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Treatment-seeking behavior and practices among caregivers of children aged ≤5 y with presumed malaria in rural Uganda

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Background: We aimed to determine the rate of herbal medicine usage and the treatment-seeking patterns of children aged ≤5 y with presumed or confirmed malaria in an endemic area of Uganda.

Methods: We interviewed guardians of 722 children aged 6 months to 5 y, who had experienced an episode of presumed malaria in the previous 3 months, about the illness history.

Results: Overall, 36.1% of patients took herbal medicines but most also sought modern medical care; 79.2% received Artemether-Lumefantrine (AL), but only 42.7% received the correct AL dose. Of the 36.6% of patients treated in drug shops, 9.8% had a diagnostic test and 30.2% received the correct dose of AL. Antibiotics were frequently provided with AL at drug shops (62%) and formal health centers (45%). There were no significant differences in the self-reported outcomes associated with different treatments.

Conclusion: Almost all of the patients who took herbal medicine also took modern antimalarials, so further research is needed to explore potential interactions between them. Although formal health facilities provided the correct diagnosis and dose of AL to a majority of children with malaria, many children still received inappropriate antibiotics. Quality of care was worse in drug shops than in formal health facilities.

Keywords: artemisinins, guideline adherence, healthcare-seeking behavior, herbal medicine, malaria, Uganda

Introduction

WHO estimates that globally there were 214 million cases of malaria in 2015 causing 438 000 deaths, most of these in sub-Saharan African children.[1] Malaria is an important contributor to continuing poverty because it adversely affects economic growth.[2] However, in Uganda, intensive efforts at malaria control in the last decade have contributed to meeting the Millenium Development Goal target on reduction of child mortality: the overall under-5 child mortality rate declined from 116 per 1000 in 2002–2006 to 64 per 1000 in 2012–2016.[3]

In the 1990s, resistance to chloroquine and sulfadoxine-pyrimethamine resulted in a great increase of mortality and morbidity from malaria.[4] WHO recommend that artemisinin combined therapy (ACTs) be used as first-line treatments for *Plasmodium falciparum* in all malaria-endemic countries.[5] Uganda adopted Artemether-Lumefantrine (AL), sold as Coartem, as the first-line treatment for malaria in 2004, and it is still regarded as the national gold standard.[6] Artemisinin derivatives clear parasitemia more rapidly than all other currently available drugs. Recent increases in the use of ACTs, along with public health interventions such as the increased use of insecticide-treated bed nets, have greatly reduced the global burden of malaria.[1,7]

However, in 2014–2016, the incidence of malaria increased slightly in most of the world, and the decline in malaria deaths stalled.[1] The reasons for this are unclear. Artemisinin-resistant *P. falciparum* has emerged in Asia,[8,9] and in 2017 a case study reported artemisinin resistance in Equatorial Guinea.[10] Early detection of artemisinin resistance in sub-Saharan Africa will be important in forming policy for malaria containment. Further, investigating the quality of malaria case management at household and health center levels is critical.

In Uganda, public health facilities offer free services to patients. However, these health facilities frequently suffer from stock-outs of medicine and diagnostic equipment, which leads to patients frequenting drug shops often staffed by underqualified or unlicensed personnel operating with very little to no oversight of compliance with guidelines.[11,12] The national policy recommends a 'test and treat' strategy for malaria,[13] but this is not always implemented, especially in drug shops.

To compensate for lack of access to western medicine, herbal remedies are often used to treat malaria and other illnesses. For example, one study in western Uganda in the Kasese district found that 81% of respondents had used herbal medicine at some point in their lives.[14] In areas where medical personnel and drugs are insufficient to treat illnesses, WHO recommends the implementation of traditional/herbal medicines including medicinal plants as a form of healthcare, and Uganda supports the use of herbal medicine if proven effective towards its integration.[15] The primary outcome of this study was the rate of herbal medicine usage. Secondary outcomes were undertaken to determine the prevalence of use of different treatments for malaria sought by caregivers of children aged ≤5 y, the diagnostic and prescription practices of healthcare workers in Uganda, as well as associated outcomes. Given its observational nature, the portion of this study regarding outcomes associated with various types of medicine was intended as an exploratory study with the necessity of further research to confirm its findings.

Methods

We conducted a cross-sectional survey of caregivers of children presumed to have had malaria in the past 3 months in eastern Uganda. We used a 'retrospective treatment outcome' method, which has previously been successfully used in Mali to identify treatment-seeking patterns and to generate hypotheses about the effectiveness of different treatments.[16–18]

Study area and period

This study was conducted in 30 villages in the Namutumba district, eastern Uganda, in June 2015, at the end of the rainy season, which lasted from March to June. The Namutumba district was chosen because of its high poverty levels and high prevalence of malaria due to the presence of marshland. The 2014–2015 malaria survey found that 49% of children were rapid diagnostic tested-positive for malaria in this region.[19] Up to 90% of the 268 900 inhabitants of Namutumba live in rural areas, while 10% live in semiurban parts of the district. There is only one paved road through the district (Figure 1).

Study population

This study recruited participants with sub-county stratification adjusted for population in the Namutumba district. Respondents were caregivers of children aged 6 months to 5 y who had had one or more signs and symptoms of malaria in the past 3 months. Children aged <6 months were excluded because other causes of fever are more common than malaria in this age group.[20,21] We anticipated that many children would not have been tested for malaria, so as well as asking about diagnostic tests, we also asked questions about symptoms.

Questionnaire for caregivers

A structured questionnaire was administered to the respondents. Demographic information was collected to ensure that the respondents met the inclusion criteria. We asked specific questions to define the disease. We asked whether healthcare was sought, whether a diagnostic method was used, within which timeframe, what treatments were taken and the duration of the illness. We also asked about outcomes associated with each treatment. We asked whether the child developed symptoms of severe malaria, such as becoming lethargic, unresponsive, showing symptoms of jaundice and having convulsions.

If the plants used as local remedies were unfamiliar to the research team, then respondents were asked to show the plant used. Specimens of each plant species were collected for formal botanical identification at the Makerere University Herbarium. The scientific names of the plant species were validated based on the Kew database.[22] Plant families were verified using the Angiosperm Phylogeny Group III at http://www.mobot.org/MOBOT/research/APweb/.

Sample size and sampling procedure

The sample size calculation was based on a two-stage cluster design, with villages constituting the primary units (clusters) and households the secondary units (samples).[23,24] The following estimations were used in calculating the desired sample size: estimated proportion of patients using herbal medicine=20%; SE=0.025; design effect=2; clusters required=30; and N total required=525. Prevalence of use of herbal medicine was the primary outcome. Through random sampling stratified by the population of each of the seven sub-counties of the Namutumba district, 30 rural villages were selected.

Data collection method and tools

The questionnaires were administered by eight university graduates fluent in English and Lusoga, chosen through an application review and subsequent interviews. Six were health workers in the Namutumba district who contributed their knowledge of the district to streamline participant interviews. Each data collector was trained on the use of the questionnaire, explaining the purpose of the study to the respondents and obtaining written consent from the caregivers of the children. The structured questionnaire was initially prepared in English, translated to Lusoga and checked for its consistency through back-translation to English.

Village health team volunteers, who are elected by the village to serve as community health workers, were present at every survey to build trust and rapport. Each team of 2–3 data collectors administered structured surveys in one study site per day. If there were several cases of presumed malaria in the same household, only the latest case was recorded. The supervision team planned to repeat 10% of the interviews at random, at least one from each of the 30 study sites, to control the quality of the data collection. When multiple discrepancies arose between the information collected by the data collection team and the supervision team, all the surveys of the data collector on that day were excluded.

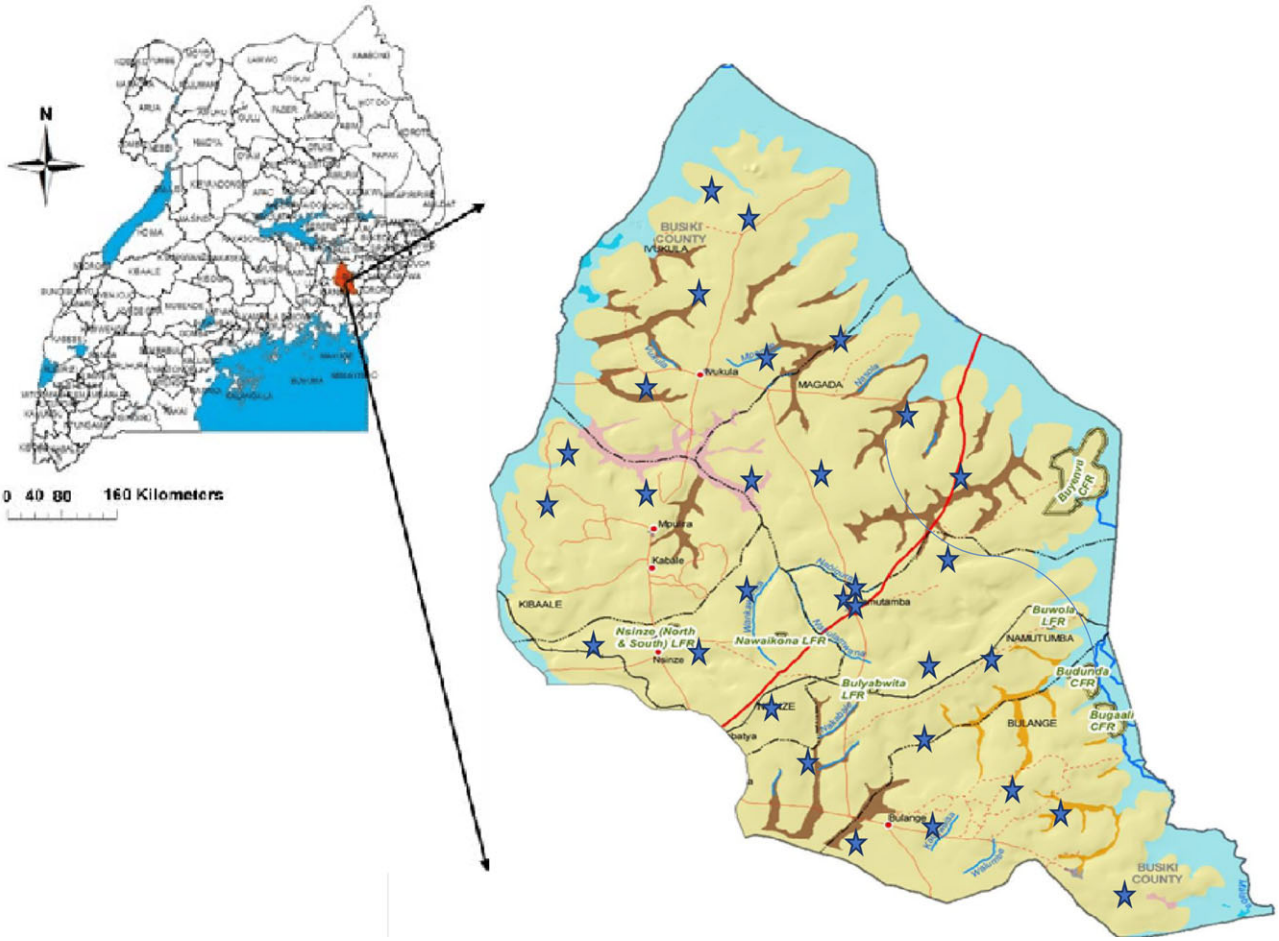

Figure 1. Map of the Namutumba district and the study sites (marked by blue stars).

To ensure the greatest probability that the children had malaria and not other febrile illnesses, questions on rapid diagnostic tests were asked, and those that tested negative were excluded. We excluded cases with symptoms most likely caused by an illness other than malaria (e.g. rashes all over the body or swollen body or legs).

Quantitative data analysis

Data were first checked for completeness and then entered into Epi Info 7 (CDC, Atlanta, GA, USA). After data entry and cleaning, the data were transferred to a Microsoft Excel 2013 spreadsheet (Microsoft Corp., Redmond, WA, USA) for analysis. Proportion-based analyses were conducted to evaluate treatment outcomes based on drug combinations, order of medication usage, appropriate vs inappropriate dosages and clinical diagnosis status. Similar analyses were conducted to evaluate differences in respondents who visited formal and informal drug shops. We also tested whether there were correlations between treatments and reported outcomes, specifically whether the patient considered themselves to be 'cured' (i.e. to have no more symptoms).The Z-test for two population proportions was used to test for significance of proportional differences.[25]

Ethical issues

Verbal informed consent was obtained from all local council chairmen of the 30 study sites before data collection. The purpose of the study was explained in the local language (Lusoga) to study participants and written consent was obtained before each interview commenced. Personal information was kept confidential and was available only to the study team. The interviews took place at a time and place chosen by participants. All data from the interviews were stored in a password-protected laptop and all paper copies were kept in a locked cabinet.

The study received ethical clearance from Washington University in St. Louis Institutional Review Board, The AIDS Support Organization (TASO) Institutional Review Board in Uganda and Uganda National Council of Science and Technology (UNCST) (HS 1816).

Results

Subject demographics

Cluster size depended on the local prevalence of malaria and the size of the village, but we interviewed an average of 24 caregivers per village. We interviewed a total of 752 caregivers

of children with presumed malaria. Of these, 30 were excluded because of data discrepencies between the collection and supervision teams, so 722 cases were retained. The mean age of the 722 children surveyed was 28 months and 54.7% were boys. The characteristics of participants showed that they were representative of the population of the Namutumba district: 74.3% of households reported an average monthly income <US$14 per month and 95.1% of respondents were subsistence farmers.

Treatment seeking

Most respondents assessed (646/722, 89.5%) eventually sought treatment at a public health facility and 219 (30.5%) did so within the first 24 h. Sixteen respondents (2.2%) exclusively used herbal medicines at home and did not take any other treatment. The remaining 706 patients obtained modern medicines. Out of the 706 patients who took modern medicines, 245 also used herbal medicines. Overall, 261 of the 722 respondents (36.1%) reported using herbal medicines. All herbal medicines were given at home, independent of drug shops and health centers. By far the most commonly used plant was *Vernonia amygadalina* (92.0%, 240/261). The second most common was *Chenopodium opulifolium* (31 respondents). Several other plants were also commonly used, and in total 51 plant species were reported for the treatment of malaria (Table 1). Whereas *V. amygdalina* was often prepared alone, many of the other plants were prepared in a mixture with *V. amygdalina*. The number of plant species in each remedy ranged from 1 to 7 (median = 2). Many herbs were prepared by squeezing the leaves or as a decoction, and the practice of preparation for herbal remedies seemed to be similar across households. Most herbal remedies were taken orally, although there were several that were taken through a bath of the solution.

The majority of respondents (422/722, 58%) consulted a formal healthcare facility, but a large proportion (39.3%) bought medicines from a drug shop. Only 9.2% of patients who went to drug shops had a diagnostic test, compared with 72.0% (304/422) of those who consulted a formal health facility (Table 2). In some cases, these treatments overlapped and resulted in drug combinations, but in most cases the drug combinations were received at the same time from one location. For the purpose of this analysis, all of these were grouped together and stratified by location of each prescription, irrespective of order.

Formal health facilities prescribed a significantly higher proportion of AL among the total prescriptions reported than drug shops (p=0.00001). For both formal health centers and informal drug shops, 203 of 376 (54.0%) total AL prescriptions were of an appropriate or excessive dose. Underdosing was reported in 173 of 376 (46.0%) cases. Of the 376 cases given AL, 148 (39%) also received co-trimoxazole, and other patients received a variety of other treatments (Table 3). Notably, in a sub-analysis of drug combinations, drug shops provided antibiotics including CTX along with AL 62% of the time, whereas formal health centers did so 45% of the time. Both findings are notable for potential overprescription to treat malaria-like symptoms.

Many respondents (247) were excluded from a more detailed analysis because either their illness started <7 d before the survey, thus rendering the symptom clearance rate irrelevant, or because the patients forgot the exact treatments that they took. Of the 475 respondents for which a more detailed analysis was possible, 11 exclusively took herbal medicines and 19 took herbal medicines and then afterwards took modern non-antimalarials.

The vast majority of patients who took herbal medicine (156/184, 84.8%) started it on the first day of their symptoms and took it as their first treatment. However, most of these patients (131/156, 84.0%) then took a modern medicine, most often an antimalarial, within the next 3 d. Additionally, higher household income (p=0.01), access to motorized transport (p=0.005) and higher health center level nearest to residence (p=0.001) were correlated with shorter length of illness.

Outcomes associated with different treatments

The mean duration of illness after treatment as defined by becoming afebrile in those who took any antimalarials was 8.01 compared with 7.65 d in those who took no antimalarials (Table 3). The fever clearance rate was similar in both groups (98.6 in antimalarial vs 97.6% in those that did not take an antimalarial medicine but only took herbal medicines and/or a non-antimalarial). None of the differences in duration of illness after treatment or fever clearance rate were found to be significant in this analysis, even in patients with a confirmed malaria diagnosis (Table 3). Under- or overdosage of AL was not associated with any significant differences in self-reported duration of illness or fever clearance rates. Addition of co-trimoxazole to AL (at a correct or excessive dose) appeared to be associated with a higher self-reported fever clearance rate at day 3 than AL alone, but these differences disappeared from day 7 onwards (data not shown). It is impossible to evaluate outcomes associated with different herbal remedies, because most patients who took herbal medicines started a modern antimalarial soon afterwards.

Discussion

Summary of main findings

Although about a third of patients in this study took herbal medicine as their first treatment, the vast majority then sought modern medical care. The majority went to formal health facilities and received AL; a diagnostic test was done to confirm malaria in about 75% of cases, but only about 50% of patients received the recommended dose of AL. Formal health facilities frequently suffer from medicine stock-outs,[11] perhaps leading the medical care providers to give less than the recommended dose of AL. More than a third of patients were treated in drug shops, where very few had a diagnostic test (9.2%) or received the correct dose of AL (30.2%). Thirty-eight percent of patients received co-trimoxazole, in most cases together with AL. At day 7, only 74% of patients who had taken AL had total symptom clearance. However, there were no significant differences in the self-reported outcomes associated with a variety of different treatments, suggesting that some of the patients may not actually have had malaria.

Table 1. Herbal remedies taken by more than one respondent whose illness started >7 d before the interview and had complete recollection of treatments taken. Most respondents took more than one herbal medicine simultaneously (n=184)

Plant species	Family	Local name (Lusoga)	Plant part used	Preparation	Route of administration	Dose	Number of patients reporting use
Vernonia amygdalina Delile	Asteraceae	Lubirizi	L	Crushed and squeezed into juice	po	5–400 ml bds	161
Chenopodium opulifolium Schrad. ex W.D. J.Koch&Ziz.	Amaranthaceae	Namuvu	L	Squeezed into juice	bathing	200 ml added in half-full basin (about 20 l), bds	31
Ocimum americanum L.	Lamiaceae	Kakubansiri	L	Boiled with *Vernonia amygdalina*, *Carica papaya* and Biyongobera	po and bathing	200 ml used for bathing in half-full basin of water and 1 sp tds	24
Momordica foetida Schumach.	Cucurbitaceae	Ebombo	L	Decoction	po	3 sp tds	19
Lantana camara L.	Verbenaceae	Kapanga	L	Decoction of pounded leaves	po	tds	16
Azadirachta indica A.Juss.	Meliaceae	Neem	Fresh L	Decoction	bathing	200 ml added in half-full basin (about 20 l), bds	13
Aloe vera (L.) Burm.f.	Xanthorrhoeaceae	Kikaka	L	Decoction	po	100 ml tds	10
Hyptis suaveolens L.	Lamiaceae	Lukowe	L	Squeezed with *Vernonia amygdalina*, *Talinum portulacifolium* and lusunsuni	bathing	bds	9
Cannabis sativum	Cannabinaceae	Ndhaye	L	Infusion	po	2 sp tds	6
Carica papaya L.	Caricaceae	Eipaapali	L	Squeezed with *Vernonia amygdalina*, *Ocimum americanum* and biyongobera	po and bathing	2 sp tds and 200 ml added in half-full basin (about 20 l), bds	6
Persea americana Mill.	Lauraceae	Fakedo	L	Squeezed in ¾ basin full of water and used for bathing, another portion of 200 ml is taken orally 3 times a day	po and bathing		6
Bidens pilosa L.	Asteraceae	Bukaala	L	Decoction	po	5 ml tds	4
Hibiscus sabdriffa L.	Malvaceae	Ribena	F	Decoction, mixed with squeezed juice of *Vernonia amygdalina*	po	1 sp tds	3
Psidium guajava L.	Myrtaceae	Mapera	L	Decoction with *Ocimum americanum* and *Chenopodium ambrosioides*	bathing	bds	3
Lycopersicon esculentum Mill.	Solanaceae	Naana	L	Decoction	po	1 sp tds	3
Amaranthus dubius Mart. ex Thell.	Amaranthaceae	Dodo	L	Squeezed with *Vernonia amygdalina* and *Lantana camara* into juice	bathing		2

Continued

Table 1. *Continued*

Plant species	Family	Local name (Lusoga)	Plant part used	Preparation	Route of administration	Dose	Number of patients reporting use
Kedrostis foetidissima (Jac q.) Cogn.	Cucurbitaceae	Zizi	L	Decoction	po	100 ml tds	2
Jatropha curcas L.	Euphorbiaceae	Kilowa	L	Juice	po	200 ml bds	2
Erythrina abyssinica DC.	Fabaceae	Kiyirigiti	B	Decoction	po and bathing	100 ml tds po and 100 ml in half-full basin of water for bathing, tds	2
Ocimum gratissimum L.	Lamiaceae	Mujaja	L	Squeezed with *Chenopodium opulifolium* and *Vernonia amygdalina*	po	4 sp tds	2
Moringa oleifera Lam.	Moringaceae	Moringa	L	Decoction, mixed with *Aloe vera* and *Vernonia amygdalina*	po	2 sp tds	2
Talinum portulacifolium (Forssk.) Asch. ex Schweinf.	Talinaceae	Mpozia	L	Crushed mixed with warm water	po	100 ml	2

Plant parts: L=Leaf, B=Bark, F=Flower
Route of administration: po = oral intake
Frequency: bds=twice a day, tds=three times a day
sp=spoon

Strengths and limitations

This was a cross-sectional retrospective survey of the community using a sampling technique to ensure that respondents were likely to be representative of this community. In addition we conducted quality control measures. As the survey was retrospective, not all cases of malaria were confirmed, but as it was conducted at the end of the malaria season in an endemic area and we used the exclusion criteria detailed in the Methods, it is likely that the majority of cases really did have malaria. We did a sensitivity analysis including only those patients with a positive malaria test and the results remained the same. It was not possible to confirm 'cure' through blood tests, so the outcomes are solely based on reporting of the duration of symptoms by the guardians of the patients. Use of patients' reported length of illness to calculate 'mean duration of illness after treatment' and fever clearance rate as defined by the termination of a fever on specific days after treatment is more useful than simply asking about 'cure' vs 'no change or worse' after taking a specified treatment (as was done in previous similar studies).[26]

In a retrospective study, recall bias could negatively affect the reliability of the data collected, although we attempted to minimize this by limiting our parameters to children who were ill in the last 3 months. To minimize the impact of low literacy in our study population in the integrity of our data, we inspected the respondents' prescription books to find out what medicines they were prescribed. Selection bias probably explains the lack of difference in symptom duration between patients who took AL and those who did not: in the group that had no malaria test, it is likely that a proportion of the patients did not actually have malaria. In the group with a positive malaria test, those with a more serious illness were probably more likely to receive AL.

The fact that most of the interviewers were health workers, and that the interviews were observed by volunteer community health workers, may have influenced the responses of participants (making them less likely to report exclusive use of herbal medicines, for which they might fear criticism from health workers, and more likely to report use of the recommended antimalarial). As the reported exclusive use of herbal medicines was lower than anticipated, the sample size was insufficient to look at differences in outcomes associated with different herbal medicines.

Comparison with existing literature

Reported rates of AL use were higher than in many African countries,[1] but the fever clearance rate at day 7 was lower than

Table 2. Health facilities consulted within first 3 d of illness and compliance with diagnosis and treatment guidelines (n=722 respondents)

Level of health facility	Number (%) of people who consulted at this level	Number (%) who had a diagnostic test to confirm malaria	Number (%) who knew what treatment they had received	Number who received any AL (% of those who knew what treatment they received)	Number (%) who received AL at correct dose (% of those who knew what treatment they received)
None (home treatment)	16 (2.2%)	NA	11 (68.8%)	NA	NA
Drug shop (informal health facility)	284 (39.3%)	26 (9.2%)	179 (63.0%)	122 (68.2%)	54 (30.2%)
Formal health facilities:	422 (58.5%)	304 (72.3%)	285 (67.5%)	254 (89.1%)	149 (52.3%)
Private clinic	30 (4.2%)	16 (53.3%)	13 (43.3%)	11 (84.6%)	5 (38.5%)
Health center II	169 (23.4%)	105 (62.1%)	64 (37.9%)	51 (79.7%)	37 (57.8%)
Health center III	188 (26.0%)	156 (83.0%)	182 (96.8%)	169 (92.9%)	100 (54.9%)
Health center IV	33 (4.6%)	25 (75.8%)	24 (72.7%)	22 (91.7%)	7 (29.2%)
Hospital	2 (0.3%)	2 (100%)	2 (100%)	1 (50%)	0 (0%)
Total	722	330 (45.7%)	475 (65.8%)	376 (79.2%)	203 (42.7%)

AL=Artemether-Lumefantrine, NA=not available.
NGO or private clinic, Health center II, Health center III, Health center IV and Hospital are categorized as formal health facilities.

Table 3. Self-reported treatment outcomes by treatment group for those who knew all the treatments they received (n=475)

Treatment taken	Number of patients	Mean duration of illness after treatment (d)		Self-reported symptom clearance (%)			
		All patients	Patients with positive malaria test	Day 3	Day 7	Day 14	Day 28
AL alone or with herbal medicine	228	7.5	8.45	21.1	74.1	90.8	98.2
AL+CTX or with herbal medicine	148	8.2	8.86	25	68.2	87.8	98.6
CTX alone or with herbal medicine	29	8.4	8.63	10	58.6	93.1	100
CTX + quinine or with herbal medicine	4	15.8	NA	25	25	75	100
Other antimalarial or with herbal medicine	18	11.3	5.5	14.3	78.6	85.7	100
Other non-antimalarial or herbal medicine only	48	7.7	6.3	37.5	72.9	89.6	97.6

AL=Artemether-Lumefantrine
Cure rate defined as becoming afebrile

expected in patients who had taken AL. There is no evidence that artemisinin resistance has reached Uganda: only a single case has been reported in Africa.[10] The lower than expected fever clearance rates at day 7 are probably explained by the persistence of other symptoms or illnesses that are not related to malaria.

The low exclusive use of herbal medicines may be testimony to the success of public health education campaigns on seeking rapid treatment for childhood fevers. Our results confirm that *V. amygdalina* is the most popular antimalarial plant in Uganda, as reported by several other studies.[27,28] However, a clinical trial has shown that (at least when given alone) a decoction is only moderately effective.[14] Our study shows that individuals who took herbal medicine by itself or with non-malarials had a relatively high fever clearance rate of 72.9% by day 7, perhaps because some herbal medicines are effective, or because some of these patients may not actually have had malaria as herbal medicines are often taken at home without a diagnostic test, or

because some may already have acquired a degree of immunity to malaria. Uganda being a malaria-endemic nation, it has been observed that many people can maintain parasitemia without experiencing symptoms.[29] What is interesting in this study is that the leaves were mainly prepared as a fresh juice (as opposed to a decoction, which is more common in other areas)[28] and that it was very often combined with a variety of other plants, especially *C. opulifolium* and *Ocimum americanum* L. It would be worth investigating these different preparations and combinations, which may lead to synergistic effects.[30]

Implications for policy, practice and further research

The most concerning finding from our study is that a large number of patients first seek care from drug shops, which often provide inadequate quality of care (inadequate diagnosis and inadequate treatment dose). The high level of antibiotic use is potentially harmful, both because of increasing the risk of antibiotic resistance and because of the risk of serious side effects such as Stevens-Johnson syndrome. Although the antibiotic Co-trimoxazole has weak antimalarial properties, it is not recommended for the treatment of malaria, but it is the first-line drug in Uganda for pneumonia.[6] Further research is needed to understand the reasons for the high levels of antibiotic prescription in Uganda in patients with presumed (or confirmed) malaria.

Conclusion

The management of malaria in Uganda has improved since previous surveys, and formal health facilities are now providing the correct diagnosis and treatment to a majority of children with malaria, although there is still some room for improvement. However, a very high proportion of patients were also given an antibiotic (most commonly co-trimoxazole). More action is needed to reduce the overprescription of CTX in patients with malaria and to improve the quality of care, especially of that given by drug shops. Although 36% of patients took a herbal medicine, only 2.2% took it solely without any modern antimalarials. Further research is needed on potential interactions of herbal medicines with modern antimalarials.

Authors' contributions: YJL, SP and ML conceived the study; YJL, SP, FK and ML designed the study protocol; YJL and RK carried out and supervised the study; YJL, GA, RK and ML conducted data analysis; YJL and RK conducted data entry; YJL, GA and ML drafted the manuscript; GA, EK, RK and SP critically revised the manuscript for intellectual content. All authors read and approved the final manuscript. YJL and ML are guarantors of the paper.

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Competing interests: The authors declare that they do not have any competing interests.

Ethical approval: Verbal informed consent was obtained from all local council chairmen of the 30 study sites before data collection. The purpose of the study was explained in the local language (Lusoga) to study participants and written consent was obtained before each interview commenced. Personal information was kept confidential. The interview teams promised to keep the personal information confidential. The interviews took place at a time and place chosen by the participants. All data from the interviews were stored in a password-protected laptop and all paper copies were kept in a locked cabinet.

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