

Value of individual household water supplies in the maintenance phase of a schistosomiasis control programme in Saint Lucia, after chemotherapy*

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Between 1970 and 1975, the incidence of new Schistosoma mansoni infections was reduced in 5 villages after each household was provided with its individual water supply and community laundry shower units were made available. In 1975, 1976, and 1977 chemotherapy with oxamniquine was offered to persons found to be infected. Transmission was reduced further and remained at a low level for the next 4 years, with no sign of an increase in spite of the reservoir of infection remaining after therapy and a poor level of sanitation in the villages.

Thus, properly maintained water supplies appear to be effective in maintaining transmission at a low level during the maintenance phase of a schistosomiasis control programme, after chemotherapy. Sporadic new infections must be anticipated among children, but these will probably be of low intensity and associated with minimal morbidity.

The effect on transmission of *Schistosoma mansoni* of providing each household with its own water supply has been studied in five villages in Richefond valley in Saint Lucia (1–3). Between 1970 and 1975, the incidence of new infections among 0–10-year-old children fell from 31% to 12.6%, overall prevalence fell from 52% to 38%, intensity of infection fell by 50%, and the contamination potential was reduced by 68%.

After stool surveys of all age groups in 1975 and 1976, chemotherapy was offered to persons then excreting *S. mansoni* ova; in 1977 all other untreated persons who at any time had been found infected were offered treatment. No further control was carried out but the transmission pattern was followed for 4 years to assess the effect of individual household water supplies on transmission in the consolidation phase of the control programme, after chemotherapy.

THE STUDY AREA

The five experimental villages in which each household was provided with its own water supply have been described elsewhere (1, 4). With a total population of approximately 2000, they are located on the south side of the Richefond valley, on the eastern side of Saint Lucia.

When the project started, one village—Grande Ravine—was situated at the end of a dirt road; as a result of development over the past 10 years the village is now on a tarmac loop road, off the main road through the valley. The other four villages have changed little and population density has been static.

Owing to increases in the price of oil and the resultant rise in the cost of electricity for pumping water, the Grande Ravine system was connected, in 1979, to a new gravity-fed water supply on the northern side of Richefond valley. This water is of better quality than that originally distributed, and resulted in much lower maintenance costs, required less electricity for pumping, and enabled a few additional houses, above the economic level for pumping water, to be supplied.

The main system providing Grande Rivière, Thomazo, and Morne Panache is also dependent on electricity, and modifications are in hand to provide a gravity-fed water supply.

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In August 1980, Hurricane Allen completely destroyed the Grande Ravine laundry unit and the power lines to the Thomazo pumping station. Water supplies were interrupted for 7 weeks and ground-water was the only source available. Although rain was not a marked feature of the hurricane it was probably sufficient to "flush out" snails and the 1981 survey gives no indication of transmission having taken place while supplies were interrupted.

In earlier reports on this project, reference was made to comparison settlements on the northern side of Richefond valley. These villages are not referred to in the present communication as, with development, they became less suitable for comparison purposes; data from them will be reported elsewhere.

MATERIALS AND METHODS

Chemotherapy

Treatment campaigns were organized as previously described (5). In 1975, children and adults were given oxamniquine at a dose of 15 mg/kg of body weight; later this was increased to 20 mg/kg for children.

Parasitological studies

Stools from children aged 0–14 years were collected by annual house visits; stools from persons of all ages were collected in 1977 and for final evaluation in 1981.

A sedimentation concentration was used for

qualitative examination for helminth ova. If the quantity of stool was sufficient, those found with *S. mansoni* ova were quantitatively examined by a filtration staining technique (6) with a lower limit of sensitivity of 10 eggs per gram; in about 2% of cases, there was insufficient stool and the Kato technique was used. Quality control has been maintained by the method described by Bartholomew & Goddard (7).

Cochran's method for combining 2×2 tables was used for significance tests of prevalence and incidence by age groups at different surveys (8).

Sanitation and water usage

In a survey of the standard of sanitation in the area, the type of latrine in each house was noted. In an enquiry into usage of water, householders were asked whether they still went to the river in spite of having their own household water supply.

Cost analysis

Detailed costs of maintaining water supplies and of the chemotherapy campaigns were kept.

RESULTS

Chemotherapy

In 1975, out of 1340 persons examined, 512 were found to be infected, and were offered treatment; 95% accepted. In 1976, of 377 found to be infected

Table 1. Incidence of new *S. mansoni* infections in children apparently negative at the first of two surveys^a

Age at survey	1974/75 ^b		1977/78 ^c		1978/79		1979/80		1980/81	
	No. examined	% positive	No. examined	% positive	No. examined	% positive	No. examined	% positive	No. examined	% positive
0–2	49	0	36	2.8	31	3.2	25	0	22	0
3–5	85	7.1	63	3.2	72	2.8	40	7.5	35	0
6–7	63	19.0	51	5.9	45	2.2	31	12.9	36	5.6
8–10	70	20.0	88	10.2	74	6.8	50	6.0	55	1.8
11–13	41	41.5	64	9.4	71	7.0	39	2.6	39	10.3
0–13	308	15.9	302	7.0	293	4.8	185	5.9	187	3.7

^a No. examined = number of children found *S. mansoni* negative at the first of two surveys. % positive = the proportion of those examined who were found *S. mansoni* positive at the second of two surveys.

^b Last year before chemotherapy was offered.

^c Treatment was offered after the 1977 survey.

only 77% accepted treatment. In 1977, the final year of the campaign, 95 were treated bringing the total treated to 841 persons.

Parasitology

Data for the incidence of *S. mansoni* infections for the year prior to the first chemotherapy campaign (1974/75) (i.e., at the end of a 4–5 year period of evaluating the effect of individual household water supplies on the control of transmission) and for the years following the last campaign (1977/78) are shown in Table 1. The fall in incidence from 15.9% in 1974/75 to 7.0% in 1977/78 reflects the reduced contamination of the environment after chemotherapy. Transmission did not increase in the subsequent years.

Changes in prevalence, intensity of infection, and contamination potential are shown in Table 2. Similar rates of prevalence were found in males and females.

As has been reported elsewhere, in longitudinal studies the cooperation of the people decreases with time (10), and in the 1981 survey (the fourteenth) only 47% and 57% of males and females, respectively, provided stools for examination. Overall prevalence declined from 38% in 1975 to 13% in 1977, and to 8% in 1981. While the intensity of infection of those infected did not change, contamination was reduced by 78% between 1975 and 1981. Compared with the figure at the start of control programme in 1970, there was a 92% reduction in the level by 1981.

Changes in the frequency distribution of different intensities of infection are shown in Table 3 and the past *S. mansoni* histories of those found to be infected in 1981 are shown in Table 4. One-third of these people were known to have been infected previously. The apparently new cases were mainly among children, most of whom had had several previous negative stools (Table 4). The new cases among adults, who had had fewer previous negative stools, may not have been truly new cases.

Table 2. Changes in prevalence of *S. mansoni* infections, intensity of infection, and contamination potential in Saint Lucia

Age group (years)	1975			1977			1981		
	No. examined	% positive	GM egg output ^a	No. examined	% positive	GM egg output ^a	No. examined	% positive	GM egg output ^a
0–4	208	6.7	13	140	2.1	18	105	1.0	10
5–9	278	22.7	17	230	10.9		169	3.0	
10–14	232	50.0	17	227	19.4	12	176	11.4	16
15–19	144	59.7	19	98	20.4	22	81	19.8	16
20–29	144	60.0	23	117	17.1	29	80	15.0	25
30–39	91	56.0	15	88	16.0	17	74	12.2	26
40–49	94	40.4	14	73	11.0		67	10.4	
50–59	74	40.5	14	59	10.2	13	53	3.8	11
≥ 60	75	38.6	15	71	11.3		46	2.2	
0–14	718	26.9	17	597	12.1	14	450	5.8	17
≥ 15	622	51.3	17	506	15.0	19	401	11.7	
Contamination potential ^b		6389			2106			1412	
% Reduction in contamination		—			67%			33%	
Cumulative reduction					67%			78%	

^a Geometric mean of egg output/ml of faeces.

^b Sum of products of prevalence and GM egg output.

Table 3. Changing pattern of frequency distribution of intensity of infection as the control programme progressed

Year	No. examined	Egg load (eggs/ml of faeces)					% negative
		≤ 50	51–100	101–200	201–400	> 400	
1970	966	35.1	8.0	7.5	3.3	1.8	44.3
1975	1340	34.0	2.5	1.2	0.4 ^a		61.9
1977	1103	11.9	0.8	0.4	0.3 ^a		86.6
1981	851	7.2	1.2	0.1 ^b			91.5

^a > 201 eggs/ml of faeces.

^b > 101 eggs/ml of faeces.

Table 4. History of *S. mansoni* infections in the 73 persons found to be infected in 1981

Age group (years)	No. previously positive		No. previously negative ^a	No. not previously examined	No. of immigrants	Total
	Not treated	Treated				
0–4	—	—	—	—	—	—
5–9	1	—	4 (2, 3, 4, 5)	—	—	5
10–14	3	4	7 (3, 4, 5, 6, 7, 9, 11)	7	2	23
15–19	5	4	1 (1)	1	1	12
20–29	6	—	1 (3)	4	3	14
30–39	4	2	1 (1)	2	—	9
40–49	2	2	2 (1, 2)	—	1	7
50–59	—	1	—	1	—	2
≥60	1	—	—	—	—	1
	22	13	16	15	7	73

^a The figures in parentheses represent the number of negative stools obtained previously from each individual.

Engineering

The costs of maintaining the water supplies over the 4-year period are summarized in Table 5. The savings in pumping (electricity) costs for Grande Ravine once a gravity-fed system had been installed are noteworthy—as are the increasing electricity costs for the Thomazo pump.

Transportation costs reflect the increase in fuel prices, and rising labour costs show the effects of inflation. High labour costs from 1978 to 1980 were due to work on clearing a heavy deposit in the pipeline of the Grande Ravine distribution system.

The cost of rebuilding the Grande Ravine laundry shower unit when it was destroyed by Hurricane Allen, was borne by the USAID relief organization. Minimal repairs (US\$ 212) elsewhere were carried out by the department.

Sanitation and water usage

In a survey of 306 houses, 67% had pit latrines, 3% had septic tanks, and 30% either had no latrine or the occupants used an open pit for faecal disposal. Nearly 10% of householders admitted to going back to the river periodically to obtain water or to bathe in spite of having a household water supply.

DISCUSSION

Chemotherapy campaigns can rapidly reduce the prevalence of *S. mansoni* infections, the intensity of infection, and the contamination potential but a considerable reservoir of infection will remain (9), and, with a poor level of sanitation and inadequate water

Table 5. Comparison of annual maintenance costs (US\$) of water supply system (US\$1 = EC\$2.7)

	1977/78		1978/79		1979/80		1980/81	
Electricity								
G. Ravine	763	50%	263	39%	77	49%	67	57%
Thomazo	4055		4286		7704		9773	
Materials and equipment	986	10%	724	6%	893	5%	861	5%
Labour	3394	35%	5855	50%	7049	43%	6389	37%
Emergency work	200	2%	404	3%	—		212	1%
Other costs	320	3%	224	2%	530	3%	81	< 1%
Total	9718	100%	11756	100%	16253	100%	17383	100%
Payment for water	221		362		431		336	
Transportation	940		2233		3009		3997	
Cost per person	5.22		6.81		9.42		10.52	

supplies, transmission may continue—as it did elsewhere in Saint Lucia (10). In these circumstances, transmission can be controlled by routine focal mollusciciding (11), or repeated therapy of children (perhaps at 2–3 year intervals) may be an alternative maintenance phase strategy (10).

The results of the present study indicate that in Saint Lucia the provision of adequate, safe, household water supplies, with laundry shower units, can be an effective strategy in the follow-up phase of control after chemotherapy. The finding contrasts with results from another area where a community water supply failed to prevent a resurgence of transmission (10).

In the study reported here, only about two-thirds of the population offered stools for examination in the 1977 survey, and, in addition, many known to have been infected at that time did not accept chemotherapy. In view of this, and the low level of sanitation—inadequate latrines in 30% of the houses and infrequently used pit-latrines in the others—continued and possibly increasing transmission would have been expected. There was, however, no evidence of any increase; the 3.7% incidence rate for 1980/81 is the lowest recorded from the area but is not significantly different from the 1978/79 level. Thus, while there may have been a downward trend, incidence may now have become established at a new low level. During the 4–5 years in which the value of the water system was evaluated, the incidence fell from 31% to 11.3% in 3 years, but in the next 2 it failed to decline further (3).

The contamination potential in 1981 was only 8%

of the pre-control level. The chance of snails being infected is therefore much reduced, but children will be exposed to sporadic infection as they play and fish in the rivers. In most cases any infections acquired will be of low intensity—though this is not always the case (10).

In order to reduce to a minimum the chance of renewed transmission after the 1981 survey, all infected but previously untreated persons were offered therapy. Two-thirds accepted treatment, and although many of those who did not may have lost their infections since being first diagnosed, 22 of 73 found infected at the 1981 survey failed to accept treatment. Regrettably, in spite of personal and radio appeals, the response to the 1981 survey was the poorest ever with only 50% participation; the potential for continued transmission thus remains, but a rapid increase appears unlikely as long as individual water supplies are maintained.

The original water scheme was installed to test the concept that well established customs—such as washing in rivers—could be changed by health education and the provision of adequate, reliable, and convenient water supplies. At the time, cost was not the prime consideration, but with inflation, and since the system has been handed over to Government, the need for a more economic policy during the maintenance phase has become obvious. Electricity costs were reduced considerably when the distribution system to one settlement was changed to a gravity-fed system; such systems with long pipelines are likely to be more economical (and reliable) than short lines dependent on pumping.

When evaluated between 1970 and 1975 household water supplies provided in these 5 villages were shown to reduce transmission. They appear now to be effective in keeping it at a low level. While the provision of water supplies is unlikely to be a primary

method of schistosomiasis control, such supplies are being provided for other medical and social reasons in many developing countries and their role in the control of this disease should not be overlooked.

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RÉSUMÉ

UTILITÉ DE L'APPROVISIONNEMENT INDIVIDUEL DES MÉNAGES EN EAU DANS LA PHASE D'ENTRETIEN DU PROGRAMME DE LUTTE CONTRE LA SCHISTOSOMIASE À SAINTE-LUCIE APRÈS LE TRAITEMENT CHIMIOTHÉRAPIQUE

Après que la fourniture d'un approvisionnement individuel en eau à chaque ménage eut réduit dans 5 villages de Sainte-Lucie la transmission de *Schistosoma mansoni* de 31,0% à 12,6% (chez les enfants âgés de 0–10 ans), un traitement chimiothérapeutique a été offert à toutes les personnes trouvées infectées en 1975, 1976 et 1977. On a administré de l'oxamniquine à une dose de 15 mg/kg de poids corporel; en 1976, la dose pour les enfants a été augmentée à 20 mg/kg. Après le traitement chimiothérapeutique, l'incidence des cas nouveaux a été encore réduite et au cours des 4 années suivantes (1977–81) elle a varié entre 4% et 7% seulement par an. La chimiothérapie a réduit les taux de prévalence, qui étaient en 1975 de 26,9% et 51,3% pour les enfants et les adultes respectivement, aux taux de 12,1% et 15% en 1977. Au cours des 4 années suivantes, il s'est produit une nouvelle réduction à 5,8% et 11,7%. Comparée avec les données de 1975, la contamination potentielle vers 1981 était réduite de 78% (et de 92% par rapport au chiffre relevé avant le programme de lutte).

Etant donné le bas niveau d'assainissement dans les villages et le réservoir d'infection subsistant après le traitement chimiothérapeutique, une certaine transmission pouvait

encore être prévue.

Vers 1981 il y avait encore quelques cas nouveaux d'infection chaque année, principalement chez les enfants; toutefois, l'intensité de l'infection demeurait basse. Des cas sporadiques d'infection apparaîtront sans nul doute dans l'avenir, mais aussi longtemps que les approvisionnements individuels d'eau dans les ménages seront adéquatement entretenus, il semble improbable qu'une brèche importante se produise dans la lutte contre la schistosomiase.

Le coût de l'électricité utilisée pour le pompage de l'eau dans ces villages a plus que doublé pendant la période 1977–81, mais des économies substantielles ont été réalisées lorsque fut construit pour desservir un village un système de distribution fondé sur la gravité.

Etant donné l'augmentation continue des coûts de construction, il est improbable que les approvisionnements en eau soient installés essentiellement comme méthode de lutte contre la schistosomiase, mais dans cette décennie internationale de l'eau potable et de l'assainissement leur utilité potentielle ne doit pas être ignorée, d'autant plus qu'ils semblent se révéler efficaces au cours de la phase d'entretien après le traitement chimiothérapeutique.

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