Trop Med Int Health. Author manuscript; available in PMC 2009 December 04.

Published in final edited form as:
Trop Med Int Health. 2009 December ; 14(12): 1484–1487. doi:10.1111/j.1365-3156.2009.02407.x.

The performance of haematuria reagent strips for the rapid mapping of urinary schistosomiasis: field experience from Southern Sudan

Emily Robinson[1], **Diana Picon**[2], **Hugh J Sturrock**[2,3], **Anthony Sabasio**[2], **Mounir Lado**[4], **Jan Kolaczinski**[1,3,*], and **Simon Brooker**[3,5]

[1]Malaria Consortium – Africa Regional Office, Kampala, Plot 2, Sturrock Road, Kololo, P.O. Box 8045, Kampala, Uganda [2] Malaria Consortium – Southern Sudan Office, Plot 6, Block 2, Nimira Talala, Juba, Southern Sudan [3] London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, United Kingdom [4] Ministry of Health, Government of Southern Sudan, Juba, Southern Sudan [5] Kenya Medical Research Institute-Wellcome Trust Research Programme, P.O. Box 43640 – 00100, Nairobi, Kenya

Abstract

The implementation of programmes to control neglected tropical diseases (NTDs) requires up-to-date information on the prevalence and distribution of each NTD. This study evaluated the performance of reagent strip testing for haematuria to diagnose *Schistosoma haematobium* infection among school-aged children in the context of a rapid mapping survey in Southern Sudan. The use of reagent strips was found to be highly sensitive (97.8%) but only moderately specific (58.8%). The proportion of false positive diagnoses was significantly higher among girls than boys, especially among girls aged 5-10 years. These findings suggest that reagent strips alone are not sufficient for rapid mapping surveys. A two-step approach is thus recommended whereby haematuria-positive urine samples are subsequently examined using urine filtration.

Keywords

urinary schistosomiasis; *Schistosoma haematobium*; diagnosis; neglected tropical diseases; mapping; Southern Sudan

Introduction

There is increasing interest in the implementation of programmes to control neglected tropical diseases (NTDs) (Lammie *et al.*, 2006). To ensure that these programmes target the areas of greatest need, there is an operational requirement for up-to-date information regarding the prevalence and distribution of each NTD. Screening using rapid, indirect tests has been proposed as a procedure to simplify mapping surveys (Brooker and Utzinger, 2007). For urinary schistosomiasis, caused by *Schistosoma haematobium*, testing urine with

[*]**Corresponding author:** Malaria Consortium - Africa Regional Office, Plot 2a, Sturrock Road, Kololo, Kampala, Uganda, PO Box 8045; j.kolaczinski@malariaconsortium.org, Phone: (256-0312) 300420, Fax: (256-0312) 300425.

Author's contributions

DP, ML, SB and JK developed the survey protocol, and ER, DP, HS and AS conducted the field work. ER analyzed the data and together with SB developed a first draft. All authors then contributed towards revision of the manuscript.

Conflicts of interest

None declared.

Europe PMC Funders Author Manuscripts

reagent strips for microhaematuria is one such simple, indirect diagnostic method, particularly for use among school-aged children (Mott *et al.,* 1983); school-based blood in urine questionnaires are another rapid, low-cost screening approach (Lengeler *et al*., 2002). At present, parasitological diagnosis remains the preferred screening approach for the other main schistosome species in sub-Saharan Africa, *S. mansoni,* which causes intestinal schistosomiasis (Brooker et al., 2009).

Several research studies report high sensitivity and specificity of reagent strips compared to urine filtration (Savioli *et al*., 1989), the considered diagnostic gold standard. Operational research studies in Africa show that screening using reagent strips is an effective method to identify school children requiring treatment and subsequently monitor control (Savioli *et al.,* 1989; French *et al.,* 2007; Ugbomoiko *et al.,* 2009). However, because of regional variation in the performance of reagent strips (Mott *et al.,* 1985), evaluation at country level is necessary to establish reliability for their use during large-scale mapping. Here, we report on the performance of reagent strips during community surveys conducted as part of the mapping phase of a national integrated NTD control programme in Southern Sudan (Rumunu *et al.,* 2009).

Materials and methods

The study was conducted from February to May 2009 in Northern Bahr-el-Ghazal State, Southern Sudan, as part of a large-scale integrated NTD mapping survey for schistosomiasis, soil-transmitted helminth infection, lymphatic filariasis and loiasis (Sturrock *et al.,* in press). School enrolment is under 30% in the area and therefore school-based questionnaire surveys were deemed unfeasible for mapping the risk of schistosomiasis. Details of the study area, recruitment method, and parasitological surveys are provided elsewhere (Sturrock *et al.,* in press). In brief, a quasi-random two-stage cluster sampling method was employed, whereby communities were selected on the basis of potential risk of filariasis and schistosomiasis, and households were randomly selected within each community. Each household head was requested to provide written consent, and all children aged 5 to 16 years were asked to give verbal consent before providing urine samples; adults were only sampled for testing of lymphatic filariasis. Individuals who did not provide consent were excluded from the study. Urine samples were generally collected from each child between 10:00 and 14:00 and tested using Hemastix® reagent strips (Bayer Diagnostics, Basingstoke, UK). Samples positive for haematuria were subsequently filtered through a hydrophilic, 12μm polycarbonate membrane, and the number of *S. haematobium* eggs was counted per 10ml of urine. A heavy infection was classified as >50 eggs/10 ml urine, and a light infection as between 1 and 50 eggs/10 ml. For each haematuria-positive sample, an age-sex matched negative sample was also filtered. Data were double entered in Microsoft Excel and analysed in STATA 9.0 (Stata Corporation, College Station, TX, U.S.A.). Comparisons of infection prevalence by sex and age group were tested with the χ^2 test. The diagnostic performance of reagent strips was assessed by calculating sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). 95% exact binomial confidence intervals (CIs) were calculated, and non-overlapping CIs were indicative of a statistical difference.

This study was part of an integrated mapping protocol, which received ethical approval from the Directorate of Research, Planning and Health System Development, Ministry of Health (MoH), Government of Southern Sudan, and from the Ethics Committee of the London School of Hygiene and Tropical Medicine, UK. Clearance to conduct the surveys was obtained from Northern Bahr-el-Ghazal State MoH, followed by County Health Departments.

Results

A total of 4,901 children from 74 communities provided urine samples, of which 370 (7.5%) had detectable haematuria. Of these, 357 samples were subsequently examined by urine filtration, and matched to 320 reagent strip negative samples that were also filtered. The prevalence of *S. haematobium* infection, determined by a positive filtration result, was 3.0% (95% CI, 2.5–3.6%). Prevalence did not significantly differ by sex, but was significantly higher in children aged 11-16 years compared those who were 5-10 years old (4.7% versus 2.4%, $p<0.001$). Table 1 presents the diagnostic performance of reagent strips overall and by age-group and sex, and shows that reagent strips had high overall sensitivity and NPV, but only moderate specificity and poor PPV. Diagnostic indices were consistently better among boys compared to girls (Table 1). Of the children who had haematuria but no detectable *S. haematobium* eggs, 71% (158/222) were female and 51% (113/222) were girls aged 5-10 years old. Sensitivity was not related to intensity of infection: 100% (95% CI, 95-100%) among those harbouring heavy infections and 96% (95% CI, 88-99%) among those with light infections. By contrast, specificity and PPV were found to be lower in low prevalence communities (Table 1).

Discussion

Previous research studies in different African settings report sensitivities of reagent strips for microhaematuria ranging from 67% to 93%, and specificities of 67% to 99% (Brooker *et al.*, in press), including a sensitivity of 87% in White Nile Province in Sudan (Eltoum et al. 1992). The present study showed that in the context of an integrated NTD survey in Southern Sudan, reagent strips had comparably high sensitivity. Specificity was, however, considerably lower than reported by previous studies, and was especially poor among young girls and in low prevalence communities. The high prevalence of false positive diagnoses among girls compared to boys is consistent with studies in Ghana (Hall and Fentiman, 1999) and Tanzania (Hatz *et al.*, 1990). Some of the observed false positives among older girls may be explained by menstruation. Among younger girls, urinary-tract infections, which are more common in girls than boys and can be the result of female circumcision, may also play a role. Female circumcision is very common custom in northern Sudan, occurring in girls as young as four year olds (Satti *et al.*, 2006), and is also practiced by some tribes in Southern Sudan.

Reagent strip testing has been proposed as a simple, indirect method for identifying children with *S. haematobium*, and hence a useful way to rapidly map the prevalence of infection to identify areas warranting mass treatment with praziquantel. Our experience in Southern Sudan shows that if reagent strips are used as the sole diagnostic tool, the observed low specificity would result in overestimation of infection prevalence, especially among low transmission villages, and potentially lead to mass treatment in communities or target groups that do not require treatment. For example, using the WHO cut-off of 10% to denote the need for mass treatment using praziquantel of school-aged children, 19 of the surveyed villages would have received mass treatment if the decision was based only on reagent strips, whereas only four villages would warrant mass treatment based on urine microscopy. Positive results obtained by reagent strip in the context of a rapid mapping survey should thus be confirmed by urine filtration. Ultimately, it would be useful to have a single rapid diagnostic tool that could reliably detect more than one of the parasites causing NTDs. For schistosomiasis, the ongoing refinement of reagent strips to test for circulating cathiodic antigen is likely to result in such tool for simultaneous detection of both *S. haematobium* and *S. mansoni* (Bergquist et al., 2009).

Acknowledgments

We would like to thank the staff of the State Ministry of Health for Northern Bahr-el-Ghazal State for their support on implementing the surveys and all of the laboratory technicians for their hard work under extremely strenuous field conditions. HS is supported by a London School of Hygiene and Tropical Medicine Graduate Teaching Assistantship and SB is supported by a Research Career Development Fellowship (081673) from the Wellcome Trust.

Funding: The work presented in this publication was made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. USAID funding was provided through RTI International to Malaria Consortium.

References

Bergquist R, Johansen MV, Utzinger J. Diagnostic dilemmas in helminthology: what tools to use and when? Trends in Parasitology. 2009; 25:151–156. [PubMed: 19269899]

Brooker S, Kabatereine NB, Gyapong JO, et al. Rapid mapping of schistosomiasis and other neglected tropical diseases in the context of integrated control programmes in Africa. Parasitology. 12 in press. Epub ahead of print.

Brooker S, Utzinger J. Integrated disease mapping in a polyparasitic world. Geospatial Health. 2007; 1:141–146. [PubMed: 18686239]

Eltoum IA, Sulaiman S, Ismail BM, et al. Evaluation of haematuria as an indirect screening test for schistosomiasis haematobium: a population-based study in the White Nile province, Sudan. Acta Tropica. 1992; 51:151–157. [PubMed: 1354933]

French MD, Rollinson D, Basáñez MG, et al. School-based control of urinary schistosomiasis on Zanzibar, Tanzania: monitoring micro-haematuria with reagent strips as a rapid urological assessment. Journal of Pediatric Urology. 2007; 3:364–368. [PubMed: 18947774]

Hall A, Fentiman A. Blood in the urine of adolescent girls in an area of Ghana with a low prevalence of infection with *Schistosoma haematobium*. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1999; 93:411–412. [PubMed: 10674091]

Hatz C, Savioli L, Mayombana C, et al. Measurement of schistosomiasis-related morbidity at community level in areas of different endemicity. Bulletin of the World Health Organization. 1990; 68:777–787. [PubMed: 2127383]

Lammie PJ, Fenwick A, Utzinger J. A blueprint for success: integration of neglected tropical disease control programmes. Trends in Parasitology. 2006; 22:313–321. [PubMed: 16713738]

Lengeler C, Utzinger J, Tanner M. Questionnaires for rapid screening of schistosomiasis in sub-Saharan Africa. Bulletin of the World Health Organization. 2002; 80:235–242. [PubMed: 11984610]

Mott KE, Dixon H, Osei-Tutu E, et al. Evaluation of reagent strips in urine tests for detection of *Schistosoma haematobium* infection: a comparative study in Ghana and Zambia. Bulletin of the World Health Organization. 1985; 63:125–133. [PubMed: 3872731]

Mott KE, Dixon H, Osei-Tutu E, England EC. Relation between intensity of *Schistosoma haematobium* infection and clinical haematuria and proteinuria. Lancet. 1983; 8332; 1:1005–1008. [PubMed: 6133057]

Rumunu J, Brooker S, Hopkins A, et al. Southern Sudan: an opportunity for NTD control and elimination? Trends in Parasitology. 2009; 25:301–307. [PubMed: 19540164]

Satti A, Elmusharaf S, Bedri H, et al. Prevalence and determinants of the practice of genital mutilation in of girls in Khartoum, Sudan. Annals of Tropical Paediatrics. 2006; 26:303–310. [PubMed: 17132295]

Savioli L, Dixon H, Kisumku UM, Mott KE. Control of morbidity due to Schistosoma *haematobium* on Pemba island; selective population chemotherapy of schoolchildren with haematuria to identify high-risk localities. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1989; 83(6):805–810. [PubMed: 2515637]

Sturrock HJW, Picon D, Sabasio A, et al. Integrated mapping of neglected tropical diseases: epidemiological findings and control implications for Northern Bahr-el-Ghazal State, Southern Sudan. PLoS Neglected Tropical Diseases. in press.

Ugbomoiko US, Dalumo V, Ariza L, et al. A simple approach improving the performance of urine reagent strips for rapid diagnosis of urinary schistosomiasis in Nigerian schoolchildren. Memórias do Instituto Oswaldo Cruz. 2009; 104:456–461. [PubMed: 19547872]

Europe PMC Funders Author Manuscripts

Europe PMC Funders Author Manuscripts

Table 1

Diagnostic performance of haematuria reagent strips according to age, sex, and *Schistosoma haematobium* prevalence in Northern Bahr-el-Ghazal State, Southern Sudan 2009

	n	Sensitivity % (95%CI)	Specificity % (95%CI)	PPV % (95% CI)	NPV % (95% CI)
Overall[a]	677	98 (94 - 99.5)	59 (55 - 63)	38 (33 - 43)	99 (97 - 99.8)
Boys 5 – 10	186	100 (93 - 100)	68 (60 - 76)	52 (42 - 63)	100 (96 - 100)
Boys 11 – 16	98	100 (87 - 100)	74 (62 - 83)	58 (52 - 72)	100 (93 - 100)
Boys all ages	284	100 (95 - 100)	70 (63 - 76)	54 (45 - 93)	100 (98 - 100)
Girls 5 - 10	270	97 (85 - 99.9)	52 (45 - 58)	24 (17 - 31)	99 (96 - 99.9)
Girls 11 - 16	122	93 (76 - 99)	52 (42 - 63)	37 (25 - 49)	96 (87 - 99.5)
Girls all ages	392	95(87 - 99)	52 (46 - 57)	28 (22 - 34)	98 (95 - 99.6)
Low prevalence payams[b]	444	100 (94 - 100)	54 (49 - 60)	26 (21 - 32)	100 (98 - 100)
Moderate prevalence payams[c]	155	96 (89 - 99)	75 (64 - 84)	78 (69 - 86)	95 (87 - 99)

PPV, positive predictive value; NPV, negative predictive value. 95% exact binomial CI in parenthesis.

[a] One record was missing data for age and sex.

[b] >0% and <10% prevalence. 15 of the 21 payams, with payams with 0% prevalence excluded.

[c] >=10% prevalence. One of the 21 payams.