Cost-effectiveness of triple drug administration (TDA) with praziquantel, ivermectin and albendazole for the prevention of neglected tropical diseases in Nigeria

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Onchocerciasis, lymphatic filariasis (LF), schistosomiasis and soil transmitted, helminthiasis (STH) are all endemic in Nigeria. Annual mass drug administration (MDA) with ivermectin (for onchocerciasis), albendazole (for STH and with ivermectin for LF) and praziquantel (for schistosomiasis) is the WHO-recommended treatment strategy for preventive chemotherapy. Separate delivery rounds for distribution of these drugs have been the usual approach to MDA. All three drugs, however, have now been shown to be clinically and programmatically safe for co-administration with what has come to be known as triple drug administration (TDA). We examined the cost savings of converting from separate delivery rounds to TDA in two states in Nigeria. In 2008, eight local government areas received a single round of ivermectin with albendazole followed at least 1 week later by a single round of praziquantel to school-aged children. The following year, a single round was administered with TDA. The number of treated individuals was essentially unchanged during both years (1 301 864 in 2008 and 1 297 509 in 2009) and no change in adverse events was reported. The total programmatic costs for the MDA, not including drug and overhead costs, reduced by 41% from \$123, 624 to \$72, 870. Cost savings were limited in larger populations due to economies of scale. TDA is recommended for mature MDA.

INTRODUCTION

The control or elimination of the ‘tool ready’ neglected tropical diseases (NTDs) onchocerciasis, lymphatic filariasis (LF), soil transmitted helminthiasis (STH) and schistosomiasis has been a topic of renewed interest in recent years since all may be controlled or eliminated by mass drug administration (MDA) of safe and effective medicines, many of which are donated by

large pharmaceutical companies (Brady *et al.*, 2006; Musgrove and Hotez, 2009; Smits, 2009; Bernhard *et al.*, 2010). Onchocerciasis is a leading cause of visual impairment and blindness in many developing countries. The disease is caused by *Onchocerca volvulus* and is transmitted through the bite of *Simulium* species of black fly. Adult worms often reside in nodules under the skin and release microfilariae into the skin that cause itching and disfiguration of the skin and inflammation in the eyes. Annual treatment with ivermectin (Mectizan[®], donated by Merck) kills the microfilariae and prevents the skin and eye

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damage they cause (WHO, 2010a, b). LF is a chronic parasitic infection caused by *Wuchereria bancrofti* or *Brugia malayi* that are transmitted by mosquitoes. The adult worms cause swelling of limbs and genital organs (lymphedema, elephantiasis and male hydrocele) and painful, recurrent, debilitating attacks of acute adenolymphangitis. The adult worms release microfilariae that circulate in the blood where they infect mosquitoes that transmit the infection. In Africa, an annual combination of two medicines, ivermectin (also donated for this purpose by Merck) and albendazole (donated by GlaxoSmithKline), kills the microfilariae and results in almost complete suppression of LF mosquito transmission (WHO, 2010a, c). STH is among the most common infections world-wide. The causal agents in humans are any of several intestinal nematodes *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale* or *Necator americanus*. Eggs from the adult females are passed into the environment in feces. Infection is caused by ingestion of fecally contaminated food or water (*Ascaris* and *Trichuris*) or through penetration of skin by larvae (*Ancylostoma* and *Necator*). Infection can cause anaemia, stunted growth, nutritional deficits and general weakness that can affect learning and work. A single dose of albendazole (recently donated for this purpose by GlaxoSmithKline) can reduce intensity of STH infection thereby controlling morbidity; ivermectin is likewise effective against *Ascaris* (WHO, 2002, 2010d). Schistosomiasis is a trematode infection transmitted to humans through contact with contaminated water. The larva (cercariae) of the parasite passes through the skin and migrates through the blood stream. Adult worms reside in venules draining either the bladder (*Schistosoma haematobium*) or the intestine (*Schistosoma mansoni*, *S. japonicum* and other human *Schistosoma* species) where they lay eggs that are released into the environment via urine or feces. If deposited into fresh water, the eggs hatch and infect specific snails. Snails later release cercariae

into the water where they can enter the skin of the next human host, completing the lifecycle. Some eggs are retained in human tissues where they cause damage to various organs (bladder, liver, kidneys and lungs). Annual treatment with praziquantel can significantly reduce the morbidity associated with infection; however, the drug is not as widely donated as are the medicines for lymphatic filariasis, onchocerciasis and soil transmitted helminthiasis (WHO, 2002; Richards *et al.*, 2006). The WHO has provided important 'Preventive Chemotherapy' (PCT) guidelines for distribution of these medicines in MDA programmes (WHO, 2006).

Recent clinical and programmatic studies have shown that these three drugs are safe for co-administration during MDA and have opened the way for what has come to be known as Triple Drug Administration (TDA) (Na-Bangchang *et al.*, 2006; Eigege *et al.*, 2008; Mohammed *et al.*, 2008; Namwanje *et al.*, 2011). The WHO guidelines for PCT allow the use of TDA only after one to two rounds of separate 'stand alone' (SA) treatments are given, one of ivermectin with albendazole and the other of praziquantel (WHO, 2006). This is to allow drug naive populations with potentially heavy worm burdens (and therefore, greater risk for reactions to the death of the worms shortly after treatment) to be treated separately, thereby reducing the risk of adverse events. Most MDA programmes have not elected to use TDA but to follow alternative PCT options that involve multiple treatment rounds in NTD endemic communities.

In Plateau and Nasarawa states in north central Nigeria, onchocerciasis, LF, STH and schistosomiasis (both urinary and intestinal) are co-endemic (Richards *et al.*, 2006; Gutman *et al.*, 2008). Since 2000, the federal and state ministries of health (MOH), with assistance from The Carter Center, have provided separate rounds of annual MDA with ivermectin, albendazole, and (when available) praziquantel in these two states. With support from the Bill &

Melinda Gates Foundation to explore new approaches to integration of the NTD programmes, TDA was investigated as a way to use resources more efficiently and to reduce delivery costs.

The primary objective of this study was to assess cost efficiencies and savings resulting from the transition from two stand-alone (SA) treatment rounds consisting of ivermectin/albendazole for LF, onchocerciasis and STH, and praziquantel for schistosomiasis to a single round of TDA.

METHODS AND MATERIALS

The contiguous states of Plateau and Nasarawa are located in north-central Nigeria with an estimated 4.1 million residents. Nasarawa was formed from Plateau in 1997 and the population of the two states is predominately Hausa speaking with approximately 80% living in rural, agricultural settings. The two states are divided into 30 administrative units called Local Government Areas (LGA), eight of which (five in Plateau and three in Nasarawa) transitioned from SA rounds in 2008 to TDA rounds in 2009 and are reviewed here for this study. Six of the eight LGAs were rural and the remaining two were urban (one in each state). The LGAs ranged in size from roughly 120 000 to 500 000 persons. All eight LGAs had received ivermectin and albendazole treatments for at least 7 years before the study and two of the eight had received some praziquantel as a separate treatment between 1999 and 2005.

Drug Distribution

Distributions of medicines were carried out by volunteer community directed distributors (CDDs) who were selected by community members for this purpose. All CDDs were trained in providing health education, proper dosing, record keeping and monitoring for adverse events (AEs). Volunteer supervisors were also trained to provide

oversight and support to CDDs, monitor drug use, and to provide summary records of drug treatments. One to two weeks before distribution, community mobilization took place in order to alert communities to the upcoming treatments and to encourage participation. In most cases, CDDs carried medicines door-to-door, but in some instances, central-point distributions (i.e. from a health post, village square, school, etc.) were used.

Treatments

Treatments were calculated as the total number of doses provided, for both praziquantel and for ivermectin with albendazole, while treated individuals (children or adults) were calculated as the number of persons receiving any treatment. CDDs used height poles (colour labelled for ivermectin and praziquantel) to provide dosing based on height as a proxy for weight. Treatments were designed to provide approximately 150 µg/kg of ivermectin and 40 mg/kg of praziquantel. In 2008, all persons >90 cm and above received a stand-alone round of ivermectin with a single 400 mg albendazole distributed by a CDD. One or more weeks later, the same CDDs delivered praziquantel to all school-aged children (height >94 cm up to the age of 15 years). During distribution, MOH and Carter Center Staff provided supervision and assistance as necessary to ensure safety, proper recording and treatment quality. The treatment eligible population excluded persons below proper height or age, pregnant women, lactating women in the first week after birth and persons who were chronically ill. Coverage was expressed as a percentage and calculated as the (number of persons treated/number treatment eligible) × 100%.

In 2009, CDDs treated all eligible school-aged children with all three medicines as TDA, while adults received only ivermectin with albendazole. The same dosing methods as described above were followed, but now with praziquantel also given to children

>94 cm to 15 years of age together with the other medicines.

Monitoring and Adverse Events

Each CDD maintained a register of every household and its members in their designated area. These registers were updated regularly and all new arrivals (births, immigration) and departures (deaths, out-migration) were recorded. Each page of the register was dedicated to a single household where the names, occupation, sex, age and (as appropriate) pregnancy status of all household members were recorded. During distributions, each eligible person was recorded as having received or not received medicines, the total dose given and whether the medicine was refused. For 48 hours after treatment, the CDDs monitored for AEs such as headaches, abdominal pain or fever, and provide analgesics (paracetamol) if necessary. Severe AEs were to be referred to a clinic or hospital. All AEs were recorded in the register and reported to the CDD supervisor.

Costs

The analysis focused on costs of conducting the MDA programme to the MOH and The Carter Center. These costs included salaries, transportation, supplies, per diems and intervention materials. Operational data were also collected in terms of specific activities that were used to allocate salary time devoted to those activities. These costs, referred to as activity costs, included advocacy, data management and reporting, drug delivery and distribution, field supervision, health education and community mobilization, procurement and training.

Costs were tracked as follows:

- **MOH costs:** the MOH provided personnel but no direct funding to the MDA programme. To calculate the value of staff salaries to the MDA programme, different staff positions and salaries were noted, and MOH field activities were monitored through employee work logs.

A sample of 26 MOH field staff (out of a total of 95 field staff) consisting of different positions (e.g. field supervisor, field officer, etc.) were selected and rotated monthly. Those selected were asked to complete a detailed work log for the month. Work logs included specific activities performed for each of the MDA interventions, the amount of time spent on these activities, whether the activities were considered integrated or stand-alone, whether there was any out-of-pocket expense or if per diems were paid. These were then used to create an average number of days worked per MDA intervention and each activity; this average was then applied to all field staff in that LGA. Time was converted to money by multiplying the daily average field staff employee salary of each LGA by the average number of days worked in that LGA to determine the cost of the employee inputs spent on specific MDA related activities for each LGA.

- **Carter Center costs:** since the Carter Center provided all direct financing, MDA programme costs could be monitored through examination of Carter Center financial records. These accounts were separated according to activity and intervention. Input costs were then categorized according to the type of input: per diems, transportation, and materials and supplies. Separate financial records were kept for praziquantel and ivermectin/albendazole treatment rounds in the SA year (2008) for all eight LGAs. In the TDA year (2009), the integration of drug delivery meant that these costs were not broken out separately as all three drugs were administered together to the target population. We determined costs for each LGA, and total costs, for both drug distribution strategies. When appropriate, we calculated the separate costs for delivery of drugs to specific target populations (school aged children for praziquantel versus total population for ivermectin/albendazole).

Costs were calculated per treatment (e.g. total cost/number of treatments of ivermectin with albendazole plus treatments of praziquantel) and per child treated [(total cost SA ivermectin and albendazole/persons treated with ivermectin and albendazole) + (total cost SA praziquantel round/children treated with praziquantel)]. During TDA, all medicines were co-administered and therefore, separate costs could not be assessed. For sake of comparison of children between SA and TDA distributions, 2009 TDA praziquantel treatments are calculated as a separate treatment delivered; in other words, children receiving TDA were counted as two treatments to give the denominator for calculating the cost per child treated [total cost/(treatments in children $\times$ 2)], while adults were counted as only a single treatment. All costs presented are delivery costs only and do not include overhead costs such as rent, utilities, Carter Center headquarters costs, etc. Carter Center Field staff salaries averaged \$172 USD per LGA per year for MDA related activities ($<$ \$0.001 per treatment) but were considered administrative overhead and were not included in the delivery costs. Reimbursements paid to CDDs by their communities were also not included in the analysis. Finally, the value of the donated medicines was not included.

Data Analysis

Statistical analysis was done using STATA 11. A two sample *t*-test was used to compare mean LGA costs and per person and per treatment costs from SA distributions to TDA. A *P* value of <0.05 was considered statistically significant. Mean costs and *P* value are presented.

RESULTS

During the 2008 SA distribution, 1 301 864 treatments of ivermectin/albendazole were given during round 1, and 279 505 treatments of praziquantel were given to children

in round 2. This represented 100% and 90% coverage of the eligible population for the respective drugs. During the 2009 TDA distribution, 1 297 509 ivermectin/albendazole treatments were given to all eligible persons (children and adults) and 299 078 praziquantel treatments were co-administered to children as TDA. This represented 100% and 98% coverage of the eligible population. Total number of treatments (ivermectin/albendazole + praziquantel) remained relatively constant during the two years: 1 581 369 and 1 596 587 treatments respectively (Fig. 1). The total cumulative MDA costs for the 2008 SA distributions were \$123 624: \$66 139 for delivery of ivermectin/albendazole and \$57 485 for praziquantel, with a mean cost per LGA of \$15 453. In 2009, the TDA approach reduced the total MDA cost by 41.1% to \$72 869 (Fig. 1). Minor adverse events (headaches, abdominal pain or fever) were reported in 0.06% and 0.02% of the population in 2008 and 2009, respectively. No severe adverse events were reported.

Total treatments and cost by LGA and by input are shown in Table 1. The mean cost per LGA reduced significantly (\$6344) from the SA distribution (\$15 453) to the TDA distribution (\$9109, $P<0.01$). The total cost per treatment for all 8 LGAs reduced by \$0.03 from \$0.08 in 2008 to \$0.05 in 2009. During the SA distribution, the total cost to deliver ivermectin with albendazole was \$0.05 and for praziquantel was \$0.21 giving a total cost of \$0.26 per child treated. Counting children as two treatments in 2009 gave a cost per child treated of \$0.10, a reduction of \$0.16 over the previous year. The mean LGA cost per treatment decreased by \$0.04 from \$0.10 to \$0.06 ($P>0.05$). The mean LGA cost to treat children reduced significantly (\$0.22) from the SA distribution (\$0.34) to TDA (\$0.12, $P<0.01$).

Economies of scale occurred in both distribution strategies. Figure 2 shows that as treatment numbers increased the cost per treatment in each LGA decreased in both 2008 and 2009. The cost differential, the

Total treatments of ivermectin with albendazole plus praziquantel and total costs, 2008 (SA) and 2009 (TDA)

FIG. 1. The total number of treatments of ivermectin with albendazole and praziquantel changed little during both years of distribution, but total costs reduced by 41.1%.

difference in cost from 2008 to 2009, was the greatest in LGAs with fewer treatments while the LGAs with populations nearing 400 000 saw much less differentiation. Thus, smaller LGAs saw the greatest proportion of cost savings in the transition from SA to TDA while larger LGAs saw smaller returns.

Total and mean input costs of per diems, transportation, and salaries decreased significantly ($P < 0.01$) from 2008 to 2009 with the exception of materials and supplies which saw a slight but significant ($P < 0.05$) increase during 2009 (Table 2). This was due to the addition of radio and television spots promoting programme activities during the year TDA was implemented. Salaries represented the majority of costs accounting for 75.5% and 72.3% of the total costs in 2008 and 2009, respectively. The mean cost of per diems reduced 43.7% from \$2530 to \$1424 ($P < 0.01$); mean cost of transportation reduced 49.3% from \$922 to \$467 ($P < 0.01$); and mean salaries 33.4% from \$3,788 to \$2,522, $p < 0.01$; mean cost

of materials and supplies increased 87.8% from \$336 to \$631 ($P < 0.05$).

Total activity costs also saw reductions from the 2008 SA distribution to 2009 TDA distribution. Again, however, the majority of cost savings came from reductions salary costs. Without the input of salaries (programme expenses only), mean activity costs reduced significantly only drug delivery (38.5% from \$1624.34 to \$999.23, $P < 0.05$) and for supervision (53.2% from \$1048.09 to \$490.50, $P < 0.01$). Activity costs were unchanged for advocacy (from \$398.96 to \$277.92, $P = \text{NS}$), data management (from \$48.72 to \$31.92, $P = \text{NS}$), training (from \$492.29 to \$456.93, $P = \text{NS}$) and health education (from \$175.23 to \$265.86, $P = \text{NS}$).

DISCUSSION

This study showed that co-administration of the drugs ivermectin, albendazole and

TABLE 1. Total costs, mean costs and total treatment by LGA and input category

	Total cost and treatment	LGA								Total
		Bassa	Bokkos	Jos South	Kanam	Kanke	Karu	Lafia	Nasarawa Eggon	
2008 (SA)	No. treatments	182 087	145 905	215 946	121 978	96 462	235 323	436 695	146 973	1 581 369
	TCC costs	\$4669	\$5128	\$3648	\$4262	\$3399	\$2962	\$2563	\$3670	\$30 301
	MOH costs	\$11 263	\$9654	\$14 481	\$11 263	\$12 872	\$11 263	\$8045	\$14 481	\$93 321
	Total costs	\$15 932	\$14 782	\$18 129	\$15 525	\$16 271	\$14 225	\$10 608	\$18 151	\$123 624
	Cost/treatment	\$0.09	\$0.10	\$0.08	\$0.13	\$0.17	\$0.06	\$0.02	\$0.12	\$0.08
	Cost by input									Mean
	Per diems	\$3149	\$3279	\$2392	\$3041	\$2116	\$1696	\$1458	\$3109	\$2530
	Transport	\$1104	\$1471	\$1,090	\$968	\$1047	\$737	\$501	\$461	\$922
	Materials and supplies	\$416	\$379	\$166	\$253	\$237	\$529	\$605	\$101	336
	Salaries	\$11 263	\$9654	\$14481	\$11 263	\$12 872	\$11 263	\$8045	\$14 481	\$11 665
2009 (TDA)	Total cost and treatment									Total
	No. treatments	170 134	136 170	236 786	114 210	89 346	232 891	446 773	170 277	1 596 587
	TCC costs	\$3076	\$2771	\$1869	\$2343	\$2578	\$2877	\$2628	\$2038	\$20 179
	MoH costs	\$6359	\$5451	\$8176	\$6359	\$7268	\$6359	\$4542	\$8176	\$52 691
	Total costs	\$9435	\$8221	\$10 046	\$8702	\$9845	\$9236	\$7170	\$10 214	\$72 870
	Cost/treatment	\$0.06	\$0.06	\$0.04	\$0.08	\$0.11	\$0.04	\$0.02	\$0.06	\$0.05
	% change from SA	40.8%	44.4%	44.6%	43.9%	39.5%	35.1%	32.4%	43.7%	41.1%
	Cost by input									Mean
	Per diems	\$1833	\$1857	\$972	\$1085	\$1485	\$1879	\$1148	\$1135	\$1424**
	Transport	\$409	\$503	\$365	\$568	\$708	\$465	\$434	\$283	\$467**
	Materials and supplies	\$834	\$411	\$533	\$690	\$384	\$533	\$1046	\$620	\$631 *
	Salaries	\$6359	\$5451	\$8176	\$6359	\$7268	\$6359	\$4542	\$8176	\$6586 **

* $P < 0.05$.** $P < 0.01$.

FIG. 2. Economies of scale: a polynomial trend line shows costs per person decreased as the number of treatments increased by LGA for both the stand alone (2008) and TDA (2009) distribution strategies. Cost savings were the greatest in LGAs with fewer treatments.

praziquantel (TDA) can be effectively administered at a significant cost savings over the traditional SA distributions. The ability to integrate these MDA systems will save both time and resources as well as speed the delivery process to those in need. The most significant savings were seen in the personnel costs of salaries and per diems; significant savings, however, were also witnessed in the direct programmatic costs of transportation, monitoring and supervision, and drug delivery costs. Using community directed interventions, we were able to safely distribute the drugs in both SA and TDA treatment rounds achieving close to 100% coverage of the

treatment eligible population with no serious adverse reactions.

The safety of co-administration of the drugs ivermectin, albendazole and praziquantel has been known for some time. In 2006, a study among uninfected individuals in Thailand showed no clinically relevant pharmacokinetic interactions or adverse reactions when the drugs were taken together compared to when given separately (Na-Bangchang *et al.*, 2006). Shortly thereafter, a large-scale trial of triple drug therapy was carried out in Zanzibar where treatment was given safely to over 700 000 at-risk and infected persons. The study noted that the

TABLE 2. Total costs by input categories and year: significant reductions in mean costs were seen in every input category except materials and supplies which increased due to added promotional campaigns. Salaries accounted for nearly three quarters of total costs in both years

	Per diems	Transport	Materials/supplies	Salaries (MOH cost)	Total
2008 (SA)	\$20 239.37	\$7377.35	\$2684.37	\$93 320.91	\$123 622.00
2009 (TDA)	\$11 393.75	\$3733.92	\$5051.19	\$52 690.78	\$72 869.64
% change	-43.7%**	-49.4%**	88.2%*	-43.5%**	-41.05%**

* $P < 0.05$.

side effects of treatment were only 'mild and self limiting events' (Mohammed *et al.*, 2008). In 2006, a smaller study by Eigege *et al.* (2008) in Plateau state, Nigeria, also showed the safety of providing TDA to 5084 persons using the CDD distribution structure. The study, which provided all three medicines to both children and adults, found that 1.1% of persons treated complaining of mild adverse events after taking the three drugs, and that CDDs only committed a 0.06% error in dosing (Eigege *et al.*, 2008). The following year, 813 077 TDA treatments were successfully provided without any significant change in adverse events. The Plateau and Nasarawa state programmes now have experience with a cumulative total of 2.04 million TDA treatments without any reports of serious adverse events.

The 2006 PCT guidelines for MDA treatment of multiple NTDs provide options for programmatic approaches, including a template for TDA launching. The guidelines call first for one to two separate, SA rounds of MDA, before moving on to TDA treatment. This is because co-administration of the drugs is not without its risks in drug naive populations, particularly ones with heavy worm burdens (WHO, 2006). Relatively high rates of adverse events, including the concern for potential serious adverse reactions, could be caused in persons with high worm loads as a result of the rapid kill-off of parasites in the initial round of treatment. For that reason, SA treatments are recommended for at least the first treatment round to reduce the community worm load. The necessity of administering at least one round of stand alone treatment in drug naive populations means that start-up costs of an MDA programme considering TDA will be significantly higher than subsequent running costs. However, we realized a savings of 41% in the second year of treatment by integrating treatments; these savings of course will vary between programmes. In our particular case, cost reductions were seen in a number of categories: salaries played the largest role in cost savings accounting for roughly

three-quarters of all expenses and reducing by 43.4% during TDA. Transportation costs, not surprisingly, dropped by 49.4% since travel was reduced by half. Generally, activity costs, not including salaries, reduced from between 30% and 53%. The input category of Materials and Supplies and the activity category of Health Education, however, increased due to the added expense of television and radio promotional materials during the TDA year of distribution; these costs were non-recurrent and would presumably reduce costs during subsequent years.

Further cost savings were achieved with economies of scale. For both treatment rounds, the total costs per person treated in a given LGA decreased as the number of treatments required by that LGA increased; as the number approached 400 000 treatments, the difference in costs between SA and TDA distributions became negligible.

The cost per treatment calculations reported here included a fraction of all costs needed to deliver this MDA programme, and so our report is an underestimation of overall programmatic expenses. We did not include in the analysis overhead costs to the MOH or Carter Center. The cost of the time of the CDDs was not included, nor the remuneration they often received that was determined and provided by their respective communities. Most importantly, we did not have to consider drugs costs as all three drugs were donated. Currently, the per-tablet cost for ivermectin is approximately \$1.50, for albendazole \$0.19 and for praziquantel \$0.08. The average number of tablets used per treatment in Nigeria was 2.8 ivermectin (average cost, \$4.20), 1.0 albendazole (average cost, \$0.19) and 1.7 praziquantel (average cost, \$0.14). Therefore, in 2008, the total market value of the medicines administered was \$5 754 314 (ivermectin \$5 467 829, albendazole \$247 354 and praziquantel \$39 131), which was more than 46 times the reported costs needed to deliver the drugs by SA methods. Similarly, in 2009, the total market value for medicines delivered was \$5 737 936 (ivermectin \$5 449 538,

albendazole \$246 527 and praziquantel \$41 871), which was 78 times the costs of delivering the drugs by TDA.

The combined impact of treatment with all three of the drugs ivermectin, albendazole and praziquantel go well beyond the control of the four diseases discussed here. Ancillary benefits to treatment include protection and treatment of other trematode infections (liver and intestinal flukes), cestode infections (tape worm) and ectoparasitic infections (such as scabies and lice).

There are challenges to using TDA. Each of the drugs, ivermectin, albendazole and praziquantel are shipped through separate programmes or agencies and at different times. This results in logistical challenges (that have a cost) in ensuring that all three drugs are readily available for distribution at the same time. Waiting for a late delivery, and delaying the programme from the projected treatment calendar, also is costly to the programme.

Large-scale pharmaceutical donation programmes have dramatically reduced the costs of MDA programmes, as have the development of community based MDA distribution structures (WHO, 2010*b, c*). New donations are scaling up STH activities, and it is hoped that more donations of praziquantel will aid in increased schistosomiasis MDA (WHO, 2010*d*, 2011). The use of current MDA structures available on ground to rapidly and safely scale-up drug delivery avoids redundancy and duplication of effort. Integrating delivery of the drugs through TDA is one of the most cost-efficient means to do this.

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