Tropical Biomedicine 26(2): 182–199 (2009)

Impact of home management of *Plasmodium falciparum* malaria on childhood malaria control in sub-Saharan Africa

Uneke, C.J.
Department of Medical Microbiology/Parasitology, Faculty of Clinical Medicine,
Ebonyi State University, PMB 053 Abakaliki, Nigeria
E-mail: unekecj@yahoo.com
Received 18 January 2009; received in revised form 11 April 2009; accepted 10 June 2009.

Abstract. In sub-Saharan Africa almost all of the malaria deaths occur in children below five years of age and these deaths occur within 48 hours of onset of symptoms. Consequently, the home management of malaria (HMM), was introduced to ensure early recognition of and prompt and appropriate response to malarial illness in children within the home or the community. In this report the impact of HMM in childhood malaria control in sub-Saharan Africa was reviewed using relevant publications identified through a Medline Entrez-Pubmed and Google search. There was convincing evidence from the studies reviewed that HMM played a contributory role in reducing progress to severe malaria and overall childhood mortality. The major challenges to the implementation of HMM included failure of caregivers to complete a full course of antimalarial drug, provision of financial motivation to community drug distributors, non-adherence of health workers to recommendations on the use of antimalarial drugs, limited acceptance, possible adverse outcomes, and long term sustainability of HMM. With increased political will and commitment of all stakeholders as well as the mobilization of additional and substantial resources for implementation by the global community, the Abuja declaration of halving mortality from malaria in African may be attained in the nearest future.

INTRODUCTION

Malaria remains the most complex and overwhelming health problem, facing humanity with 300 to 500 million cases and 1 to 3 million deaths per year (WHO, 2000). Malaria is a disease known to be associated with poverty and underdevelopment, and is a major scourge in the vast majority of tropical and subtropical regions of the world. Sub-Saharan Africa is the most affected region where about 90% of all malaria deaths in the world today occur largely because the majority of infections are caused by Plasmodium falciparum, the most dangerous of the four human malaria parasites. In addition, high malaria transmission intensity, limited access to adequate treatment, increasing parasite resistance to affordable and safe medicines (chloroquine, sulphadoxine-pyrimethamine and amodiaquine); increasing vectors resistance to widely used insecticides, delayed care-seeking and inappropriate treatment at home or at community level, are some other major causes for this deleterious situation (Ajayi *et al.*, 2008a, 2008b; Tiono *et al.*, 2008; WHO, 2008; Hopkins *et al.*, 2007). Furthermore, the greatest burden of malarial disease and death is borne by poor people in the poorest countries of sub-Saharan Africa, whose populations also have the least access to interventions against the disease (WHO, 2005a). The reported number of malaria outpatients increased steadily from 3.2 million in 2001 to 8.4 million in 2006 in the countries of the WHO African Region, and hospital admissions for malaria in these countries doubled from 1 million to 2.2 million over the same period, and malaria

deaths rose from 100 504 to 258 548 (Rowe *et al.*, 2006; Sharp *et al.*, 2007; WHO, 2003, 2005a, 2005b, 2005c, 2008).

In sub-Saharan Africa almost all of the malaria deaths occur in children below five years of age and this translates to the child mortality of nearly 1 million each year (DFID, 2004; Hopkins *et al.*, 2007; WHO, 2008). Indeed, every 30 seconds a child dies of malaria, a death toll of about 3000 children every day in the sub region (WHO, 2003, 2008). The consensus view of recent studies and reviews is that malaria causes at least 20% of all deaths in children under 5 years of age in Africa (Rowe *et al.*, 2006; Gyapong & Garshong, 2007; Hopkins *et al.*, 2007; Sharp *et al.*, 2007). It was noted that in year 2000 nearly all (94%) of the deaths due to malaria in children were in areas with high intensity transmission in the central regions of Africa and two thirds (68%) of these deaths occurred in rural areas with high intensity transmission, and a quarter (26%) were in urban areas with high intensity transmission (Snow *et al.*, 2001; 2003, 2004; Omumbo *et al.*, 2004; Oumbo & Snow, 2004; Rowe *et al.*, 2006). Kakkilaya (2006) noted that in endemic and hyperendemic areas, the parasite rate increases with age from 0 to 10% during first three months of life to 80 to 90% by one year of age and the rate persists at a high level during early childhood. In areas of low endemicity, where the immunity is low, severe infection occurs in all age groups including adults and the morbidity and mortality due to malaria in children tend to be very high in these areas. Severe falciparum malaria has been shown to be the commonest cause of death in infants and children in areas endemic and hyperendemic for malaria. Inadequate immunity results in rapid increase in the parasite count and development of complications; furthermore, delay in diagnosis and treatment also contributes to the mortality (Miller *et al.*, 2002; Dzeing-Ella *et al.*, 2005; Kakkilaya, 2006).

Up to eighty percent of the childhood deaths due to *P. falciparum* malaria occur during the first 24 hours following admission (Schellenberg *et al.*, 1999; Breman, 2001; WHO 2002; DFID, 2004; Idro *et al.*, 2006). The acquisition of malaria immunity is closely linked to the level of transmission and severe *P. falciparum* infection is very rare after the age of 5 years in highly endemic areas (Newton & Krishna, 1998; Murphy & Breman, 2001; Dzeing-Ella *et al.*, 2005; Rowe *et al.*, 2006). Since the majority of children who die from malaria do so within 48 hours of onset of illness, the early use of effective antimalarial medicines in or near the home was thought to be able to reduce the burden of malaria in endemic areas. This acknowledged time element is critical to saving children's lives in Africa, and reducing severe malaria morbidity and mortality in non-immune older children and adults in other regions of the world (Newton & Krishna, 1998; Baume, 2002; Were, 2004).

Despite the established fact that a strong health-care delivery system would ideally be able to provide early, reliable diagnosis and appropriate, prompt and effective treatment, most people at highest risk of malaria, particularly in rural areas in sub-Saharan Africa, live outside easy geographical reach of health facilities, and their access to curative and diagnostic services is, therefore, limited (Foster, 1995; Salako, *et al.*, 2001; WHO, 2005a). Consequently, the malaria control programmes in various countries of sub-Saharan Africa have sought to make treatment available as near to the home as possible, whether in the community or in the home itself (Gyapong & Garshong, 2007; Hopkins *et al.*, 2007). This strategy of community-based management of malaria cases which is referred to as the home management of malaria (HMM), was designed to ensures early recognition of and prompt and appropriate response (treatment) to malarial illness in children under five years of age within the home or the community (Sirima *et al.*, 2003; Were, 2004; WHO, 2005a; Tiono *et al.*, 2008). In the Abuja Declaration of April 2000, African Heads of State resolved to support scaling-up of the malaria interventions, which form the core of the Roll Back Malaria (RBM) strategy, aimed at halving mortality from malaria particularly in African children by 2010 (Abuja, 2000; WHO, 2002, 2004, 2005, 2008).

The objective of this report therefore was to review the impact of the home management of malaria which is one of the major strategies designed to accomplish the Abuja declaration with respect to childhood malaria control in sub-Saharan Africa. This is with the view to assessing progress made so far, and highlighting the need for the development of appropriate public health policy on the prevention, care, prompt treatment, and support activities in light of the epidemiological importance of *P. falciparum* malaria and its impact on child well-being in sub-Saharan Africa. To achieve this, a total 134 publications was retrieved from the Medline Entrez-Pubmed search as of November 2008 for the review. Additional publications were obtained via the Google search. References from selected publications were also used to identify additional relevant literature for the review.

Burden of childhood malaria in Sub-Saharan Africa

It is pertinent to state that childhood mortality remains unacceptably high in sub-Saharan Africa despite a better understanding of pathophysiology and management of childhood malaria (Marsh *et al.*, 1995; Miller *et al.*, 2002; Rowe *et al.*, 2007; Roca-Feltrer *et al.*, 2008). Countries such as Burkina Faso, Chad, Niger, Mali and Nigeria recorded more than 8 childhood deaths per 1000 in the year 2006 (Table 1) (WHO, 2008). There were an estimated 881 000 (610 000–1 212 000) deaths worldwide in 2006 due to malaria of which 90% were in the African Region and an estimated 85% of deaths occured in children under 5 years, but the proportion is much higher in the African (88%) than in other regions (WHO, 2008). Eighteen countries which account for 90% of deaths due to malaria in the African Region include Malawi, Zambia, Guinea, Chad, Mozambique, Côte d'Ivoire, Angola, Cameroon, Mali, Ghana, Burkina Faso, Kenya, Niger, United Republic of Tanzania, Ethiopia, Uganda, Democratic Republic of the Congo, and Nigeria (WHO, 2008). Children in areas with very high malaria transmission in sub-Saharan Africa have been shown to record the highest admission parasite densities and proportion of patients with life threatening features (Idro *et al.*, 2006; Abdalla *et al.*, 2007; Bassat *et al.*, 2008; Eliades *et al.*, 2006; Mabunda *et al.*, 2008). According to Roca-Feltrer *et al.* (2008) an estimated 545 000 (uncertainty interval: 105 000–1 750 000) children under the age of 5 in SSA experienced an episode of severe malaria for which they were admitted to hospital, while a total of 24 000 (interquartile range: 12 000–37 000) suffered from persistent neurological deficits as a result of cerebral malaria and the number of malaria fevers associated with high parasite density in under-5s in SSA in 2000 was estimated as 115 750 000 (uncertainty interval: 91 243 000–257 957 000).

Kazembe *et al.* (2007) indicated that malaria endemicity is an important risk factor for child mortality and confirmed the effects of bio-demographic and socio-economic variables (maternal education, maternal age, birth order and place of residence) on infant and child mortality. The profound consequences that one or more episodes of malaria may have on a child's subsequent health and development are often unrecognized or inadequately managed (WHO, 2002; Korenromp *et al.*, 2004; Ringsted *et al.*, 2006). The high, early and repeated exposure to malaria results in low haemoglobin levels and a high proportion with severe anaemia (Snow *et al.* 1994; Greenwood, 1997; Snow *et al.*, 1999; Reyburn *et al.*, 2005). Although nutritional deficiencies, hookworm infection, and HIV all predispose to anaemia in children, evidence suggests that, in endemic countries, malaria is one of the most important factors (WHO, 2002; Dzeing-Ella *et al.*, 2005; Mabunda *et al.*, 2008). It has been estimated that severe malarial anaemia causes between 190 000 and 974 000 deaths each year among children < 5 years (Murphy & Breman, 2001). Although blood transfusion may be life-saving in this situation, it also exposes children to the risk of HIV and other blood-borne diseases (WHO, 2002).

It is estimated that African children have between 1.6 and 5.4 episodes of malarial fever each year, a figure that varies according to geographical and epidemiological

circumstances (Murphy & Breman, 2001). Under conditions of high transmission children are exposed to a high number of infectious bites and develop correspondingly high parasite densities (Slutsker *et al.*, 1996). The sequestration of such high parasite loads in cerebral vessels may be responsible for initiating pathological mechanisms that may result in seizure disorders (Gimenez *et al.*, 2003). Comparisons between different types of malaria parasites provided further evidence to suggest that *P. falciparum* parasites may be epileptogenic (Wattanagoon *et al.*, 1994). The frequency of severe malarial anaemia, seizures both simple and repeated, and impaired consciousness as manifestations of severe malaria in children under 5 years of age increase with rising transmission intensity and parasite load, thus heavy *P. falciparum* malaria parasitaemia may be important in the development of seizures, severe anaemia and impaired consciousness (Idro *et al.*, 2006).

Cerebral malaria attributable to *P. falciparum* infection is a very common occurrence amongst children in malaria endemic areas and is estimated to affect 575,000 children in sub-Saharan Africa every year and is among the deadliest forms of malaria, with an average estimated mortality rate of 18.6% (Murphy & Breman, 2001; John, 2007). Neurologic effects of malaria have been studied in subjects who have recovered from cerebral malaria. Such studies have revealed psychological as well as neurologic sequelae including learning disabilities among post-cerebral malaria subjects (Meremikwu *et al.*, 1997; Holding *et al.*, 1999; Boivin, 2002). Idro *et al.* (2007) reported neurological involvement in nearly 50% of children with acute falciparum malaria in Kenya which manifested as seizures, agitation, prostration, and impaired consciousness or coma. They further noted that factors independently associated with neurological involvement included past history of seizures, fever lasting 2 days or less, delayed capillary refill time, metabolic acidosis, and hypoglycemia with mortality being higher in children with the neurological involvement. A number of reports have indicated that children who had falciparum malaria neurological involvement and those who succumb to cerebral malaria but survive are often left damaged (John, 2007; Idro *et al.*, 2007). In fact it is reported that approximately 7% of children who survive cerebral malaria are left with permanent neurological problems including weakness, spasticity, blindness, speech problems and epilepsy (WHO, 2002; Carter *et al.*, 2005a; Hunt *et al.*, 2006; Boivin *et al.*, 2007). In most parts of sub-Saharan Africa the plight of such children is compounded by the limited availability of specialized educational provision and equipment. Consequently opportunities for subsequent learning, and for attainment of independence, are compromised even further (Carter *et al.*, 2005a, 2005b, 2006; WHO, 2002). Holding *et al.* (1999) had earlier provided evidence which suggests that some children who appear to have made a complete neurological recovery from cerebral malaria may develop significant cognitive problems (attention deficits, difficulty with planning and initiating tasks, speech and language problems), which can adversely affect school performance. This condition reduces social interaction, increases learning difficulties, leading to poor development (Fernando *et al.*, 2003). Recurrent infections can leave the child listless and with a poor appetite. Recurrent episodes of malaria in the child are likely to result in the loss of a substantial amount of time from school. Preliminary data from Sri Lanka suggest that multiple attacks of uncomplicated malaria *per se* have a deleterious effect on school performance, and that this is independent of both school absenteeism and socioeconomic circumstances (Fernando *et al.*, 2003).

In endemic regions of sub-Saharan Africa the childhood malaria case-fatality rate greater than 0.6% has been recorded (Table 1) (WHO, 2008). As most deaths from malaria occur in the first 24 hours of admission, this highlights the need for early recognition and treatment of the most severely ill children (WHO, 2002). This is a key RBM strategy and is based on the widespread recognition that untreated *P. falciparum* malaria contributes both directly and indirectly to death,

Table 1. Estimated cases and deaths due to malaria amongst children (<5 years old) in sub-Saharan Africa in 2006

Country	Malaria cases	Malaria deaths	Malaria case-fatality rate (%)	deaths per 1000
Angola	1 872 000	17 000	0.91	5.5
Burkina Faso	3 791 000	25 000	0.69	9.6
Cameroon	2 767 000	18 000	0.65	6.3
Chad	2 533 000	17 000	0.67	8.7
Cote D'Ivoire	3 928 000	18 000	0.46	6.3
Congo DR	14 815 000	90 000	0.61	4.5
Ethiopia	2 073 000	25 000	1.20	1.9
Ghana	3 935 000	21 000	0.53	6.6
Kenya	NA	18 000	NA	2.9
Madagascar	234 000	1 800	0.77	0.57
Malawi	4 528 000	11 000	0.43	4.5
Mali	2 610 000	22 000	0.84	9.8
Mozambique	4 470 000	15 000	0.34	4.1
Niger	3 590 000	30 000	0.84	11
Nigeria	34 096 000	219 000	0.63	8.8
Senegal	391 000	8 700	2.20	4.5
Uganda	6 353 000	39 000	0.61	6.7
Tanzania	5 469 000	31 000	0.57	4.5
Zambia	2 083 000	12 000	0.58	6.0

NA = Data not available
Source: WHO 2008

particularly in the non-immune (Were, 2004). Prompt treatment with effective antimalarial therapy is essential and African leaders have committed to ensuring that 80% of malaria episodes are adequately treated within 24 hours of onset of symptoms by 2010 (WHO/RBM, 2005). Other benefits of early treatment include reduction of malaria associated anaemia, reduction in debilitation and the days off work or school leading to increased school attendance, productivity and hence economic growth (Fernando *et al.*, 2003; Were, 2004). Early diagnosis and classification of severe malaria would therefore allow appropriate management, including basic adjunctive therapy such as to prevent hypoglycaemia, and better use of scarce health care resources and together these improvements could contribute to a reduction in the intractably high mortality due to the disease (Dzeing-Ella *et al.*, 2005). However, treatment of malaria is challenged by inadequate health-care infrastructure in many parts of Africa (Kager, 2002). Health facilities are often resource-limited, and access to care may be limited by distance, fees, inadequate staffing, and lack of essential medicines (Foster, 1995). The worst malaria situations occur in remote rural areas and among marginalised poor populations, ethnic minorities, and forest dwellers in sub-Saharan Africa (Were, 2004).

Justification for home management of malaria of malaria

In an effort to address the malaria scourge and reduce the resultant high childhood mortality in Africa, the African Heads of State had adopted the access to prompt and effective treatment for at least 60% of those

suffering from malaria as one of the goals in reducing the malaria burden for the vulnerable population in Africa (Abuja, 2000). However, Tiono *et al.* (2008) noted that this goal in the context of the limited coverage of the population by health facilities in most of the malaria endemic countries particularly in sub-Saharan Africa seems quite ambitious and difficult to achieve. This development therefore justifies the introduction of the HMM with the view to providing prompt and effective treatment of malaria episodes to those who need it close to their homes and this represents one of the major strategies that could contribute to achieve this goal (WHO, 2005a). In Africa when a child is sick of malaria or other childhood illness, the choice of treatment is greatly influenced by the access that individuals have to health care (McCombie, 1996). Snow *et al.* (1992) had noted that the determinants of treatment-seeking behaviour in Africa are the distance to be travelled, the cost of care, care providers' attitudes, time spent at the facilities and the overall availability of the services and medicines. As a result of inadequate public health care facilities in most malarious areas of sub-Saharan Africa and the very poor access to such health facilities when available, individuals have resorted to self-medication through the unregulated private and informal sector in a bid to treat childhood malaria. Consequently, taking their children to health centres is the last thing that mothers consider when a sick child has failed to respond to home treatment or the condition is exceptionally severe (Deming *et al.*, 1989; Ruebush *et al.*, 1995; Foster, 1995). It is estimated that fewer than 20% of children with malaria in endemic areas are treated in formal health-care settings (Breman, 2001). Generally, it is the mothers who identify fever in their children and provide presumptive treatment. Studies in Ghana, Mali, Nigeria and Zambia have shown that as many as 90% of children with fever are treated at home (Salako *et al.*, 2001; Baume, 2002; WHO/RBM, 2005).

A number of recent studies conducted in sub-Saharan Africa have provided evidence to prove that HMM can improve the ineffective self-medication practices that are very common in malaria-endemic countries; these studies recognized HMM as an integral part of an overall malaria case management strategy aiming to improve access to treatment for malaria in areas with limited access to health facilities and if correctly implemented it can enhance the early identification of malaria and appropriate treatment, especially in children under five years of age, in the home (Malik *et al.*, 2006; Dada & Omokhodion, 2007; Gyapong & Garshong, 2007; Tiono *et al.*, 2008; Hopkins *et al.*, 2007; Nsabagasani *et al.*, 2007; Nsungwa-Sabiiti *et al.*, 2007; Ajayi *et al.*, 2008a, 2008b, 2008c, 2008d; Mumuni & Nyanchongi, 2008). In Uganda Nsabagasani *et al.* (2007) demonstrated that the community appreciates the contribution of home based management of fever which is an important prerequisite in the strengthening of HMM. Another study from Uganda reported that under home based management of fever including malaria, starting treatment within 24 hours of symptoms onset and taking treatment for the recommended three days duration was associated with a lower perceived treatment failure and caregiver's perceived treatment outcome was better in HMM compared to alternative informal sources of treatment (Malimbo *et al.*, 2006). Because HMM will benefit the poor and has proven effective in reducing child mortality, morbidity, reports have indicated that it has gained acceptance among rural mothers and spreads across sub-Saharan Africa (Sirima *et al.*, 2003; Kilian *et al.*, 2003; Källander *et al.*, 2006; Ajayi *et al.*, 2008b).

Thus, medicine shops or vendors, retail shops and left-over medicines are often the first and even the only response to treatment at the onset of symptoms (McCombie, 1996). Reasons for preferring shops include greater geographical accessibility, shorter waiting times, longer opening hours, greater confidentiality and lower costs (Brugha & Zwi, 1998). Unfortunately, the quality of treatment in these settings is often sub-standard because in most cases poor quality drugs and inadequate treatment are administered. Mothers and caregivers only

usually visit a health centre or hospital after the illness has failed to respond to several drugs and ineffective self treatment. This practice increases morbidity and mortality in addition to contributing to possible emergence of drug resistance in sub-Saharan Africa (WHO, 2002).

To reduce the morbidity and mortality of childhood malaria and the development of drug resistance the World Health Organization developed a strategy which includes, as one of its main components, the early diagnosis and appropriate treatment of malaria (WHO, 1993). Since many childhood deaths from malaria occur within 48 hours of onset of symptoms, it was recommended that antimalarial drugs be given at home to all febrile children (WHO, 1993). This strategy was expected to have optimal impact if appropriate treatment were to be given early. Consequently there arose a need for mothers and community members to be trained to recognise malaria and respond appropriately (Kidane & Morrow, 2000; Sirima *et al.*, 2003). This is the basis for the introduction of the HMM. HMM is therefore an integral part of malaria case management within the overall RBM strategy and is particularly relevant to ensuring effective care for non-immune people at risk of malaria, such as children under five years of age in high-transmission situations (WHO, 2005a).

It has been shown that interventions designed to improve HMM through training of providers and pre-packaging of antimalarial medicines had the lowest cost, compared with other malaria control strategies such as chemoprophylaxis, indoor residual spraying, and use of insecticide-treated nets (ITNs) (Goodman *et al.*, 1999; 2000). Thus in recent years the WHO through the Tropical Disease Research (TDR) has funded several studies on HMM in Africa with the intention of developing a strategy to increase access to effective antimalarial treatment close to the home, thereby addressing the failure of the formal health system in many endemic countries of he sub-region to deliver effective treatment promptly to those in need (Gyapong & Garshong, 2007).

The home management of malaria strategy

The strategy of HMM aims to improve the ineffective self-medication practices that are very common in malaria- endemic countries; its overall goal is the early recognition and prompt and appropriate response to malarial illness, especially in children under five years of age, in the home or community. It therefore, empowers communities to respond to malaria illness using effective, good-quality antimalarial medicines through community involvement (WHO, 2005a). The antimalarial medicines used for HMM usually come in the form of a pre-packaged drug, defined as a course of treatment in a sealed primary packaging, the treatment being composed of individual doses in easily identifiable subunits and conforms to WHO guidelines on the technical specifications for pre-packaging antimalarial medicines in compliance with good manufacturing practice requirements (WHO, 2005b).

According to WHO (2004, 2005a), the four components of the HMM strategy include: (i) ensuring that there is an effective communication strategy for behaviour change to enable caretakers recognize malaria illness early and take an appropriate action; (ii) ensuring that community drug or service providers have the necessary skills and knowledge to manage malarial illness; (iii) ensuring availability and access to effective good quality preferably pre-packed antimalarial medicines at the community level close to the home as possible; (iv) ensuring that there is good mechanism for supervision and monitoring of the community activities.

A number of successful childhood malaria intervention studies have been conducted in sub-Saharan Africa using the HMM strategy. One prominent factor that was a key to the success of these interventional studies was the adoption of enhanced communication strategy in the training of mothers, primary care givers including community health workers and community drug providers to enhance their ability to recognize symptoms of malaria and give appropriate early and prompt treatment (Pagnoni *et al.*, 1997; Marsh *et al.*, 1999;

Kidane and Morrow, 2000; Ajayi *et al.*, 2008a, 2008b; Tiono *et al.*, 2008). In these interventional studies the key areas that were addressed in all the communication strategy included: the link between mosquitoes and malaria; the risk of malaria for young children and pregnant women; how to recognize uncomplicated malaria and danger signs; what actions to take in cases of uncomplicated malaria or those with severe malaria; the importance of prompt and complete treatment; where to get or purchase good-quality, approved medicines; and where to go in case of danger signs or if there is no improvement.

A major tool usually used was a treatment guideline which was developed using participatory approach involving mother trainers and community members. Pictorial illustrations of some common clinical features of uncomplicated and complicated malaria, the steps to take for the different types of presentation of malaria and the correct dose and regimen of appropriate treatment according to the age of the child were used and usually presented as cartoons. The studies all attest to the fact that majority of treatment for malaria take place in the home with drugs bought from local drug vendors. They also provided evidence for the effectiveness of community-based approach to malaria treatment. The World Health Organization noted that after training, the trained individuals usually passed the information on to other community members, so giving the programme community ownership (WHO, 2005a). Implementing HMM is however, recognized as a huge task and requires the total commitment of all stakeholders and the members of the local community concerned. It has been shown that a core working group or team that included all stakeholders (key ministry of health (MOH) departments, academic and research institutions, drug and other regulatory authorities, the Medicine manufacturing Industry, Private and Informal health providers, Professional organizations, NGOs, Mass media, bilateral and global development agencies and Donor organizations), was useful in terms of advocacy, planning, and implementation of the HMM programme that would likely be successful (WHO, 2005a; Gyapong & Garshong, 2007).

It is pertinent to state that the overall success of HMM is to a large extent dependent on the implementation within the overall framework of the national health policy on community or primary health care, guided by the overall policy on malaria case management and treatment. A reasonable financial base is also a major requirement especially with the involvement of larger network of delivery points and the number of people who will use the services. It is also very important to Integrate all stages of the process of developing HMM, from the planning stage to the stage of reaching the community, into other health programmes thereby reducing duplication, cost, time, and provide consistency in methods and messages (WHO, 2005a).

The challenges of home management of malaria

In sub-Saharan Africa indigenous tradition and culture influence the pattern of care for the sick, consequently the practices of malaria home management vary greatly in different situations and generally there is limited programme experience to influence good practice (Gyapong & Garshong, 2007; Ajayi *et al.*, 2008a, 2008d). Furthermore in the rural areas where the impact of malaria scourge is most prominent the low literacy level of the populace generated a lot of concern in the early period of the introduction of HMM (Deming *et al.*, 1989; Foster, 1995; WHO, 2004; Hopkins *et al.*, 2007). Distributors who are not fully literate represented the greatest challenge: a significant amount of time was invested in training such people and monitoring them when drugs were dispensed (WHO, 2004; Gyapong & Garshong, 2007). There was thus opposition to improving HMM because of concerns that indiscriminate use of antimalarials by the so-called "illiterate population" could lead to increased antimalarial drug resistance and mothers were thought to be unable to comply with

the complicated diagnosis and dosing schedule that proper treatment requires (WHO, 2004).

However it is now generally accepted that, with appropriate training and using pre-packaged drugs, mothers, community health workers and other local care givers can recognize fever, and administer prompt, appropriate treatment. Consequently efforts were made in various malaria intervention programmes to improve HMM. These interventions were however not without some major challenges. These include failure of caregivers to complete a full course of antimalarial drug, provision of financial motivation to community drug distributors CDDs, non-adherence of health workers to recommendations on the use of antimalarial drug, limited acceptance, possible adverse outcomes, performance of supervision, and hence, long term sustainability of HMM (Mwenesi, 2003; Batega, 2004; Nsungwa-Sabiiti *et al.*, 2004; Falade *et al.*, 2006; Wasunna *et al.*, 2008).

Despite the existence of these challenges associated with HMM in sub-Saharan Africa, HMM was shown to be both feasible and effective in ensuring prompt access to appropriate treatment in the African region especially in the most remote areas. Thus the scaling-up of the programme became a very attractive option and was recommended by the WHO based on the report on the evidence, experience, and lessons learned in scaling up HMM in Burkina Faso, Ghana, Kenya, Nigeria, Uganda and Zambia (WHO, 2004). The challenges of scaling up implementation of HMM – expanding beyond small geographical areas and/or controlled conditions – are however peculiar and enormous. According to WHO (2004), Some of the practical challenges of large-scale implementation of HMM include: the increasing ineffectiveness of commonly available and relatively cheap drugs for treating malaria; developing community ownership and sustainability of community volunteers through provision of incentives; ensuring that severely ill children are rapidly referred and appropriately treated; referral facilities are often very few, provide inadequate service and poor-quality care, and are mistrusted; reluctance to scale up HMM; and the renewed fears that actively promoting home treatment of malaria will encourage inappropriate drug use and accelerate the development of drug-resistant parasites.

In an effort to stem the worsening morbidity and mortality due to drug resistant malaria, many countries in sub-Saharan Africa have changed their malaria treatment policy from chloroquine (CQ) or sulfadoxine-pyrimethamine (SP) to artemisinin based combination therapy (ACT) in line with the WHO recommendation (WHO, 2001). However, while wide deployment of ACT at the community level through HMM has the potential to greatly reduce malaria related mortality and severe morbidity, such implementation has not actively taken off in many sub-Saharan African countries due to substantial economic and public health issues (Ajayi *et al.*, 2008c). Although more than 25 countries in Africa have now adopted HMM with ACT in their malaria control programmes only a few have succeeded in implementing the strategy in some selected districts (Mumuni & Nyanchongi, 2008).

The major concerns centre on the effective use of ACT at the community level, and the fact that the parasitological cure rate that is achieved with ACT in the context of HMM, when dispensed by community medicine distributors (CMDs) and used unsupervised by caregivers at home, has not been properly elucidated (D'Alessandro *et al.*, 2005; Ajayi *et al.*, 2008c). Another concern about the wide-scale use of ACTs by the CHWs/CMDs is the possibility of over-prescription of the drug, leading to wastage and possibly increasing the risk of emergence of resistance (D'Alessandro *et al.*, 2005; Pagnoni *et al.*, 2005). A multi-country study conducted in Ghana, Nigeria and Uganda confirmed that HMM with ACT can work as with chloroquine, unfortunately the study revealed that even under optimal trial conditions a significant proportion of caregivers (about 40%) did not adhere to ACT treatment (Ajayi *et al.*, 2008d). In addition to this, there are reports of failure to provide

adequate storage conditions to ensure drug stability in the community- a condition which could reduce the efficacy of ACT and also facilitate the emergence of drug resistance (Ajayi *et al.*, 2008c).

The role of home management of malaria in malaria intervention

Despite the high morbidity and mortality rate of malaria in sub-Saharan Africa, there is an increasing body of evidence suggesting that the burden of malaria has been decreasing over the past decade and continues to do so in some sub-Saharan African countries (Gosling *et al.*, 2008). The countries where this decline has been reported in recent times include Eritrea (Nyarango *et al.*, 2006), Guinea Bissau (Rodrigues *et al.*, 2008), Kenya (Okiro *et al.*, 2007), Tanzania (Schellenberg *et al.*, 2004), Mozambique, South Africa and Swaziland (Sharp *et al.*, 2007). It was argued that presumptive treatment of fever cases as malaria which is a component of HMM strategy may have played a role in reducing transmission of malaria by the prophylactic effect of antimalarials and their widespread use (Gosling *et al.*, 2008).

Some studies conducted in parts of sub-Saharan Africa have indicated that HMM helped in the reduction of childhood malaria burden (Kindane & Morrow, 2000; Yeboah-Antwi *et al.*, 2001; Sirima *et al.*, 2003). An earlier report from Liberia showed that there was an increase in the availability of antimalarial drugs in the homes after three years of intervention, and there was a reduction in childhood mortality rate by 28% compared with baseline (Becker *et al.*, 1993). More recently, Unger *et al.* (2006) observed that without any malaria control intervention, the population cure rate was 8.4% with home treatment, but was 13% if access to timely treatment were improved as in Kenya. Hopkins *et al.* (2007) noted that findings from Burkina Faso suggested that HMM decreased the proportion of severe malaria cases, while another study from the same country showed a decrease in the risk of progression to severe malaria. In Uganda it was observed that following an intervention which consisted of volunteers educating mothers and providing a 3-day course of pre-packaged chloroquine plus sulfadoxine/pyrimethamine tablets, free of charge, for the treatment of under-five fevers, an assessment of the intervention effect indicated 13.5% improvement in the accumulated proportion of patients (1) treated, (2) treated within 24h of illness onset, (3) treated with the recommended antimalarials, (4) treated at an adequate dosage and (5) treated for the correct duration (Nsungwa-Sabiiti *et al.*, 2007). Studies have shown that early and effective treatment at the community level, through training of community resource persons or mothers, and providing them with pre-packed antimalarial drugs, reduced progress to severe malaria by more than 50% in Burkina Faso (Sirima *et al.*, 2003) and overall childhood mortality by 40% in Ethiopia (Kidane & Morrow, 2000). It was therefore noted that appropriate use of antimalarials – through provider and community training and pre-packaging of the drugs – provides opportunities to control an increasingly chaotic component of the informal health sector in many setting of sub-Saharan Africa and may reduce drug resistance (WHO, 2004). Furthermore it has been shown that targeting retailers, either through short training workshops or distribution of information, education and communication materials through existing medicine suppliers, improved knowledge and practices on appropriate use of antimalarial drugs by more than four-fold amongst trained retailers (Marsh *et al.*, 1999).

In a recent study conducted in Burkina Faso, Tiono *et al.* (2008) investigated the potential fall-out of HMM on the work burden at the peripheral health facilities level and observed that the increase in the number of malaria cases treated at the community level was associated with a reduction of the overall workload at health facility level. In the study, the health facility attendance rate was lowered by 43% in the intervention arm, with most malaria cases being treated in the community. This finding has as important public health implication with respect to the

limited workforce in formal health facilities in sub-Saharan Africa. Thus, the precious time saved could be used by the health staff, for other curative or preventive activities, or to allow a longer nurse-patient contact time, a factor known to be associated with correct management of patients, and higher adherence by caregivers (Rowe *et al.*, 2000).

Although HMM has been shown to play a contributory role in the reduction of malaria burden in many parts of Africa, conclusions regarding the impact of HMM on morbidity and mortality endpoints are actually mixed (Hopkins *et al.*, 2007). In Kenya, an earlier investigation conducted in a perennial transmission area showed no obvious effect of the intervention (Spencer *et al.*, 1987a, 1987b), while another investigation done in the Democratic Republic of Congo showed a decrease in malaria morbidity but no impact on mortality (Delacollette *et al.*, 1996). However in a randomized trial conducted in Ethiopia which investigated mortality endpoint a benefit was demonstrated (Kidane & Morrow, 2000). Hopkins *et al.* (2007) noted in their systematic review on the impact of HHH on health outcomes in Africa that data showing an impact of community-based programmes on malaria morbidity are also relatively sparse. Only one study showed a decrease in malaria prevalence and incidence (Delacollette *et al.*, 1996), and one demonstrated a decreased risk of progression to severe (essentially cerebral) malaria (Sirima *et al.*, 2003). It is therefore very obvious that more studies are required to substantiate the health benefit of home- and community-based presumptive treatment of fever with antimalarials, because the current evidence appears to be hardly sufficient to support widespread implementation of HMM sub-Saharan Africa. Nevertheless, the WHO has advocated scaling up home-based programmes in malaria-endemic countries, based on the positive results obtained from the studies in Ethiopia (Kidane & Morrow, 2000), Burkina Faso (Sirima *et al.*, 2003), Ghana, Nigeria and Uganda (WHO, 2004; Gyapong & Garshong, 2007).

CONCLUSION

Evidence from studies in sub-Saharan Africa has shown that presumptive treatment of febrile children with pre-packaged antimalarials in HMM programmes is likely to increase delivery of effective drugs, and improve the timing, adherence, and dosing of treatment. Many interventions to improve adherence to correct dose of antimalarial drug at home level have been demonstrated to be effective (Marsh *et al.*, 1999; Kidane & Morrow, 2000; Ajayi *et al.*, 2008a). Providing safe and effective malaria treatment demands that the public sector takes stewardship role in formulating up-to-date malaria treatment policies and also establish strong health systems to cater for diagnostic evaluation and management of referred cases (Were, 2004). Any intervention to improve management of sick people at the community level should ideally be part of a larger package that includes improving quality of care at facilities and improvements of health systems (Winch *et al.*, 2005). This can only materialize when sufficient commitment and resources are channelled into the health sector by the governments of sub-Saharan African countries. The need to mobilise additional and substantial resources for implementation by the global community in partnership with the endemic countries cannot be overstated. It is hoped that with sustained effort from all stake holders the Abuja declaration of halving mortality from malaria in African may be attained in the nearest future.

REFERENCES

Abuja (2000). The Abuja Declaration on Roll Back Malaria in Africa. http://www.usaid.gov/our_work/global_health/id/malaria/publications/docs/abuja.pdf.

Abdalla, S.I., Malik, E.M. & Ali, K.M. (2007). The burden of malaria in Sudan: incidence, mortality and disability – adjusted life – years. *Malaria Journal* **6**: 97.

Ajayi, I.O., Falade, C.O., Olley, B.O., Yusuf, B., Gbotosho, S., Iyioma, T., Olaniyan, O., Happi, C., Munguti, K. & Pagnoni, F. (2008a). A qualitative study of the feasibility and community perception on the effectiveness of artemether-lumefantrine use in the context of home managemdnt of malaria in south-vest Nigeria. *BMC Health Servicg Research* **8**: 119.

Ajayi, I.O., Falade, C.O., Bamgboye, E.A., Oduola, A.M.J. & Kale, O.O. (2008b). Assessment of a treatment guideline to improve home management of malaria in children in rural south-west Nigeria. *Malaria Journal* **7**: 24.

Ajayi, I.O., Browne, E.N., Bateganya, F., Yar, D., Happi, C., Falade, C.O., Gbotosho, G.O., Yusuf, B., Boateng, S., Mugittu, K., Cousens, S., Nanyunja, M. & Pagnoni, F. (2008c). Effectiveness of artemisinin-based combination therapy used in the context of home management of malaria: A report from three study sites in sub-Saharan Africa. *Malaria Journal* **7**: 190.

Ajayi, I.O., Browne, E.N., Garshong, B., Bateganya, F., Yusuf, B., Agyei-Baffour, P., Doamekpor, L., Balyeku, A., Munguti, K., Cousens, S. & Pagnoni, F. (2008d). Feasibility and acceptability of artemisinin-based combination therapy for the home management of malaria in four African sites. *Malaria Journal* **7**: 6.

Bassat, Q., Guinovart, C., Sigaúque, B., Aide, P., Sacarlal, J., Nhampossa, T., Bardají, A., Nhacolo, A., Macete, E., Mandomando, I., Aponte, J.J., Menéndez, C. & Alonso, P.L. (2008). Malaria in rural Mozambique. Part II: children admitted to hospital. *Malaria Journal* **7**: 37.

Batega, D.W., Greer, G.J. & Plowman, B.A. (2004). Home-based management of fevers strategy in Uganda: Assessment of implementation and operation at district and community levels. Ministry of Health Uganda, the World Health Organisation, and BASICS II for the United States Agency for International Development, Arlington, Va.

Baume, C. (2002). Comparing care-seeking for childhood malaria: lessons from Zambia and Kenya. Arlington, Basic Support for Institutionalizing Child Survival (BASICS II) for the United States Agency for International Development, Arlington, Va.

Becker, S.R., Diop, F. & Thornton, J.N. (1993). Infant and child mortality in two counties of Liberia: results of a survey in 1988 and trends since 1984. *International Journal of Epidemiology* **22**(Suppl. 1): S56–S63.

Boivin, M.J. (2002). Effects of early cerebral malaria on cognitive ability in Senegalese children. *Journal of Development, Behavioural Pediatrics* **22**: 353–364.

Boivin, M.J., Bangirana, P., Byarugaba, J., Opoka, R.O., Idro, R., Jurek, A.M. & John, C.C. (2007). Cognitive impairment after cerebral malaria in children: a prospective study. *Pediatrics* **119**: 360-366.

Breman, J.G. (2001). The ears of the hippopotamus: manifestations, determinants, and estimates of the malaria burden. *American Journal of Tropical Medicine and Hygiene* **64**: 1-11.

Brugha, R. & Zwi, A. (1998). Improving the quality of private sector delivery of public health services: challenges and strategies. *Health Policy and Planning* **13**: 107–120.

Carter, J.A., Lees, J.A., Gona, J.K., et al. (2006). Severe falciparum malaria and acquired childhood language disorder. *Developmental Medicine and Child Neurology* **48**: 51 –57.

Carter, J.A., Mung'ala-Odera, V., Neville, B.G., Murira, G., Mturi, N., Musumba, C. & Newton, C.R. (2005a). Persistent neurocognitive impairments associated with severe falciparum malaria in Kenyan children. *Journal of Neurology Neurosurgery and Psychiatry* **76**: 476-481.

Carter, J.A., Ross, A.J., Neville, B.G., et al. (2005b). Developmental impairments following severe falciparum malaria in children. *Tropical Medicine and International Health* **10**: 3.

Dada, O.A. & Omokhodion, F.O. (2007). Home management of malaria by mothers of children under-five in Abeokuta, Southwest Nigeria. Tropical Doctor **37**(4): 217-219.

D'Alessandro, U., Talisuna, A. & Boelaert, M. (2005). Should artemisinin based combination treatment be used in the home-based management of malaria? *Tropical Medicine and International Health* **10**: 1-2.

Delacollette, C., Van der Stuyft, P. & Molima, K. (1996). Using community health workers for malaria control: experience in Zaire. *Bulletin of World Health Organization* **74**: 423-430.

Deming, M.S., Gayibor, A., Murphy, K., Jones, T.S. & Karsa, T. (1989). Home treatment of febrile children with antimalarial drugs in Togo. *Bulletin of World Health Organization* **67**: 695-700.

Department for International Development DFID. (2004). Fact Sheet-Malaria. http://www.dfid.gov.uk/pubs/files/malaria-factsheet.pdf

Dzeing-Ella, A., Nze Obiang, P.C., Tchoua, R., Planche, T., Mboza, B., Mbounja, M., Muller-Roemer, U., Jarvis, J., Kendjo, E., Ngou-Milama, E., Kremsner, P.G., Krishna, S. & Kombila, M. (2005). Severe falciparum malaria in Gabonese children: clinical and laboratory features. *Malaria Journal* **4**: 1.

Eliades, M.J., Wolkon, A., Morgah, K., Crawford, S.B., Dorkenoo, A., Sodahlon, Y., Hawley, W.A., Hightower, A.W., Ter Kuile, F.O. & Terlouw, D.J. (2006). Burden of malaria at community level in children less than 5 years of age in Togo. *American Journal of Tropical Medicine and Hygiene* **75**(4): 622–629.

Falade, C.O., Ogundiran, M.O., Bolaji, M.O., Ajayi, I.O., Akinboye, D.O., Oladepo, O., Adeniyi, J.D. & Oduola, A.M.J. (2006). The Influence of Cultural Perception of Causation, Complications and Severity of Childhood Malaria as Determinants of Treatment and Preventive Pathways. *International Quarterly Community Health Education* **24**: 345-361.

Fernando, S.D., Gunawardena, D.M., Bandara, M.R.S.S., De Silva, D., Carter, R., Mendis, K.N. & Wickremasinghe, A.R. (2003). The impact of repeated malaria attacks on the school performance of children. *American Journal of Tropical Medicine and Hygiene* **69**(6): 582–588.

Foster, S. (1995). Treatment of malaria outside the formal health services. *Journal of Tropical Medicine and Hygiene* **98:** 29-34.

Gimenez, F., Barraud de Lagerie, S., Fernandez, C., Pino, P., Mazier, D. (2003). Tumor necrosis factor alpha in the pathogenesis of cerebral malaria. *Cell Molecule and Life Science* **60**(8): 1623-1635.

Goodman, C., Coleman, P. & Mills, A. (2000). Economic analysis of malaria control in sub-Saharan Africa.Geneva, Global Forum for Health Research (Strategic Research Series).

Goodman, C.A., Coleman, P.G. & Mills, A.J. (1999). Cost-effectiveness of malaria control in sub-Saharan Africa. *Lancet* **354**: 378–385.

Gosling, R.D., Drakeley, C.J., Alex Mwita, A. & Chandramohan, D. (2008). Presumptive treatment of fever cases as malaria: help or hindrance for malaria control? *Malaria Journal* **7**: 132.

Greenwood, B.M. (1997). The epidemiology of malaria. *Annals of Tropical Medicine and Parasitology* **91**: 763–769.

Gyapong, M. & Garshong, B. (2007). Lessons learned in Home Management of Malaria: Implementation research in four African countries. World Health Organization, Geneva.

Holding, P.A., Peshu, N., Stevenson, J. & Marsh, K. (1999). Cognitive sequelae of severe malaria with impaired consciousness. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **93**: 529–534.

Hopkins, H., Talisuna, A., Whitty, C.J.M. & Staedke, S.G. (2007). Impact of home-based management of malaria on health outcomes in Africa: a systematic review of the evidence. *Malaria Journal* **6**: 134.

Hunt, N.H., Golenser, J., Chan-Ling, T., Parekh, S., Rae, C., Potter, S., Medana, I.M., Miu, J. & Ball, H.J. (2006). Immunopathogenesis of cerebral malaria. *International Journal of Parasitology* **36**: 569-582.

Idro, R., Aloyo, J., Mayende, L., Bitarakwate, E., John, C.C. & Kivumbi, G.W. (2006). Severe malaria in children in areas with low, moderate and high transmission intensity in Uganda. *Tropical Medicine and International Health* **11**: 115–124.

Idro, R., Ndiritu, M., Ogutu, B., Mithwani, S., Maitland, K., Berkley, J., Crawley, J., Fegan, G., Bauni, E., Peshu, N., Marsh, K., Neville, B. & Newton, C. (2007). Burden, features, and outcome of neurological involvement in acute *falciparum* malaria in Kenyan children. Journal of American Medical Association **297**(20): 2232-2240.

John, C.C. (2007). Cerebral Malaria Pathogenesis, What Can We Learn from Microarray Analysis? *American Journal of Pathology* **171**: 1729-1732.

Kager, P.A. (2002). Malaria control: constraints and opportunities. *Tropical Medicine and International Health* **7**: 1042-1046.

Kakkilaya, B.S. (2006). Malaria in Children. http://www.malariasite.com/malaria/Children.htm.

Källander, K., Tomson, G., Nsungwa-Sabiiti, J., Senyonjo, Y., Pariyo, G. & Peterson, S. (2006). Community referral in home management of malaria in western Uganda: A case series study. *BMC International Health and Human Rights* **6**: 2.

Kazembe, L.N., Appleton, C.C. & Kleinschmidt, I. (2007). Spatial analysis of the relationship between early childhood mortality and malaria endemicity in Malawi. *Geospatial Health* **2**(1): 41-50.

Kidane, G. & Morrow, R.H. (2000). Teaching mothers to provide home treatment of malaria in Tigray, Ethiopia: a randomized trial. *Lancet* **356**: 550–555.

Kilian, A.H.D., Tindyebwa, D., Gülck, T., Byamukama, W., Rubaale, T., Kabagambe, G. & Korte, R. (2003). Attitude of women in western Uganda towards pre-packed, unit-dosed malaria treatment for children. *Tropical Medicine and International Health* **8**: 431-438.

Korenromp, E.L., Armstrong-Schellenberg, J.R.M., Williams, B.G., Nahlen, B.L. & Snow, R.W. (2004). Impact of malaria control on childhood anaemia in Africa – a quantitative review. *Tropical Medicine and International Health* **9**(10): 1050–1065.

Mabunda, S., Casimiro, S., Quinto, L. & Alonso, P. (2008). A country-wide malaria survey in Mozambique. I. *Plasmodium falciparum* infection in children in different epidemiological settings. *Malaria Journal* **7**: 216.

Malik, E.M., Hanafi, K., Ali, S.H., Ahmed, E.S. & Mohamed, K.A. (2006). Treatment-seeking behaviour for malaria in children under five years of age: implication for home management in rural areas with high seasonal transmission in Sudan. *Malaria Journal* **5**: 60.

Malimbo, M., Mugisha, E., Kato, F., Karamagi, C. & Talisuna, A.O. (2006). Caregivers' perceived treatment failure in home-based management of fever among Ugandan children aged less than five years *Malaria Journal* **5**: 124.

Marsh, K., Forster, D., Waruiru, C., Mwangi, I., Winstanley, M., Marsh, V., Newton, C., Winstanley, P., Warn, P., Peshu, N., Pasvol, G. & Snow, R. (1995). Indicators of life threatening malaria in African children. *The New England Journal of Medicine* **332**: 399-1404.

Marsh, V.M., Mutemi, W.M., Muturi, J., Haaland, A., Watkins, W.M., Otieno, G. & Marsh, K. (1999). Changing home treatment of childhood fevers by training shop keepers in rural Kenya. *Tropical Medicine and International Health* **4**: 383-389.

McCombie, S.C. (1996). Treatment seeking for malaria: a review of recent research. *Social Science and Medicine* **43**: 933–945.

Meremikwu, M.M., Asindi, A.A. & Ezedinachi, E. (1997). The pattern of neurological sequelae of childhood cerebral malaria among survivors in Calabar, Nigeria. *Central African Journal of Medicine* **43**: 231–234.

Miller, L.H., Baruch, D.I., Marsh, K. & Doumbo, O.K. (2002). The pathogenesis basis of malaria. *Nature* **515**: 673-679.

Mumuni, I. & Nyanchongi, B. (2008). Home Management of Malaria with ACTs: The role of informal structures Modern drugs and traditional treatments in the control of malaria: a multi-disciplinary and multi cultural approach. Training workshop, Camerino, Italy, 17-25 July 2008.

Murphy, S.C. & Breman, J.G. (2001). Gaps in the childhood malaria burden in Africa: cerebral malaria, neurological sequelae, anemia, respiratory distress, hypoglycemia, and complications of pregnancy. *American Journal of Tropical Medicine and Hygiene* **64**(1-2 Suppl): 57-67.

Mwenesi, H.A. (2003). Sociocultural and behaivoural issues in the treatment and prevention of malaria. Paper for the WHO/TDR Scientific Working Group on Malaria, Geneva, Switzerland, 24–27th March 2003.

Newton, C.R. & Krishna, S. (1998). Severe falciparum malaria in children: current understanding of pathophysiology and supportive treatment. *Pharmacology and Therapeutics* **79**(1): 1–53.

Nsabagasani, X., Jesca-Nsungwa-Sabiiti, Källander, K., Peterson, S., Pariyo, G. & Tomson, G. (2007). Home-b*ased management of fever in rural Uganda: community perceptions and provider opinions.* Malaria Journal **6**: 11.

Nsungwa-Sabiiti, J., Kallander, K., Nsabagasani, X., Namusisi, K., Pariyo, G., Annika, J., Tomson, G. & Peterson, S. (2004). Local fever illness classification: implications for home management of malaria strategies. *Tropical Medicine and International Health* **9**: 191-199.

Nsungwa-Sabiiti, J., Peterson, S., Pariyo, G., Ogwal-Okeng, J., Petzold, M.G. & Tomson, G. (2007). Home-based management of fever and malaria treatment practices in Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene **101**(12): 1199-1207.

Nyarango, P.M., Gebremeskel, T., Mebrahtu, G., Mufunda, J., Abdulmumini, U., Ogbamariam, A., Kosia, A., Gebremichael, A., Gunawardena, D., Ghebrat, Y. & Okbaldet, Y. (2006). A steep decline of malaria morbidity and mortality trends in Eritrea between 2000 and 2004: the effect of combination of control methods. *Malaria Journal* **5:** 33.

Okiro, E., Hay, S.I., Gikandi, P.W., Sharif, S.K., Noor, A., Peshu, N., Marsh, K. & Snow, R.W. (2007). The decline in paediatric malaria admissions on the coast of Kenya. *Malaria Journal* **6**: 151.

Omumbo, J.A., Hay, S.I., Guerra, C.A. & Snow, R.W. (2004). The relationship between the *Plasmodium falciparum* ratio in childhood and climate estimates of malaria transmission in Kenya. *Malaria Journal* **3**: 17.

Omumbo, J.A. & Snow, R.W. (2004). *Plasmodium falciparum* prevalence in East Africa: a review. *East African Medical Journal* **81**: 649–656.

Pagnoni, F., Convelbo, N., Tiendrebeogo, J., Cousens, S. & Esposito, F. (1997). A community based programme to provide prompt and adequate treatment of presumptive malaria in children. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **91**: 512-517.

Pagnoni, F., Kengeya-Kayondo, J., Ridley, R., Were, W., Nafo-Traore, F., Namboze, J. & Sirima, S. (2005). Artemisinin-based combination treatment in home-based management of malaria. *Tropical Medicine and International Health* **10**: 621-622.

Reyburn, H., Mbatia, R., Drakeley, C., Bruce, J., Carneiro, I., Olomi, R., Cox, J., Nkya, W.M., Lemnge, M., Greenwood, B.M. & Riley, E.M. (2005). Association of transmission intensity and age with

clinical manifestations and case fatality of severe *Plasmodium falciparum* malaria. *Journal of American Medical Association* **293**: 1461-1470.

Ringsted, F.M., Bygbjerg, I.C. & Samuelsen H. (2006). Early home-based recognition of anaemia via general danger signs, in young children, in a malaria endemic community in north-east Tanzania. *Malaria Journal* **5**: 111.

Roca-Feltrer, A., Carneiro, I. & Armstrong-Schellenberg, J.R. (2008) Estimates of the burden of malaria morbidity in Africa in children under the age of 5 years. *Tropical Medicine and International Health* **13**(6): 771-783.

Rodrigues, A., Armstrong Schellenberg, J., Kofoed, P.E., Aaby, P. & Greenwood, B. (2008). Changing pattern of malaria in Bissau, Guinea Bissau. *Tropical Medicine and International Health* **13**(3): 410-417.

Rowe, A.K., Steketee, R.W., Arnold, F., Wardlaw, T., Basu, S., Bakyaita, N., Lama, M., Winston, C.A., Lynch, M., Cibulskis, R.E., Shibuya, K., Ratcliffe, A.A., Nahlen, B.L. & Roll Back Malaria Monitoring and Evaluation Reference Group. (2007). Viewpoint: Evaluating the impact of malaria control efforts on mortality in sub-Saharan Africa. *Tropical Medicine and International Health* **12**(12): 1524–1539.

Rowe, A.K., Hamel, M.J., Flanders, W.D., Doutizanga, R., Ndoyo, J. & Deming, M.S. (2000). Predictors of correct treatment of children with fever seen at outpatient health facilities in the Central African Republic. *American Journal of Epidemiology* **151**:1029-1035.

Rowe, A.K., Rowe, S.Y., Snow, R.W., Korenromp, E.L., Armstrong Schellenberg, J.R.M., Stein, C., Nahlen, B., Bryce, J., Black, R.E. & Steketee, R.W. (2006). The burden of malaria mortality among African children in the year 2000. *International Journal of Epidemiology* **35**: 691–704.

Ruebush, T.K., Kern, M.K., Campbell, C.C. & Oloo, A.J. (1995). Self-treatment of malaria in a rural area of western Kenya. *Bulletin of World Health Organization* **73**(2): 229-236.

Salako, L.A., Brieger, W.R., Afolabi, B.M., Umeh, R.E., Agomo, P.U., Asa, S., Adeneye, A.K., Nwankwo, B.O. & Akinlade, C.O. (2001). Treatment of childhood fevers and other illnesses in three rural Nigerian communities. *Journal of Tropical Pediatrics* **47**(4): 230-238.

Schellenberg, D., Menendez, C., Aponte, J., Guinovart, C., Mshinda, H., Tanner, M. & Alonso, P. (2004). The changing epideimology of malaria in Ifakara Town, Southern Tanzania. *Tropical Medicine and International Health* **9**(1): 68-76.

Schellenberg, D., Menendez, C., Kahigwa, E., Font, F., Galindo, C., Acosta, C., Schellenberg, J.A., Aponte, J.J., Kimario, J., Urassa, H., Mshinda, H., Tanner, M. & Alonso, P. (1999). African children with malaria in an area of intense Plasmodium falciparum transmission: features on admission to the hospital and risk factors for death. *American Journal of Tropical Medicine and Hygiene* **61**(3): 431-438.

Sharp, B., Kleinschmidt, I., Streat, E., Maharaj, R., Barnes, K., Durrheim, D.N., Ridl, F.C., Morris, N., Seocharan, I., Kunene, S., La Grange, J.J.P., Mthembu, J.D., Maartens, F., Martin, C.L. & Barreto, A. (2007). Seven years of regional malaria control colaboration-Mozambique, South Africa and Swaziland. *American Journal of Tropical Medicine and Hygiene* **76**(1): 42-47.

Sirima, S.B., Konate, A., Tiono, A.B., Convelbo, N., Cousens, S. & Pagnoni, F. (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**: 133-139.

Slutsker, L., Khoromana, C.O., Hightower, A.W., Macheso, A., Wirima, J.J., Breman, J.G., Heymann, D.L. & Steketee, R.W. (1996). Malaria infection in infancy in rural Malawi. *American Journal of Tropical Medicine and Hygiene* **55**(1 Suppl): 71-76.

Snow, R.W., Armstrong, J.R., Forster, D., Winstanley, M.T., Marsh, V.M., Newton, C.R., Waruiru, C., Mwangi, I., Winstanley, P.A. & Marsh, K. (1992). Childhood deaths in Africa: uses and limitations of verbal autopsies. *Lancet* **340**(8815): 351-355.

Snow, R.W., Bastos de Azevedo, I., Lowe, B.S., Kabiru, E.W., Nevill, C.G., Mwankusye, S., Kassiga, G., Marsh, K. & Teuscher, T. (1994). Severe childhood malaria in two areas of markedly different falciparum transmission in east Africa. *Acta Tropica* **57**(4): 289-300.

Snow, R.W., Craig, M., Deichmann, U. & Marsh, K. (1999). Estimating mortality, morbidity and disability due to malaria among Africa's non-pregnant population. *Bulletin of World Health Organization* **77**(8): 624-640.

Snow, R.W., Trape, J.F. & Marsh, K. (2001). The past, present and future of childhood malaria mortality in Africa. Trends in Parasitology **17:** 593–97.

Snow, R.W., Craig, M.H., Newton, C.R.J.C. & Steketee, R.W. (2003). The public health burden of Plasmodium falciparum malaria in Africa: Deriving the numbers. Working Paper No. 11, Disease Control Priorities Project. Bethesda, MD: Fogarty International Center, National Institutes of Health, August 2003. Available at: http://www.fic.nih.gov/dcpp/wps/wp11.pdf (Accessed November 2, 2008).

Snow, R.W., Korenromp, E.L. & Gouws, E. (2004). Pediatric mortality in Africa: Plasmodium falciparum malaria as a cause or risk? *American Journal of Tropical Medicine & Hygiene* **71**: 16–24.

Spencer, H.C., Kaseje, D.C., Collins, W.E., Shehata, M.G., Turner, A., Stanfill, P.S., Huong, A.Y., Roberts, J.M., Villinski, M. & Koech, D.K. (1987a). Community based malaria control in Saradidi, Kenya: description of the programme and impact on parasitaemia rates and antimalarial antibodies. *Annals of Tropical Medicine and Parasitology* **81**(Suppl 1): 13-23.

Spencer, H.C., Kaseje, D.C., Mosley, W.H., Sempebwa, E.K., Huong, A.Y., Roberts, J.M. (1987b). Impact on mortality and fertility of a community based malaria control programme in Saradidi, Kenya. *Annals of Tropical Medicine and Parasitology* **81**(Suppl 1): 36-45.

Tiono, A.B., Kaboré, Y., Traoré, A., Convelbo, N., Pagnoni, F. & Sirima, S.B. (2008). Implementation of Home based management of malaria in children reduces the work load for peripheral health facilities in a rural district of Burkina Faso. *Malaria Journal* **7**: 201.

Unger, J.P., d'Alessandro, U., De Paepe, P. & Green, A. (2006). Can malaria be controlled where basic health services are not used? Tropical Medicine and International Health **11**(3): 314-322.

Wasunna, B., Zurovac, D., Goodman, C.A. & Snow, R.W. (2008). Why don't Health Workers Prescribe ACT? A qualitative study of factors affecting the prescription of artemether lumefantrine. *Malaria Journal* **7**: 29.

Wattanagoon, Y., Srivilairit, S., Looareesuwan, S. & White, N.J. (1994). Convulsions in childhood malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **88**(4): 426-428.

Were, W. (2004). Bringing malaria management closer to the home. Supporting Agency – Roll Back Malaria, Mera 3-4. World Health Organization, Geneva.

Winch, P.J., Gilroy, K.E., Wolfheim, C., Starbuck, E.S., Young, M.W., Walker, L.D. & Black, R.E. (2005). Intervention models for the management of children with signs of pneumonia or malaria by community health workers. *Health Policy and Planning* **20**: 199-212.

World Health Organization. (1993). Global strategy for malaria control. World Health Organization, Geneva.

World Health Organisation. (2001). Antimalarial Drug Combination Therapy: Report of a WHO Technical Consultation. WHO/CDS/RBM/2001.35. World Health Organization, Geneva.

World Health Organization (2002). Reducing malaria's impact on child health, development and survival. Roll Back Malaria briefing document. WHO/CDS/RBM/2002.38. World Health Organization, Geneva.

World Health Organization. (2003). African malaria Report. http://mosquito.who.int/amd2003/amr2003/amr_toc.htm. World Health Organization, Geneva.

World Health Organization. (2004). Scaling up home-based management of malaria from research to implementation. WHO/HTM/MAL/2004.1096. World Health Organization, Geneva.

World Health Organization. (2005a). The roll back malaria strategy for improving access to treatment through home management of malaria. WHO Technical Consultation on Home Management of Malaria Harare, Zimbabwe, 27–30 January 2004.

WHO/HTM/MAL/2005.1101. pp 54. World Health Organization, Geneva.

World Health Organization. (2005b). Specifications for prepackaging antimalarial medicines. Report of a WHO Technical Consultation. Geneva, World Health Organization (WHO/HTM/MAL/2005.1100). World Health Organization, Geneva.

World Health Organization /Roll Back Malaria (2005). In Global strategic plan 2005-2015 World Health Organization / Roll Back Malaria Partnership. World Health Organization, Geneva.

World Health Organization. (2008). World Malaria Report 2008. WHO/HTM/GMP/2008.1. World Health Organization, Geneva.

Yeboah-Antwi, K., Gyapong, J.O., Asare, I.K., Barnish, G., Evans, D.B. & Adjei, S. (2001). Impact of prepackaging antimalarial drugs on cost to patients and compliance with treatment. *Bulletin of the World Health Organization* **79**: 394-399.