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Schistosomiasis control in Ghana: case management and means for diagnosis and treatment within the health system

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Abstract

An essential component of integrated schistosomiasis control as promoted by WHO is adequate clinical care for patients presenting at health care facilities. We evaluated the functioning of the Ghanaian health system for diagnosis and treatment of schistosomiasis by interviewing health workers from 70 health care facilities in 4 geographical areas in April and May 2000. Results from presentation of 4 hypothetical cases and a subsequent interview demonstrated that patients presenting with symptoms related to schistosomiasis have a small chance of receiving adequate treatment: often health workers do not recognize the symptoms, especially those of *Schistosoma mansoni*; patients are frequently referred for a diagnostic test or treatment with a large risk of non-compliance; and praziquantel was not available in 78% of the health care facilities with reported schistosomiasis in their coverage area. The overall cost of treatment is considerable: €2.13 for *S. haematobium* and €1.81 for *S. mansoni* patients, with drug costs contributing approximately 40% of the total cost. To better meet WHO recommendations for passive case detection as part of integrated schistosomiasis control, the Ghanaian health system needs to emphasize training of health workers in schistosomiasis case recognition and case management and increase the availability of praziquantel. Experience from other West African countries indicate that this is feasible.

Keywords: schistosomiasis, *Schistosoma mansoni*, *Schistosoma haematobium*, control, primary health care, integration, cost analysis, Ghana

Introduction

In Ghana, foci endemic for *Schistosoma haematobium* and/or *S. mansoni* infection have been known for several decades (Edington, 1957; McCullough, 1957; Onori *et al.*, 1963; McCullough & Ali, 1965). Since the completion of the Akosombo dam across the Volta River in 1964, urinary schistosomiasis prevalence in Ghana has increased steadily along the shores of the man-made Volta lake and the Volta River (Scott *et al.*, 1982; Wen & Chu, 1984; Klumpp & Webbe, 1987). Also, in other parts of the country, construction of dams and irrigation facilities have promoted the spread of schistosomiasis (*S. haematobium* and *S. mansoni*) (Zijlmans *et al.*, 1989; Amankwa *et al.*, 1994). The Volta River Authority started a schistosomiasis control programme that initially used molluscicide to kill the intermediate snail hosts and control the infection. After the drug praziquantel became available, the team started to visit affected villages to deliver mass treatment. In other parts of the country no official control programmes exist, so control of schistosomiasis is confined to treatment of clinical cases by local health workers.

Since 1991, the main principle of schistosomiasis control recommended by the WHO is morbidity control through measures implemented in the primary health system (WHO, 1993). It was recognized that the first essential component of integrated control should be adequate clinical care for patients presenting at the health care facilities (passive case detection) (Engels *et al.*, 2002). This requires the health workers to have adequate knowledge about the symptoms of the infection, availability of diagnostic and therapeutic means, and adequate prescription of treatment (praziquantel).

By interviewing medical staff of 70 health care facilities in Ghana, we determined the clinical care that patients can expect when they present with schistosomiasis symptoms. In particular, we compared the functioning of the Ghanaian health system for the control of schistosomiasis with the 3 main recommendations of WHO for passive case detection (WHO, 1993): (i) if a laboratory is available, sensitive diagnostic tests (e.g. urine filtration or centrifugation for *S. haematobium* and Kato–Katz for *S. mansoni*) should be used for diagnosis; (ii) if diagnostic facilities are not available in the health care facility, case detection should be performed on presenting symptoms (symptom-based treatment); and (iii) symptomatic cases should be treated with praziquantel at all levels of the health system.

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Methods

Ghanaian health system

The health services in Ghana are organized according to the primary health care principle (WHO, 1978). The first level of contact with patients is the health centres. These are staffed with medical assistants or nurses helped by other personnel such as ward assistants. Their main task is providing basic primary care to the population in their area. This includes patients presenting with symptoms of early schistosomiasis infection, such as haematuria and blood in stool. Cases that can not be handled at health centre level are referred to the district hospital, which is under the direction of a medical doctor. These hospitals are equipped to give all curative and preventive services at primary care level. Complicated cases (including patients with long-term consequences of schistosomiasis, such as kidney failure and haematemesis) are referred to the regional hospitals. Most districts also have private clinics, mission clinics and/or mission hospitals. Normally, laboratory diagnosis can be performed at district, regional and mission hospitals. Mission clinics and hospitals are part of the Christian Health Association of Ghana (CHAG). Patients can buy drugs from the health system but also from private pharmacies and from drug peddlers (persons who travel from place to place to sell drugs).

The Ghanaian Ministry of Health introduced the 'Cash and Carry' system in 1992 (based on the Bamako initiative) (Biritwum, 1994). This requires that patients pay for registration, diagnostic tests and drugs. To improve financial access, paupers are exempted from payment, but in reality this involves only a small part of the population. Other exemptions are patients with tuberculosis and leprosy, psychiatric patients, pregnant women and children aged < 4 years (Nyonator & Kutzin, 1999).

Study area and health care facilities

The study was performed in April and May 2000, in Ghana. Four geographical areas were selected and in each area 2 or 3 representative districts were chosen. The surveyed districts were Kassena-Nankana, Builsa and West Mamprusi (Upper East and Northern region, North Ghana), North Tongu and South Tongu (Volta region, East Ghana), Bosomtwi Kwanwoma and Atwima (Ashanti region, Centre Ghana) and Kraboa Coaltar (Eastern region, South Ghana) (Fig. 1).

In each district, the district hospital, one mission hospital (if present) and a random sample of health centres and mission clinics were selected. If private clinics were present in a district, one was selected. In total, we selected 10 health care facilities per district, or all health care facilities if there were 11 or less present.

Interviews and data collection

For the interview we used an adapted version of a successfully applied questionnaire (translated into English) developed for a comparable study in Senegal (Van der Werf *et al.*, 2002). Each selected health care facility was visited and the person in charge interviewed. If this person was not present, the second-in-command was interviewed. We did not reveal the specific aim of our study: evaluation of schistosomiasis control as performed by the health system. After introduction, we presented 4 hypothetical cases with symptoms related to *S. haematobium* and *S. mansoni* infection in random order: (A) 10-year-old girl with blood in urine; (B) 40-year-old man with blood in urine and painful urination; (C) 10-year-old boy with abdominal discomfort and bloody diarrhoea; and (D) 30-year-old woman with diarrhoea and abdominal discomfort. The respondents were requested to imagine that these cases visited their health care facility and to explain their usual case management policy for such patients. Thereafter, we revealed the focus of our study and continued by asking the respondents to list symptoms caused by *S. haematobium* or *S. mansoni* infection. Then we asked if these infections were present in their coverage area. Respondents working in areas with reported schistosomiasis endemicity were asked further questions about their practices for patients presenting with symptoms caused by haematuria (*S. haematobium* infection) and blood in stool/bloody diarrhoea (*S. mansoni* infection).

We concluded the interview by collecting information about the size of the population covered and number of curative consultations and schistosomiasis patients in 1999. We recorded the availability of diagnostic materials and the number of praziquantel tablets in stock at the time of the interview. Finally, the price of registration, diagnostic test, praziquantel and public transport to the nearest referral centre was recorded. For all questions we tried to obtain the exact value, otherwise an estimated value was asked for. Sometimes, information was provided by mail or telephone up to a few days after the interview.

If the respondent did not know about schistosomiasis or if it was unknown whether schistosomiasis was present in the coverage area, the data were analysed as not having schistosomiasis in the coverage area. The replies given by different professional groups or primary health care levels were statistically compared using the χ^2/Fisher's exact test and SPSS (SPSS Inc., Chicago, IL, USA). A P value < 0.05 was considered significant.

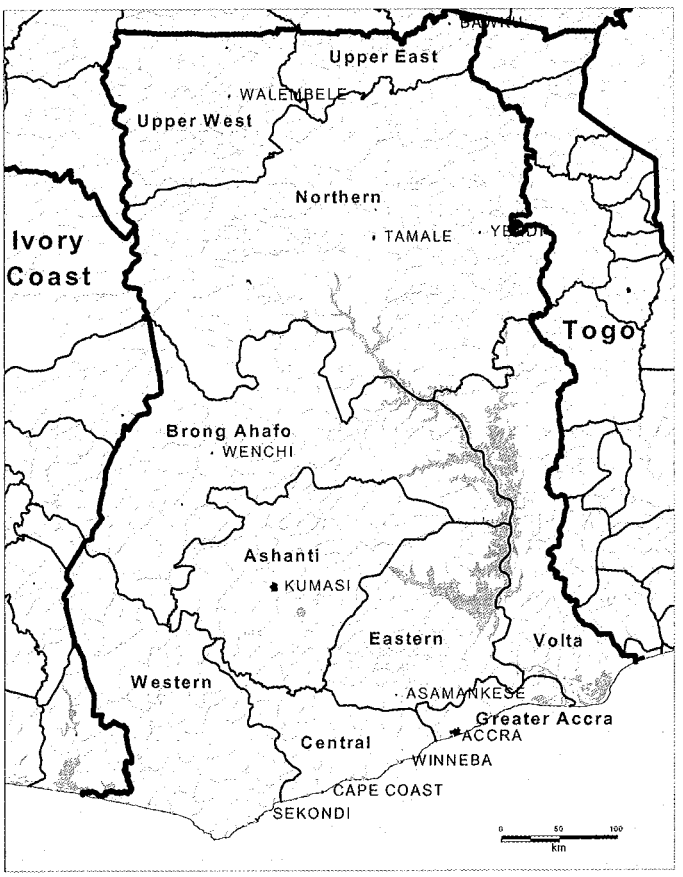

Fig. 1. Map of study area in Ghana, 2000.

Cost analysis

Calculation of the average cost of treatment is described by Van der Werf *et al.* (2002). Briefly, the costs of treatment for schistosomiasis were calculated by adding the price of registration, diagnostic test and treatment with 4 praziquantel tablets (dose for an adult). If the health worker reported that they would refer patients for a diagnostic test and/or for buying praziquantel, we used the price of a diagnostic test and/or praziquantel in the referral centre. If health workers reported that they would refer patients to a health care facility outside the study sample or private clinic/pharmacy, we used the mean costs of a diagnostic test or praziquantel in hospitals. If a diagnostic test was not requested costs were nil. Also, if patients were not referred for a diagnostic test or treatment, transportation costs were nil. All costs are presented in Euros. In May/June 1999, €1 was approximately 4000 cedis (local currency).

Results

A total of 70 health care facilities was surveyed (Table 1). Forty-nine respondents (70%) reported presence of *S. haematobium* in their coverage area, 12 (17%) also reported *S. mansoni* infection. In our study there were no areas with only *S. mansoni* reported. Twenty-one percent of the health workers could not recall the existence of *S. mansoni*. Two others (2.9%) did not know whether *S. mansoni* infection existed in their coverage area, whilst one respondent (1.4%) did not know about the presence of *S. haematobium* infection in the coverage area of the health care facility.

Most hospitals employed at least one medical doctor and/or medical assistant (Table 2). Health centres and mission clinics were staffed mainly by nurses. The beds in health centres and private clinics were used only for short-term observation. Laboratories were in possession of all necessary equipment for performing urine centrifugation (microscope, tubes, glass-slides and centrifuge) and direct smear tests (microscope and glass-slides). The Kato–Katz test was not used for the diagnosis of *S. mansoni* in the visited health care facilities and the necessary materials were not available. Only 11 health care facilities of 49 with reported schistosomiasis in the coverage area had praziquantel available at the time of the interview. The remainder referred to another health care facility or private pharmacy. However, of 5 private pharmacies in schistosomiasis-endemic areas visited during the survey, none had praziquantel available (data not shown).

Urinary schistosomiasis was mentioned as an initial diagnosis for hypothetical cases A and B by the majority of the respondents in areas reported to be endemic for *S. haematobium* (Table 3). In contrast, cases C and D were hardly ever given the initial diagnosis of (intestinal) schistosomiasis. If the 4 cases were really schistosomiasis patients, we can conclude that the ultimate probability of prescription of praziquantel without referral was only 43%, 37%, 58% and 67%, respectively. For cases C and D, praziquantel was only prescribed after a positive diagnostic test, for A and B, one-third would receive praziquantel treatment directly.

Ninety-six percent of the health care workers reported haematuria, the main presenting symptom of *S. haematobium* infection, when asked to mention symptoms related to *S. haematobium* infection (Fig. 2A). Symptoms less commonly or not associated to infection with *S. haematobium* were also mentioned (e.g. fever and loss of appetite). There was no significant difference in (the quality of) the answers given by doctors

Table 1. Characteristics of the 70 health care facilities surveyed in Ghana, April–May 2000

Health care facility	*N*	Population coverage (0000) median (range)[a]	No. of consultations in 1999 (0000) median (range)[b]	Presence of schistosomiasis reported in coverage area: *Schistosoma haematobium* *n* (%)	Presence of schistosomiasis reported in coverage area: *Schistosoma mansoni* *n* (%)
District hospital	9	110 (54–234)	16.4 (1.8–35)	8 (89)	3 (33)
Mission hospital	3	163 (128–200)	49.0 (18–63)	3 (100)	3 (100)
Health centre	45	15 (0.8–69)	2.2 (0.2–28)	26 (58)	4 (9)
Mission clinic	8	13 (7.9–26)	1.4 (0.6–32)	7 (88)	1 (13)
Private clinic	5	43 (8.0–156)	3.6 (1.0–25)	5 (100)	1 (20)
Total	70			49 (70)	12 (17)

[a]Population coverage for one mission hospital and one health centre were not available and 2 private clinics did not indicate a specified population.
[b]Four health centres and one mission clinic did not practice throughout 1999 and were therefore not included.

Table 2. Availability of personnel and equipment in 49 Ghanaian health care facilities with reported schistosomiasis in their coverage area, April–May 2000

Personnel/equipment	Hospital ($n = 11$)	Health centre and mission clinic ($n = 33$)	Private clinic ($n = 5$)
Doctors[a]	1 (0–6)	0 (0–1)	0 (0–1)
Medical assistants[a]	1 (0–2)	0 (0–2)	0 (0–2)
Nurses[a]	16 (8–67)	4 (1–11)	1 (1–3)
Beds[a]	54 (8–220)	4 (0–21)	2 (0–10)
Laboratory	10 (91%)	1 (3%)[b]	2 (40%)
Praziquantel	6 (55%)	4 (12%)	1 (20%)

[a]Median (range).
[b]Two health centres did have a laboratory, but the laboratory was not functioning because of the absence of the laboratory technician.

Table 3. Diagnosis and treatment strategy for four hypothetical cases in Ghanaian health care facilities with reported *Schistosoma haematobium* or *S. mansoni* in their coverage area, April–May 2000

	Schistosoma haematobium ($n = 49$)		*Schistosoma mansoni* ($n = 12$)	
	Case A[a] *n* (%)	Case B[a] *n* (%)	Case C[a] *n* (%)	Case D[a] *n* (%)
Initial diagnosis schistosomiasis	45 (92)	31 (63)	2 (17)	0 (0)
Action				
Direct prescription of praziquantel	8 (16)	5 (10)	0 (0)	0 (0)
Prescription of praziquantel if schistosome eggs found in diagnostic test[b]	13 (27)	13 (27)	7 (58)	8 (67)
Prescription of other drug[c]	8 (16)	14 (28)	5 (42)	4 (33)
Referred for diagnosis and/or treatment	20 (41)	17 (35)	0 (0)	0 (0)

[a]Hypothetical cases were: 10-year-old girl with blood in urine (case A); 40-year-old man with blood in urine and painful urination (case B); 10-year-old boy with abdominal discomfort and bloody diarrhoea (case C); and 30-year-old woman with diarrhoea and abdominal discomfort (case D).
[b]Diagnostic test used for *Schistosoma haematobium* was urine centrifugation test and for *S. mansoni* was direct faecal smear test.
[c]Mainly antibiotics, metrifonate, metronidazole and oral rehydration salts.

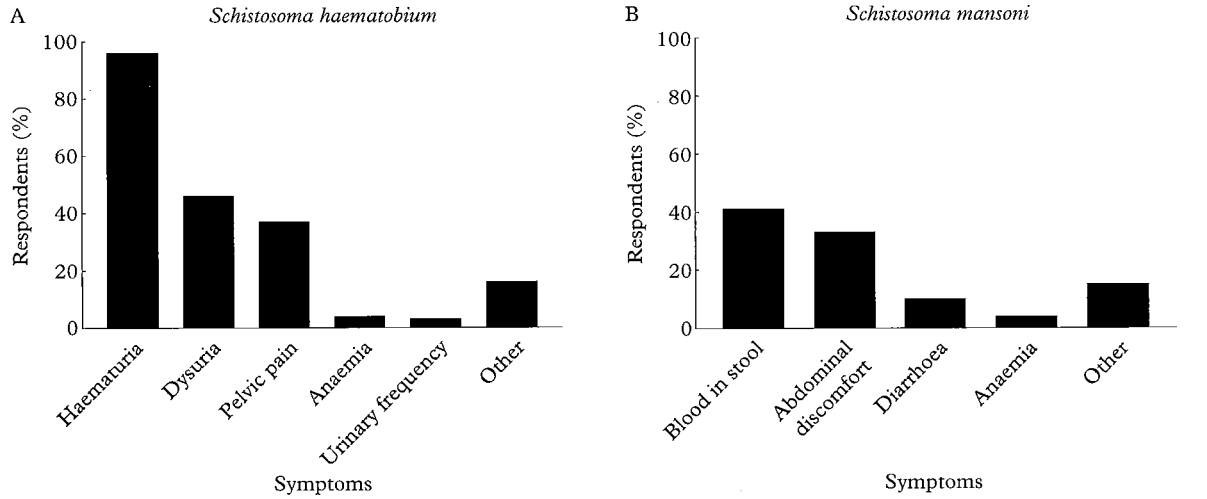

Fig. 2. Symptoms mentioned by 70 respondents at Ghanaian health care facilities to be related to (A) *Schistosoma haematobium* and (B) *S. mansoni* infection, April–May 2000. Respondents were requested to mention as many symptoms related to schistosomiasis as possible. Fifteen health workers did not know about *S. mansoni* infection and 18 could not mention a symptom caused by *S. mansoni* infection. 'Other' refers to symptoms less commonly associated with schistosomiasis. In order of importance, these were fever, problems with urinating, sexual weakness, female infertility, loss of weight and loss of appetite for *S. haematobium*, and mucous in stool, fever, nausea, vomiting, colic, losing weight, itching, itching in anal region, constipation, haematuria, dark stool, waist pain, bloated abdomen, looking weak and loss of appetite for *S. mansoni*.

and other health workers. There was also no difference in answers given by health workers from areas with reported *S. haematobium* and areas without reported *S. haematobium*. Eighty percent of the respondents working in endemic areas requested a diagnostic test to confirm the symptomatic diagnosis for patients suspected of *S. haematobium* infection that presented with haematuria (Table 4). Fourteen (29%) health workers prescribed the treatment recommended by WHO (praziquantel 40 mg/kg bodyweight), 12 (24%) prescribed other dosages of praziquantel (one health worker prescribed 30 mg/kg bodyweight, 3 prescribed 60 mg/kg bodyweight and 8 did not prescribe per kg bodyweight), 2 (4%) prescribed metrifonate and 4 (8%) prescribed other drugs for treatment of *S. haematobium* (antibiotics or metronidazole). Of the 9 (18%) health workers who performed symptom-based treatment, 6 (67%) prescribed praziquantel and 4 (67%) of them had it in stock at the time of interview.

The main presenting symptom of early *S. mansoni* infection, bloody diarrhoea or blood in stool, was mentioned by 41% of the respondents (Fig. 2B). Symptoms occurring in the advanced stage of the infection such as ascites and haematemesis were not mentioned at all. Often, symptoms less commonly associated with *S. mansoni* infection were mentioned (i.e. itching, fever and nausea). The symptoms of blood in stool and abdominal discomfort were more frequently mentioned by doctors compared to other health workers ($P = 0.013$ and $P = 0.001$, respectively). All doctors could mention at least one symptom related to *S. mansoni* infection, whereas, of the other health care workers, 25% did not know about *S. mansoni* and 30% could not mention a symptom. Health workers that reported *S. mansoni* infection in their coverage area more often reported the symptoms blood in stool, abdominal discomfort and diarrhoea ($P = 0.002$, $P = 0.050$ and $P = 0.014$, respectively) compared to health workers that reported no *S. mansoni* in their coverage area. For patients suspected of *S. mansoni* infection and reporting

Table 4. Management of patients suspected of schistosomiasis and reporting with haematuria or blood in stool/bloody diarrhoea to Ghanaian health care facilities in areas where, respectively, *Schistosoma haematobium* or *S. mansoni* was reported to be present, April–May 2000

Case management and treatment	Hospital *n* (%)	Health centre and mission clinic *n* (%)	Private clinic *n* (%)
Haematuria (*Schistosoma haematobium*) ($n = 49$)			
Symptom not mentioned	0 (0)	1 (3)	0 (0)
Symptom-based treatment			
Praziquantel	0 (0)	6 (18)	0 (0)
Other drug[a]	0 (0)	2 (6)	1 (20)
Diagnosis by urine centrifugation, if positive[b]			
Praziquantel	10 (91)	1 (3)	1 (20)
Other drug[c]	0 (0)	0 (0)	2 (40)
Referral for diagnostic test, if positive[b] praziquantel	0 (0)	7 (21)	1 (20)
Referral for diagnostic test and treatment	1 (9)	16 (48)	0 (0)
Total	11 (100)	33 (100)	5 (100)
Blood in stool and bloody diarrhoea (*Schistosoma mansoni*) ($n = 12$)			
Symptom not mentioned	2 (33)	0 (0)	0 (0)
Symptom-based treatment with praziquantel	0 (0)	1 (20)	1 (100)
Diagnosis by direct smear, if positive[b] praziquantel	4 (67)	1 (20)	0 (0)
Referral for diagnostic test, if positive[b] praziquantel	0 (0)	2 (40)	0 (0)
Referral for diagnostic test and treatment	0 (0)	1 (20)	0 (0)
Total	6 (100)	5 (100)	1 (100)

[a]Antibiotics, metronidazole and metrifonate.
[b]Positive for diagnosis means *Schistosoma haematobium* eggs detected in urine sample or *S. mansoni* eggs detected in stool sample.
[c]Metrifonate and antibiotics.

with blood in stool/bloody diarrhoea, 67% of the respondents from areas with reported *S. mansoni* infection would request a diagnostic test to confirm the symptomatic diagnosis (Table 4). Seven (58%) health care facilities with reported *S. mansoni* in the area prescribed the recommended treatment. One (8%) health worker prescribed praziquantel at 30 mg/kg bodyweight, and 3 (25%) prescribed 60 mg/kg bodyweight and one (8%) referred to another health care facility for treatment. Symptom-based treatment for patients presenting with the main symptom of *S. mansoni* infection was performed in 2 (18%) health care facilities. One of the 2, a private clinic, had praziquantel in stock.

Registration costs were higher in hospitals and private clinics compared to health centres and mission clinics (analysis of variance [ANOVA], $P = 0.019$) (Table 5). The mean price for a urine centrifugation test is €0.37 (range €0.08–0.75). Patients visiting health centres or mission clinics paid less for a diagnostic test compared to patients visiting hospitals or private clinics (ANOVA, $P = 0.043$). For diagnosis of *S. mansoni* infection by direct smear test the mean price is €0.29 (range €0.13–0.63). Prices for diagnostic tests in the different types of health care facilities were similar. As most health workers referred their patients to a hospital or private pharmacy for treatment, comparison between prices for treatment in different health care facilities was not possible. Costs of additional transportation are substantial for patients visiting health centres and mission clinics because these facilities frequently refer patients for diagnostic tests and/or treatment. The

Table 5. Mean costs in Euros of registration, diagnostic test and treatment in different types of Ghanaian health care facilities, April–May 2000

Itemized services	Hospital	Health centre and mission clinic	Private clinic	All
Schistosoma haematobium reported in area[a]	($n = 11$)	($n = 30$)	($n = 2$)	($n = 43$)
Registration	0.49	0.29	0.75	0.36
Urine centrifugation[b]	0.48	0.32	0.36	0.37
Four praziquantel tablets	0.87	0.78	1.05	0.82
Transportation to other HCF[c]	0.18	0.76	0.20	0.59
Total costs	2.02	2.16	2.37	2.13
Schistosoma mansoni reported in area	($n = 6$)	($n = 5$)	($n = 1$)	($n = 11$)
Registration	0.47	0.27	0.50	0.39
Direct smear[b]	0.42	0.20	0.00	0.29
Four praziquantel tablets	0.73	0.89	1.20	0.84
Transportation to other HCF[c]	0.05	0.65	0.00	0.30
Total costs	1.67	2.01	1.70	1.81

[a]One health centre, 2 mission clinics and 3 private clinics did not prescribe praziquantel for treatment of *Schistosoma haematobium* and were excluded for the calculation.
[b]If a diagnostic test was not requested its cost was nil. The average costs of a diagnostic test in health care facilities where a test was requested is €0.40 for *Schistosoma haematobium* and €0.35 for *S. mansoni*.
[c]If a patient is not referred to another health care facility (HCF) the transportation cost was nil. The average transportation cost for patients that were referred was €0.80 for *Schistosoma haematobium* patients and €0.89 for *S. mansoni* patients.

total costs for treatment of *S. haematobium* or *S. mansoni* infection was comparable between hospitals, health centres and mission clinics, and private clinics with treatment taking about 40% of overall costs.

Discussion

To meet WHO recommendations for integrated schistosomiasis control would require several alterations within the Ghanaian health system. In clinics and hospitals with diagnostic facilities, WHO recommends case detection by sensitive diagnostic tests (WHO-recommendation 1). In our sample, only 13 (27%) health care facilities had a laboratory available and were capable of performing a laboratory test to diagnose *S. haematobium* or *S. mansoni* infection. These laboratories all used the urine centrifugation test for diagnosing *S. haematobium* infection and the direct faecal smear test for *S. mansoni*. The use of this simple but insensitive diagnostic technique for *S. mansoni* will certainly leave some patients undiagnosed.

In health care facilities without diagnostic facilities the identification of patients should preferably be symptom-based (WHO-recommendation 2). One essential requirement for adequate case detection is knowledge of the main presenting symptoms of schistosomiasis, which was sufficient for *S. haematobium* but limited for *S. mansoni* (41% mentioned blood in stool). Hypothetical cases C and D confirmed that patients with symptoms related to intestinal schistosomiasis have little chance of being identified as such. Both blood in stool and abdominal pain were frequently interpreted as coming from amoebiasis, food poisoning or bacterial or parasitic intestinal infection. Therefore, we conclude that passive case detection for *S. mansoni* requires a more specific clinical algorithm to distinguish between schistosomiasis patients and other diseases. In the case of no diagnostic facilities, most clinics referred their patients to another health care facility for a test. This results in extra costs for the patient and a higher risk of non-compliance.

In our sample, most health workers reported that they would prescribe praziquantel to patients identified by symptoms or diagnostic test (WHO-recommendation 3). As only 11 of 49 health care facilities had the drug in stock at the time of the interview most had to refer their patients to another health care facility or private pharmacy for buying drugs, again entailing a risk of non-compliance. We realize that the reported actions might not fully correspond with real actions (Russell *et al.*, 1991; Kopelow *et al.*, 1992). However, it is encouraging that the results about case management from the questionnaire and the hypothetical cases are comparable.

Health workers that reported not having schistosomiasis in their coverage area were not questioned about their management of patients presenting with symptoms of schistosome infection because it was considered likely that they would never suspect a patient of schistosomiasis and therefore never prescribe adequate treatment. Data from laboratories in the regions visited suggest that *S. haematobium* is endemic in Kraboa Coaltar district in Eastern region and Bosomtwi Kwanwoma district in Ashanti region and that both *S. haematobium* and *S. mansoni* are endemic in the other districts visited. There are indications that especially the presence of *S. mansoni* infection is not known by many health workers (A. Danso-Appiah, personal communication). Therefore, a number of health workers not questioned about their management of schistosome patients may have schistosome patients presenting at their health care facility who will most likely never receive adequate treatment.

The largest part of the cost for treatment of schistosomiasis is due to praziquantel and extra transportation after referral. Introduction of symptom-based treatment or wider availability of praziquantel will reduce the costs of transportation. A reduction in the price of praziquantel will also help to increase the financial accessibility of treatment. In Ghana, the gross national product per capita in 1999 was US$390 (US$1 = €1 in May 2000) (http://devdata.worldbank.org/external, 17 April 2001). For families who live in relatively poor rural areas where schistosomiasis is endemic, it may not be feasible to spend approximately €2 for treatment of schistosomiasis, especially because other (more serious) diseases such as malaria will also require medical expenditure.

In conclusion, many patients with symptoms of (early) schistosome infection that visit health care facilities in Ghana will not be identified as such, especially when having symptoms related to *S. mansoni* infection. Most health workers request a diagnostic test (often with limited sensitivity), which does not conform to WHO recommendations for integrated schistosomiasis control. A few health workers perform symptom-based treatment and also have praziquantel in stock. From the current study it is clear that for the Ministry of Health in Ghana to proceed with a policy to integrate schistosomiasis control, several challenges have to be addressed. Following a similar study in Northern Senegal (Van der Werf *et al.*, 2002), it proved possible to reach high levels of symptom-based treatment and availability of praziquantel as a result of special interventions including training of staff and improvement in the dissemination of praziquantel. Also in Mali, where emphasis on integrated schistosomiasis control has existed for many years, the results are promising (A. Landouré, personal communication). For Ghana, wider availability of praziquantel in endemic areas and training of staff to improve case recognition as well as case management are the most important requirements.

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Book Review

Emerging Pathogens. Archaeology, Ecology and Evolution of Infectious Disease. Charles Greenblatt & Mark Spigelman (editors). Oxford: Oxford University Press, 2003. xiv + 250 pp. Price £75.00. ISBN 0-19-850900-6 (hardback), 0-19-850901-4 (paperback).

Do not be misled by the title. Readers of the *Transactions* might expect to see something about emerging diseases but this is not what this multi-author book is about. It is actually concerned with the emergence and evolution of infections and the emphasis is on what DNA can tell us about these processes. These are topics that have received scant attention and the information that is available is scattered throughout a diverse literature not all of which is available to those interested in diseases. A quick skim through the titles of the chapters should be enough to entice the casual reader to delve more deeply into this volume. The 17 chapters cover topics such as how infection began and became disease, the emergence and co-evolution of human pathogens, infection processes around the dawn of civilization, evolution and ancient diseases and the evolution of arthropod disease vectors. More specific topics are also covered and these include earth history and the evolution of primates, bacterial symbionts of protozoa and the microbiology of amber. About half the book, however, is devoted to considerations of the ways in which modern molecular techniques, especially the use of DNA, can reveal details about the past and, within this area, there are chapters on palaeoepidemiology, palaeobacteriology, specifically mycobacterial infections, and archaevirology, specifically the 1918 influenza epidemic. There is much in this book that invites further reading, for example, the amazing list of communicable and non-communicable diseases that can be identified from ancient human remains using DNA techniques and the thought-provoking final chapter that asks such questions as 'are we endangering ourselves by digging up the past? and 'are we asking the right questions?'. This is a very nicely produced book that contains much that is likely to be of interest to readers of the *Transactions* and the editors are to be congratulated on their initiative in producing a book that can truly be said to be original and for drawing so much disparate information together.

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