

A Home-Based Urine Test for Clinical Malaria

Eddy C. Agbo* & Anne M. Derrick

Fyodor Biotechnologies, Inc.
3607 Frankford Avenue
Baltimore, MD 21214

* Corresponding Author: eddy.agbo@fyodorbio.com

Summary

Improving capacity for effective rapid diagnostic tests is a major focus of malaria control efforts, particularly in remote areas where malaria risk is high. *Plasmodium falciparum* (*Pf*) antigens have been reported from urine of malaria patients showing febrile illness. However, available *Pf* HRP-2 tests which recognize only native proteins in blood are not optimal for antigen detection when tested in urine. We have developed and preliminarily validated a rapid urine-based malaria test (UMT) under field conditions. The test was positive in 5-10 minutes and as specific as microscopy or blood-based rapid diagnostic tests, but more sensitive than blood-based RDTs. The UMT is proposed as a home-based test so that people can know immediately if their fever is due to malaria, and if so, to seek immediate specific treatment. It will be less expensive than currently available rapid tests, and result in the reduction of the overall cost of managing malaria.

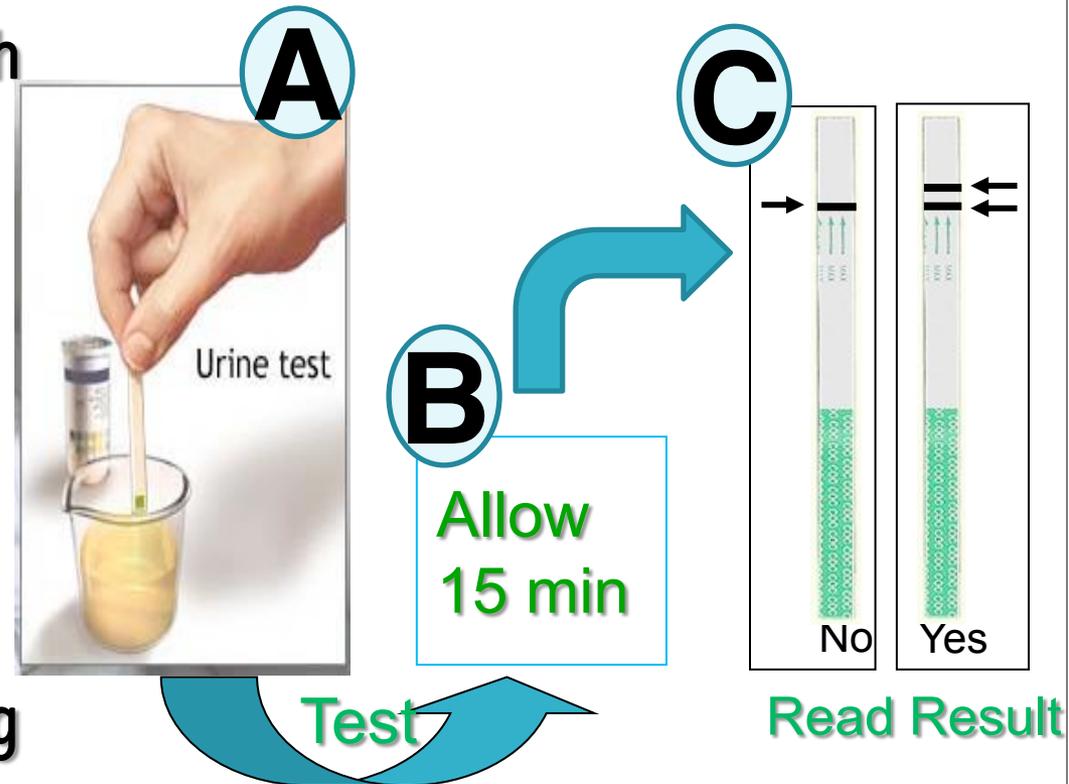
Introduction

Malaria claims a global toll of 247 million clinical cases and nearly 1 million deaths per year. There is an increasing need for accurate for diagnosis at home or peripheral health centers where most of the cases occur.

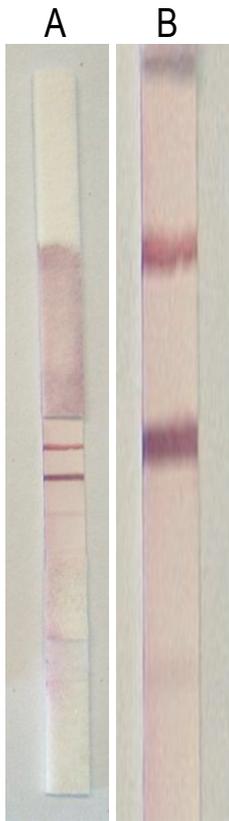
Imagine a mother in a remote Nigerian village, and her child is sick. Maybe the fever and malaise are caused by a virus and will pass in a day or two. Or, perhaps they are early signs of malaria requiring prompt medical attention. Should she and her child start the two-hour walk to the nearest clinic or local drug store, or gamble that she will soon be feeling better? Now, imagine that she can avoid the dilemma altogether. From her cupboard, she takes a cardboard strip and dips it in a tablespoon of her child's urine. If two lines appear on the strip, the child is positive for clinical malaria and the mother knows instantly that the infection very likely is malaria and she needs to start walking to the nearest drug store or clinic. But, if a single line appears on the strip, the fever is not due to malaria. The urine malaria test will markedly alter the way malaria is diagnosed and treated worldwide.

Study Procedure

- ▶ Place UMT strip in 100 μ l fresh urine sample
- ▶ Allow 15 min, with no other manipulations
- ▶ Read results
- ▶ Further test validation ongoing



Evaluation of UMT Using Urine Samples From Symptomatic Patients



- (A) Is positive result with two clear bands on full test strip;
(B) Is close-up of read-out section of the positive test strip result.

The UMT was positive in 16 of 17 (94% sensitivity) symptomatic children with confirmed blood film parasitemia, while only 2 of 23 asymptomatic children identified by an active community surveillance screen with confirmed blood films were positive for urine antigen detection (91% specificity).

The geometric mean in the symptomatic and asymptomatic children was 22,676 and 1,270 parasites/microliter (960-232,600 and 137-17,560), respectively.

Results & Discussion (1)

Table 1. Preliminary Sensitivity – The UMT was positive in 16 of 17 symptomatic children with confirmed blood film parasitemia (94% sensitivity).

par/ul	clinical	Malaria Urine Test		Blood film	Multistix Urinalysis		
		Prot. 1	Prot. 2		prot	pH	spec grav
232800	Symptomatic	2	0.5	3+	30	6.5	1.02
222153	Symptomatic	0.5	0	nil	30	6.5	1.01
188689	Symptomatic	1	0	1+	nil	6.5	1.01
89943	Symptomatic	1	0	nil	15	6	1.03
84000	Symptomatic	0	0	nil	nil	6	1.03
57900	Symptomatic	0.5	0	nil	1+	5	1.025
34000	Symptomatic	2	1	1+	nil	5	1.01
25600	Symptomatic	2	0.5	nil	nil	5	1.005
18470	Symptomatic	2	0	2+	nil	5	1.005
13700	Symptomatic	0.5	0	3+	1+	5	1.03
13000	Symptomatic	1	0.5	nil	nil	6	1.005
10000	Symptomatic	2	0.5	1+	1+	6	1.015
8539	Symptomatic	2	0.5	nil	nil	6	1.02
2800	Symptomatic	1	0.5	1+	1+	6	1.03
960	Symptomatic	2	0.5	nil	1+	6	1.005
	Symptomatic	2	0.5	nil	30	6.5	1.03
	Symptomatic	2	0.5	1+	30	6	1.03

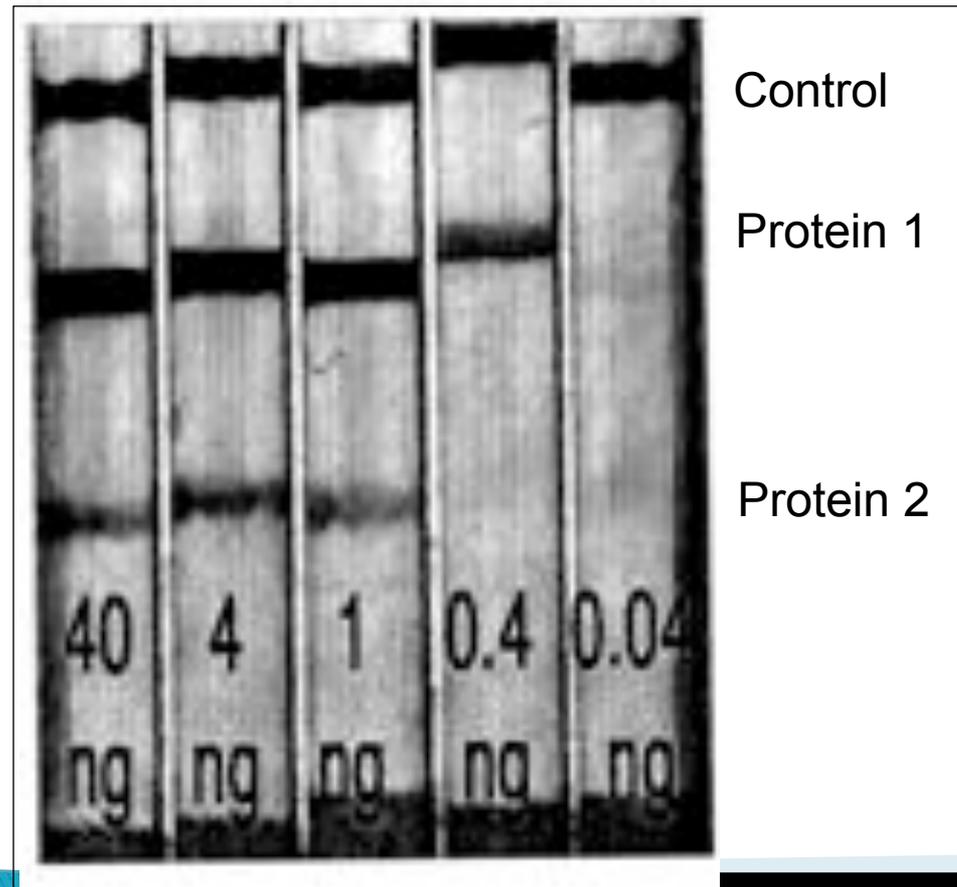
Results & Discussion (2)

Table 2. Preliminary Specificity – 2 of 23 asymptomatic children with confirmed blood films were positive for urine antigen detection in UMT testing (91% specificity).

par/ul	clinical	Malaria Urine Test		Blood film	Multistix Urinalysis		
		Prot. 1	Prot. 2		prot	pH	spec grav
17560	Asymptomatic	0	0	nil	nil	8	1.01
13508	Asymptomatic	0	0	nil	100	7	1.025
6545	Asymptomatic	0	0	nil	nil	5	1.03
6200	Asymptomatic	0	0	2+	nil	7	1.005
5130	Asymptomatic	0	0	nil	0	8.5	1.005
3000	Asymptomatic	0	0	3+	nil	6	1.005
2400	Asymptomatic	0	0	1+	nil	6	1.02
2150	Asymptomatic	0	0	nil	nil	8.5	1
1760	Asymptomatic	0	0	1+	nil	6	1.025
1708	Asymptomatic	0	0	nil	nil	5	1.03
1280	Asymptomatic	0	0	nil	nil	8	1.005
1200	Asymptomatic	0	0	1+	1+	5	1.015
1090	Asymptomatic	0	0	3+	200	8.5	1.005
731	Asymptomatic	0	0	nil	nil	8.5	1.005
651	Asymptomatic	0	0	3+	300	8.5	1.005
615	Asymptomatic	0	0	nil	nil	6	1.03
475	Asymptomatic	0	0	nil	nil	6	1.03
456	Asymptomatic	0	0	nil	nil	8.5	1.02
408	Asymptomatic	0	0	nil	30	8.5	1.005
385	Asymptomatic	1	0.5	nil	30	7	1.015
235	Asymptomatic	0	0	nil	30	8.5	1.005
200	Asymptomatic	0	0	nil	nil	7.5	1.02
137	Asymptomatic	0.5	0	1+	nil	7	1

Results and Discussion

Figure 2. Limit of assay detection. UMT detected 40 pcg of HRP-2 in 100 μ L urine, i.e. \sim 50 times more sensitive than most immunochromatographic blood tests.



Conclusion

The Urine Malaria Test offers procedural and clinical advantages over the current tools:

- Non-invasiveness, requiring 4-5 drops of urine sample
- Prevents occupational hazards associated with blood draw, reducing risk of disease
- Can be performed by individuals at home allowing them to seek specific treatments
- Lower expense than blood-based tests
- Higher accuracy
- Opportunity for malaria diagnosis at home or community levels