Interventions to Improve Providers' Ability to Diagnose and Treat Uncomplicated Malaria:

A Literature Review

Prepared by Lindsay Mangham,

Department of Public Health and Policy,

London School of Hygiene and Tropical Medicine (LSHTM)

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Executive Summary

Prompt access to effective malaria treatment is important, and many individuals rely on providers to diagnose malaria and dispense the recommended treatment. Whether the emphasis is on presumptive or parasitological diagnosis, ensuring that providers are able to supply treatment in line with national guidelines is critical for patient care. There are, however, longstanding problems with the care available at many public health facilities and private sector outlets. Given these problems and the recent interest in the use of RDTs, there is a need for interventions that improve the ability and practice of providers to treat patients that present at a health facility with a fever. This literature review examines the evidence available on interventions to improve providers' ability to diagnose or treat uncomplicated malaria.

A comprehensive search of the published literature was undertaken using bibliographic databases. Relevant publications in the grey literature were identified from review articles, reference lists of relevant publications and from websites of development agencies. Publications since 1990 were eligible if they met all of the following inclusion criteria:

- The **intervention** was intended to improve providers' ability to diagnose or treat uncomplicated malaria.
- The **population exposed to the intervention** are providers.
- The **study design** included a comparison group.
- The effect was reported on a **malaria-related outcome.**
- The **study setting** was an area of endemic malaria transmission in sub-Saharan Africa or Asia.

Evidence on effectiveness was synthesized using three types of outcome: i) presumptive treatment of uncomplicated malaria; ii) appropriate treatment of uncomplicated malaria (following a diagnostic test); and iii) the accuracy of prescribing antimalarial treatment regimens.

Twenty-nine publications were eligible for the review, which report on 27 studies and 32 different interventions. The majority of the studies were from Africa, with 8 from Kenya, 5 from Tanzania, 4 from Uganda and 3 from Nigeria. The majority of the interventions were designed to focus on malaria, though several included malaria within the Integrated Management of Childhood Illnesses (IMCI). Provider training was dominant, and the principal activity in 21 of 32 interventions. The training interventions included studies focusing on presumptive treatment of malaria, and studies on diagnostic testing.

Most interventions had a significant positive effect on the presumptive treatment of uncomplicated malaria, and the accuracy of the doses and advice given. The provision of RDTs and training on diagnostic tests improved the appropriate treatment of malaria, though the proportion of test-negative patients receiving antimalarials often remained relatively high. No studies compared an intervention in both public and private sector providers and only two programmes reported on the cost-effectiveness of the intervention.

Further work on interventions to improve the appropriate treatment of febrile patients would be valuable. The studies show that provider training and the provision of RDTs can be beneficial, though suggest that conventional approaches may have only a limited effect.

Abbreviations

ACT	Artemisinin Combination Therapy
AL	Artemether Lumefantrine
AM	Antimalarial
AQ	Amodiaquine
ASAQ	Artesunate Amodiaquine
BCC	Behaviour Change Campaign
CQ	Chloroquine
HW	Health Worker
IMCI	Integrated Management of Childhood Illnesses
NGO	Non-Governmental Organization
N/A	Not Applicable
OTC	Over the Counter
RCT	Randomized Control Trial
RDT	Rapid Diagnostic Test
SP	Sulphadoxine Pyrimethamine

Table of Contents

Boxes, Figures & Tables

1. Background

Malaria is a major cause of mortality, and the majority of the disease burden falls in sub-Saharan Africa [1]. There are approximately 250 million episodes of malaria each year, and about one million malaria-related deaths, mostly in children under five years of age [1]. Prompt access to effective malaria treatment is important, and many individuals rely on providers to diagnose malaria and dispense the recommended treatment. The most effective treatment for uncomplicated malaria is artemisinin combination therapy (ACT) and this medicine is the first-line recommended antimalarial across sub-Saharan Africa [2]. ACT replaced less effective antimalarials, such as sulphadoxine-pyrimethamine (SP) and guards against drug resistance by combining the artemisinin derivative with another type of antimalarial, such as lumefantrine or amodiaquine (as in artemether-lumefantrine and artesunate-amodiaquine).

The introduction of ACT has, however, brought new challenges. The treatment regimen for ACT is more complex than the former first-line treatment SP, which was taken as a single dose, and should be taken twice daily for three days in a dose suitable for the patient's weight or age. ACT is also considerably more expensive than alterative antimalarials, and as it can cost up to ten times more than SP, affordability is a key concern. The high cost of ACT also brought into question the widespread use of presumptive treatment in areas of low to medium malaria transmission. A revived an interest in parasitological diagnosis also coincided with the release of rapid diagnostic tests (RDTs) for malaria. Malaria RDTs have been shown to have high specificity and sensitivity, and have the potential to transform access to malaria testing since they are suitable for use in resource-constrained settings and do not require laboratory equipment or specialist skills.

Whether the emphasis is on presumptive or parasitological diagnosis, ensuring that providers are able to supply treatment in line with national guidelines is critical for patient care. However, there are longstanding problems with the care available at many public health facilities and private sector outlets [3, 4]. For example, despite the efforts of the Zambian malaria control programme to disseminate guidance on the change in first-line treatment from sulphadoxine pyrimethemine (SP) to artemether lumefantrine (AL), two years after AL (a type of ACT) had been adopted as the first-line antimalarial only 42% of children under five years received treatment in line with national guidelines [5]. Ensuring patients receive the recommended type of antimalarial is the first step, though it is also important that they receive the appropriate dose and understand how to take the full course of treatment. In terms of the dosage, recent studies from Kenya and Uganda reported more than 90% of children received ACT in the recommended dose, however such accuracy in dosing has not always been the case [5, 6]. For example, a study on treatment in government health centres in Nigeria found that 39% of antimalarials were in the correct dose, with 30% receiving an insufficient dose and a further 30% receiving more than required [7]. The same study showed even greater problems in the private sector, with 28% of patients at patent medicine dealers obtaining the correct dose, while half of the patients received an inadequate amount [7]. The advice given by providers to patients on how to administer the medicine may be a further source of problem [8].

Given the problems with the delivery of ACTs in several settings, as well as the relatively recent interest in the use of RDTs, there is a need for interventions that improve the ability and practice of providers to treat patients that present at a health facility with a fever. This literature review

examines the evidence available on interventions to improve providers' ability to diagnose or treat uncomplicated malaria. The review has been undertaken as part of the Research on the Economics of ACTs (REACT) project. The objective of REACT is to design and evaluate interventions to improve the treatment of uncomplicated malaria in Cameroon and Nigeria. This literature review has been undertaken to inform intervention selection and design.

This is not the first paper to review the literature on interventions to improve malaria treatment. Smith *et al* (2009) recently reviewed interventions to improve provider practice and user behaviour in relation to prompt and effective malaria treatment in sub-Saharan Africa [9]. Goodman *et al* (2007) and Brieger *et al* (2005) both review the literature on the role of private practitioners and interventions that have been used to improve their practice [4, 10]. Other related review articles have focused on interventions to improve home-based management of malaria or on improving prescribing practices [11-14]. This review of interventions to improve providers' ability and practice in treating malaria is distinct insofar as it includes papers that report on a wider range of malaria-related outcomes and from settings across both Africa and Asia. The literature in this area is constantly evolving, and even since the review by Smith et al, there have been several new publications.

2. Objectives

The aim of the literature review is to synthesize evidence on interventions to improve the ability of providers to diagnose and/or treat uncomplicated malaria. Specific objectives of the review are:

a) to identify the range of interventions evaluated that sought to improve providers' ability to diagnosis or treat uncomplicated malaria;

b) to review the characteristics of the studies in terms of the approach and research methods used to evaluate the intervention; and

c) to compare the effectiveness of the interventions.

3. Methods

3.1 Literature Search Strategy

A comprehensive search of the published literature was undertaken using the following databases: Medline, Embase, Global Health, International Bibliography of Social Sciences (IBSS), CAB Abstracts and International Network for the Rational Use of Drugs (INRUD). The databases were last accessed on 26 November 2009.

From the research question four concepts were derived and underpin the search. The concepts were: malaria; treatment; intervention; and provider (as shown in Box 1 with their synonyms). The synonyms were used as keywords for title and abstract searches in Medline, Embase, Global Health, IBSS and CAB Abstracts. Truncation search terms were used to make the search inclusive. The outputs from the title and abstract searches for all the synonyms in each concept were combined using the Boolean operator "or". The four concepts were then brought together using the "and" operator. The search of the INRUD database was less restrictive, and used the keywords "malaria" or

"fever" or "febrile" in all indexed fields. The citations obtained from each of the databases were exported to Endnote reference management database, and all duplicates were removed.

Box 1. Search strategy

Concept: malaria	Concept: treatment	Concept: intervention	Concept: provider
fever	diagnos*	intervention	public
febrile	management	education	private
malaria	knowledge	training	personnel
	practice		clinician*
	treatment*		health worker*
	test*		retailer*
			seller*
			provider*

Within each concept terms were combined with the operator "or"
Results from each concept were combined using the operator "and"
Search was limited to publications since 1 January 1990

The search focused on publications available in peer-review academic journals since we are primarily interested in evaluation studies grounded in a rigorous study design. Relevant publications in the grey literature were identified from review articles, reference lists of relevant publications and from websites of development agencies.

3.2 Inclusion Criteria

Publications were eligible if they met all of the following inclusion criteria:

- The publication reports on an **intervention** that was intended to improve the ability or practice of providers to diagnose or treat uncomplicated malaria. Improving providers' ability or practice to treat uncomplicated malaria could be the primary focus, or contained within a range of objectives.

- The **population exposed to the intervention** are providers. The providers may be from any cadre, with any or no qualification and from any type of health facility or outlet. This population can therefore include individuals working in government, mission and private facilities, pharmacies and drug retail outlets as well as community-based actors.

- The **study design** was defined as a (cluster) randomized control trial, pre-post design with a control group, repeated cross-sectional studies, pre-post design without control, or a post-only evaluation which included a comparison group. One-time cross-sectional studies and post-only designs without a comparison were excluded as they lack a comparison group.

- The study reports the effect of the intervention on **malaria-related outcomes.** It can use any outcome measure for provider knowledge, provider competence, or treatment outcomes in relation to the care received by patients or their health status. The term malaria-related is defined to include confirmed and unconfirmed malaria cases, since it is common for malaria diagnoses to be based solely on febrile symptoms.

- The **study population** depends on the outcome reported, though may be patients for whom treatment is sought, mystery clients that seek treatment, or providers.

- The **study setting** was an area of endemic malaria transmission in sub-Saharan Africa or Asia.

Studies were excluded if the abstract was not available in the English language and if it was published before 1990.

Characteristics of publications that failed to meet the inclusion criteria include: interventions that directly target patients, caregivers or the community (e.g. home management of malaria interventions to educate mothers, or mass-media campaigns); interventions that introduce as well as train community based agents (e.g. recruit and train village malaria assistants); and interventions that focused on malaria prevention strategies (e.g. bednets or intermittent preventative treatment).

3.3 Data extraction and synthesis

The title and abstract of each citation were reviewed to identify publications for the full-text review. The full-text of identified publications were read to determine it if met all the inclusion and none of the exclusion criteria.

For each eligible publication summary details were extracted in a tabular form, capturing the nature of the intervention, study context, study design, research methods and outcomes reported. Based on the description of the intervention it was categorized both in terms the principal element of the intervention package, and any supplementary activities. The categories used in this review are listed and defined below and based on a recent World Health Organization report (Box 2) [15].

Box 2. Different categories of intervention

Consumer Education: *activities to improve the knowledge or awareness of patients, their caregivers or the community. These range from mass-media campaigns to displaying a poster or leaflets at a health facility.*

Economic Intervention: *economic incentives are created to change the practice of health providers.*

National Policy Initiative: *the intervention is part of a national programme of activities, or closely aligned to a government initiative.*

Pre-packaged Antimalarials: *drugs are repackaged and as such presented in age-specific packs or with additional information.*

Provider Educational Process: *providers are educated using an approach that differs to conventional workshop-based provider training.*

Printed Educational Materials: *participants receive written or pictorial documents, such as a training manual, clinical algorithm or another form of job aid.*

Provider Training: *participants attend workshop-based training, possibly including practice sessions. A variety of learning techniques may be used within the workshop-format including lectures, seminars, role-play and assessment.*

Rapid Diagnostic Testing (RDT) Provision: *providers have RDTs available to use.*

Refresher Training: *participants have the opportunity to attend a second training workshop.*

Enhanced Supervision: *providers receive additional supervision or support visits.*

To compare the effectiveness of the interventions on the ability of provider to diagnose and treat malaria we have focused on three types of outcome: 1) presumptive treatment of uncomplicated

malaria in febrile patients; 2) appropriate treatment of uncomplicated malaria in febrile patients (following a diagnostic test); and 3) the accuracy of prescribing antimalarial treatment regimens. Thus for synthesis, outcomes have also been assigned to the following categories:

1) Presumptive treatment of uncomplicated malaria in febrile patients:

- Provider knowledge of how to diagnose and/or treat malaria
- Proportion of patients that were presumptively prescribed or treated with an antimalarial
- Proportion of patients that were presumptively prescribed or treated with the recommended antimalarial

2) Appropriate treatment of uncomplicated malaria in febrile patients:

- Provider ability to conduct malaria diagnostic testing
- Proportion of patients that were prescribed or treated with an antimalarial following a malaria diagnostic test

3) Accuracy of prescribing antimalarial treatment regimens:

- Provider ability to prescribe or dispense an antimalarial in the correct dose
- Provider ability to prescribe or dispense an antimalarial with correct advice on the regimen

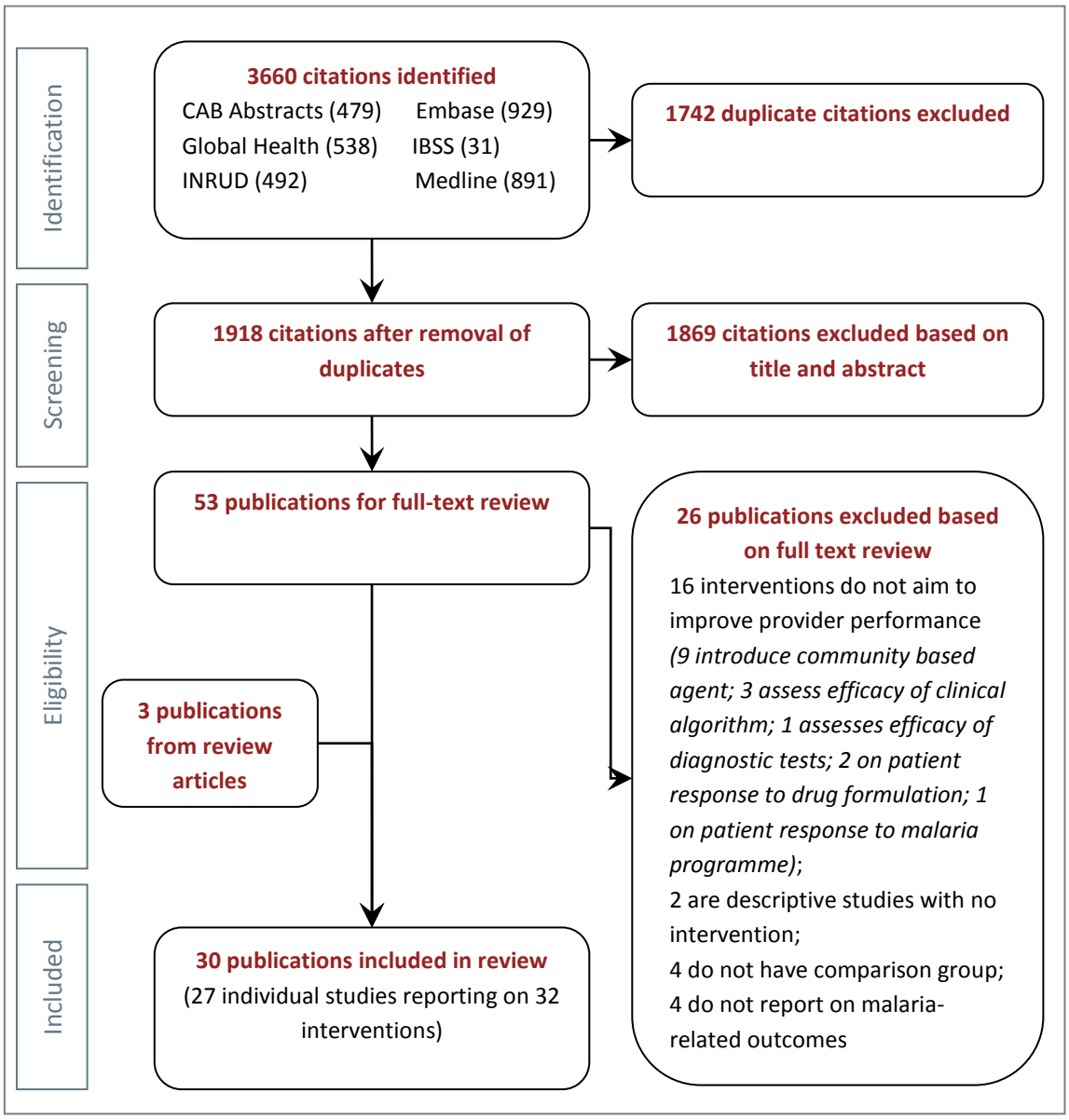
For those outcomes that report on the treatment prescribed or received we distinguish between outcomes obtained from simulated mystery client visits and outcomes from real-world patient-provider interactions. The latter, by definition, entail patient variation in terms of their symptoms, demographic and socio-economic characteristics. In contrast, the outcomes from the simulated mystery client visits present a standardized case with which to measure the competence of the provider. The providers' ability to conduct diagnostic testing is also considered a measure of their competence.

4. Results

4.1 Search results and selection of publications

The process for selecting publications is shown in Figure 1. A total of 1918 publications were identified from the database and reference lists searches once duplicates were removed. From the title and abstract 53 publications were selected for full-text review. After the review of the full text, 26 publications were rejected as they did not meet the inclusion criteria (Appendix A). Sixteen were rejected because the intervention does not seek to improve the ability of providers, predominately because the intervention involved introducing a community-based agent, such as village health volunteer. Other publications were rejected because the study was descriptive (2 publications), there was no comparison group (4 publications) or because the publication did not report on malaria-related outcomes (4 publications). Twenty-six publications [16-41] were eligible and a further 3 publications [42-44] were identified from review articles and the reference lists of eligible articles.

Figure 1: Flow chart for selection of studies



4.2 Overview of the selected publications

Thirty publications were eligible for the review. These publications report on 27 studies, since some publications report on the same studies [17, 19, 20, 24, 31-33] and other publications report on multiple studies [20, 33]. Moreover, the publications report on a total of 32 interventions as 5 studies evaluate multiple interventions [21, 25, 29, 33, 35]. For instance, Harvey et al (2008) use a 3-arm intervention trial to consider the impact of provider training and job aid, a job aid alone in comparison to a control group[21].

The characteristics of the selected studies are summarized in Table 1 and Appendix B. The majority of the studies (17 of 27) were set in three countries in East Africa, with 8 from Kenya, 5 from Tanzania and 4 from Uganda [16, 17, 23-27, 29, 31-38, 40, 42]. A further 8 were from West Africa (of which 3 were from Nigeria) [18, 28, 30, 39, 41-44]. The remaining three studies were from Ethiopia, Zambia [21] and India [22].

The studies were reasonably balanced between public and private sector facilities. Fifteen studies were located in public facilities, predominately focusing on malaria diagnosis and treatment at the primary care level. Eleven studies engaged private sector actors; primarily drug retailers with no or little formal training though a few were from private health clinics. A couple of studies involved wholesalers of malaria treatment in addition to retail outlets [32, 37]. One study evaluated training of community health workers [21].

4.3 Different types of intervention

Thirty-two interventions were evaluated within the 27 studies. The majority of the interventions were designed to focus on malaria (21 of 32 interventions or 16 of 27 studies) (Appendix B). In the 12 remaining interventions, improving malaria diagnosis and treatment was part of a broader objective, often the management of a range of common childhood illnesses. There was one exception, in which the objective of the intervention was to improve the quality of laboratory services [18].

In 21 of the 32 interventions (or 19 of 27 studies), the principal activity was categorized as provider training, and in total provider training was used in 27 of the interventions (Box 3). The different types of studies and interventions are summarized in Box 3 and described in Appendix B. Within the category of provider training there was considerable variation. Improving diagnosis and treatment of malaria was the focus in the majority of the training interventions, though in some instances this was a component of a child health training programme. For example, 4 interventions were training implemented as part of the Integrated Management of Childhood Illnesses (IMCI) initiative [17, 22, 31, 39]. The use of malaria diagnostic tests, either using microscopy or rapid diagnostic tests, was covered in 6 training interventions [18, 25, 29, 35, 36, 40]. The training workshops used a range of learning techniques, and many sought active participation by including practical sessions and role-playing, in addition to seminars and presentations. The training workshops also varied in length, with courses lasting from one-hour to 11 days.

Box 3. Categorization of the studies and interventions

CATEGORY	INTERVENTION		STUDY
	Principal activities	Principal & supplementary activities	Principal activities
Consumer Education	-	7	-
Economic Intervention	3	3	2
National Policy or Initiative	-	4	-
Pre-packaged Antimalarials	1	4	1
Provider Educational Process	3	3	3
Printed Educational Materials	1	24	-
Provider Training	21	27	19
Provision of Rapid Diagnostic Testing	2	2	2
Refresher Training	1	3	-
Enhanced Supervision	-	9	-
TOTAL	**32**		**27**

Three interventions were categorized as a provider educational process, since they sought to improve providers' knowledge and practice but without taking a workshop-based training approach

[37, 42, 44]. Two interventions used self-assessment in order to encourage participants to reflect on the quality of the services provided, and discussion with colleagues [42, 44]. The other educational intervention focused on peer-to-peer learning, with wholesalers trained and encouraged to educate their customers from drug retail outlets on new malaria treatment guidelines [37].

Nine interventions (within 7 studies) focused on conducting tests to diagnose malaria [18, 21, 25, 29, 35, 36, 40]. Three studies evaluated the impact of provider training on the ability of health workers to accurately conduct diagnostic tests [18, 21, 29]. Two studies evaluated the impact of training in microscopy, in addition to training in malaria management, on the treatment received by febrile patients [25, 36]. Finally two studies evaluated the impact of providing RDTs on the treatment received by febrile patients [35, 40].

Two studies focused on changing provider practices by adjusting economic incentives [32, 33]. These two interventions were country case studies undertaken in the context of preparatory work on the Affordable Medicines Facility – malaria (AMFm) [32, 33]. The AMFm proposes to subsidize ACT, with the aim of increasing the availability and affordability of ACT, whilst also crowding out artemisinin monotherapies whose use can contribute to drug resistance. One study reports on the impact of a price subsidy, shopkeeper training, and behaviour change communication activities in Tanzania, with an additional arm also evaluating the impact of including a suggested retail price [32]. The other case study was a franchise scheme in Kenya [33].

As the studies range from the early 1990s until 2009, they have been undertaken in the context of different national policies for the first-line recommended treatment for uncomplicated malaria. Only 6 of the 27 studies report on an intervention that has been undertaken in the context of ACT, and of these 4 focus on improving malaria diagnosis in public sector facilities, either by training on microscopy or RDTs or by making RDTs available [21, 35, 36, 40]. The remaining 2 studies are the AMFm case studies, which consider improving the availability and affordability of ACTs though private sector distribution channels [19, 32, 33].

While the interventions have been described by focusing on their principal component, it should be noted that the vast majority of the interventions involved a package of activities. For instance, provider training and provider educational process interventions were typically supplemented by printed educational materials such as training manuals, guidelines or wall charts displaying clinical algorithm for treating malaria. In 9 instances the interventions referred to an enhanced level of supervision [16, 23-25, 35, 38, 39] and in three of interventions there were opportunities for refresher training [23, 24, 29]. Activities that sought to enhance consumer awareness were mentioned in 7 interventions [16, 23, 24, 32, 33, 37, 43], while 4 interventions involved the distribution of repackaged antimalarials [32, 41, 43]. Finally, 4 of the interventions were closely aligned to a national government programme or initiative, such the dissemination of change of first-line treatment [16, 18, 35].

4.4 Evaluation methods

Studies were eligible to be included in the literature review if they adopted a study design which permitted the intervention to be evaluated with reference to a comparison group. Three studies applied a cluster randomized or individual randomized control design [16, 25, 41]. Ten studies used a pre-post design with a control group [18, 22-24, 26, 27, 30, 32, 33, 35] and 7 studies used a pre-post

design without a control group [28, 29, 36, 38-40, 43]. The remaining 7 studies evaluated post intervention with a comparison group [17, 21, 31, 34, 37, 42, 44].

The studies used a variety of research methods to evaluate the impact of the intervention. They also tended to employ several methods of data collection to validate and contextualize their findings. The main methods used to assess the impact of the intervention on providers' ability to treat according to guidelines were direct observation of the patient consultation (in 10 studies) [17, 21, 23, 31, 34, 35, 39, 41, 42, 44] and exit surveys with patients or their caregiver (in 9 studies) [17, 25, 31, 32, 34, 35, 40-42]. The latter sometimes involved a re-examination of the patient, re-reading of blood slides or independent testing for malaria parasites. Mystery clients were used in 6 studies [16, 24, 26, 37, 38, 43], as an alternative method for assessing provider competence in delivering treatment, and with the advantage that the same scenario is presented in each case in order to control for variation in patient characteristics, such as their age or symptoms. In two studies patient records were consulted, though there were concerns about the reliability of these data [28, 35], and in two studies patients were followed up either on day 4 to obtain information on patient adherence to treatment or on day 7 to know the health status of patients [25, 41].

Additional research methods were used to assess the impact of the intervention. For instance, household surveys were used in 3 studies to examine the treatment seeking behaviour and treatment received by febrile patients [20, 24, 33]. Five studies used methods of assessing health worker knowledge of malaria treatment [18, 22, 27-29], and 5 studies involved a health facility survey or retail audit to determine, amongst other things, the availability of diagnostic services and medicines [16, 37, 40, 42, 43]. Qualitative research was undertaken in 8 studies, usually interviews or focus group discussions with the health care providers, though 2 studies sought the views of patients or caregivers[17, 33, 40-42, 44]. The objective of the qualitative work also varied, in some cases it sought to obtain a deeper understanding of the effect and acceptability of the intervention. In other cases, however, qualitative methods were used during the development stage, such as in the design of activities or materials, or more generally to explore the feasibility of the intervention. Finally, only two studies reported on the cost-effectiveness of the intervention [19, 22].

4.5 Effect of intervention

The evaluation studies report a range of different outcome measures, as summarized in Table 1. The outcome measures have been grouped to determine the effect of the intervention on the providers' ability to deliver presumptive treatment, appropriate treatment following a diagnostic test, and the accuracy of the treatment provided in terms of dosage and advice on regimen. These results are presented in Tables 2, 3 and 4, respectively. Evidence across the studies has been synthesized, though it is important to note direct comparison is limited by variation in the specific indicators used as well as differences in other dimensions such as the methods of data collection and the study context.

In the majority of cases the intervention had a significant positive effect on the presumptive treatment of uncomplicated malaria (Table 2). Three studies show provider training had a positive impact on providers' knowledge of how to treat malaria [22, 30, 37]. A further 8 studies show that provider training had a significant positive impact on whether febrile patients received either any antimalarial or the recommended antimalarial, and these studies cover interventions with providers in both public and private sector facilities [16, 23, 24, 26, 35, 37, 38, 43]. Studies that used mystery

clients to assess provider competence consistently show that training is effective in improving presumptive treatment. However, in two instances was the effect was not significant [25, 39]. The first compares training on a clinical algorithm to diagnose malaria as has having no significant impact on whether the patient receives an antimalarial, though the proportion of febrile patients receiving an antimalarial is very high in the intervention and control arms [25]. The other study shows that provider training has no significant effect on proportion of febrile patients *without* malaria that receive an antimalarial, and as desired the proportion is relatively low in both groups [35].

Provider training and job aids designed to improve the accuracy of diagnostic testing show a positive effect, with the studies by Harvey and Ohrt reporting improvements in conducting the test and in understanding the test results (as in Table 3) [21, 29]. The appropriateness of the treatment received by febrile patients following a diagnostic test is also reported in Table 3. Treatment with an antimalarial is considered appropriate following a positive test result for the presence of malaria parasites, and inappropriate following a negative test result. The results from two interventions that introduced RDTs show that the introduction of RDTs reduced the proportion of RDT negative patients that received an antimalarial, though only in one of the two studies was the reduction statistically significant [35, 40]. In the two studies that evaluated the impact of provider training, it was found that the proportion of parasite negative patients that received an antimalarial was significantly reduced [25, 36].

Several studies assessed the accuracy with which health workers deliver treatment in the correct dose and with advice on how the treatment should be administered (Table 4). Overall the interventions had a significant positive effect on the proportion of patients that received an antimalarial in the correct dose or with correct advice on the treatment regimen. Only in one study was the effect not significant, and in this case prior to the intervention more than three-quarters of the patients were prescribed an antimalarial in the correct dose [36].

The other interventions which are not reported in these tables are the two AMFm cases studies which introduced an economic incentive. The study from Tanzania, which introduced a price subsidy and rolled out supporting interventions including shopkeeper training and behaviour change communication in the community showed a significant positive impact on the availability of ACTs in retail outlets and in the use of ACTs [32]. The inclusion of a suggested retail price also had a positive impact, though caution was noted in setting the price since the mean price charged was slightly higher in that district. Finally the results of a household survey in Kenya show an increase in the use of ACTs, though it is not possible to determine the source of the ACT and therefore the effect of the franchise scheme on their use.

5. Discussion

The review identified studies that have evaluated interventions to improve the ability of providers to diagnose malaria and treat patients. In total 30 publications met the eligibility criteria and these contained 27 studies and evaluated 32 different interventions. In the majority of studies the intervention involved provider training or an educational process intended to enhance providers' knowledge and skills when treating febrile patients, either specifically in the context of malaria or for a wider range of childhood illnesses. The most recent studies were undertaken since ACT was

adopted, and included studies that sought to improve malaria diagnosis in the public sector facilities as well as others that promoted the availability and affordability of ACT in the private sector. This reflects the concerns about the higher price of ACTs and the need to limit resistance to artemisinin derivatives.

Overall the studies were found to have a positive effect on presumptive treatment of febrile patients, and the accuracy of the doses and advice given. This shows that provider training (and other interventions) can change the knowledge, competence and practice of providers working in the public and private sectors. The results also show that the provision of RDTs and training on diagnostic tests led to improvements in the appropriate treatment of malaria, with reductions in the proportions of patients receiving an antimalarial if they were found to be test negative. Despite the reductions, the proportions of test-negative patients receiving antimalarials were still relatively high, suggesting that more would be needed to prevent inappropriate treatment with antimalarials in patients who tested negative for malaria. The overprescribing of antimalarials following parasitic diagnosis has been the focus of research in Tanzania, which highlights the considerable change in mind-set required to influence the prescribing behaviour of public sector health workers [45, 46].

In synthesizing the effect of the interventions it is important to be cognizant of the differences in the context, actors, and research methodology, as well as the variations in the outcome indicators used. There was also variation in the study designs used. The more rigorous approaches employed a randomized, or cluster randomized design or alternatively a pre-post design with a control group. These designs mitigate bias, by controlling for comparatively more potential confounders, though are used in only 13 of the 27 studies.

None of the studies compared the implementation of an intervention across public and private sector providers. This may reflect the need to tailor the intervention to the type of provider, and what makes sense in the public sector may not be readily transferred to the private sector and vice versa. It might be useful to know the relative impact of, say, a training intervention with providers in the public and private sectors to know where best to direct efforts to improve treatment of uncomplicated malaria. However, such decisions ought also to take into account the patterns of treatment seeking and the relative cost-effectiveness of the interventions. In that vein, it was noteworthy that only two programmes reported on the cost-effectiveness of the intervention. The impact of the intervention from an equity perspective was also a notable gap in the research.

6. Conclusion

The review of the interventions to improve the ability of provider to diagnose and treat uncomplicated malaria provides valuable background to the design of interventions for the REACT project. It is useful to know what approaches have been tried and tested, as well as the methods used to evaluate their effect. The review also highlights areas for further work. For instance, while it has been shown that provider training and other educational processes can have a significant effect on providers' knowledge and practice, the magnitude of the effect varies considerably. Moreover, in developing a training package, it is clear the following aspects would benefit from further consideration: the length of the programme, learning techniques, importance of supervision and benefits of refresher training.

The studies also suggest that further work on interventions to improve the appropriate treatment of febrile patients would be valuable. The studies show that provider training and the provision of RDTs can be beneficial, though suggest that conventional approaches may have only a limited effect. The findings also indicate the focus of the REACT project on analysing the cost-effectiveness and equity implications of an intervention will be important since these perspectives have received limited consideration. Thus, REACT should demonstrate the feasibility and importance of bringing an economic perspective to evaluation of interventions targeting service delivery improvements.

Table 1. Overview of selected studies

Intervention	Country, Year	Facility or Outlet	First-line AM	Study Design	Research instruments	Outcome Measures	Study
Provider Training (malaria)	Kenya, 2005	60 Private sector drug retailers	AQ / SP for OTC	Cluster RCT	• Mystery clients • Retail audit	• % mystery clients sold (any) AM • % mystery clients sold recommended AM • % mystery clients sold recommended AM with correct advice on regimen	[16]
Provider Training (IMCI)	Tanzania, 2000	20 Primary health facilities	Not specified	Post + control (up to 3 years after training)	• Observation of consultation • Exit survey of febrile <5yrs (including re-examination) • Interviews with providers	• % febrile <5yrs observed that were correctly treated for malaria	[17, 20]
Provider Training (laboratory tests)	Ghana, 2000	205 Public sector peripheral laboratories	Not specified	Pre-Post (after 18 months)	• Provider survey	• % of laboratories surveyed with accurate results for malaria microscopy 6-months after training	[18]
Educational Process (self- assessment)	Guinea and Kenya, 2001	8 Primary care clinics in each country	Not specified	Post + control (after 15 months)	• Health facility survey • Observation of patient consultations • Exit survey of febrile <5yrs • Interviews & FDGs with staff	• % febrile <5yrs observed that were correctly prescribed malaria treatment	[42]
Provider Training & Pre-packaged AMs	Nigeria, 2003	200+ Private drug retailers	CQ and SP	Pre-post	• Mystery clients • Retail audit	• % of mystery clients sold the recommended AM	[43]
A) Provider Training (RDT) & Job Aid B) Job Aid	Zambia	79 Community health workers	Not-specified	3-arm study	• Observation of CHW performance using 16-item checklist • Responses to 10 standard test results	• % steps in using RDT performed correctly • % RDTs read correctly	[21]
Educational Process (self- assessment & peer feedback)	Mali, 2001	Public health facilities	Not specified	Post + control	• Observation of provider-client interaction; • Interviews with study participants	• % provider that comply to fever care standards	[44]

Intervention	Country, Year	Facility or Outlet	First-line AM	Study Design	Research instruments	Outcome Measures	Study
Provider Training (IMCI)	India	Public health facilities (85 health workers)	Not specified	Pre-Post (immediately after)	• Multiple choice and problem-based questionnaire	• Malaria knowledge score	[22]
Provider Training (malaria)	Kenya, 1995-1997	23 Private sector drug retailers	CQ	Pre-Post (after 1yr and after 2yrs)	• Observations of patient consultations	• % of those seeking treatment for fever that were sold an AM • % of AMs sold in correct dose • % of AMs sold with advice on use	[23]
Provider Training (malaria)	Kenya 1999-2000	Private sector drug retailers	CQ / SP	Pre-Post + control in two study sites*	• Mystery shoppers • Household survey (children <5yrs reporting fever in past two weeks)	• % mystery clients advised to buy an AM • % mystery clients sold CQ / SP that were given advice on regimen • % AM users taking adequate dose	[19, 24]
A) Provider Training (microscopy + clinical diagnosis) B) Provider Training (clinical diagnosis)	Tanzania 2003-2004	16 public health centres & 13 dispensaries	SP	Cluster RCT (3 arms)	• Exit survey of febrile <5yrs (including re-examination and microscopy test) • Follow up on day-7	• % febrile children attending facility that receiving AM prescription	[25]
Provider Training (childhood illness)	Tanzania, 2004	40 private sector drug retailers	SP	Pre-Post with control (after 6 months)	• Mystery clients	• % mystery clients sold the recommended AM (SP) • % mystery clients sold the recommended AM with correct advice on regimen	[26]
Provider Training (rational drug use)	Uganda, Not specified	private providers	Not specified	Pre-Post with control	• Mystery clients	• % mystery clients sold an AM • % mystery clients sold an AM and given advice on the regimen	[27]
Provider Training (malaria)	Ghana, Not specified	Medical assistants from 40 public health centres	CQ	Pre-Post, no control (after 3-9 months)	• Prescription survey from outpatient records • Knowledge assessment • FGDs	• % providers know correct dose for 3yr old • % providers know correct dose for 5yr old	[28]
Provider Training (microscopy) + Refresher Training (microscopy)	Kenya	Kenyan & international microscopists	Not specified	Pre-Post	• Pre-post examination / assessment (including reading slides)	• % point improvement on knowledge of microscopy • % point improvement on slide sensitivity and specificity	[29]

Intervention	Country, Year	Facility or Outlet	First-line AM	Study Design	Research instruments	Outcome Measures	Study
Provider Training (childhood illnesses)	Nigeria	28 private sector drug retailers	CQ	Pre-Post with control	• provider knowledge assessment	• Mean knowledge score	[30]
Provider Training (IMCI)	Uganda, 2000, 2001, 2002	public and NGO facilities	Not specified	Post + Control	• Observation of patient consultation • Exit survey of febrile >5yrs (including re-examination) • Interviews with providers	• % febrile <5yrs observed that were given an AM in the correct dose	[31] [20]
Economic Incentive A) Price subsidy, BCC, training, & suggested retail price B) Price subsidy, BCC & training C) No intervention	Tanzania, 2007-08	private sector drug retailers	AL	Pre-Post with control (after 6 months)	• Patient Exit Interviews	• % of consumers purchasing AMs that bought AL	[32, 33]
Economic Incentive (Franchise scheme)	Kenya, 2007	9 Community & family wellness shops that joined franchise	AL	Pre-Post (after 9 months)	• Household survey (reporting fever in past 2 weeks) • Interviews with franchisee • FGDs with caregivers	• Use of AL (but cannot be attributed to franchise scheme)	[33]
Provider Training	Ethiopia	3 public health facilities without laboratories (6 nurses)	CQ	Post + comparison	• Observation of patient consultation • Exit survey of febrile >5yrs (including re-examination)	• No. of children that providers diagnosed with fever compared to control (clinical diagnosis by study paediatrician)	[34]
A) RDT provision vs No RDTs B) Pre vs post training, guidelines, supervision	Kenya, 2006	60 government health facilities (hospitals, health centres, dispensaries)	AL	Pre-Post with control	• Observation of patient consultation • Exit survey of febrile >5yrs (including re-examination and microscopy test)	• % febrile >5yrs with and without uncomplicated malaria that received recommended AM • % febrile >5yrs who were RDT test positive and received recommended AM • % febrile >5yrs who were RDT test negative and received ACT	[35]

Intervention	Country, Year	Facility or Outlet	First-line AM	Study Design	Research instruments	Outcome Measures	Study
Provider Training (microscopy)	Uganda 2006	8 public facilities with microscopy services (also malaria surveillance sites)	AL	Pre-Post (after 4 months)	• Patient-level surveillance data from health facility (febrile patients, all ages) • Gold standard microscopy to determine diagnostic accuracy	• % febrile <5yrs / >5yrs who were parasite positive and received AM • % febrile <5yrs / >5yrs who were parasite negative and received AM • % <5yrs / >5yrs prescribed AM who were prescribed a correct dose	[36]
Provider Educational Process (peer educators)	Kenya, 2000	Private sector wholesalers and drug retail outlets	SP	Post & Control (Intervention arm if poster was visible)	• 2 mystery clients per facility. • Retail audit	• Mean malaria knowledge score (based on 10-question true/false quiz) • % mystery clients that were sold recommended AM (SP) • % outlets with the recommended AM in stock	[37]
Provider Training (childhood illness)	Uganda, 2002-2003	Private clinics and drug shops	CQ + SP	Pre-Post (after 3 months)	• Mystery clients	• % mystery clients supplied recommended AM • % mystery clients supplied recommended AM in the correct dose • % mystery clients supplied recommended AM with correct advice on regimen	[38]
Provider Training (IMCI)	Nigeria, Not specified	4 urban public health centres (32 health workers)	Not specified	Pre-post (after 3 months)	• Observation of patient consultation (for children <5yrs)	• % of children <5yrs correctly (clinically) diagnosed for malaria • % of children <5yrs observed that received an AM • % of children <5yrs observed correctly prescribed an AM	[39]

Intervention	Country, Year	Facility or Outlet	First-line AM	Study Design	Research instruments	Outcome Measures	Study
Provision of RDTs (including training)	Tanzania, 2005	6 rural public dispensaries (without microscopy services)	AL	Pre-Post (after 8 weeks)	• Health facility survey • Patient exit survey (incl. microscopy and RDT) • Qualitative exit interviews with patients • Qualitative interviews with providers	• % of AM prescriptions that were RDT test negative	[40]
Pre-packaged AMs (compared to routine prescription)	Ghana, Not specified	6 public health facilities	CQ	Cluster RCT (3 facilities as intervention, 3 facilities as control)	• Observations of patient consultations • Patient exit survey • Follow up on day-4 on adherence to AM • FGDs on perception of packaging	• % of clinical diagnosed malaria cases that were given the correct prescription	[41]

* First study site: no training 1998 vs CQ training 1999 vs SP trained 2000 and 2001; Second study site: no training 1998 and 1999 vs SP training 2000 and 2001
Abbreviations: ACT = artemisinin-based combination therapy; AL = artemether lumefantrine; AM = antimalarial; ARI = acute respiratory infection; AQ = amodiaquine; ASAQ = artesunate amodiaquine; BCC = behaviour change campaign; CQ = chloroquine; HW = health worker; IMCI = Integrated Management of Childhood Illnesses; NGO = nongovernmental organization; N/A = Not applicable; OTC = over the counter; RCT = randomized controlled trial; RDT = rapid diagnostic test; SP = sulphadoxine pyrimethamine

Table 2. Effect of interventions on providers' ability to presumptively treat uncomplicated malaria

Intervention	Outcome Indicator	Pre-Intervention or Control Arm	Post-Intervention or Intervention Arm	Significance	Study
Effect on providers' knowledge of how to treat malaria					
Provider Training	Mean knowledge score (out of 100)	43.2 (n=33)	71.6 (n=37)	P<0.001	[30]
Provider Training (8-day IMCI)	Mean knowledge score (out of 100)	28.5 (n=35)	80.0 (n=35)	P<0.05	[22]
Provider Training (5-day IMCI)	Mean knowledge score (out of 100)	20.0 (n=50)	80.0 (n=50)	P<0.001	[22]
Provider Educational Process (Peer Educators)	Mean malaria knowledge score (10-question true/false quiz)	7.1	8.7	P<0.001	[37]
***Effect* on ability of providers to clinically diagnose malaria**					
Provider Training (IMCI)	No. of children providers diagnosed with fever compared to control (clinical diagnosis by study paediatrician)	39	248	33% sensitivity 99% specificity	[34]
Effect on proportion of patients that were prescribed or treated with any antimalarial (AM)					
Provider Training	% mystery clients that were sold an AM	58% (n=135)	78% (n=143)	OR:2.6, Not specified	[16]
Provider Training	% mystery clients that were advised to buy an AM	2% (n=224)	54% (n=183)	Significant	[24]
Provider Training	% mystery clients that were sold an AM	33% (n=78)	27% (n=30)	Not significant	[27]
Provider Training (IMCI)	% febrile <5yrs observed that received an AM	87% (n=32)	100% (n=46)	Not specified	[39]
Provider Training (clinical diagnosis)	% febrile children attending facility that receiving AM prescription	control: 99% (n=1100)	algorithm only: 95% (n=1058)	Not significant	[25]
Provider Training	% of those seeking treatment for fever that were sold an AM	34% (n=289)	Post 1yr: 84% (n=237) Post 2yr: 79% (n=150)	P<0.001 P<0.001	[23]
Effect on proportion of patients that were prescribed or treated with the recommended antimalarial (AM)					
Provider Educational Process (Peer Educators)	% mystery clients sold the recommended AM (SP)	5% (n=302)	29% (n=202)	P<0.001	[37]
Provider Training	% mystery clients sold the recommended AM (SP)	55% (n=20)	85% (n=20)	P<0.01	[26]
Provider Training	% mystery clients sold the recommended AM	21% (n=135)	52% (n=143)	OR: 5.0, P<0.001	[16]
Provider Training	% mystery clients given or recommended correct AM	2% (n=57)	73% (n=66)	P<0.001	[38]
Provider Training + Pre-packaged antimalarial	% of mystery clients sold the recommended AM	48% (n=112)	87% (n=100)	P<0.01	[43]
Provider Training + Materials + Supervision	% of febrile patients >5yrs with uncomplicated malaria that received recommended treatment	7% (n=27)	48% (n=13)	P=0.05	[35]
Provider Training + Materials + Supervision	% of febrile patients >5yrs without uncomplicated malaria that received ACT	13% (n=401)	14% (n=297)	P=0.86	[35]

Table 3. Effect of interventions on providers' ability to appropriately treat malaria by improving malaria diagnosis

Intervention	Outcome Indicator	Pre-Intervention or Control Arm	Post-Intervention or Intervention Arm	Significance	Study
Effect on providers' competence in malaria diagnostic testing					
Provider Training (laboratory tests)	% of laboratories surveyed with accurate results for malaria microscopy 6-months after training	84% (n=58)	91% (n=54)	Not specified	[18]
Provider Training (microscopy)	Pre-test score and % point improvement following training: written examination on knowledge of microscopy	62% (n=77)	+ 27% (n=77)	P<0.001	[29]
Provider Training (microscopy)	Pre-test score and % point improvement following training: sensitivity and specificity of slide readings	74% (n=77) 76% (n=77)	+ 14% (n=77) + 17% (n=77)	P<0.001 P<0.001	[29]
Refresher Training (microscopy)	Pre-test score and % point improvement following training: written examination on knowledge of microscopy	82% (n=23)	+ 15% (n=23)	P<0.001	[29]
Refresher Training (microscopy)	Pre-test score and % point improvement following training: sensitivity and specificity of slide readings	89% (n=23) 94% (n=23)	+ 6% (n=23) + 3% (n=23)	Not significant Not significant	[29]
Provider Training (RDTs)	% steps in using RDT performed correctly	80% (n=21)	92% (n=26)	P<0.05	[21]
Provider Training (RDTs)	% RDTs read correctly	80% (n=21)	93% (n=26)	P<0.05	[21]
Printed Educational Materials (Job Aid on RDTs)	% steps in using RDT performed correctly	57% (n=32)	80% (n=21)	P<0.05	[21]
Printed Educational Materials (Job Aid on RDTs)	% RDTs read correctly	54% (n=32)	80% (n=21)	P<0.05	[21]
Effect on treatment with antimalarial					
RDT Provision + Provider Training	% of AM prescriptions who were RDT test negative	55% (n=365)	16% (n=168);	Significant	[40]
RDT Provision	% of febrile >5yrs who were RDT test positive and received recommended treatment	48% (n=13)	36% (n=13)	P=0.04	[35]
RDT Provision	% of febrile >5yrs who were RDT test negative and received ACT	14% (n=297)	11% (n=346)	P=0.30	[35]
Provider Training	% febrile <5yrs who were parasite positive (from microscopy) and receiving AM	95.0%	96.7%	P=0.06	[36]

Intervention	Outcome Indicator	Pre-Intervention or Control Arm	Post-Intervention or Intervention Arm	Significance	Study
Provider Training	% febrile >5yrs who were parasite positive (from microscopy) and receiving AM	90.4%	90.8%	P=0.87	[36]
Provider Training	% febrile <5yrs who were parasite negative (from microscopy) and receiving AM	47.9%	19.6%	P<0.001	[36]
Provider Training	% febrile >5yrs who were parasite negative (from microscopy) and receiving AM	38.8%	15.6%	P<0.001	[36]
Provider Training	% febrile children attending facility who received AM prescription	algorithm only: 95% (n=1058)	algorithm & microscopy training 61% (n=973)	Significant	[25]

Table 4. Effect of the interventions on providers' ability to give accurate dose and advice on regimen

Intervention	Outcome Indicator	Pre-Intervention or Control Arm	Post-Intervention or Intervention Arm	Significance	Study
Effect on providers' ability to provide correct dose of antimalarial					
Provider Training	% providers who know correct dose for 3yr old	25% (n=32)	58% (n=33)	Not specified	[28]
Provider Training	% providers who know correct dose for 5yr old	12.5% (n=32)	30% (n=33)	Not specified	[28]
Provider Training (IMCI)	% febrile <5yrs observed given an AM in the correct dose	25% (n=135)	88% (n=169)	P<0.001	[17]
Provider Training (IMCI)	% febrile <5yrs observed given an AM in the correct dose	In 2000: 24% (n=224) In 2001: 38% (n=73) In 2002: 30% (n=105)	48% (n=142) 47% (n=138) 52% (n=378)	P<0.001 Not significant P<0.05	[20, 31]
Provider Training (IMCI)	% febrile <5yrs observed given an AM in the correct dose	36% (n=32)	84% (n=46)	Not specified	[39]
Pre-packaged drugs	% of clinically diagnosed malaria cases who were received an AM in the correct dose	74% (n=340)	93% (n=314).	P<0.001	[41]
Provider Training	% patients <5yrs prescribed AM treatment who were prescribed a correct dose	86.3%	89.0%	P=0.39	[36]
Provider Training	% patients >5yrs prescribed AM treatment who were prescribed a correct dose	78.6%	79.5%	P=0.86	[36]
Provider Training	% mystery clients given or recommended correct AM in the correct dose	0% (n=57)	50% (n=66)	P<0.001	[38]
Provider Training	% of AMs sold in correct dose	32% (n=99);	Post 1yr: 83% (n=199) Post 2 yr:90% (n=119)	P<0.001 P<0.001	[23]
Provider Education Process (self-assessment)	% febrile children observed prescribed AMs in the correct dose	51% (n=160)	62% (n=160);	P<0.001	[42]
Effect on providers' ability to provide advice on treatment regimen					
Provider Training	% mystery clients who were sold the recommended AM with correct advice on regimen	5% (n=135)	31% (n=143)	OR: 8.8, P<0.001	[16]
Provider Training	% mystery clients who were sold SP who were given appropriate advice on regimen	0% (n=2)	98% (n=98)	Significant	[24]
Provider Training	% mystery clients who were sold the recommended AM with correct advice on regimen	13% (n=20)	40% (n=20)	P<0.01	[26]
Provider Training	% mystery clients who were given or recommended correct AM with correct advice on how to administer	8% (n=57)	49% (n=66)	P<0.001	[38]
Provider Training	% of AMs sold with advice on use	2% (n=99)	Post 1yr: 94% (n=199) Post 2 yr: 98% (n=119)	P<0.001 P<0.001	[23]

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Appendix A. Reasons for rejection of publications based on full text review

Country	Intervention	Reference
Intervention did not seek to improve the ability of health workers: involves introduction of community agent		
Ghana, Nigeria, Uganda	Recruit & train community medicine distributors	Ajayi IO, Browne EN, Garshong B, et al. 2008. Feasibility and acceptability of artemisinin-based combination therapy for the home management of malaria in four African sites. *Malaria Journal* 7:6.
Nigeria	Recruit & train community medicine distributors to sell pre-packaged drugs	Brieger WR, Salako LA, Umeh RE, et al. 2002-2003. Promoting prepackaged drugs for prompt and appropriate treatment of febrile illnesses in rural Nigerian communities. *International Quarterly of Community Health Education* 21(1):19-40.
Ghana	Recruit & train community medicine distributors	Chinbuah AM, Gyapong JO, Pagnoni F, et al. 2006. Feasibility and acceptability of the use of artemether-lumefantrine in the home management of uncomplicated malaria in children 6-59 months old in Ghana. *Tropical Medicine and International Health* 11(7):1003-1006.
Zaire	Recruit & train community health workers	Delacollette C, Van der Stuyfy, P, Molima K. 1996. Using community health workers for malaria control in Zaire. *Bulletin of the World Health Organization* 74(4):423-430
Sudan	Recruit & train malaria control assistants to use RDTs and treat malaria	Elmardi KA, Malik EM, Abdelgadir T, et al. 2009. Feasibility and acceptability of home-based management of malaria strategy adapted to Sudan's conditions using artemisinin-based combination therapy and rapid diagnostic test. *Malaria Journal* 8:39.
Sri Lanka (refugee camp)	Compares treatment by community health workers to Field Laboratory	Hoek WVD, Premasiri DAR, Wickremasinghe AR. 1997. Early diagnosis and treatment of malaria in a refugee population in Sri Lanka. *Southeast Asian Journal of Tropical Medicine and Public Health*. 28(1):12-17.
Nigeria	Introduction of community health workers to provide malaria treatment	Onwujekwe O, Uzochukwu B, Ojukwu J, et al. 2007. Feasibility of a community health workers strategy for providing near and appropriate treatment of malaria in southeast Nigeria: An analysis of activities, costs and outcomes. *Acta Tropica* 101(2):95-105.
Kenya	Selection, training and job aids for community health workers	Rowe SY, Kelly JM, Olewe MA, et al. 2007. Effect of multiple interventions on community health workers' adherence to clinical guidelines in Siaya district, Kenya. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 101(2):188-202.
Burkina Faso	Home management of malaria using community health workers /key opinion leaders	Tiono AB, Kabore Y, Traore A, et al. 2008. Implementation of home-based management of malaria in children reduces the workload for peripheral health facilities in a rural district of Burkina Faso. *Malaria Journal* 7:201.
Intervention did not seek to improve the ability of health workers: Assesses efficacy of clinical algorithm		
India	Clinical algorithm for malaria diagnosis	Chandramohan D, Carneiro I, Kavishwar A, et al. 2001. A clinical algorithm for the diagnosis of malaria: results of an evaluation in an area of low endemicity. *Tropical Medicine and International Health* 6(7):505-510.
Kenya	Clinical algorithm for IMCI	Perkins BA, Zucker JR, Otieno J, et al. 1997. Evaluation of an algorithm for integrated management of childhood illness in an area of Kenya with high malaria transmission. *Bulletin of the World Health Organization* 75(S1):33-42.

Gambia	Clinical algorithm for IMCI	Weber MW, Mulholland EK, Jaffar S, et al. 1997. Evaluation of an algorithm for the integrated management of childhood illness in an area with seasonal malaria in the Gambia. *Bulletin of the World Health Organization* 75(S1):25-32.
Intervention did not seek to improve the ability of health workers: Assesses efficacy of diagnostic tests		
Philippines	Compares symptom-based diagnosis, RDTs and microscopy	Bell D, Go R, Miguel C, Walker J, et al. 2001. Diagnosis of malaria in a remote area of the Philippines: comparison of techniques and their acceptance by health workers and the community. *Bulletin of the World Health Organization* 79(10):933-941.
Intervention did not seek to improve the ability of health workers: Assesses patient response to drug formulation		
Ghana	Pre-packaged chloroquine tablets and syrup	Ansah EK, Gyapong JO, Agyepong et al. 2001. Improving adherence to malaria treatment for children: the use of pre-packaged chloroquine tablets vs chloroquine syrup. *Tropical Medicine and International Health* 6(7):496-504.
Myanmar	Introduces blister packaging	Shwe T, Lwin M, Aung S. 1998. Influence of blister packaging on the efficacy of artesunate + mefloquine over artesunate alone in community based treatment of non-severe falciparum malaria in Myanmar. *Bulletin of the World Health Organization* 76(S1):35-41
Intervention did not seek to improve the ability of health workers: Assesses patient response to national malaria programme		
Vietnam	Malaria programme on prevention, early diagnosis and treatment	Giao PT, Vries PJ, Binh TQ, et al. 2005. Early diagnosis and treatment of uncomplicated malaria and patterns of health seeking in Vietnam. *Tropical Medicine and International Health* 10(9):919-925.
Descriptive study without intervention		
Zambia	Descriptive study reporting on treatment in health centres with microscopy available	Barat L, Chipipa J, Kolczak M, et al. 1999. Does the availability of blood slide microscopy for malaria at health centers improve the management of persons with fever in Zambia? *American Journal of Tropical Medicine and Hygiene* 60(6):1024-1030.
Cambodia	Descriptive study of rational drug use	Chareonkul C, Khun VL, Boohshuyar C. Rational drug use in Cambodia: study of three pilot health centers in Kampong Thom Province. *Southeast Asian Journal of Tropical Medicine and Public Health* 33(2):418-424.
Intervention, but without comparison group		
Madagascar	Training course open to international participation	Domarle O, Randrianarivelojosia M, Duchemin JB, et al.. Atelier paludisme: an international malaria training course held in Madagascar. *Malaria Journal* 7:80.
International	Online training course in microscopy	Icke G, Davis R, McConnell W. 2005. Teaching health workers malaria diagnosis. *PLoS Medicine*. 2(2):108-110.
Uganda	Provider Training (IMCI)	Karamagi CAS, Lubanga RGN, Kiguli S, et al.. 2004. Health providers' counselling of caregivers in the integrated management of childhood illnesses (IMCI) programme in Uganda. African Health Sciences 4(1):31-39.
Burkina Faso	Training of community health workers	Sirima SB, Konate A, Tiono AB, et al.. 2003. Early treatment of childhood fevers with pre-packaged antimalarial drugs in the home reduces severe malaria morbidity in Burkina Faso. *Tropical Medicine and International Health* 8(2):133-139.
Do not report on malaria-related outcomes		
Bangladesh	Provider Training (IMCI)	Arifeen Se, Hoque DE, Akter T, et al.. 2009. Effect of the Integrated Management of Childhood Illness strategy on childhood mortality and nutrition in a rural area of Bangladesh: a cluster randomised trial. *Lancet* 374(9687):393-403.

India	Quality improvement intervention (feedback to providers on case management)	Chakraborty A, D'Souza SA, Northrup RS. 2000. Improving private practitioner care of sick children: testing new approaches in rural Bihar. *Health Policy and Planning* 15(4):400-407.
Peru	Provider Training (IMCI)	Huicho L, Davila M, Gonzales F, et al. 2005. Implementation of the Integrated Management of Childhood Illness strategy in Peru and its association with health indicators: an ecological analysis. *Health Policy and Planning* 20(S1):i32-i41.
Pakistan	Provider Training (IMCI)	Luby S, Zaidi N, Rehman S, et al. 2002. Improving private practitioner sick-child case management in two urban communities in Pakistan. *Tropical Medicine and International Health* 7(3):210-219.

Appendix B: Detail of the different types of interventions

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training (malaria)	Provider Training: 2-day workshop on malaria. Covered symptoms, treatment, prevention, drug resistance, referral, storage and expiry of drugs, and communication skills Printed Educational Materials: Training booklets. Posters. Supervision: Local monitoring by public health officers Consumer Education: Widespread public information campaigns National policy or initiative: MoH training programme during change from SP to ACT. Though as ACT were not OTC then were promoting AQ in drug retailers.	Yes	60 Private sector drug retailers	Kenya, 2005	[16]
Provider Training (IMCI)	Provider Training: 11-day training on IMCI, tailored to country context. Covered assessing signs, symptoms, classifying the illness based on treatment needs and providing appropriate treatment and education of the child's caregiver. Printed Educational Materials: Training materials in local language	No, childhood illnesses	20 Primary health facilities	Tanzania, 2000	[17, 20]
Provider Training (laboratory tests)	Provider Training: Workshops and workplace training covering 7 common tests including microscopy National Policy or Initiative: Assess feasibility of nationwide system for quality assurance of laboratory testing	No, training on several laboratory tests	205 Public sector peripheral laboratories	Ghana, 2000	[18]
Educational Process (self-assessment)	Provider Educational Process: 2-3 day workshop to initiate participatory approach. Followed by self-assessment to reflect on service quality and planning. Also, i) a client exit interview tool to encourage staff to talk with and listen to their clients about quality of services offered; ii) a client flow analysis tool to measure how long clients wait for services and how much contact time they have with service providers; and iii) an action planning tool to help identify root causes of problems and to develop a realistic, time bound plan. Printed Educational Materials: Self-administered guides with questions on client rights and health care needs.	No quality improvement approach	8 Primary care clinics in each country	Guinea and Kenya, 2001	[42]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training & Pre-packaged AMs	Pre-packaged antimalarials Age-specific packs of CQ and SP Provider Training 2-day training for peer educators, who then conducted 1-day training for drug retailers. Printed Educational Materials: Training manual. Materials, such as flip charts, were developed by the peer educators to use in their training workshops Consumer Education: Retailers were provided with caregiver manuals, and logos and stock to show completed malaria training. Also mass media (including radio, billboards) to encourage prompt treatment of malaria.	Yes	200+ Private drug retailers	Nigeria, 2003	[43]
A) Provider Training (RDT) & Job Aid B) Job Aid	Provider Training: 3-hour training course in preparing RDTs, including practical and an assessment of skills in conducting the test and interpreting the results. Printed Educational Materials: Job aid developed and tested with focus groups	Yes	79 Community health workers	Zambia	[21]
Educational Process (self-assessment & peer feedback)	Provider Educational Process: Self-monitoring tool and peer feedback mechanism to improve the quality of care for fever and to improve aspects of structural quality, such as cleanliness and drug availability. Self-assessment contained questions to the provider on care of fever and was used weekly for 3 months. Providers would ask colleague to observe consultation and assess compliance to fever care standards. Head of the facility completed a monthly questionnaire on the facility: services offered; supervision and oversight; drug commodities and vaccine availability; quality of physical space and equipment; and cleanliness and hygiene.	No, all febrile illness	Public health facilities	Mali, 2001	[44]
Provider Training (IMCI)	Provider Training: 5-day training on IMNCI, tailored to country context. Covered assessing signs, symptoms, classifying the illness based on treatment needs and providing appropriate treatment and education of the child's caregiver. Printed Educational Materials: Training materials in local language	No, neonatal and childhood illnesses	Public health facilities (85 health workers)	India	[22]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training (malaria)	Provider Training: 3-day training, that encouraged active participation, provides practical training. Covered brand name drugs frequently stocked. Trained to use dosage charts for CQ and rubber-stamps that depict correct CQ regimen in children of different ages. Also trained on symptoms that require referral to a trained HW. Printed Educational Materials: Training materials, including dosage charts Supervision: 1-2 hour individual sessions to observe retailers' skills in his/her normal workplace. Refresher training: 2-day refresher workshop after 6 months. Consumer Education: Information on regimen using rubber-stamps.	Yes	23 Private sector drug retailers	Kenya, 1995-1997	[23]
Provider Training (malaria)	Provider Training: 4-day malaria training using participatory methods, including role-play, practicals, small group discussions and exercises. Covered causes; symptoms; treatment; drug resistance; stock management; referral; and communication skills. In 1999 trained on CQ, from 2000 trained on SP as it became first-line OTC AM. Printed Educational Materials: Training materials. Accreditation certificates. Supervision: Two annual supervisory visits Refresher Training: 1-day workshops each year Consumer Education: Raised awareness on trained retailers and importance of prompt and effective treatment, changes in first-line AM and when to consult health professional.	Yes	Private sector drug retailers	Kenya 1999-2000	[19, 24]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
A) Provider Training (microscopy + clinical diagnosis) B) Provider Training (clinical diagnosis)	Provider Training: (both arms) 5-day training on clinical diagnosis and malaria treatment malaria. Used presentations and practicals. Covered signs and symptoms, history taking, physical examination, referral, appropriate treatment and counselling patients on use of drugs. Malaria Diagnostic Testing: (one arm) 5-day training on malaria microscopy (in intervention arm). Covered how to prepare thick blood smears, identify and count malaria parasites, maintain microscope and store blood slides. Printed Educational Materials: Clinical algorithm (both arms) Malaria microscopy training manual (one arm). Supervision: Weekly supervision	Yes	16 public health centres & 13 dispensaries	Tanzania 2003-2004	[25]
Provider Training (childhood illness)	Provider Training: 1-hour individual training to improve retailers' adherence to national guidelines for malaria and common childhood illnesses (diarrhoea, ARI). Covered rational prescribing, dispensing, correct labelling, correct information or instructions on how to use or administer AM, antibiotics, anti-diarrhoea. Printed Educational Materials: Included wall charts on approved brands, and dosage charts of SP and antipyretics. Posters on how to dispense drugs given to both arms.	Yes	40 private sector drug retailers	Tanzania, 2004	[26]
Provider Training (rational drug use)	Provider Training: 1-day workshop: presentations on rational use of drugs, & national treatment policy. Also opportunity to discuss findings from baseline surveys to reinforce importance of good prescribing. Printed Educational Materials: Copies of WHO guidelines on Good Prescribing and other printed materials on treatment of ARI, malaria and diarrhoeal diseases were distributed.	No, several illnesses	private providers	Uganda, Not specified	[27]
Provider Training (malaria)	Provider Training: In-service training for medical assistants. 2-hour lecture on malaria. Covered clinical features, diagnosis and treatment, severe and un complicated malaria, chemoprophylaxis and AM side-effects of drugs. Followed by workplace training.	Yes	Medical assistants from 40 public health centres	Ghana, Not specified	[28]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training (microscopy) + Refresher Training (microscopy)	Provider Training: 12-day course on malaria microscopy. Involved laboratory practical, lectures, group discussions, demonstrations, and take home assignments. Printed Educational Materials: Training materials including microscopy slides Refresher Training: 4-day course on malaria microscopy offered to those that had previously completed the 12-day course.	Yes	Kenyan & international microscopists	Kenya	[29]
Provider Training (childhood illnesses)	Provider Training: 8 weekly 2-hour sessions on malaria, diarrhoea, guinea worm, gonorrhoea, cough, malnutrition, medication counselling and reading prescriptions. Used a participatory approach with cultural appropriate methods such as storytelling, role play and use of proverbs. Printed Educational Materials: Written and pictorial hand out materials based on lesson plans.	No, several illnesses	28 private sector drug retailers	Nigeria	[30]
Provider Training (IMCI)	Provider Training: 11-day training on IMCI, tailored to country context. Covered assessing signs, symptoms, classifying the illness based on treatment needs and providing appropriate treatment and education of the child's caregiver. Printed educational materials: Training materials in local language	No, childhood illnesses	public and NGO facilities	Uganda, 2000, 2001, 2002	[31] [20]
Economic Incentive A) Price subsidy, BCC, training, & suggested retail price B) Price subsidy, BCC & training C) No intervention	Economic incentives to providers: Pilot ACT subsidy: AL is sold to private wholesalers at subsidized prices in intervention areas using the supply chain. Then uses existing distribution channels to deliver AL to private drug retailers. Provider Training: Shopkeeper training Printed Educational Materials / Pre-packaged drugs: Simplified dosing instructions in local language. Drugs and behaviour change materials with a suggested retail price (in one of two intervention areas) Consumer Education: Behaviour change campaign (BCC)	Yes	private sector drug retailers	Tanzania, 2007-08	[32, 33]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Economic Incentive (Franchise scheme)	Economic incentives to providers: ACTs made available through private shops in targeted rural areas. Shops operate via franchise and provide a range of services. Participating shops were upgraded to private clinics by recruiting a qualified nurse. AL distributed by government central medical stores and administered free of charge to patients with malaria after confirmation with RDT. Patients pay for consultation and RDT.	Yes	9 Community & family wellness shops that joined franchise	Kenya, 2007	[33]
Provider Training (IMCI)	Provider Training: 9-day training using pre-tested IMCI course. Covered assessment and classification, identification of treatment, treat the child, counsel the mother. Involved written exercises, role plays, group discussions and drills, & practice sessions in the clinic. Printed Educational Materials: 3 case management wall charts, booklets of the wall charts, recording forms for the assessment of the sick child, draft video and photo booklet	No, childhood illnesses	3 public health facilities without laboratories (6 nurses)	Ethiopia	[34]
A) RDT provision vs No RDTs B) Pre vs post training, guidelines, supervision	Provider Training: (both arms) 3-day training course on malarial guidelines, use of AL and diagnostic tests (microscopy and RDTs) for at least one provider per facility. Provision of RDTs: (intervention arm) Provided RDTs and supplies for safe use and disposal. Printed Educational Materials: (both arms) Copy of the revised national malaria treatment guidelines and supervision. Supervision: Half-day on-site interactive discussion on RDT use, revised national malaria treatment guidelines for outpatients >=5yrs, dosing and administration of AL, management of severe malaria. National Policy or Initiative: MoH supplied AL. Training was part of the national implementation of new antimalarial policy.	Yes	60 government health facilities (hospitals, health centres, dispensaries)	Kenya, 2006	[35]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training (microscopy)	Provider Training: 6-day training on malaria for medical officers, clinical officers, nurses, midwives, laboratory staff and records clerks. Involved didactic and practical sessions. Covered malaria epidemiology, national malaria policy, medical ethics, clinical management of malaria, management of patients with fever and a negative blood slide, and medical record keeping. Malaria Diagnostic Testing: Training on preparation of blood slides and microscopy skills. Printed Educational Materials: Training materials Supervision: Supervisory visits were held after 6 and 12 weeks	Yes	8 public facilities with microscopy services (also malaria surveillance sites)	Uganda 2006	[36]
Provider Educational Process (peer educators)	Provider Educational Process: Train and equip drug wholesalers to be unpaid outreach educators of new malaria guidelines (SP now OTC). Following 3-hour orientation wholesalers offered, 1-day training for wholesaler attendants and retailers. Supervision after 3 months. Provider Training: 1-day training with wholesalers, with role play on using posters as communicate tool. Wholesalers distributed the job aids at the point of sale to vendors from wholesale and retail outlet. Printed Educational Materials: Poster for a retailer on AMs: listing malaria symptoms, dosage chart of approved brands of SP and antipyretics, and treatment advice Consumer Education: Poster at retailer to generate demand for 5 approved brands of SP and to communicate SP was now available OTC.	Yes	Private sector wholesalers and drug retail outlets	Kenya, 2000	[37]
Provider Training (childhood illness)	Provider Training: 3-day negotiation participatory sessions intended to improve private practitioners' quality of management of childhood illness. Baseline survey results were used to stimulate participants to consider their own practice compared to desired practice. Printed Educational Materials: Illustrative materials such as posters were used to explain correct malaria treatment doses. Supervision: Support visit after 1-2 months.	No, childhood illnesses	Private clinics and drug shops	Uganda, 2002-2003	[38]

Intervention	Detail of Intervention	Malaria Specific	Facility or Outlet	Country, Year	Study
Provider Training (IMCI)	Provider Training: 4-day IMCI training (not recommended 11 days). Training on case malaria management, diarrhoeal disease, pneumonia and measles. Covered signs and symptoms, classifying the illness, appropriate treatment, counselling to caregiver about how to administer medicines and appropriate home care, and when caregiver should return to facility Printed Educational Materials: Training materials Supervision: Supervision visit after 4 weeks	No, childhood illnesses	4 urban public health centres (32 health workers)	Nigeria, Not specified	[39]
Provision of RDTs (including training)	Provider Training: 2-day training and practical on RDTs for dispensary staff (in intervention arm). Covered diagnosis and treatment algorithms, and RDT (including how to perform and interpret the test, and storage and disposal). Providers instructed to prescribe per national guidelines (negative result = no AM and investigate other causes of febrile illnesses). Provision of RDTs: RDT training and sufficient supplies of RDTs (Paracheck) were distributed to each dispensary. Printed Educational Materials: Training guides	Yes	6 rural public dispensaries (without microscopy services)	Tanzania, 2005	[40]
Pre-packaged AMs (compared to routine prescription)	Pre-packaging of drugs: Pre-packaged CQ and paracetamol available in seven weight-specific regimens. Packs of CQ tablets were divided into three compartments, each containing a daily dose. Syrups pre-packaged in plastic bottles purchased by the district health management team. Patients charged for medicines. Intervention facilities charged for cost of pre-packaging, while control charged for prescribing envelopes, CQ syrup included small fee to cover the cost of the bottles.	Yes	6 public health facilities	Ghana, Not specified	[41]