COSTS, BENEFITS AND OPERATIONAL IMPLICATIONS OF USING QUANTITATIVE TECHNIQUES TO SCREEN FOR SCHISTOSOMIASIS HAEMATOBIUM IN EGYPT

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Abstract. The official strategy for schistosomiasis control in Egypt relies on individual case detection and treatment. Screening for *Schistosoma haematobium* has traditionally involved urine sedimentation which shows whether or not eggs are present in the urine, thereby providing only a qualitative assessment of infection status. Recently the Ministry of Health introduced the nucleopore filtration technique into a few villages to assess its applicability for broader use in areas where *S. haematobium* is endemic. This method gives an indirect quantitative measure of morbidity in terms of egg counts/10 ml urine. The overall purpose of this study was to provide rapid feedback to the Ministry on the likely implications of expanding the use of the filtration technique by examining the benefits, costs and operational problems that may be involved. From 2 villages in Giza Governorate, systematic random samples were taken from the general populations and from schools. Each selected person provided a urine specimen on which the two diagnostic techniques were performed. Filtration offered no additional benefits over sedimentation in terms of defining if a person was infected or not, with sensitivities ranging from 59.6%-75% for filtration and from 60%-73.1% for sedimentation. The additional non-labor costs of using the filtration technique in the two villages were calculated and showed that, if extended to all rural health units in Egypt, the Ministry would need to find an additional 31.6 million pounds (US$9.5 million) each year. A number of operational problems would also be involved in the wider application of the technique.

INTRODUCTION

Schistosomiasis has been endemic in Egypt for centuries (Abdel-Wahab, 1982). At present, *Schistosoma mansoni* is prevalent among the inhabitants of the Nile Delta region in Lower Egypt and shows some focal distribution in Upper Egypt. *S. haematobium* is the more prevalent species in Upper Egypt. but is almost disappearing from Lower Egypt. In Giza Governorate, south of Cairo, *S. haematobium* infection is the more prevalent species (El-Khoby *et al*, 1991).

For decades, the Ministry of Health (MOH) has made intensive efforts to control the disease. The strategy depends mainly on identifying infected individuals for treatment through 3 approaches: passive detection by routine examination of people attending rural health units (RHU); active sampling of 10% of the population monthly; and active examination of all school children twice a year, in Autumn and in Spring (El-Khoby and Webbe, 1992). Only individuals known to be infected by prior screening are treated by 40 mg praziquantel per kg body weight.

In general, screening in areas endemic for *S. haematobium* is based on a simple sedimentation technique, sometimes combined with centrifugation. These qualitative tests give a yes/no answer (the person is either infected or not), but do not indicate the intensity of infection which is directly associated with the resulting morbidity. Recently, the MOH has introduced the quantitative nucleopore filtration method in selected "index villages", from which the intensity of infection is measured in terms of egg counts per 10 ml of urine. The initial purpose of this strategy was to provide useful epidemiological data on trends in the intensity of infection as an indirect measure of morbidity. The MOH is now considering whether it should generalize the use of the nucleopore filtration technique to routine case detection in all RHUs.

This article reports results from a small exploratory study designed to provide rapid feedback to the

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MOH on some of the implications of such a policy. It had three objectives. The first was to compare the diagnostic accuracy of nucleopore filtration and simple sedimentation techniques under field conditions found in rural health centers in Egypt. The second was to determine if there would be additional costs involved in switching to the nucleopore filtration technique, and to make projections of the extra costs that would need to be incurred if it was introduced throughout Egypt. The third was to explore the operation issues and difficulties that might emerge if the quantitative techniques are more widely introduced.

MATERIALS AND METHODS

Study sites

Exploratory visits were made to 10 RHUs in Giza Governorate before the start of the field work (6 "index" villages where the filtration technique was supposed to be used, and 4 villages using the sedimentation method). Two were chosen, one from each group (Village A and Village B) on the basis of *S. haematobium* presence and the overall readiness of the local rural health unit workers to participate in the study. As part of a broader study to determine the prevalence and intensity of infection in these selected villages, a systematic random sample of houses was taken from the two villages and urine samples were collected from everyone in the selected households. In Village A, there were 3 primary schools, one of which was chosen randomly and all pupils in that school were included in the study. Village B had only one large primary school. In each of the 5 grades there were two classes, one of which was selected randomly.

Parasitological techniques

A minimum of 50 ml of urine was collected in plastic cups with a tight-screwed cover. At examination urine was thoroughly shaken and 10 ml were filtered over nucleopore filters (Peters *et al*, 1976). The residue (minimum 40 ml) was poured into urine flasks and left to sediment for 30 minutes. The supernate was decanted and a drop of the sediment was placed on a glass slide and examined microscopically for the presence of eggs. If no eggs were observed, the remaining sediment was reexamined to ensure negativity. Two experienced technicians from Theodor Bilharz Research Institute performed the tests in both villages, in the local health centers under field conditions. The reasons for this are discussed later.

In the absence of a recognized gold standard diagnosis, all individuals who showed eggs in at least one test (whether nucleopore filtration or sedimentation) were defined as positives. True negatives were those who were negative in both tests. People who were negative in one but positive in the other were defined as false negatives in the negative test. Sensitivities were calculated for each site separately, and for the pooled results, using the gold standard as the positive results of both techniques. These assumptions imply a specificity of 100% for each test.

Cost analysis

The use of consumables for both techniques was monitored. Because it is the additional costs of switching from sedimentation to filtration which concerns the MOH, only those that differed between the two techniques are reported. There were no differences in terms of major items of capital such as buildings and vehicles. The time required for preparing samples, examining the urine and reporting results was monitored for both techniques and is reported here without attempting to translate into monetary terms. The operational implications of these calculations, however, are considered. Training costs that would be incurred in introducing the filtration technique are not estimated. Accordingly, the cost estimates reflect mainly the additional cost of consumables that would be incurred by switching from sedimentation to filtration.

Operational issues

During the exploratory visits to the six "index" villages before the start of the study, checks were made on the presence of the material needed to use the filtration technique (such as filters, syringes, holders, etc), and on the rural health unit records. Rural health unit technicians were observed and judged for their ability to prepare the urine filters and to count eggs as required by the filtration technique. All rural health unit staff were interviewed about their attitudes towards the quantitative techniques, and their willingness to use them in the future.

RESULTS

Diagnostic performance

Table 1 describes the prevalence obtained with different techniques in the 2 villages and 2 schools. Except for village A, the prevalence determined by filtration was higher than that by sedimentation with a difference varying from 1.7% to 4.1%. However, both methods consistently underestimated the prevalence as obtained by the combined results.

Table 2 compares the paired results in the total study population (*ie* the results of both tests on the same urine sample for each individual). A total of 1,034 persons was examined, 865 cases were negative in both tests and 56 cases were positive (agreement = 89.1%). Each test gave almost the same number of false negatives (55 *vs* 58).

The sensitivities of the two techniques using the above assumptions are found in Table 3, along with the sensitivities estimated for each village and school separately. The confidence limits show that the differences were not statistically significant in any individual site. Clearly the pooled results show no benefits of filtration in terms of improved sensi-

Table 1

Prevalence by filtration and sedimentation from the four study sites.

Site	No. examined	Percent prevalence		
		Sedimentation %	Filtration %	Cumulative prevalence %
Village A	415	9.2	7.5	12.5
School A	71	7.0	8.5	11.3
Village B	403	8.7	9.4	13.4
School B	145	22.8	26.9	37.9

* The proportion in which at least one test was positive, taken as the gold standard.

Table 2

Diagnostic performance of filtration and sedimentation techniques, pooled results.

Filtration	Sedimentation		Total
	Positive	Negative	
Positive	56	58	114
Negative	55	865	920
Total	111	923	1,034

Table 3

Sensitivity of filtration and sedimentation techniques.

Site	Sensitivity	
	Filtration %	Sedimentation %
Village A	59.6	73.1
(95% CI)	(46.0-72.9)	(61.0-80.0)
School A	75.0	62.5
(95% CI)	(45.0-100.0)	(29.0-96.0)
Village B	70.4	64.8
(95% CI)	(62.0-86.0)	(52.0-77.0)
School B	70.9	60.0
(95% CI)	(60.0-82.0)	(47.0-73.0)
Total	67.5	65.7
(95%CI)	(64.6-70.1)	(62.8-68.6)

Table 4

Cost-analysis of filtration and sedimentation techniques.

Material	Purchase unit	Cost/Unit Egyptian pounds (LE)	Cost/1,000 filters (LE)	Cost/1,000 sediments (LE)
Cups for urine collection	Cup (100 ml)	0.22	same	same
Slides	Box/50 slides	2.65	same	same
Gloves	Glove	3.47	same	same
Marking pencils	One pencil	6.00	3 × 6.00 = 18.00	1 × 6 = 6.00
Cotton	kg	11.00	0.5 × 11 = 5.50	0.25 × 11 = 2.75
Acetone	1 liter	15.00	1 × 15 = 15.00	0.5 × 15 = 7.50
Savlon	1 liter	35.00	0.25 × 35 = 8.75	0.5 × 35 = 17.5
Syringes	syringe/10 ml	0.40	50 × 0.40 = 20.00	0
Filters	Box/100	148.5	10 × 148.5 = 1,485 LE	0
Tissue paper	Roll	1.00	15 × 1 = 15.00	0
Urine flasks	One flask	4.00	0	12 × 4 = 48.00
Holders	Box/10	81.2	*0.4 × 81.2 = 32.5 LE	0
Slide box	Box/100 slides	6.00	3 × 6.00 = 18.00	0
Total			1,617.7 LE	81.75 LE

1,617.7 - 81.75 = 1,535.95 LE/1,000 tests

* 4 holders were consumed performing 1,000 tests

tivity under the field conditions found in the study site.

Costs

A number of minor items of capital equipment are required for the two techniques, including slide boxes, filter holders and urine flasks. During the field work, records were kept of the number that were inoperable, broken or had disappeared. The costs of these items were divided by the number of tests to obtain a cost per 1,000 tests. This slightly underestimates the costs of these items because there is a small depreciation cost of the objects that were used for the tests but were still in working order after the field work. However, given the quantities and unit costs involved, the underestimation is likely to be very small.

The costs of consumables required to undertake the two techniques are shown in Table 4 along with details of their calculation. These costs are measured in terms of the prices actually paid by the MOH for the materials. Some of the material, such as cups for urine collection, slides and gloves, were required in equal quantities for both techniques. All other material, with the exception of disinfectant (savlon), are used in greater quantities for the filtration technique. Urine flasks were only used for the sedimentation technique. The calculations show that for each 1,000 tests completed, it would cost approximately an additional 1,535 Egyptian Pounds (approximately US$465 at current exchange rates) to switch from sedimentation to filtration, or 1,535 additional pounds (US$0.46) per test, solely for the additional consumables.

Not only does the filtration require more consumables, it also requires more time for preparing the filter, counting the eggs and recording the results. Given the study design, it was not possible to compare times taken by different technicians, but the technician used in the research was timed undertaking the three tasks. Preparing the filter took 3.2 ± 1.2 minutes per specimen if 10 specimens were prepared together, and 2.3 ± 1.1 minutes per specimen if 20 specimens were prepared together. Time for counting and recording the results of the nucleopore filtration technique depends on the presence of eggs, as well as the intensity of infection. On average, 3 ± 2 minutes were required, so each specimen took between 5.3 and 6.2 minutes using filtration. For the sedimentation technique, examining the urine and recording the results took on the average 1.5 ± 1 minutes (no time for preparation is required). If these results were generalizable, a laboratory technician would spend a minimum of 3.8 extra minutes per test to undertake the filtration technique compared to sedimentation. The calculations do not include the time required to collect the sample, examine and treat patients, which are the same for both methods.

Operational issues

Five of the six "index" villages visited in the exploratory study did not have the materials required to use the filtration technique, even though they were supposed to be using it routinely. The technicians in all the centers were then asked to prepare urine filters and count eggs if any, with the research team providing any material not available at the health center. No technician was able to perform the work completely without help from the team. This is the main reason why experienced technicians were transferred to the study sites for the research.

All of the technicians who were usually attached to the health centers took a great interest in the filtration method during the research period from a technical viewpoint. All commented, however, that it would take much more of their time if introduced routinely. They had no doubt that they would be able to use the technique appropriately after training, but questioned the value of doing so. To illustrate, the technicians in the "index" villages had already received a short training course on filtration techniques, but argued that they were not motivated to use it when it did not make any difference to the way patients were treated, or to the way control activities were organized. Unless the results were going to be used, they saw no point in spending the extra time.

DISCUSSION

The results of this study suggest that there is no significant difference between the performance of the nucleopore filtration technique and the sedimentation technique in terms of identifying whether or not individuals are infected. Both methods miss just over 30% of the infected population with an experienced technician. However, the nucleopore filtration technique has the potential to add more useful information about the intensity of infection, that is considered a good indirect indicator for morbidity and for evaluation and monitoring of control activities (Tanner, 1989). This is potentially important in Egypt, where reduction of morbidity is the aim rather than interruption of transmission (El-Khoby *et al*, 1991). A further advantage claimed for filtration is that quality control of routine urine results would be facilitated if the filtration technique is used to check the performance of the laboratory technicians (Mott and Cline, 1980).

However, a switch to the routine use of nucleopore filtration for screening of *S. haematobium* would impose a considerable additional financial burden on the MOH. If the technique was introduced routinely in the whole of Egypt, the MOH would have to find an additional 31.6 million pounds (US$9.5 million) to cover only the extra consumables required. This estimate was based on the reported number of individuals undergoing urine examination in 1993 (20,653,825). Training and supervision costs would be extra. These results confirm the suggestion of studies elsewhere that filtration would be more costly in terms of time and materials than sedimentation (Feldmeier and Poggensee, 1993; Peters *et al*, 1976; Richards *et al*, 1984), but this is the first estimate of the magnitude of these costs for Egypt.

The question of whether there is a real opportunity cost in terms of time required of moving to filtration is more complex. There is now excess capacity in most health centers, so that the extra time needed for the filtration technique may not restrict the ability of the technicians to undertake other duties. It would not be necessary for the government to hire additional technicians or to extend their official working hours in most of the year. The problem may be, however, the unevenly distributed work load through the year which peaks during October and November when active case detection for the school surveys is done in addition to the routinely examined passive returns. The average number of urine samples examined during the year in Village A was 23 ± 9 samples daily, but in October, an average of 42 specimens were examined daily. Using the earlier calculations, a switch to filtration would require just over 1.4 hours of additional work per day in the slow season. But in October, it would require an extra 2.6 hours of time from the laboratory technicians each day, approximately doubling the time required to undertake the tests.

The introduction of filtration technique has already met with some resistance from the technicians who are not eager to spend extra time and effort when it is not clear to them how the results are used, and what are the benefits of using it. This is because the official strategy is to treat everyone with eggs detected in the urine. Another problem is the irregular supply of the required material. The MOH could, of course, overcome this problem by improving communications and supply systems and introducing more rigorous monitoring, but these actions would also impose an additional financial burden.

The aim of the Schistosomiasis Control Program is to control morbidity rather than transmission, and it would undoubtedly be useful to have an indicator of morbidity that could be used to monitor the success of the program over time. Tanner (1989), reported that although the objectives of control shifted in many countries from transmission control to morbidity control, this process was not accompanied by change in the approaches to evaluating and monitoring the control activities. Egg counts as an indirect measure of *S. haematobium* morbidity, detected through the use of the filtration technique, would provide the MOH with such an indicator. However, the results of the present study suggest that the decision to extend filtration beyond the current "index" villages should be examined carefully. It will prove significantly more costly than the sedimentation technique, more time consuming, and offers no advantage over sedimentation in terms of diagnostic accuracy, confirming the earlier results of Richards *et al* (1984). It is also likely to be met with some resistance from laboratory technicians.

Alternative methods can be suggested as more cost-effective ways of applying the filtration method to serve the purpose of the MOH. Quantitative techniques may be used, for example, only for subsamples of the population, or in special target high risk groups, or at certain times of the year. At present the MOH supplied the nucleopore filters that were used in this study, but cheaper versions are now available and could be tested by the MOH. The use of hemastrips for detection of hematuria could also be considered. At a community level, the prevalence of hematuria reflects the degree of morbidity and their use is easy and accepted by the primary health care workers. They cost relatively little compared to the nucleopore filtration technique, although it may result in the identification and treatment of more cases, thereby increasing the cost of the drug consumed (Savioli *et al*, 1989). Few studies have been done to evaluate hemastrips in Egypt.

The sample size in this study was small and the results may not reflect the situation in other parts of Egypt. Yet, it indicates that any decision to switch diagnostic strategies and methods on a large scale should be considered carefully.

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