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The assessment of fever in under-five children in the Ekounou Health Area of Yaounde, Cameroon: Usefulness of rapid diagnostic tests

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Improper diagnosis and management of febrile patients results in the persistence of malaria and other conditions with similar symptoms. The algorithm established here with Rapid Diagnostic Tests (RDTs) will help in the follow-up and treatment of fever patients according to the guidelines on Integrated Management of Childhood Illness (IMCI). This study aimed at determining the causes of fever in children and at valorizing the use of RDTs for the diagnosis of febrile diseases. Fifty children with fever, aged between 0 and 5 years, were recruited in a cross-sectional study at the Ekounou Baptist Clinic in Yaounde. RDTs were used to assess for the four common causes of febrile illness in the area. Microscopy was done and the *Plasmodium* species were confirmed by nested Polymerase Chain Reaction (PCR). Of the 50 febrile children, none was rubella seropositive, while 8% had malaria, 22% had toxoplasmosis infection, 8% had *Salmonella typhi*, 14% had a malaria-typhoid fever co-infection, 4% had a malaria-toxoplasmosis co-infection, 6% had a malaria-toxoplasmosis-typhoid fever co-infection, and 38% were negative for all the suspected common causes of fever in the health district. The overall frequencies of occurrence attributed 32% to malaria, 32% to toxoplasmosis and 28% to typhoid fever. Among all the positive malaria cases (n=16 (32%)) *Plasmodium falciparum, Plasmodium malariae* and *Plasmodium ovale* were identified by nested PCR. Malaria RDT results agreed significantly with the microscopy (kappa=0.81; $p<0.0001$) and PCR (kappa=0.84; $p<0.0001$) results; and the microscopy results also concurred significantly with the PCR results (kappa=0.77; $p<0.0001$). Malaria was not the exclusive cause of fever. Toxoplasmosis was found to occur in the same proportion as malaria (32%) in the study population. *S. typhi* was the third most important infection. Therefore RDTs are appropriate tools for the management of childhood febrile diseases.

Key words: Fever, malaria, toxoplasmosis, typhoid, rubella, rapid diagnostic test (RDT), Cameroon.

INTRODUCTION

Fever is a nonspecific response to various types of infectious and/or non-infectious stimuli; and the factors that provoke it constitute its pyrogenic profile. In sub-Saharan Africa, fever remains a major public health problem since it is a particularly predominant symptom in children less than 5 years old (Nnedu et al., 2010) and a

frequent reason for parents to seek primary care. In Cameroon, its prevalence in children of this age range was 42.2% in 2010, and it did not vary with age or gender (INS, 2010). Fever has been shown to be the main clinical manifestation of malaria in endemic areas, where transmission is intense, the burden of the illness is greatest and where severe disease and mortality are largely registered. The Cameroon National Malaria Control Program defined the most vulnerable group of people to be children, with 56 and 52% cases of malaria listed in 2008 and 2010 respectively (PNLP, 2011). Malaria treatment is often dispensed on the basis of "fever" and other associated symptoms (chills, headache, vomiting), rather than on parasitologically confirmed diagnosis. The policy of presumptive treatment of malaria for all febrile illnesses had also been widely advocated in sub-Saharan Africa prior to the advent of better diagnostic procedures. However, such presumptive therapy results in significant overdiagnosis and overtreatment (WHO, 2008). Secondly, the use of antimalarials without confirmation by biological tests provides approximate treatment, thus further incriminating the already condemned notion of self-medication. This could eventually lead to heavy consequences on resistance to the recently introduced artemisinin-based combination therapies (ACTs - sulfadoxine pyrimethamine, atovaquone-proguanil, etc.). Furthermore, the resulting poor management of non-malarial pathologies takes a heavy toll on family income. Most importantly, the delays in the etiological diagnosis of non-malarial fevers can have serious consequences on the patient (Amexo et al., 2004; Barnish et al., 2004; Nankabirwa et al., 2009). Many other diseases such as typhoid fever, pneumonia, toxoplasmosis, rubella and other bacteraemia are very often misdiagnosed for malaria because of their very similar clinical manifestations, making their differentiation difficult (Redd et al., 1992; Prasad et al., 2015). With reports of the decline in the incidence of malaria in many African countries (Bouyou-Akotet et al., 2009; Delacollette et al., 2009; Satoguina et al., 2009), it is imperative that parasite confirmation of malaria be scaled up in all age groups. Rapid diagnostic tests (RDTs) are cheap and practical for improving on the diagnosis and treatment of malaria and have been adopted as a public health policy in several African countries (Reyburn et al., 2007; Bisoffi et al., 2009; Bastiaens et al., 2011). The causes of non-malarial fevers can then be followed up and managed appropriately (Oladipo and Wellington, 2013). To determine the causes of fevers in the Ekounou Health Area, about 6 km from the centre of Yaounde, this study sought to evaluate clinical, parasitological, molecular and RDT data in order to provide an algorithm for fever management.

MATERIALS AND METHODS

Study population and sample collection

At the Ekounou Health Clinic of the Cameroon Baptist Convention, by convenient sampling, a total of 50 children were recruited consecutively for a cross-sectional study during the period of February to April 2013. The children were enrolled if they met the following criteria: 6 to 60 months of age, documented fever at presentation or history of fever in the last 24 h (rectal temperature ≥ 37.5ºC or axillary temperature ≥ 38ºC), absence of signs of complicated/severe malaria or any known serious chronic disease (to avoid the rapid deterioration of the state of such children which is common if not promptly contained), and the willingness of the parent/guardian to grant a written assent. Those that presented with signs of complicated malaria such as convulsion/coma, prostration, and/or severe vomiting, were excluded and managed appropriately or referred to the next level of healthcare in the area. The Case Report Form (CRF) that documented axillary body temperature, history of fever and other presenting symptoms was completed for each patient before venous blood puncture.

Ethical issues

Ethical clearance for the study was obtained from the Cameroon National Ethics Committee in a project entitled "An equity and cost effectiveness analysis strategy for the deployment of artemisinin-based combination therapy (ACT) at the community level'' (N°113/CNE/SE/2011). The participation in this study was proposed to every parent/guardian who brought his child to the clinic for reasons of fever. After information and response to all enquiries those who authorised the participation of their children concretised their agreement by signing the assent form.

Sample collection

The clinical and anthropometric parameters of each child were measured, followed by venous puncture under aseptic conditions for the collection of 3 ml of blood in Ethylene Diamine Tetra-acetic Acid (EDTA) tubes. From the total blood, 2 slides were immediately prepared for microscopy (thick and thin blood smears), and some drops were used to determine the random blood sugar and haemoglobin levels. Some more drops were also used for RDTs (malaria, typhoid fever), while a last few were deposited on filter paper and dried at room temperature for Deoxyribonucleic Acid (DNA) extraction. The remaining blood found in the EDTA tubes was centrifuged thereafter at 20 000 rpm for 5 min to collect plasma, part of which was used for the rapid diagnosis of rubella and toxoplasmosis. The remaining part was preserved at -20°C for further use

Disease diagnosis by RDTs

For each child enrolled, one-step RDTs were carried out on total blood for malaria (*SD BIOLINE Malaria Ag Pf/Pan*) and typhoid

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fever (*OnSite Typhoid IgG/IgM Combo Rapid Test*) and on plasma for rubella (*Rubella* ^{TM}) and toxoplasmosis (*OnSite Toxo IgG/IgM Rapid Test)*. Were performed as recommended in the manufacturers' guidelines found in the kits. The Malaria RDTs detected the Histidine-Rich Protein II (HRP-II) and *Plasmodium* Lactate Dehydrogenase (*p*LDH) antigens that are specific for Plasmodium species, while the 3 others (for typhoid, rubella and toxoplasmosis) detected Immunoglobulin M (IgM) and Immunoglobulin G (IgG) antibodies in blood and plasma. The choice of the 4 RDTs was guided by the increased frequency of these illnesses in the region and there was an anecdotal claim of a rubella outbreak (INS, 2010).

Parasitological diagnosis of malaria

Venous blood from each child was used to prepare thick and thin smears on 2 slides each. The thin films were fixed with absolute ethanol and left to dry. The prepared smears were stained with 10% Giemsa at pH 7.2 for 15 min. The parasite density was calculated as the number of parasites per 200 leucocytes on a thick film and reported as parasites per microliter of blood, assuming an average white blood cell count of 8000/µL (Greenwood and Armstrong, 1998). Stained slides were examined under a light microscope using the 100X objective with immersion oil. A slide was considered negative after 100 high power fields (HPF) were examined and two other microscopists reread the slides for confirmation. Parasite counts with more than 20% discordance between two readers were reread by a third person, who served as the tie breaker. The counts with less than 20% discordance between the first and second readers were accepted and the mean parasite count taken to compute the parasite density or parasitaemia for each child.

Measurement of biological parameters

Glycaemia and haemoglobinemia were measured using *OneTouch Ultra 2* and *URIT-12-Hemoglobin Meter* kits respectively and performed as recommended by the manufacturers, knowing that the normal range of blood glucose is 70 to 110 mg/dL and for the age- and gender-dependent total haemoglobin levels: Male adults (13.5-18.0 g/dL), female adults (12.0-16.0 g/dL), 1-5-year olds (11.4-14.1 g/dL) and infants (14.5-22.5 g/dL).

White blood cell counts were estimated microscopically in a counting chamber with a cover glass (haematocytometer) after diluting 20 µL of blood with 0.38 mL of diluting fluid (acetic acid-Gentian Violet). The count was done using the 10X objective and was reported as the number of white blood cells per litre of blood using a simple calculation (Cheesbrough, 1998).

Faeces examination was done to detect yeast cells microscopically after fixing a small amount of stool on a glass slide with a Bunsen flame. It was then visualized under a slide cover using a saline solution with the 40X objective (Cheesbrough, 1998).

Molecular analyses

DNA extraction

The Chelex method (Bio-Rad) was used to extract DNA for nested PCR from human blood that had been blotted as spots on filter paper and dried. A single blood spot from each filter paper was excised and then incubated for 4 h at room temperature or overnight at 4°C in 1 ml of 0.5% saponin in phosphate-buffered saline (PBS). The filter paper was washed for 30 min in PBS at 4°C and transferred into new tubes containing 50 µL of 5% Chelex-100 (Bio-Rad Laboratories, SIGMA) and the tubes were homogenised for 30 s. The mixture was incubated at 100°C for 15 min, homogenised for 30 s, heated again at 100°C for 15 min to elute the DNA, homogenised one more time, and then centrifuged (10,000 rpm for 2 min). The supernatant (DNA extract) was either used immediately for the reaction or stored in aliquots at 20°C.

Nested PCR for speciation

The species-specific nucleotide sequences of the 18S rRNA genes of *Plasmodium* were the targets of the experiment that was carried out as described by Snounou et al. (1993). The reaction conditions were according to the method of Boonma et al. (2007) with slight modifications as described subsequently.

In the first PCR, 2 µL of template DNA (corresponding to approximately 0.25 to 0.5 µl of blood) were added to a 18 µL PCR mixture that consisted of 10 µM each of universal primers (P1 forward primer [5'-TTAAAATTGTTGCAGTTAAAACG-3'] and P2 reverse primer [5'-CCTGTTGTTGC CTTAAACTTC-3']), 10 mM of each deoxynucleoside triphosphate, 15 mM $MgCl_2$ in 10X PCR Thermopol Buffer, and 5 U Taq DNA polymerase. DNA amplification was carried out under the following conditions: 95°C for 15 min, followed by 26 cycles at 94°C for 30 s, then 58°C for 1.5 min, and 72°C for 1 min, ending with a final hybridation and extension at 58°C, and 72°C respectively for 5 min. One microliter of this solution (Outer DNA product) was used in the second amplification in which it was added to 19 µL of master mix. This PCR was performed at 94°C for 10 min followed by 30 cycles at 92°C for 30 s, 60°C for 1.5 min, 72°C for 1 min, and ending with a final extension at 72°C for 5 min with the P1 forward primer in combination with each species-specific reverse primer (*P. falciparum f/r*, 5'TTAAACTGGGAAAACCAAATATATT/ACACAATGAACTCAATCATGACTA CCCGTC3'; *P. malariae f/r*, 5'ATAACATAGTTGTACGTTAAGAATAACCGC/AAAATTCCCATGCA TAAAAAATTATACAAA-3'; *P. ovale f/r*, 5' ATCTCTTTTGCTATTTTTTAGTATTGGAG/GGAAAAGGACACATTTGTATCCTAGTG-3'). The amplified products were visualized on 2% agarose gels stained with ethidium bromide. The expected band sizes were approximately 1200 bp for the first PCR products specific for the *Plasmodium* genus; and for the second one specific for species, 205 bp for *falciparum*, 144 bp for *malariae,* and 800 bp for *ovale*. To prevent cross-contamination, different sets of pipettes and distinct work areas were used for DNA template preparation, PCR mixture preparation, and DNA amplification.

Statistical analyses

The XLSTAT Windows version 13.0 was used both for data entry and analyses. Differences in clinical parameters were evaluated using a non-parametric (Mann-Whitney) test. Concordances between the RDT/MIC, RDT/PCR and MIC/PCR were evaluated using the Kappa Cohen coefficient test. The performances (sensitivity, specificity, positive predictive value and negative predictive value) of the tests were also determined, using standard formulae, to compare the diagnostic methods. Significant levels were fixed at 5%.

RESULTS

A total of 50 less-than-five-year-old patients were enrolled in the study, including 24 males (48%) and 26 females (52%). The median age was 27.5 months (CI: 18-48) and the mean body temperature was 38.8±0.72°C.

Table 1. Causes of febrile diseases in the study.

	Number of cases	Cases (%)
	Mono- and co-infection (n=50)	
Toxoplasmosis	11	22
Malaria	4	8
Typhoid fever	4	8
Malaria-typhoid fever	7	14
Malaria-toxoplasmosis	2	4
Malaria-toxoplasmosis-typhoid fever	3	6
Total toxoplasmosis	16	32
Total malaria	16	32
Total typhoid fever	14	28
Rubella	0	0
Undetermined	19	38

Table 2. Symptomatic presentation of children with infections.

Symptoms	Malaria	Toxoplasmosis	Typhoid Fever	Undetermined
	Positive n=16 (%)	Positive n=16 (%)	Positive n=14 (%)	n=19 (%)
Cough	11 (68.75)	11 (68.75)	10 (71.42)	19 (100)
Diarrhea	2 (12.25)	3 (18.75)	1 (7.14)	5 (26.31)
Asthenia	14 (87.5)	13 (81.25)	12(85.71)	16 (84.21)
Ear-nose-throat	5 (31.25)	11 (68.75)	6 (42.85)	7(36.84)
Skin rashes	0 (00.00)	4 (25)	0 (00.00)	7 (36.84)
Headaches	7 (43.75)	3 (18.75)	6 (46.85)	5 (26.31)
Respiratory distress	2 (12.25)	3 (18.75)	1 (7.14)	5 (26.31)
Stomach pain	5 (31.25)	5 (31.25)	3 (21.42)	1(5.2)
Vomiting	8 (50)	6 (37.5)	5 (35.71)	0(00)
Anorexia	10 (62.5)	7 (43.75)	8 (57.14)	9(47.36)
Chills	5 (31.25)	2 (12.25)	4 (28.57)	1(5.2)
Constipation	2 (12.25)	0 (00)	2 (14.28)	1(5.2)
Convulsion	1 (6.25)	1 (6.25)	0 (00.00)	0(00)

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Table 1 shows the causes of the febrile illnesses in the study population. Toxoplasmosis and malaria were the major causes of the fevers which in some cases presented as single, double and even triple infections. No case of rubella was detected and these RDTs for the four common causes of fever in the setting could not determine the cases of 19 children.

Table 2 depicts the burden of clinical symptoms that the febrile children presented with. They were found to be highly similar for the 3 diseases, with asthenia as the most noted, while erythema, constipation and convulsion were the least represented.

Table 3 indicates the biological parameters of the febrile children. With respect to these, glycaemia was not significantly different with or without malaria (p=0.6), toxoplasmosis (p=0.2), or typhoid fever (p=0.8).

However, children with malaria had significantly lower median total white blood cell counts (p=0.02), while a significantly lower median haemoglobin level was seen in children infected with toxoplasmosis (p=0.03).

Table 4 shows the relationships between possible sources of exposure to the 3 diseases. There was no significant impact of the factors on disease occurrence.

Figure 1 depicts Plasmodium species identified by nested PCR. Microscopy for malaria without speciation revealed that 14 (28%) were positive for the parasite while the rest of the 36 (72%) were negative and the parasite density ranged from 1000 to 270 000 parasites/µl of blood while the median was 43 474 parasites/µl of blood. From the 2 rounds of nested PCR, 19 (38%) turned out to be positive for malaria against 31 (62%) negative cases. Three species were differentiated: *Falciparum, malariae* and *ovale* in the mono- and mixed infections. *P. falciparum* was not the dominant species

Table 3. Biological parameters of the children with febrile diseases.

Parameter	Malaria		Toxoplasmosis		Typhoid fever	
	Mal+ (16)	Mal- (34)	Toxo+ (16)	Toxo- (34)	Typhi+ (14)	Typhi- (36)
Glycaemia (mg/dL)	109(91-142)	104 (97-120)	104 (91-115)	111 (97-139)	105 (90-141)	106 (95-127)
P values	(*p*=0.6)		(*p*=0.2)		(*p*=0.8)	
Haemoglobinemia (g/dL)	9.85 (7.9-11.25)	9.85 (8.9-11.1)	9.06 (8.9-10.7)	10.45 (9.75-11.35)	9.6 (9.4-10.7)	9.95 (8.95-11.15)
P values	(*p*=0.4)		(*p*=0.03)		(*p*=0.9)	
WBC x10^{9}cell/µl	4.95 (3.8-5.7)	6.65 (5-9.3)	6.65 (4.85-11.2)	5.5 (4.6-7.1)	5.7 (4.9-6.7)	6.15 (4.6-8.1)
P values	(*p*=0.02)		(*p*=0.2)		(*p*=0.7)	

Mal, Malaria; Toxo, Toxoplasmosis; Typhi, Typhoid fever; WBC, White Blood Cells; cell, cells. The results are presented in median (interquartile domain).

Table 4. Relationship between febrile illness and possible sources of exposure.

Parameter	Malaria		Toxoplasmosis		Typhoid	
	Mal+ (16)	Mal- (34)	Toxo+ (16)	Toxo- (34)	Typhi+ (14)	Typhi- (36)
Use of mosquito nets						
Yes	9	23	-	-	-	-
No	7	11	-	-	-	-
P value	*p*=0.434		-		-	
Contact with domestic animals						
Yes	-	-	8	11	-	-
No	-	-	8	23	-	-
P value			*p*=0.230		-	
Consumption of drinking water						
Yes	-	-	-	-	11	27
No	-	-	-	-	3	9
P value	-		-		*p*=0.8	
Cleanliness of habitat						
Yes	5	8	-	-	4	9
No	11	29	-	-	10	27
P value	*p*=0.6		-		*p*=0.796	
Consumption of vegetables/meats						
Yes	-	-	9	13	7	15
No	-	-	7	21	7	21
P value	-		*p*=0.231		*p*=0.6	

Mal+ , Cases of malaria; Mal- , cases without Malaria; Toxo+ , cases of toxoplasmosis; Toxo- , cases without toxoplasmosis; Typhi+ , Cases of typhoid fever; Typhi, cases without typhoid fever.

encountered (11/19, 57.86%) though slightly less than *malariae* (12/19, 63.15%) and more than *ovale* (7/19, 36.84%). The mixed *falciparum-malariae* infections represented 21.05% of the cases.

Of the 19 fever cases not diagnosed by any of the RDTs, 7 had yeast in their faeces, 9 had upper respiratory tract infections (URTI) and 3 were unspecified.

Table 5 shows the performances of RDT, microscopy and PCR for malaria. The malaria RDT showed a very good performance as compared to microscopy with a sensitivity of 92.9% DI [66.1-100] and a specificity of 91.7% DI [77.3-97.7]. Malaria RDT and PCR showed good performance when compared to microscopy which is the gold standard method for the detection of this disease.

DISCUSSION

Malaria is a frequent and preoccupying health issue in children in malaria-endemic areas. Because of the similarity of its symptoms with other common causes of

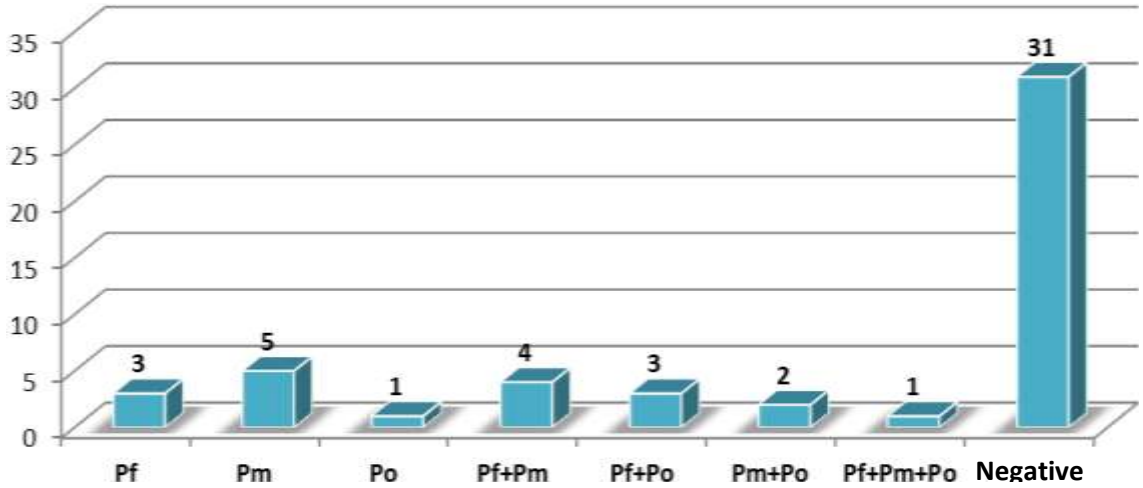

Figure 1. Malaria speciation by nested PCR.

Table 5. Sensitivity, specificity of nested PCR, microscopy and RDTs in the diagnosis of malaria in the study population.

Test	MIC				
	Sensitivity %	**Specificity %**	**PPV %**	**NPV %**	***k***
RDT	92.2(66.1-100)	91.7(77.3-100)	81.3(62.1-100)	97.1(91.7-100)	0.81(p<0.0001)
PCR	100(86.6-100)	73.7(50.8-88.4)	100(100-100)	86.1(74.8-97.4)	0.77(p<0.0001)

MIC, microscopy; RDTs, rapid diagnostic tests; PPV, positive predictive value; NPV, negative predictive value; 95% confidence intervals are indicated in parentheses.

fever, it is the most frequent culprit, and this results in failure to diagnose and treat other life-threatening conditions. The present study highlighted the causes of fever in children less than 5 years old in a health facility in Yaounde, Cameroon, a country in sub-Saharan Africa where approximately 95% of the malaria cases are due to *P. falciparum*. RDTs made it possible to detect that the fevers were related to malaria, toxoplasmosis and typhoid, with no case of rubella. Microscopy and PCR methods were strongly in agreement with the RDT results for malaria. A preceding study in Burkina Faso during the rainy season, using RDTs, showed that almost half of all the fevers were due to malaria and this proportion was very high among the children and infants (Wang et al., 2005). Our study, undertaken during the rainy season (March-April) as well, on the contrary showed a lower frequency of malaria in less than half (1/3) of the children. These results however corroborated with the 29% (1/3) of malaria cases found among febrile patients by Mangham et al. (2012) in Cameroon. They equally found 70% (2/3) with negative results for whom an antimalarial had been prescribed or administered, pointing to the overdiagnosis and wrong treatment of the condition, and thereby overlooking the real causes of the fevers. This supports the fact that even in high malaria transmission zones, fever in children less than 5 years is not exclusively due to malaria and malaria case management has to be improved since symptomatic diagnosis is inefficient because two-thirds of febrile patients may be found not to have malaria.

The cases of fever in our study were due to mono- and co-infections. The co-infections could explain the persistence of the condition due to the poor or insufficient diagnosis. The number of children with fever due to toxoplasmosis mono-infection was a call for more attention to be paid to this disease which is not often included in the differential diagnosis of fever (Asad et al., 2006). The present study found that toxoplasmosis cases were higher in number than malaria and typhoid fevers. Sayang et al. (2009) had also shown that malaria was not the first cause of fevers in children less than 5 years old in Yaounde. The observation of the absence of rubella could be an indication that the anti-rubella vaccine administered to pregnant women and the resulting transplacental passive immunisation of their unborn children is very effective. The symptoms of malaria, toxoplasmosis and typhoid fever were very similar, indicating the difficulty in discriminating malaria from the others on a simply clinical basis. This again exacerbates the limits of presumptive diagnosis in the management of these diseases. Indeed, Hogh et al. (1995) had shown that the clinical diagnosis of malaria, especially in infants,

has a poor accuracy and a low positive predictive value because its symptoms and signs are variable and can easily be mimicked by other infectious or non-infectious diseases.

Malaria was associated with a significant drop in the level of white blood cells, which could be explained by the fact that during the illness they relocalise from the members (where blood is generally drawn for the tests) to the spleen and other such affected internal organs where they actively get involved in the fight (McKenzie et al., 2005).Toxoplasmosis was associated with a drop in the level of red blood cells. This can be explained by the fact that the parasite infects these cells, resulting in anaemia which is a critical manifestation of the disease (Michelson and Lammi, 1984). The presence of yeast in the stool of some of the patients could explain the cause of their fever that was not detected by the RDTs. The 57.86% frequency of *P. falciparum* obtained was higher than the 12% reported in Tanzania (Mazigo et al., 2011), close to the 56.9% reported in a similar study in Nigeria (Ikeh and Teclaire, 2008) and the 72.86% found in Cameroon (Achonduh et al., 2013), and lower than the 96.5% reported in another similar study in Nigeria (Bousema et al., 2008). Moreover, Bousema et al. (2008) reported that a mixed *P. falciparum/P. malariae* infection could have an implication on the transmission of *P. falciparum* since *P. malariae* seems to increase the gametocytes of *P. falciparum* (Swartout et al., 2007).

Few studies have been carried out specifically on the use of RDTs in the case management of sick African children less than 5 years old in areas of intense malaria transmission (Tarimo et al., 2001; Rimon et al., 2003). The statistical kappa test showed a very good significant association between RDT/MIC (0.81, p<0.0001) and RDT/PCR (0.84, p<0.0001) and a good significant agreement between PCR/MIC (0.77, p<0.0001). This suggests that the RDT is a good and simple tool for the diagnosis and confirmation of malaria cases for management of febrile illnesses in children (Faucher et al., 2010). It can therefore be implemented in the Integrated Management of Childhood Diseases program (Tarimo et al., 2001), allowing for a rationalized management of children with fevers (Sayang et al., 2009; Msellem et al., 2009). To be able to institute clinical management, other structures would have to be put in place to improve on health delivery services that would help in lowering unnecessary expenditures.

An indirect advantage of the malaria RDT is that it draws quick attention to the non-malarial infections in the event of negative results (Sayang et al., 2009; Swartout et al., 2007) but the disadvantage is that this latter event can easily increase the use of antibiotics, promoting resistance.

The small sample size of the population stands as a limit to sustain the conclusions arrived at, though the hypothesis initially set was confirmed by this pilot study. Nevertheless, the results presented show that RDTs are reliable in peripheral settings where microscopy or PCR are not available. Therefore, there is a need for an epidemiological study to be conducted on the other causes of fever over the national territory where the epidemiology of malaria is not uniform. In this way, a follow-up algorithm can be proposed for patients with fever based on biological diagnosis.

Conclusion

Malaria was not the exclusive cause of fever in the population of children studied. Toxoplasmosis occurred in proportions similar to malaria (32%). Typhoid fever was the third most common infection, affecting 28% of the patients. RDTs were shown to be good diagnostic tools that can be used for the appropriate diagnosis and management of childhood malaria and other illnesses which have fever as the major aetiology.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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