FIELD ACTIVITY COST ESTIMATES FOR THE FIRST 3 YEARS OF THE WORLD BANK LOAN PROJECT FOR SCHISTOSOMIASIS CONTROL IN CHINA

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Abstract. The World Bank Loan Project for schistosomiasis in China commenced field activities in 1992. In this paper, we describe disease control strategies for levels of different endemicity, and estimate unit costs and total expenditure of screening, treatment (cattle and humans) and snail control for 8 provinces where *Schistosoma japonicum* infection is endemic. Overall, we estimate that more than 21 million US dollars were spent on field activities during the first three years of the project. Mollusciciding (43% of the total expenditure) and screening (28% of the total) are estimated to have the most expensive field activities. However, despite the expense of screening, a simple model predicts that selective chemotherapy could have been cheaper than mass chemotherapy in areas where infection prevalence was higher than 15%, which was the threshold for mass chemotherapy intervention. It is concluded that considerable cost savings could be made in the future by narrowing the scope of snail control activities, redefining the threshold infection prevalence for mass chemotherapy, defining smaller administrative units, and developing rapid assessment tools.

INTRODUCTION

The strategy of the World Bank Project on Schistosomiasis Control in China was to use mass chemotherapy in high endemic areas and selective chemotherapy in medium and low endemic areas, Snail-control by molluscicide was conducted in areas of high transmission (World Bank, 1989). The strategy was planned by experts from China and abroad in three discussion meetings, on the basis of epidemiological data from a national survey in 1989 (MOPH, 1990a).

During the first three years of the project, data from the evaluation and monitoring indicators on schistosomiasis control in China, as reported annually to the World Bank, indicated a significant reduction in morbidity. The rate of infection and intensity of infection dropped in the eight project provinces, especially in high endemic areas, but also in medium and low endemic areas. In consequence, the number of areas classified as highly-endemic was reduced (Yuan, 1992).

Cost analysis of schistosomiasis control programs is a valuable method of comparing the financial input of different control strategies (Bundy and Guyatt, 1992; Prescott, 1987). In the context of the control program in China, planning for the future requires an understanding of the way the total budget was distributed in the first three years, and how the costs of each strategy compare. In this paper we therefore estimate costs for different field activities of the project, excluding those supported by local government funds. We also compare the potential costs of different strategies in the same communities. The results will serve as a reference for developing sustainable methods of schistosomiasis control in China.

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METHODS

Study area

The World Bank Loan Project on schistosomiasis control covered eight provinces including the lake-river regions Hunan, Hubei, Jiangxi, Anhui, Jiangsu and Zhejiang, and the mountain regions Yunnan and Sichuan. Hunan, Hubei, Jiangxi and Anhui are the provinces most seriously affected by schistosomiasis. These provinces are located along the Yangtze River and have many lakes, including the Poyang and Dongting lakes, which are the largest lakes in China. Flooding cannot be controlled and snail-ridden areas are large. Snail control is difficult. The residents in these areas are at high risk of infection, since agricultural production, fishing and activities of daily living bring them into contact with contaminated water (Wu, 1992). In the two mountainous provinces, despite sparse populations, the level of endemicity is high. In Jiangsu and Zhejiang provinces the infection levels are lower than in the other provinces; however the population is dense and people travel frequently to other areas (Chen, 1989). If these provinces are neglected it would be possible for the disease to break out; therefore they were included in the project. There is a different economic situation in each of the eight provinces.

Strategies of disease control (MOPH, 1990b)

In China, natural villages in close proximity are grouped into units called administrative villages. The administration and operation of the World Bank Project were based on these units. Each administrative village was classified as one of three endemicity groups, defined according to the estimated prevalence of infection. In high endemic areas (prevalence of infection > 15%) mass chemotherapy was applied. In areas of medium endemicity (prevalence of infection form 3-15%) and low endemicity (prevalence of infection < 3%) selective chemotherapy was applied.

Each year, 30% and 5% of the total population in areas of medium and low endemicity respectively was surveyed. The sampled individuals were drawn from 7-14 year-old children and fishermen as these were groups at highest risk of infection. Individuals positive for *S.japonicum* infection were treated. All cattle in high endemic areas and some cattle in medium and low endemic areas were treated. Mollusciciding with niclosamide was used in some of the high transmission areas reduce the snail population.

Mass chemotherapy: In areas of high endemicity, mass chemotherapy was conducted by a mobile team consisting of doctors and specially trained health workers from the county schistosomiasis control station and the township schistosomiasis control group. Team members went to villages where they delivered medication house by house. The teams only left the households after the medication had been swallowed. A single oral dose of praziquantel was given (40 mg/kg for adults and 60 mg/kg for children).

Selective chemotherapy: Screening was conducted by a mobile team, consisting of technicians and specially trained health workers. Team members went to the village and took blood samples from the high risk groups described above. Blood samples were then tested for the presence of antibodies to *S. japonicum* antigens (using the COP test, the IHA test or the ELISA test). Depending on the local situation, blood samples were tested either in the control station or in the field. All individuals to be positive by antibody detection were treated with a single oral dose of praziquantel (40 mg/kg for adults and 60 mg/kg for children). A second mobile team (including a doctor) was usually responsible for the delivery of medication.

Treatment of cattle: In areas of high endemicity, all cattle were treated by a mobile team con sisting of a veterinarian, specially trained staff from the county veterinary station, and individuals from the township veterinary group. Cattle were treated house by house with praziquantel powder (30 mg/kg).

In areas of medium endemicity, treatment of cattle and individuals was conducted simultaneously. The cattle were selected by the local veterinarian, concentrating on those which had been brought from high endemic areas, and those which often grazed in high- transmission marshland. In low endemic areas the treatment of cattle concentrated on those which had been brought from high or medium endemic areas.

Snail control: The county schistosomiasis control station organized professional staff to survey snail-ridden areas which were near the villages and frequented by many of the residents. If infected snails were found, these areas were treated with niclosamide. The control station sent a technician to organize and guide the local residents in spraying niclosamide at 2 g/m^2.

Data sources

Data for specific provinces were supplied by provincial schistosomiasis control project offices. These collected data from the schistosomiasis control station in each county and made a report to central government twice a year. The data were related to costs incurred by the provinces, based on their own field activities. For this analysis the following information was supplied by each province: salaries and allowances of doctors, veterinarians and technicians; average distance of each village from the schistosomiasis control stations; average number of individuals treated in one week by one mobile team; average number of square metres treated with niclosamide in three days by one team; average number of cattle treated per week by one team; the unit cost of one antigen detection test. These figures were used to derive province-specific unit costs for each activity.

Further data supplied by the provincial offices were related to the overall control effort. These data consisted (for each province) of the total number of individuals and cattle treated, the number of square metres surveyed in snail control activities, and the number of square metres treated with molluscicide for 1992 and 1994. Province-specific figures for 1993 were unavailable. Estimates for each province in 1993 were made by averaging the proportionate contribution of each province in the other two years.

Analysis

Model parameters: For the purpose of this analysis, a standardized model was adopted to describe the mobile control teams involved in the different activies: Treatment of people: 3 doctors and 1 health worker; treatment of cattle: 2 veterinarians and 1 trained assistant; case-identification: 2 technicians and 1 health worker; snail control : 2 technicians and 10 local residents.

Unit costs: For each activity (treatment, screening and snail control), unit costs were calculated under the headings of personnel, vehicle, and consumables, following the convention of Guyatt *et al* (1994). Parameters were taken from data supplied by the provincial schistosome control offices. Denominators were related to the activity; thus unit costs for screening and treatment activities were calculated per person, or per head of cattle. For snail surveys and control, the denominator was the number of 10,000 m^2 surveyed or treated respectively. For the purposes of this analysis, all costs are reported in US dollars (1 US $ = 8.5 RMB Chinese Yuan).

Total expenditures: Total expenditures were calculated by multiplying the appropriate unit costs by the total number of treatments (human and cattle), or by the area treated with molluscicide. The total costs of each activity under the headings described above were calculated, in addition to the total costs of each activity in each province.

Comparative costs of different strategies: A comparison was made between potential cost of a selective chemotherapy strategy, in which all individuals are screened and only infected individuals are treated, and a mass chemotherapy strategy, in which all indivduals are treated. It was assumed that the time spent on the two strategies would be equal, and that compliance would be 100%. The specificity of the test was assumed to be 100%. The cost of each strategy was calculated for areas with infection prevalences between 0 and 100%. For this analysis, the size of the population was not required; thus the outcome is applicable to large or small populations. Several comparisons were made, using the unit costs as calculated above for each province. This approach enabled the expected costs of different strategies to be compared within each province, at different levels of infection.

RESULTS

We estimate that over 7.5 million people were treated in the first three years of the control project; 53% in high endemic areas and 47% in medium and low endemic areas. Mass chemotherapy in high endemic areas covered almost 11,400 villages and treated 4.3 million individuals at an estimated cost of US$ 1.7 million. Selective chemotherapy covered approximately 133 thousand villages where endemicity was medium or low. The screening of 15.9 million individuals in these villages cost approximately US$ 4.9 million, and the subsequent treatment of 3.4 million individuals cost an estimated US$ 1.5 million. The total cost of cattle treatment is estimated to be US$ 1.5 million. Molluscicide application over 850 million cost approximately US$ 10.5 million, and surveys for sites with infected snails are estimated to have cost an additional US$ 1.1 million. The total cost of the disease control activity is therefore estimated to have been more than US$ 21 million over the first three years.

Table 1 shows the estimated total expenditure for each activity, divided into costs for personnel, transport and consumables. The table also shows the proprotionate cost of each item as proportion of total operational expenditure. Screening accounted for the greatest proportion of personnel costs, which accounted for almost half the total expenditure. Of the consumable costs, mollusciciding accounted for the greatest amount, and is estimated to have been the single most expensive activity during the first three years of the project.

Table 2 shows the total amount spent on field activities in each province, over the first 3 years of

Table 1

The estimated cost (US$ 1994), and percentage contribution to the total expenditure, of different activities within the schistosomiasis control program, under the headings of personnel, vehicle and consumable costs.

	Personnel	(%)	Vehicle	(%)	Consumable	(%)	Total	(%)
Treatment of humans	2,694,347	10%	230,944	1%	1,770,571	7%	4,695,862	18%
Treatment of cattle	708,319	3%	66,823	0%	1,082,526	4%	1,857,668	7%
Screening	5,884,989	22%	477,161	2%	1,113,376	4%	7,475,526	28%
Survey	1,079,577	4%	0	0%	0	0%	1,079,577	4%
Mollusciciding	2,145,592	8%	264,583	1%	9,017,950	34%	11,428,125	45%
Total	12,512,824	47%	1,039,511	4%	12,984,423	49%	26,536,758	100%

Table 2

The total estimated cost (US$ 1994) of different activities in each province, during the period 1992-1994.

	Hunan	Hubei	Jiangxi	Anhui	Jiangsu	Zhejinag	Yunnan	Sichuan	Total
Treatment of humans	1,103,471	851,996	357,522	215,130	39,430	33,916	153,437	489,577	3,244,479
Treatment of cattle	717,906	317,469	154,378	78,954	4,574	12,313	81,954	122,873	1,490,421
Screening	996,261	961,896	496,201	242,293	1,085,024	466,559	136,120	509,040	4,893,394
Survey	340,020	346,944	143,628	58,224	124,031	57,256	18,066	12,880	1,101,049
Mollusciciding	4,807,005	2,986,159	965,750	640,842	851,740	3,770	104,904	106,304	10,466,474
Total	7,964,663	5,464,464	2,117,479	1,235,443	2,104,799	573,814	494,481	1,240,674	21,195,817

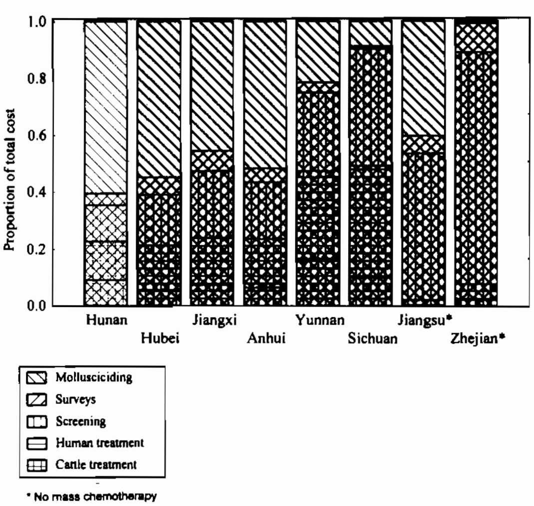

Fig 1–The percentage contribution of the cost of each component activity to the overall field activity expenditure within each province, during the three years period 1992-1994. All figures in US$.

the project. There was wide heterogeneity in the total expenditure by province, ranging from US$ 0.6 million (Zhejiang), to US$ 7.9 million (Hunan). In Hunan, Hubei, Jiangxi, and Anhui, mollusciciding was the most expensive activity. In Jiangsu, Zhejinag and Sichuan, the most expensive activity was screening. In Yunnan, treatment of humans and costs of screening were approximately equal. Fig1 shows the distribution of total expenditure by province. The differences reflect the different levels of endemicity in the various provinces, leading to different control strategies, and also differences in unit costs.

Comparison of unit costs by province

Table 3 lists the unit cost of each field activity by province. Unit costs are presented for consumables, personnel and vehicles. As a result of differences between provinces in terms of geography, population density, distances from control stations to vil-

Table 3

Unit costs of each field activity (US$ 1994) by province. Average costs are given in the final columm.

	Hunan	Hubei	Jiangxi	Anhui	Jiangsu	Zhejinag	Yunnan	Sichuan	Average
Treatment of humans									
Personnel	0.17	0.09	0.21	0.18	0.7	0.93	0.26	0.29	0.35
Vehicle	0.02	0.01	0.02	0.02	0.04	0.06	0.02	0.02	0.03
Medication	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Total	0.42	0.33	0.46	0.43	0.97	1.22	0.51	0.54	0.61
Treatment of cattle									
Personnel	0.6	0.31	0.2	0.88	1.84	2.06	0.71	0.99	0.95
Vehicle	0.09	0.06	0.03	0.11	0.13	0.18	0.08	0.11	0.1
Medication	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
Total	2.31	1.99	1.85	2.61	3.59	3.86	2.41	2.72	2.67
Screening									
Personnel	0.25	0.14	0.28	0.14	0.44	0.38	0.23	0.15	0.25
Vehicle	0.04	0.03	0.04	0.02	0.04	0.04	0.03	0.02	0.03
Reagents	0.06	0.02	0.05	0.05	0.08	0.05	0.08	0.05	0.06
Total	0.35	0.19	0.37	0.21	0.56	0.47	0.34	0.22	0.34
Molluciciding									
Personnel	10.9	12.7	16.3	18.3	39.8	31.2	40.3	32.6	25.26
Vehicle	1.92	1.97	2.34	2.25	1.88	3.46	4.8	6	3.08
Niclosamide	106	106	106	106	106	106	106	106	106
Total	118.82	120.67	124.64	126.55	147.68	140.66	151.1	144.6	134.34
Snail survery	4.71	4.92	3.76	3.52	3.45	3.52	4.9	5	4.22

lages, and accessibility of villages and snail habitats, the average number of treatments and amount of snail control activity per unit time also varied. Variation in data supplied by the provincial offices also reflected the use of different strategies in different provinces, depending on the level of endemicity.

Consumables: For consumables, the unit costs for medication and niclosamide were the same throughout, as they were purchased in bulk by the Ministry of Public Health. A tablet of praziquantel cost US$ 0.23 per person, and praziquantel powder cost US$ 1.62 per head of cattle. Niclosamide cost US$ 106 per 10 thousand square metres. The costs of the consumables used in screening tests varied as they came from different suppliers.

Personnel: The unit costs for personnel varied considerably from province to province for the same activity. This was partly because salaries and local conditions varied, and partly because of geographical differences. Travelling time, for example, was much longer in the more mountainous provinces.

The highest unit costs for personnel were in Zhejiang (US$ 0.93) and Jiangsu (US$ 0.7). The large discrepancy with respect to other provinces was due to higher salaries and allowances. Unit costs were also relatively high in Yunnan and Sichuan Provinces. In these provinces salaries and allowances are not very different from those in the remaining provinces, but the villages are a long way away from the schistosomiasis control station. The average distance is 80 km, which is 30 km further than in the other provinces.

Screening: Costs varied due to differences in personnel costs, mainly because each province had its own method for screening. Costs also depended on the price of the reagents and the time required, which were not necessarily the same in each province, since there was no central supplier. Hunan, Hubei, Jiangxi, Anhui, and Yunnan Provinces used an Indirect hemagglutination test, Jiangsu Province used the circumovum precipitate test, and both Zhejiang and Sichuan Provinces used ELISA based technics.

Treatment of cattle: The cost of this activity in the whole project accounted for only 7% of the total expenditure. However, the unit cost for the treatment of cattle was four times higher than that for humans. The main reasons are that praziquantel powder is more expensive than tablets, and the treatment of cattle is more time-consuming than the treatment of humans. Also, farmers often need considerable persuation before they allow a procedure that they perceived as potentially debilitating for the animals, and this results in a low number of treatments per unit time.

Snail control: As with the treatment of humans, the unit costs varied although the cost of consumables was fixed. Unit costs in Jiangsu and Zhejiang Provinces were high, as salaries and allowances are higher than in other provinces. However, in Yunnan and Sichuan Provinces the manpower expenditure was about double that in the remaining four provinces. Yunnan and Sichuan Provinces are in mountainous regions, where the geography and the environment are complicating factors. The areas surveyed were not large, but more of them were snail-ridden. As a result of these factors, snail control was not easy to carry out, and required more time and manpower than in other provinces.

Comparison of different strategies

Having calculated the unit costs of treatment and screening, it was possible to calculate the expected costs of two different strategies in each province. The cost per person for the mass chemotherapy option was assumed to remain constant in one province, and vary between provinces according to heterogeneities in personnel costs. The cost of the selective chemotherapy option included the costs of screening, which varied considerably between provinces, due to the different methods of screening, and different levels of endemicity within each province.

Fig 2 shows the ratio of the expected costs of mass chemotherapy and selective chemotherapy strategies in each province. Where the ratio is equal to one, the costs of two different strategies are equal, and when it falls below one, selective chemotherapy is estimated to be cheaper. As the unit costs vary between provinces, there is a marked difference between provinces in the prevalence of infection where the two strategies are equally expensive. The figure show that when the prevalence is below 20%, it would be cheaper to use selective chemotherapy in all the provinces, except in Jiangxi and Hunan, where the costs of two strategies would be approximately equal. However, the model predicts that in some provinces selective chemotherapy would still be cheaper at considerably higher prevalence levels. At 50% infection prevalence, selective chemotherapy would still be cheaper than mass chemotherapy in Anhui, Zhejiang and Sichuan Provinces.

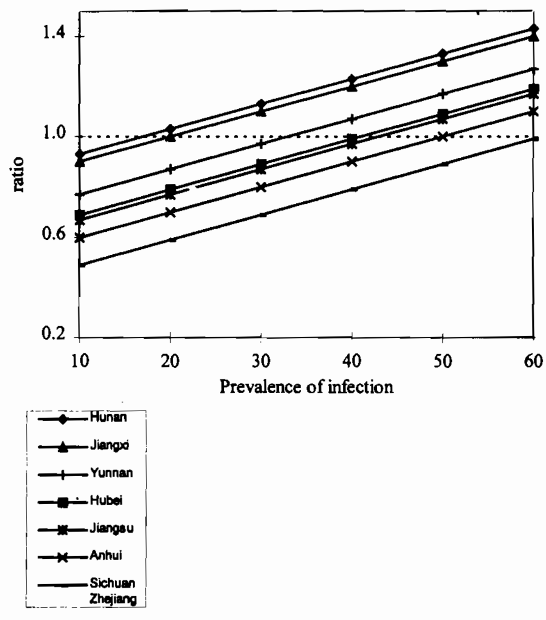

Fig 2–The expected cost of a mass chemotherapy strategy compared with the cost of a selective chemotherapy strategy, for different infection prevalences in each province. Each line represents the cost ratio of the two strategies (selective/mass). The dotted line represents cost equality; ratios obove this line indicate that mass chemotherapy would be the cheapest option. Ratios for Sichuan and Zheijang provinces are represented by one line, as the estimates for these provinces were equal to one decimal place.

DISCUSSION

In the analysis presented here, we used data provided by provincial field stations to estimate unit costs for the main components of field activities. From the available data, we also estimated that more than US$ 21 million was spent in the first three years of the project. This is unlikely to be a precise estimate, since we adopted a standard model to claculate unit costs. In particular, data supplied by provincial offices related to experiences using their own control teams, with potentially different personnel than used in the model. In addition, assumptions regarding the time spent on each activity in different areas may alter the relative cost of each activity in different provinces. Nonetheless, we can draw inferences from the results which may be useful in the long term control of schistosomiasis in China, particularly in the development of cost effective strategies.

In the first phase of the project, mass chemotherapy was used in all areas of high-endemicity, defined as those with a rate of infection over 15% (on the basis of older medical records). Mass chemotherapy has played an important role in large-scale schistosomiasis control programs, but it inevitably involves wastage if a large number of uninfected people are treated. The preliminary results presented here indicate that selective chemotherapy is cheaper than mass chemotherapy in areas with a prevalence of *S. japonicum* infection higher than 15% - in almost all provinces the cost of a strategy based on selective chemotherapy is estimated to be lower at 20% infection prevalence, and in some provinces selective chemotherapy may be cheaper at 50% infection prevalence. Results from surveys suggest that the distribution of *S. japonicum* infection is highly focal, and only in rare patches does it reach 40% or higher (Yuan, 1992).

The analysis did not account for variations in the specificity of the tests or compliance rates. Low values for either of these parameters would reduce the number of infected individuals treated if selective chemotherapy were to be used. The costs of the two strategies would not be affected, but a mass chemotherapy strategy would be more effective in this situation heterogeneities in the costs of different items, which may alter the attractiveness of a strategy in a particular location, were also not considered. Whereas a reduction in screening costs would reduce the cost of a selective chemotherapy strategy, a reduction in the price of medication would have the greatest effect on the cost of a mass chemotherapy strategy.

During the control project, classification into endemic levels was based on the unit of the administrative village. An administrative village covers a large area and consists of many settlements (in some cases more than 20 villages), which may differ from each other in geographical features, occupations, professions and behavioral habits of the inhabitants. All these factors can influence the prevalence of infection. Therefore it may be more effective to consider the endemicity level of individual settlements rather than administrative villages when deciding whether to use selective or mass chemotherapy. This would involve more screening; however, the results of the present analysis suggest that the extra cost may be outweighed by the saving on medication if only infected individuals are treated. This approach may be more readily accepted by the community if fewer uninfected residents are treated.

Calculations presented here demonstrate that snail-control was a particularly expensive activity. The approach used in China, namely the identification of areas with infected snails before application of niclosamide, ensured that mollusciciding was focal. This approach has been demonstrated to be more cost effective than area-wide snail control (Klump and Choo, 1987). Nonetheless, snail control still accounted for the largest percentage of the budget in medium and high endemic areas.The biggest item in the cost of snail control was the niclosamide treatment of one million m^2 of snail habitat was equal to the cost of medication for 23,000 patients. Further, the specific benefits of mollusciciding could not be estimated, and therefore it is not clear to what extent snail control contributed to the reduction in infection prevalence. This clearly indicates the need for well defined outcomes to be introduced into future study design.

The results of the present analysis suggest three possibilities for reducing expenditure in the future. First, classification of endemicity by natural village rather than administrative village could lead to more precise targeting of intervention, thus reducing drug costs. Related to this is the possibility of using selective mass chemotherapy (Prescott, 1987) in groups at highest risk of infection. Second, in areas of low and medium endemicity, more economical methods for screening before treatment could be developed. Although low-cost, rapid-assessment, technics have so far only been developed and validated for *S. haematobium* (Lengeler *et al,* 1991; Red Urine Study Group, 1995) and *S. mansoni* (Odermatt, 1994, Utzinger *et al*, submitted), a questionnaire based approach also be feasible for *S. japonicum* infections (Booth *et al,* 1996). Third, the scope of snail control could be narrowed down as much as possible; concentrating on areas where there is greatest contact between infected snails and humans.

After the first three years of the schistosomiasis control project in China, many areas were classified as low- or medium-endemic. One challenge for the future will be to maintain a low prevalence of infection. The results of this analysis are presented in such a way that they can easily be incorporated into frameworks used by program managers who wish to evaluate various control options at different levels of endemicity. However, it should be noted that the unit costs are applicable only to a vertical program, which may be unsustainable when there are severe budget limitations (Evans, 1992). The future of the schistosomiasis control program in China may therefore have to be considered in the context of inclusion into other health care strategies. In addition, it will be important the contribution of individual activities to reduction in infection and morbidity, in order to develop the most cost-effective strategies. This may require alternative diagnostic procedures, involving collection of parasitological and morbidity data in parallel with control activities.

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REFERENCES

Booth M, Li Y, Tanner M. Helminth infections, morbidity indicators, and schistosomiasis treatment history in three villages, Dongting Lake region, PR China. *Trop Med Int Health* 1996; 1: 464-74.

Bundy DAP, Guyatt HL. Cost analysis of schistosomiasis. *Trans R Soc Trop Med Hyg* 1992; 86: 646-8.

Chen MG. Progress and problems in schistosomiasis control in China. *Trop Med Parasitol* 1989; 40: 174-6.

Evans D. Economics and tropical diseases: a research agenda using schistosomiasis as an example. *Southeast Asian J Trop Med Public Health* 1992; 23: 641-6.

Guyatt HL, Evans D, Lengeler C, Tanner M. Controlling schistosomiasis: the cost-effectiveness of alternative delivery strategies. *Health Pol Plan* 1994; 9: 385-95.

Klumpp RK, Chu KY. Focal mollusciciding: an effective way to augment chemotherapy of schistosomiasis. *Parasitol Today* 1987; 3: 74-6.

Lengeler C, De Savigny D, Mshinda H, *et al.* Community-based questionnaires and health statistics as tools for the cost-effective identification of communities at risk of urinary schistosomiasis. *Int J Epidemiol* 1991; 20: 796-807.

MOPH. Report of nation-wide sampling survey on schistosomiasis Sichuan Province, People's Publishing House, China, 1990a (Chinese).

MOPH. The handbook of schistosomiasis control. Shanghai Scientific Technical Publishing House, China 1990b (Chinese).

Odermatt P. Comparative investigations on the population dynamics of *Bulinus globosus* and *Biomphalaria pfeifferi* with special regard to the assessment of high risk areas for the transmission of intestinal schistosomiasis. University of Basel 1994. PhD Thesis

Red Urine Study Group. Identification of high risk communities for schistosomiasis in Africa: A multicountry study. *WHO TDR/SER Rep Ser* 1995; 15.

Prescott NM. The economics of schistosomiasis chemotherapy. *Parasitol Today* 1987; 3: 21-4.

World Bank. The general strategy of schistosomiasis control in China. Unpublished report, 1989.

Wu ZW. Role of human and domestic animal reservoirs of schistosomiasis japonica in Dongting and Boyang Lake regions. *Chung-Kuo-Chi-Sheng-Chung-Hsueh-Yu-Chi-Sheng-Chung-Ping-Tsa-Chih.* 1992; 10: 194-7.

Yuan HC. Epidemiological features and control of schistosomiasis japonica in China. *Mem Inst Oswaldo Cruz* 1992; 87 (suppl 4): 241.