive chemotherapy' campaigns was that there are very few people left in Africa who can correctly identify the snail intermediate host. This is a serious obstacle for future integrated control efforts, but not impossible to overcome. Control staff can be retrained to correctly identify the snail host and historically endemic snail habitats can be revisited. However, considerable effort is required to correctly identify 'snail hotspots' for targeted molluscicide.[3] Local staff who are largely untrained and often unmotivated, must be lead on the ground by a member of the project leadership team who fully appreciates the importance of this component of control. Without this operational leadership on the ground, this essential component will not be achieved.

There is no question that this component will take time and considerable effort in the field. However, in Northern Samar with a team of ten (Figure 6) we were able to cover approximately 3-4 villages per day.[3] Each village typically had 2-4 endemic zones ranging in size from 0.5-1 squared kilometre. It is clearly not possible to spray the entire area given the size of the transmission zones, the price of niclosamide, and the fact that niclosamide is a pollutant. Hence, GPS identified 'hotspots' were targeted for molluscicide. If the goal is to achieve disease elimination, this is a vital component of integrated control that cannot be omitted. In the current global MDA strategy, this component has been left out, thus another reason why 'preventive chemotherapy' is inherently flawed.

3.6. Health education

Health education is a further component of integrated control that has again been neglected in the era of MDA. Clearly this impacts on drug coverage if the technical knowledge and expertise is not available at the national, regional, state, district and most importantly, the village level. Any lack of knowledge in delivery of the drug will lead to a significant drop in drug coverage. The rate limiting step is at the village level and this is where most MDA programs are failing. Poor understanding of the disease also leads to reduced patient compliance to free treatment and risk taking behaviour (e.g., exposure to endemic freshwater). If a patient knows about the disease and knows that they are infected (e.g., confirmed by diagnosis) they are more likely to comply with treatment on an annual basis. A video-based health educational intervention package for soil transmitted helminths (STHs) was recently tested among school children in China and showed a 50% reduction in the incidence rate and a significant change in behaviours.[27,28] Clearly an educational package is needed on many fronts as part of an integrated control strategy for schistosomiasis.

3.7. WASH

Long-term schistosomiasis control will require improvements to WASH, in order to break the life cycle of the disease. WASH interventions are diverse, potentially including improvements in water access (e.g., water quality, water quantity, and distance to water), sanitation access (e.g., access to improved latrines, latrine maintenance, and faecal sludge management), and hygiene practices (e.g., handwashing before eating and/or after defecation, water treatment, soap use, wearing shoes, and water storage practices). Interventions often include multiple components while also providing hygiene education. WASH access and practices are generally associated with reduced odds of STH infection. Pooled estimates from all meta-analyses indicated at least a 33% reduction in the odds of infection associated with individual WASH practices.[29] There are a number of low cost solutions (e.g., urine diverting dry toilets), that are worth pursuing if funding permits. However, the reality is that little funding is spent by national governments on this poverty reduction initiative. Thus, local communities, in partnership with donor agencies, will need to make this essential intervention a priority.

3.8. Program evaluation

Annual program evaluation of the control work is critical for the implementation and sustainability of integrated control, and again this is lacking in most MDA programs. There is considerable variation (e.g., ecological, political commitment etc.) from region to region and from village to village. Each village will have obstacles to overcome that must be monitored in an ongoing

Figure 6. A. Snail intermediate host survey in an endemic barangay in Northern Samar, the Philippines. B.GPS identification of snail hotspots for future focal niclosamide spraying.[3]

manner and evaluated annually. Some villages will be supportive, while others will be more challenging to motivate, with a multitude of reasons. As mentioned, success is largely based on village cooperation and the motivation of the control team. If a village will not comply despite concerted efforts to convince them (e.g., multiple meetings with the village and local government leaders), it will have to be omitted from the control program. There is simply a finite amount of financial resources that have to be well spent. It is also demoralizing for the control staff to work in a community where they feel their efforts are not valued or appreciated. In Northern Samar we have had barangays that would simply not comply despite our best efforts to persuade them.[3] The mayor met with the barangay captains and the health workers, but still they refused to participate, hence the hard decision was made to omit them from future control efforts. Tough decisions such as these rise periodically and require ongoing monitoring and evaluation.

3.9. Financing global integrated control

Neglected tropical diseases are in reality a low priority for many developing nations who struggle to pay healthcare salaries and keep tertiary-care hospitals functioning. Many of these countries are crippled by the allocation of constrained resources towards HIV, malaria and TB control, and periodic epidemics, thus limited or negligible resources are left for NTDs. However, WHO and many senior academics have openly stated that by 2020, schistosomiasis will be eliminated from many countries, thus the disease is deemed a low priority.[7] Why spend money on a disease that is close to elimination? In the Philippines, WHO has stated that schistosomiasis is close to elimination, thus the Secretary of Health stated at a recent schistosomiasis conference that the disease was no longer a public health priority. However, schistosomiasis is not close to elimination in the country and it is indeed a major public health problem in the Visayas (e.g., Samar, Leyte) and Mindanao.[3,17] This same scenario is true for many African nations. In sum, in the developing world most countries view NTDs as a low priority thus limited national support will be provided for integrated control efforts.

International donors have limited understanding of the complex life cycle of schistosomes and the coordination of disease control programs on the ground.[5,7,16] International donors and foreign governments (i.e., USAID and DFID, using taxpayers dollars) have recently given large sums of money for MDA programs (primarily in Africa) that are typically for 3-5 years in duration. However, such funds will have little or no impact given the control strategy deployed (MDA), duration of the project, and that NGOs such as Family Planning International (FHI), and Christian Blind Mission (CBM) are coordinating this work on the ground using 'trained non-healthcare personnel' to deliver the drugs.[7] The NGOs have local logistical expertise but have little or no history of working on NTDs.[7] Clearly long-term (5-10 years) funding is required for integrated control and the package delivered by health-care teams with disease specific expertise. However, one major donor informed us "everyone knows that long-term funding is required for integrated control, and that this is the way forward but no one will fund it. People want quick returns on their investments and to see the numbers".

4. Conclusions

It is becoming increasingly clear that the global sustainable control of schistosomiasis will require an integrated, intersectorial approach that goes beyond deworming. Table 1 illustrates some of the operational inputs and expected outputs of 'mass drug administration' versus 'integrated control' required for the global elimination of schistosomiasis. Clearly integrated control is the way forward but it will require a long-term financial investment that must largely be supported by national governments. Is it realistic to believe that a disease that has been endemic in many countries for over 2,000 years can be eliminated by one drug in 3-5 years? Clearly the 2020 and the 2030 elimination goals put forward are unrealistic and undermining global control efforts.[7] It is time to set a new agenda for the global elimination of schistosomiasis over the next century.

The new global strategy proposed for the elimination of schistosomiasis is just one part of the 'integrated health package' required for rural and remote communities in the developing world where most of the 'bottom billion' struggle on less that one dollar per day (Figure 7). Limited donor funding needs to be better spent on sustainable development initiatives that addresses poverty and the life cycle of these diseases. Ultimately these

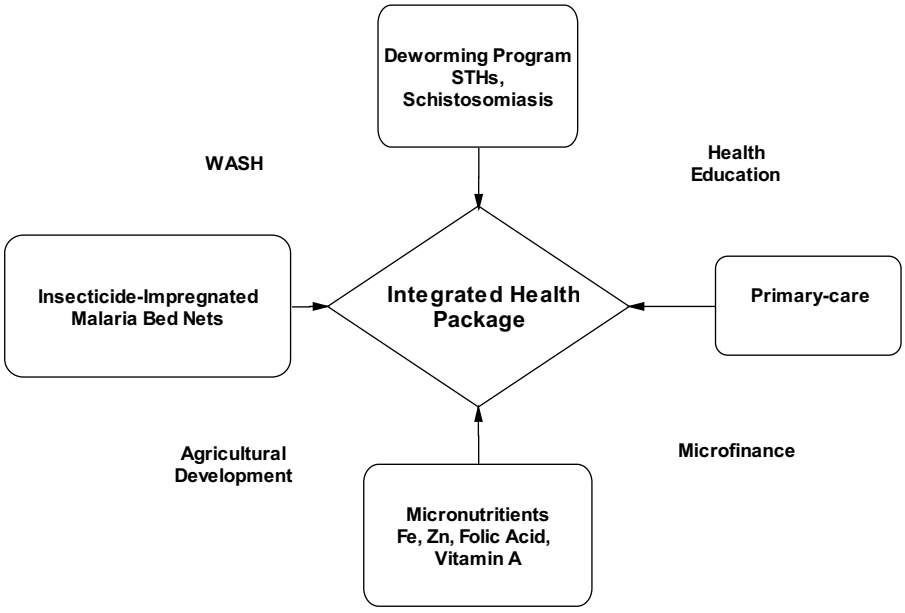

Figure 7. Proposed low cost integrated health package for rural and remote communities in the developing world. Note: Integrated control for schistosomiasis is part of the deworming program.

Table 1
Operational inputs and expected outputs of Mass Drug Administration versus Integrated Control for the global elimination of schistosomiasis

Inputs	Mass Drug Adminstration	Integrated Control
Logistics	Minimal	Extensive
Pharmaceutical industy involvement	Extensive	Minimal
National Drug Supply Chains	Required	Required
Baseline Assesement	Minimal or none	Extensive
Program Evaluation	Minimal or none	Extensive
Operational cost	Minimal	Moderate or extensive
Operational coordination	Minimal	Extensive
Impact on Prevalence	Moderate	Extensive
Impact on Incidence	Minimal	Moderate to extensive
Impact on Morbidity	Short-term	Long-Term
Use of unpaid volunteers	Moderate or extensive	None
Use of skilled expertise	Minimal	Extensive
Diagnostics	Minimal or none	Extensive
Project Commitment	Short-term (e.g. 3-5 years)	Long-term (>5 years)
Political Commitment	Short-term	Long-term
Sustainability	Short-lived	Long-term

endemic communities will have to lift themselves out of poverty though cooperatives and microenterprise.

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