

## Review article

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# Intervention models for the management of children with signs of pneumonia or malaria by community health workers

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A systematic review was conducted to categorize and describe Intervention Models involving community health workers (CHWs) that aim to improve case management of sick children at the household and community levels. The review focused on management of children with signs of malaria or pneumonia. Seven Intervention Models were identified, and classified according to: (1) the role of CHWs and families in assessment and treatment of children, (2) system of referral to the nearest health facility (verbal or facilitated), and (3) the location in the community of the drug stock. Standardization of terminology for Intervention Models using this or a similar classification could facilitate comparison and selection of models, including deciding how to modify programmes when policies change concerning first-line drugs, and setting priorities for further research. Of the seven models, that of CHW pneumonia case management (Model 6) has the strongest evidence for an impact on mortality. Pneumonia case management by CHWs is a child health intervention that warrants considerably more attention, particularly in Africa and South Asia.

**Key words:** childhood illnesses, malaria, pneumonia, acute respiratory infections (ARI), under-five mortality, community case management, household and community Integrated Management of Childhood Illness (IMCI), referral, community health worker (CHW)

## Background

The last few decades have witnessed large and sustained decreases in child mortality in most low- and middle-income countries. However, an estimated 10.6 million children under the age of five still die each year, mostly from preventable or treatable conditions including malnutrition (Bryce et al. 2005; WHO 2005). Many of these deaths are attributable to the conditions targeted by Integrated Management of Childhood Illness (IMCI): diarrhoea, pneumonia, malaria, measles and malnutrition (Lambrechts et al. 1999; Ahmad et al. 2000; Black et al. 2003). A large proportion of these deaths could be prevented through early, appropriate and low-cost treatment of sick children in the home or community with antibiotics, antimalarials or oral rehydration therapy. Improvements in care at health facilities through IMCI and other initiatives are necessary, but not sufficient. Children from the poorest families are significantly less

likely to be brought to health facilities, and may receive lower quality care once they arrive (Schellenberg et al. 2003; Victora et al. 2003). Furthermore, preliminary results of the Multi-Country Evaluation (MCE) of IMCI (Bryce et al. 2004) indicate that, even where impressive gains are made in the quality of care in health facilities, the level of care seeking from these same facilities remains suboptimal (Armstrong Schellenberg et al. 2004b; El Arifeen et al. 2004). Although large numbers of sick children have no contact with health facilities, few countries have made quality care for malaria or pneumonia available at scale outside of health facilities.

A number of countries and organizations are now renewing their commitment to child survival, and seeking guidance on which programmatic models would be most effective and sustainable for improving the management of sick children outside of health facilities. This paper proposes a classification of intervention models to

improve management at the household and community levels of children with signs of malaria and/or pneumonia. The information presented here is taken from a larger review that also examined operational aspects of community health worker (CHW) programmes, including recruitment and retention of CHWs, quality of services provided, utilization and accessibility of services, sustainability, and approaches to implementation at scale (Gilroy and Winch 2005).

**Methodology**

The review focused on those programmes that employ CHWs, not based at health facilities, to manage malaria or pneumonia among children under 5 years of age. The review was supported by WHO and UNICEF, and sought to locate information on programmes having at least one of the following characteristics:

- (1) Coverage of at least an entire district; preferably state or nation-wide coverage;
- (2) Sale or dispensing of antimicrobial agents outside of health facilities; or
- (3) Innovative approaches to identification, classification, treatment, referral or follow-up for sick children.

CHW programmes were identified through: (1) a systematic search of the major reference databases including PubMed and POPLINE; (2) identification of referenced sources cited in documents; and (3) nomination of programmes by organizations participating in this review: WHO, UNICEF, United States Agency for International Development (USAID), Johns Hopkins University and the CORE Group, a consortium of US-based non-governmental organizations (NGOs) working in the health sector. Approximate numbers of documents reviewed were: 20 reports by Ministries of Health, 50 reports by UNICEF, WHO or USAID, 75 reports by NGOs, 5 masters and doctoral theses, 10 books or book chapters, and 220 published articles. In addition to written documentation, this paper is based on interviews with more than 25 programme managers from various health organizations. These informants also provided additional documents and referrals to other informants. This review did not seek to formally analyze the effectiveness of different intervention models, but where data on effectiveness or formal meta-analyses are available, this is indicated. Although evidence for each model was reviewed and is presented here, due to the variability of the documentation, no conclusions should be drawn regarding the relative effectiveness of the different models.

**Classification of Intervention Models for management of children with signs of malaria or pneumonia outside of health facilities**

Table 1 describes seven Intervention Models for case management by CHWs of children with signs of malaria or pneumonia. Table 2 summarizes the level of available

**Table 1.** Classification of Intervention Models for case management of children with malaria and/or pneumonia outside of health facilities

Intervention Model	Assessment and diagnosis				Provision of treatment by CHW (or family)			Referral to nearest health facility: verbal or facilitated (Box 1)
	Assessment of sick child by CHW	Family assesses need for antimalarial	Malaria microscopy or rapid test	Provision of antimalarial treatment	Provision of antibiotics for pneumonia			
Model 1 CHW basic management and verbal referral	Limited	No	No	No	No	No	Verbal	
Model 2 CHW basic management and facilitated referral	CHW assesses signs requiring referral	No	No	No, CHW may provide initial treatment prior to referral	No, CHW may provide initial treatment prior to referral	No, CHW may provide antimicrobial	Facilitated for all sick children needing an antimicrobial	
Model 3 CHW-directed fever management	Sometimes use simple algorithm	No	No	Yes, by CHW	No	Usually verbal	Usually verbal	
Model 4 Family-directed fever management	No	Yes	No	Yes, by family only or shared responsibility with CHW	No	Verbal	Verbal	
Model 5 CHW malaria management and surveillance	Usually limited	No	Yes	Yes, by CHW	No	Usually verbal	Usually verbal	
Model 6 CHW pneumonia case management	Check respiratory signs	No	No	No	Yes, by CHW	Usually verbal	Usually verbal	
Model 7 CHW integrated multiple disease case management	CHW uses algorithm to classify as malaria, pneumonia or both	No	No	Yes, by CHW	Yes, by CHW	Verbal or facilitated	Verbal or facilitated	

**Table 2.** Documentation of Intervention Models for case management of children with malaria and/or pneumonia outside of health facilities

Intervention Model Number	Title	Selected examples of programmes using this Intervention Model	Reviews summarizing experience	Evidence for impact on mortality?	Formal meta-analyses conducted
Model 1	CHW basic management and verbal referral	BRAC, Bangladesh (Mushtaque et al. 1998)	No	No	No
Model 2	CHW basic management and facilitated referral	CARE, northern Peru (Espejo and Tam 2001) CRS, Intibuca, Honduras	No	No	No
Model 3	CHW-directed fever management	Homapak, Uganda (Batega et al. 2004; Fapohunda et al. 2004) Tigray, Ethiopia Malaria Control Project (Ghebreyesus et al. 1999; Ghebreyesus et al. 2000) Bougouni, Mali (Winch et al. 2003) Saradi, Kenya (Kaseje and Spencer 1987; Kaseje et al. 1987)	Yes, unpublished (Kallander et al., submitted)	No, likely to be similar to Model 4	No
Model 4	Family-directed fever management	Burkina Faso (Pagnoni et al. 1997; Sirima et al. 2003) Tigray, Ethiopia mothers' groups (Kidane and Morrow 2000)	No	Yes (Kidane and Morrow 2000)	No
Model 5	CHW malaria management and surveillance	Latin America (Ruebush and Godoy 1992; Ruebush et al. 1992, 1994) Thailand (Okanurak and Sornmani 1992; Okanurak and Ruebush 1996)	Yes (Okanurak and Sornmani 1992; Okanurak and Ruebush 1996)	No, likely to be similar to Model 4	No
Model 6	CHW pneumonia case management	India/SEARCH (Bang et al. 1990, 1994) Nepal (Pandey et al. 1989, 1991; Dawson 2001; Dawson et al., unpublished)	Yes (Rasmussen et al. 2000; WHO 1988, 2002)	Yes (Bang et al. 1990; Pandey et al. 1991)	Yes (Sazawal and Black 1992, 2003)
Model 7	CHW integrated multiple disease case management	BRAC, Bangladesh (Hadi 2001, 2002, 2003) Pakistan (Oxford Policy Management 2000, 2002) Siaya, Kenya (Kelly et al. 2001; Foster 2002)	No	No, likely to be similar or greater to Model 6	No

documentation and evidence for each Model. The classification is based on what assessment of the sick child, if any, is performed by CHWs and family members, whether antimalarials or antibiotics are dispensed or sold by the CHW, the system of referral of sick children to the nearest health facility, and the location in the community of the drug stock (Table 1). In Models 3, 5, 6 and 7, CHWs select and dispense or sell a full course of an antimicrobial agent. In Model 4, the family and CHW share this responsibility. The following paragraphs describe these seven Intervention Models, focusing on CHW roles in: (1) assessment of sick children, (2) treatment, and (3) promotion of care-seeking and referral to the nearest health facility.

#### **Intervention Model 1: CHW basic management and verbal referral**

This Intervention Model is the most widely implemented by both governments and NGOs. Much of the CHW's role relates to communication and awareness creation about both prevention and treatment through community meetings or visits to individual households, growth monitoring and promotion of appropriate feeding practices.

- (1) *Assessment*: Assessment procedures taught to CHWs typically are basic, with little assessment of the child beyond detection of signs such as dehydration and fever, and no use of algorithms.
- (2) *Treatment*: CHW activities may include selling or providing treatments such as antipyretics, vitamins, ointments, antihelminthics or oral rehydration salts (ORS) sachets, and demonstrating the preparation and administration of ORS or other form of oral rehydration therapy (ORT). They do not sell or provide antimalarials or antibiotics.
- (3) *Referral*: If a sick child is identified who requires treatment with antimicrobial agents, the CHW generally will verbally refer the child to an existing health facility. The CHW also promotes care-seeking from health facilities during meetings and household visits. This education could be about the signs of dehydration, malaria and respiratory diseases.
- (4) *Programmatic example – BRAC in Bangladesh*: The Bangladesh Rural Advancement Committee (BRAC) operates a nation-wide NGO programme in Bangladesh. Female CHWs, known as *Shastho Shebika*, are chosen by the community and receive 21 days training and 1 day a month of refresher training. These CHWs do not treat with antimicrobials, but treat the 'essential ten diseases': diarrhoea, dysentery, goiter, scabies, anaemia, ring-worm, intestinal worms, cold, fever and stomatitis. Antimalarials and antibiotics have been used in smaller pilot programmes (Hadi 2001, 2003), but are not standard medications in the main programme. If CHWs see children with malaria or pneumonia, they verbally refer caregivers to Government of Bangladesh or BRAC-run health facilities (Mushtaque et al. 1998).

- (5) *Evidence for the effectiveness of this Model*: Despite the prevalence of this Model, relatively little is known about its effectiveness. There is evidence from a number of countries such as Sri Lanka that increased levels of care-seeking have made a significant contribution to reductions in under-five mortality (Amarasiri de Silva et al. 2001). The research question is whether promotion by CHWs of care-seeking from health facilities for malaria and pneumonia, combined with verbal referral and, in some CHW programmes, active case detection, is effective in increasing the proportion of children requiring antimicrobial treatment who receive an appropriate course of treatment from a health facility. This question has yet to be definitely answered. Ali and colleagues have examined a community-based programme in Matlab, Bangladesh, and provide some evidence that active case detection and referral to facilities by CHWs can have a beneficial effect on pneumonia mortality (Ali et al. 2001).

#### **Intervention Model 2: CHW basic management and facilitated referral**

The CHW performs activities comparable to Model 1 described above. The CHW does not dispense a full course of antimicrobials, but takes a number of steps to ensure that the sick child will be taken to a health facility where antimicrobials are available. This Model has been preferred where access to health facilities is good, but other factors may favour its selection in the future. For example, governments may want to restrict the dispensing of combination therapy for malaria to health facilities due to concerns about cost, limited supplies of artemisinin-based drugs, and drug resistance (Snow et al. 2003; Duong et al. 2004; D'Alessandro et al. 2005).

- (1) *Assessment*: Assessment procedures taught to CHWs typically are basic, with no use of algorithms. CHWs may be given additional training on assessment of signs that require immediate referral to the nearest health facility, such as elevated respiratory rate.
- (2) *Treatment*: Similar to Model 1, CHWs dispense a variety of treatments other than antimicrobials, such as ORS sachets. An initial dose of the antimicrobial may be given to a child with signs of malaria or pneumonia prior to referral, particularly if the facility is distant (Box 1), because referral may entail a significant delay in initiation of treatment. A variant on this approach that has been proposed is initial treatment of severe malaria with an artesunate suppository prior to referral (Wilairatana et al. 1997; Awad et al. 2003).
- (3) *Referral*: Facilitated referral is the distinguishing characteristic of this Model, and its components are described in Box 1: (1) promotion of compliance with referral, (2) monitoring of referral and supervisory support, (3) addressing barriers to referral (geographic and financial access), and in some cases, (4) provision of initial treatment. Short of dispensing

**Box 1.** Definition of 'facilitated referral'

A community health worker is performing 'facilitated referral' if, at a minimum, she/he performs actions #1, #2 and #3 and at least one action in Component 3, in an effort to ensure that sick children requiring care reach the nearest facility.

**Component 1. CHW promotes compliance with referral (both actions)**

1. CHW counsels families about why referral is necessary and promotes compliance with referral.
2. CHW fills out a referral slip or writes in a referral book (or in 'patient held' record such as health booklet or growth monitoring card) and gives it to the child's caretaker.

**Component 2. Monitoring of referral (all actions)**

3. CHW records all referred cases in a register.
4. After examining and treating the child at a health facility, health worker writes a note to the CHW stating the outcome of the referral and explaining the follow-up that the CHW should perform in the home - this is sometimes called 'counter-referral'.
5. Both referral and counter-referral are tracked in a health information system, and the outcome of referral is one topic covered in supervisory visits or monthly meetings.

**Component 3. CHW addresses barriers to referral: geographic access and financial access (at least one action)**

6. CHW inquires about barriers to referral and works with the family to address them.
7. CHW has access to, or can inform the family about, a source of money at the community level that can provide or lend the family the funds necessary to seek care from a health facility.
8. CHW has access to, or can inform the family about, a source of emergency transport at the community level.
9. CHW accompanies the family to the health facility to ensure that they receive immediate care.

**Component 4. CHW provides initial treatment prior to referral**

This is performed especially for cases where it will take several hours to reach the first-level facility, and delay in initiation of treatment puts the child's life at risk.

10. CHW may provide an initial dose of antimicrobial therapy prior to referral to children with signs of pneumonia, such as elevated respiratory rate.
11. CHW may provide an initial oral treatment for malaria prior to referral. It has also been proposed that CHWs could treat with artesunate suppositories prior to referral for children with signs of severe malaria (once the effectiveness of this approach has been documented in current trials).

a full course of antimicrobial treatment directly, facilitated referral seeks to ensure that families reach a health facility where treatment will be provided.

- (4) *Programmatic example – Care/Peru:* The Care/Peru *Enlace* (1996–2000) and *Redes* (2000–2004) projects were implemented with support from the Peruvian Ministry of Health and Community Health Promoter Associations (CHPAs) in two rural provinces in northern Peru. In this intervention, training is decentralized, with Ministry of Health personnel in each health centre training all the CHWs of the CHPA in diarrhoea and ARI case management. CHWs make monthly visits to households with woman of reproductive age. If a child is encountered with rapid or difficult breathing or chest indrawing, the CHW works with the family to ensure the child is taken to a facility. In more remote communities, an initial dose of cotrimoxizole is administered to the child. CHWs in these remote communities received more extensive training and supervision.

The system of facilitated referral is highly developed and includes provision of a referral slip to families by the CHW, 'counter-referral' or feedback by the facility-based health worker to the CHW on the diagnosis and treatment of the child, formation of an 'evacuation brigade' to transport sick children to the nearest facility, and radio contact with facilities to announce the arrival of a sick person/child.

- (5) *Evidence for the effectiveness of this Model:* There has been limited evaluation of the effectiveness of facilitated referral from the community to first-level facilities. An evaluation of the Care/Peru programme found that the percentage of children under 2 years with suspected pneumonia seen by a qualified provider increased from 32% to 60% over the 4 years of the programme. At the close of the project, it was found that over 70% of persons (adults and children) receiving care at facilities arrived with a referral slip from a CHW (Espejo and Tam 2001). The impact of Model 2 on health outcomes has not been formally evaluated.

**Intervention Model 3: CHW-directed fever management**

Models 3 and 4 both involve presumptive treatment of fever with antimalarials, and are most commonly implemented in malaria-endemic areas in sub-Saharan Africa. The word fever is used in the titles of Models 3 and 4 instead of malaria, as the diagnosis is presumptive. The division of responsibility varies greatly between the CHW and the family in community programmes treating malaria presumptively. On one end of the continuum, the CHW is primarily responsible for classifying the sick child and identifying treatment (Model 3), while at the other end, the family classifies the sick child and identifies treatment, with the CHW providing varying degrees of support to the family (Model 4). We present a description and classic programme examples of Model 3 and Model 4;

however, a majority of programmes employing the presumptive treatment of malaria by CHWs fall somewhere in between these two extremes.

In Model 3, the CHW classifies and identifies and dispenses treatment for febrile children, and maintains a supply of antimalarial drugs.

- (1) *Assessment*: The need for treatment is based on presence or history of fever, and the CHW typically performs only minimal verification of history of fever to make treatment decisions. Caregivers are responsible for recognizing symptoms and deciding to seek care from the CHW. CHWs may be taught to recognize the signs of pneumonia as well as signs of severe disease that require referral to a health facility.
- (2) *Treatment*: The CHW sells or provides the drugs to families and relies on the family to administer the doses. The drugs may be pre-packaged to assist families in correct administration in the home. Depending on the programme, the CHW may also: (1) monitor compliance with treatment; (2) counsel caretakers or families about drug administration, (3) promote and sell insecticide-treated nets, and (4) provide intermittent preventive malaria treatment for pregnant women.
- (3) *Referral*: In almost all programmes, CHWs perform verbal referral only for children they judge to require treatment in a health facility, but in a small number of programmes CHWs perform facilitated referral (Box 1).
- (4a) *Programmatic example – Uganda*: In the Home-Based Management of Fever (Homapak) programme, the Government of Uganda recruits community volunteers, called community drug distributors (Batega et al. 2004; Fapohunda et al. 2004). These CHWs are trained for 3 days on drug distribution and counselling of caretakers on the signs of malaria and drug dosage and administration. Caretakers are responsible for recognizing fever in their children; however, the CHW generally assesses the need for treatment. They also counsel caretakers on the importance of completion of treatment, compliance with referral, and danger signs that require immediate care. CHWs verbally refer severely ill children to health facilities. Initially, a pre-packaged combination of chloroquine and sulfadoxine-pyrimethamine (SP, Fansidar) was distributed by the CHWs, but in 2004 Uganda selected artemether-lumefantrine as its new first-line drug. There is recognition of outstanding issues regarding use of artemisinin combination therapy (ACT) at the community level (cost, limited supply, concerns about drug resistance). This requires careful assessment, as well as close monitoring and evaluation, as ACT is incorporated into home-based management of malaria activities.
- (4b) *Programmatic example – Mali*: Save the Children/USA, in collaboration with the Malian Ministry of Health, has established over 300 village drug kits in the southern region of Mali (Winch et al. 2003).

CHWs receive 35 days literacy training, followed by 1 week on drug kit management. Assessment of sick children is based on history of fever. In pilot areas, CHWs also sell intermittent preventive treatment for pregnant women. When the CHW sees a child requiring referral, the child's name and the reason for referral are recorded in a notebook, the notebook is placed in a 'referral bag', and the caretaker is instructed to take the sick child, along with the referral bag, to the nearest community health facility (Winch et al. 2003).

- (5) *Evidence for the effectiveness of this Model*: Studies have found that programmes employing the presumptive treatment of malaria by CHWs (Model 3) can increase the number of patients receiving treatment (Delacollette et al. 1996; Ghebreyesus et al. 1999; WHO 1999; Ghebreyesus et al. 2000; Fapohunda et al. 2004), can increase the correct administration of drug regimens in the home (Winch et al. 2003), and decrease malaria morbidity and parasitological indices (Delacollette et al. 1996). The facilitated referral mechanism utilized in Mali was also associated with higher rates of referral and counter referral (Winch et al. 2003). The impact of this model on malaria mortality, when examined, has been inconclusive (Spencer et al. 1987; Greenwood et al. 1988; Delacollette et al. 1996; Ghebreyesus et al. 1999; WHO 1999; Ghebreyesus et al. 2000; Kallander et al. submitted).

#### **Intervention Model 4: Family-directed fever management**

In a number of programmes, families are given additional specific training, beyond the communication and awareness-raising activities in Model 3, to enable them to make informed decisions about treatment and referral of sick children. Instead of CHWs having the primary responsibility for assessment, selection of treatment and dispensing of drugs, responsibility is shared to a greater degree between CHWs and families. CHWs play various supportive roles, such as maintaining a central store of drugs from which families restock their home supplies of antimalarial drugs.

- (1) *Assessment*: Both families and CHWs are trained on symptom classification. The family takes the lead role in assessing fever and deciding on the need for treatment.
- (2) *Treatment*: Both CHWs and families are trained on correct dosage schedules. After assessing a child with fever, a family either purchases malaria treatment from a CHW, or initiates treatment directly from a stock of antimalarial drugs maintained in the home.
- (3) *Referral*: Little detail on the referral system is provided in programme documents.
- (4a) *Programmatic example – Burkina Faso*: In Burkina Faso, the National Centre for Malaria Control and provincial health teams sponsor a programme which promotes the treatment of uncomplicated malaria with pre-packaged drugs at the household level (Pagnoni et al. 1997; Sirima et al. 2003).

Nurses from the health centres train core groups of mothers, village leaders and CHWs in symptom classification and correct dosage schedules. The core mothers and leaders then share the messages with other members of the community. Caregivers and CHWs assess sick children using a simple algorithm based on the presence of fever and absence of danger signs. Caregivers treat sick children, while CHWs supply colour-coded pre-packaged courses of anti-malarials and antipyretics (Pagnoni et al. 1997; Sirima et al. 2003).

- (4b) *Programmatic example – Ethiopia:* In a study conducted in the Tigray Region, Ethiopia, ‘mother coordinators’ (CHWs) educated other mothers to recognize malaria symptoms in their children, give appropriate doses of chloroquine, and identify adverse reactions to chloroquine (Kidane and Morrow 2000). The decision to treat was made by the family. The parents maintained a supply of chloroquine within their home, and were taught how to administer age-appropriate courses of treatment to their children. The CHW (mother coordinator) functioned in a purely facilitative role, rather than providing treatment directly. Pictorial charts illustrating dosage by age were used by mother coordinators and also given to every participating household. Mother coordinators were to refer children who did not improve after 48 hours (Kidane and Morrow 2000).
- (5) *Evidence for the effectiveness of this Model:* Interventions involving family-directed treatment of fever have been associated with improved administration of antimalarial drugs in the home, especially combined with the use of pre-packaged regimens (Menon et al. 1988; Pagnoni et al. 1997; Sirima et al. 2003). The use of this model, along with pre-packaged drugs, has also been shown to reduce the incidence of severe malarial disease (Pagnoni et al. 1997; Sirima et al. 2003). One study, conducted in Tigray Region, Ethiopia, examined the impact of this model on mortality. Treatment of malaria by mothers in the home reduced overall and malaria-related mortality, with an observed reduction in overall under-five mortality of 40% in the intervention localities (95% CI 29–51%) (Kidane and Morrow 2000). Further trials in Africa related to this Model are under development.

#### **Intervention Model 5: CHW malaria management and surveillance**

Model 5 is more common in parts of Latin America and Asia where malaria transmission is not intense, and consequently many or most episodes of fever are due to causes other than malaria. This Model is typically implemented through national malaria control programmes.

- (1) *Assessment:* The CHW provides antimalarials; the need for treatment is based on presence of a fever. The programmes generally function similarly to

Model 3, but the CHW also takes a blood smear to confirm malaria infection, and often assesses and treats both children and adults. The blood smear is read by a local or national laboratory or clinic; results are used by national control programmes for disease surveillance and decision-making, as well as to confirm the original diagnosis made by the CHW. No current programmes were identified that employ rapid tests, but the feasibility of their use by CHWs has been demonstrated (Premji et al. 1994; Singh et al. 1997; Cho Min and Gatton 2002). Use of microscopy or rapid tests may be attractive to programme planners seeking to limit the use of more expensive combination therapy in areas of less intense malaria transmission (Charlwood 2004).

- (2) *Treatment:* Initial treatment decisions may be modified based on the results of microscopy. Where both *P. falciparum* and *P. vivax* are present, blood smears serve to identify those patients who require additional treatment, such as primaquine to eliminate the liver stage of *P. vivax*.
- (3) *Referral:* Few details were provided on the functioning of referral systems. Typically the work of the CHW is supervised by the malaria control programme and links to health facilities may not be well developed.
- (4a) *Programmatic example – Latin America:* A programme of volunteer CHWs (*Colaboradores Voluntarios*) was established throughout Latin America in the 1950s. The system is still operating at scale, and is a major source of the national data on trends in malaria incidence. These CHWs have similar responsibilities throughout Latin America, which include providing presumptive malarial treatment, taking a blood smear, and recording demographic information (WHO 1986; Ruebush and Godoy 1992; Ruebush et al. 1992). In Guatemala, only the first dose of chloroquine is given presumptively; further treatment with primaquine is given after results are obtained for the blood smear from a central laboratory (Ruebush et al. 1994). In other countries, such as El Salvador, full treatment is given presumptively and blood smear results are primarily utilized for programme decision-making (Okanurak and Ruebush 1996).
- (4b) *Programmatic example – Thailand:* The Malaria Division of the Thai Ministry of Health started the Village Voluntary Malaria Collaborator Program in 1961, with many similarities to the programmes in Latin America. CHWs are trained for 2 days and receive periodic refresher training. Blood smears are taken only in areas of high transmission and are collected weekly by malaria programme officers for epidemiologic surveillance (Okanurak and Sornmani 1992; Okanurak and Ruebush 1996). Treatment with first-line drugs was given presumptively until 2001, when it was phased out in favour of early diagnosis and prompt radical treatment according to parasite species at health facilities (Thailand MOH 2005).
- (5) *Evidence for the effectiveness of this Model:* Several studies have evaluated the operational outcomes

of these programmes, with favourable results (Ruebush et al. 1990, 1992, 1994; Ruebush and Godoy 1992). These CHWs collect over 10% of malaria slides used for epidemiological surveillance and programme decisions in Latin America and Thailand (Okanurak and Sornmani 1992; PAHO 2002). Slides collected from patients seen by CHWs have similar or greater malaria positivity rates to those taken in health facilities (Ruebush et al. 1992). In that it employs presumptive treatment of malaria, but with the added component of microscopy for surveillance, the impact of this Model can be expected to be similar to that of Model 3.

#### **Intervention Model 6: CHW pneumonia case management**

In this Model, CHWs assess the signs of respiratory infections in young children, and treat with antibiotics if there are signs of pneumonia. Extensive effort was invested in the development of this Model by the WHO ARI Control Programme in the late 1980s and early 1990s (WHO 1988; Sazawal and Black 1992), resulting in development of a training package for CHWs (WHO 1992). Of the seven Intervention Models described in this paper, this is the model with the strongest evidence for an impact on mortality (Sazawal and Black 1992; Sazawal and Black 2003), as well as a record of success in scaling up. Based on evidence presented at an inter-agency meeting in Stockholm in 2002 (WHO 2002), WHO and UNICEF issued a joint statement in May 2004 in support of this approach (WHO/UNICEF 2004b). Despite the fact that pneumonia is one of the top causes of under-five mortality (Ahmad et al. 2000; Black et al. 2003), CHW treatment of pneumonia with antibiotics is relatively uncommon, especially in Africa.

- (1) *Assessment*: The CHW performs a targeted physical examination, including detection of chest indrawing and determination of respiratory rate using a watch, a stopwatch or an ARI timer. The CHW may use a classification algorithm to make treatment decisions.
- (2) *Treatment*: The CHW both prescribes and dispenses antibiotic treatment, often cotrimoxazole or amoxicillin. The CHW may also monitor response to treatment by following up the child's response to treatment in the home.
- (3) *Referral*: CHWs are trained to recognize the signs of severe pneumonia (or severe respiratory illness) that require referral to a health facility for treatment and monitoring beyond what can be provided in the community by the CHW. Various programmes have developed referral cards for use by CHWs, but this review did not encounter examples of systems of facilitated referral as described earlier in this paper.
- (4a) *Programmatic example – Bangladesh*: In Bangladesh, BRAC and the Government of Bangladesh collaborated on a community-based pneumonia programme that expanded the activities of the CHWs described in Model 1. It covered 10 sub-districts (population 2.4 million) in northern and central regions of the

country. CHWs were trained for 5 days and were responsible for detecting, classifying and treating childhood pneumonia in approximately 150 to 250 households each. CHWs carried out active detection, visiting households monthly. Each CHW was given a stopwatch to time respirations, and a supply of cotrimoxazole. They also educated mothers about signs and symptoms of pneumonia, and monitored sick children (Hadi 2001, 2002, 2003). CHWs were instructed to refer severe or complicated cases to BRAC or government facilities, and also to follow-up children they had treated and refer any child who was not improving.

- (4b) *Programmatic example – Nepal*: A collaborative programme between the Government of Nepal, USAID, John Snow International (JSI), WHO, UNICEF and several NGOs was initiated with Model 6, in which female CHWs use the case management strategy to treat pneumonia. This programme was based on earlier pilot studies in Nepal that demonstrated substantial reductions in childhood mortality (Pandey et al. 1989, 1991). Later the programme evolved, as diarrhoea, nutrition, vitamin A and immunization components subsequently were added. The programme is currently integrated with the Community-Based IMCI initiative in Nepal (Dawson 2001), and now has some characteristics of Model 7. As of July 2004, the programme operates in 21 of Nepal's 75 districts, and covers approximately 43% of the under-five population. There are plans to expand to an additional six districts so that 57% of the population will be covered by July 2005. CHWs are trained for 7 days, and guidelines for assessing sick children are based on the IMCI guidelines. CHWs count respiratory rates and other signs. They verbally refer severe cases and infants less than 2 months to facilities. Traditional healers have also been included in some parts of the programme and refer children with suspected pneumonia to the CHW or to health facilities.
- (4c) *Programmatic example – Maharashtra State, India*: In rural Maharashtra State, the NGO Society for Education, Action and Research in Community Health (SEARCH) has experimented for over 20 years with different approaches to improving the care of sick children in the community. CHWs, paramedics and traditional birth attendants have been trained to assess and treat pneumonia in children (Bang et al. 1990, 1994), and later the approach was extended to pneumonia (Bang et al. 1993) and sepsis in neonates (Bang et al. 1999). In the earlier pneumonia intervention, CHWs, traditional birth attendants (TBAs) and paramedics were trained in six 1.5-hour sessions. Innovative approaches were developed so that illiterate TBAs could assess the signs of pneumonia, including a 1-minute sand timer with an abacus to assist with counting (Bang et al. 1994). Workers were provided with cotrimoxazole syrup, paracetamol and salbutamol tablets to treat pneumonia (Bang et al. 1994). A later study built on

the ARI case management approach but expanded on it considerably, introducing treatment of neonatal sepsis with gentamicin and cotrimoxazole (Bang et al. 1999).

- (5) *Evidence for the effectiveness of this Model:* There is stronger evidence for this model than for any of the others. In the early 1980s, WHO commissioned a series of studies, which found that CHWs were capable of managing pneumonia adequately in the community using simple guidelines for classification (WHO 1988). Subsequent studies confirmed this finding (Zeitz et al. 1993; Bang et al. 1994; Hadi 2003; Dawson et al., unpublished manuscript), although CHWs did have difficulties managing severe disease (Zeitz et al. 1993; Bang et al. 1994; Hadi 2003). In Nepal, a large-scale programme significantly increased the number of suspected pneumonia cases receiving treatment (Dawson et al., unpublished manuscript). The WHO-commissioned studies and others, which used the standard case management strategy and active case detection, showed significant impact on under-five mortality (WHO 1988; Pandey et al. 1989, 1991; Khan et al. 1990; Fauveau et al. 1992). Infrequent or passive case detection by CHWs and/or TBAs, along with community education, has also been shown to significantly reduce both pneumonia-specific and all-cause mortality (Mtango and Neuvians 1986; Bang et al. 1990, 1993, 1994). A recent update (Sazawal and Black 2003) of a previous meta-analysis (Sazawal and Black 1992) of community-based pneumonia case management studies estimated a 20% reduction in overall infant mortality and a 24% reduction in overall under-five mortality. Recent reviews also highlight and confirm the impact of such interventions on under-five mortality (Rasmussen et al. 2000; Kallander et al., submitted).

#### **Intervention Model 7: CHW integrated multiple disease case management**

In this Model CHWs manage sick children having one or more of the diseases or conditions (such as malnutrition) targeted by Integrated Management of Childhood Illness (IMCI). An extension of this Model involves training CHWs to assess and manage neonatal infection, which accounts for a significant proportion of under-five mortality (Bang et al. 1999; Darmstadt et al. 2000).

- (1) *Assessment:* CHWs are trained to systematically detect signs of the major causes of under-five mortality. The CHW performs a broader physical examination than in Model 6, including counting of respiratory rate, and checking for fever, dehydration and chest indrawing. CHWs classify the child using an integrated algorithm or other decision tool. In a malarious area, the algorithm or tool should take into consideration the clinical overlap of malaria and pneumonia (Kallander et al. 2004), although most tools collected for this review do not. A starting

point for many training programmes for CHWs are the IMCI algorithms and training materials for facility-based health workers, which are then simplified considerably for use by CHWs with limited formal education.

- (2) *Treatment:* CHWs dispense antimalarials and antibiotics, as well as basic treatments mentioned in Models 1 and 2 such as ORS sachets and antipyretics.
- (3) *Referral:* Referral guidelines tend to be more developed for this Model than for many of the others. The specific form and wording of IMCI guidelines for referral from first- to second-level facilities provide a template for the development of guidelines for referral from CHWs to first-level facilities (Gove et al. 1999). Record-keeping is emphasized in this model, and this emphasis extends to referral slips and monitoring of referral.
- (4a) *Programmatic example – Kenya:* In 1995 in Kenya, Care International initiated the Community Initiatives for Child Survival in Siaya (CICSS) project. CHWs in Siaya district use a simplified IMCI algorithm in order to treat children with multiple diseases. The guidelines allow CHWs to classify and treat malaria, pneumonia and diarrhoea/dehydration concurrently (Kelly et al. 2001). CHWs are trained for 3 weeks and assigned to 10 households in their community. Community-based pharmacies are established and serve as re-supply points for the CHWs' drug kits. CHWs sell the drugs to community members and use monies from sales to buy more drugs to restock their kits in a revolving fund scheme (Orimba 2001).
- (4b) *Programmatic example – Pakistan:* A National Programme for Family Planning and Primary Health Care was initiated in Pakistan in 1993. This programme soon began to employ a cadre of salaried, female CHWs, called Lady Health Workers. The programme currently employs approximately 69 000 of these CHWs and covers about one-fifth of the entire Pakistani population (Oxford Policy Management 2002). Initial CHW training lasts for 3 months and then occurs 1 week a month for at least a year. Each CHW is responsible for approximately 1000 individuals. They use the WHO case management guidelines to classify pneumonia and treat fever presumptively, and are provided with a kit that includes contraceptive pills, condoms, paracetamol tablets and syrup, eye ointment, ORS sachets for diarrhoea, chloroquine for malaria, and cotrimoxazole for respiratory infections. A referral form is used to refer children to next level facilities, if they need further care (Oxford Policy Management 2002).
- (5) *Evidence for the effectiveness of this Model:* Broader roles for CHWs, including curative treatment of malnutrition, ARI and diarrhoea, have been found to improve utilization of CHW services (Curtale et al. 1995). Evidence also suggests that CHWs' ability to manage multiple diseases is generally adequate, but there are still important deficiencies which may vary by disease and severity (Kelly et al. 2001;

Lain 2002; Oxford Policy Management 2002). For example, in Siaya, Kenya, an evaluation found that CHWs could adequately assess, classify and treat the majority of malaria cases, but they had difficulties managing pneumonia and severe disease. It is hypothesized that the complexity of the treatment algorithms contributed to the difficulties (Kelly et al. 2001). CHWs in Pakistan also experience some difficulties in the adequate treatment of childhood disease.

The impact of this model on health outcomes has been little studied. An evaluation of a primary health care (PHC) programme in The Gambia, which centred on the management and treatment of malaria, ARI, diarrhoea and malnutrition by CHWs, found that measures of child morbidity decreased in the PHC area, but that child and infant mortality declines were similar in PHC and non-PHC areas (Greenwood et al. 1990). In Pakistan, childhood mortality trends in those areas served by CHWs and in comparison areas were also found to be similar after adjusting for other factors (Oxford Policy Management 2002).

## Discussion

Recent studies of IMCI, including the Multi-Country Evaluation (Bryce et al. 2004) and the Analytic Review of IMCI implementation, have demonstrated that integrated approaches can produce significant improvements in quality of care (Amaral et al. 2004; Armstrong Schellenberg et al. 2004a,b; El Arifeen et al. 2004; Gouws et al. 2004). However, in Tanzania and Bangladesh, only 38% and 19% of children sick in the previous 2 weeks were reported to seek care at the IMCI facilities, respectively (Armstrong Schellenberg et al. 2004b; El Arifeen et al. 2004). Therefore, there have been calls to implement a household and community component of IMCI to serve the sick children who never reach these facilities (Winch et al. 2002). One framework for Household and Community IMCI defines three Elements: (1) partnerships between health services and communities; (2) care from community-based providers; and (3) promotion of key family practices, in addition to multi-sectoral activities (Winch et al. 2002; Bessenecker and Walker 2004). The present review examines the role of CHWs relative to the second Element in this framework.

This paper identifies seven Intervention Models based on: the role of community health workers and families in assessment and treatment of children with signs of malaria or pneumonia; system of referral (verbal or facilitated) to the nearest health facility; and the location in the community of the drug stock. The terms 'home treatment' and 'community-based treatment' are usually ill defined and the differences are blurred in much of the documentation. Standardization of terminology for Intervention Models using this framework could facilitate comparison

and selection of models for improving health care for children outside of health facilities.

Any intervention to improve management of sick children at the community level should ideally be part of a larger package that includes improving quality of care at facilities and improvements to health systems. A recent editorial on IMCI points out that Multi-Country Evaluation investigators found that 'weakness in the basic health system was preventing more than nominal execution' of IMCI in many countries (Gwatkin 2004). Health systems need to provide CHWs with medications and other supplies, regular supervision and links to a referral system. There is a growing demand for CHWs to take on not only management of malaria and pneumonia, but also diarrhoea treatment with zinc and ORS (WHO/UNICEF 2004a), and neonatal infections (Bang et al. 1999), and yet weak health systems and limited training and monetary incentives for CHWs pose real limitations. Programmes will need to make hard choices about what responsibilities it is realistic to assign to CHWs.

WHO and UNICEF have recently issued a policy statement on pneumonia management by CHWs, highlighting the strong evidence for impact from Model 6 (WHO/UNICEF 2004b). Most programmes reviewed were categorical, in that CHWs manage one single disease, usually malaria. In most countries in sub-Saharan Africa, malaria and pneumonia together account for about half of the mortality, and exhibit a great degree of overlap in their clinical presentation (O'Dempsey et al. 1993; Black et al. 2003; Kallander et al. 2004). Nevertheless, most programmes follow Models 3 or 4, where CHWs assess and presumptively treat sick children for malaria only. This ignores the substantial overlap in the clinical presentation of malaria and pneumonia, and puts the caregiver in the position of making a presumptive diagnosis of either malaria or pneumonia, for which to then seek appropriate care: CHW for malaria treatment, health facility or private sector for pneumonia treatment. If national policy allows both antibiotics and antimalarials to be provided by CHWs, then Intervention Model 7 may be appropriate.

Artemisinin combination treatment is now being introduced in many African countries. Questions have been raised about where in the health system these new drugs should be available, out of concern for their high cost, the current limited supply of artemisinin-based drugs, compliance and drug resistance (Snow et al. 2003; Duong et al. 2004; D'Alessandro et al. 2005). These concerns are often voiced specifically in relation to programmes following Intervention Models 3 or 4, but also apply to treatment obtained from facilities with limited diagnostic capabilities. Close monitoring of financial access to treatment, patterns of care-seeking, treatment compliance and drug resistance is needed when combination therapy is introduced through any of the Intervention Models. Where these therapies are restricted to use only in health facilities, interventions in the community should include some form of facilitated referral (Model 2).

Unfortunately, there is the least evidence for Model 2 of all the Models, so research is urgently needed on how facilitated referral can be made to work.

This review did not systematically identify programmes training CHWs to assess and treat children with diarrhoea or neonatal infections. Few programmes train CHWs to identify signs of severe dehydration or dysentery, or to manage neonatal infections (Bang et al. 1999). WHO and UNICEF have recently issued another policy statement on management of diarrhoea in children, including the recommendation that children with diarrhoea receive a 10 to 14 day course of zinc supplementation and that a newer low-osmolarity formulation of ORS be used (WHO/UNICEF 2004a). Further efforts are also needed to integrate management of neonatal infections into CHW programmes (Darmstadt et al. 2000). These new recommendations could be integrated in different ways into all of the Intervention Models described in this paper, but with the caveat that simultaneous efforts are needed to strengthen health systems and ensure that the overall workload of CHWs is reasonable.

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Kate E Gilroy, BSc, ScM, is a doctoral student in the Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health. Her main areas of interest are the community case management of sick children with signs compatible with both malaria and pneumonia, and the design, conduct and analysis of

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Cathy Wolfheim, MPH, is a senior technical staff of the World Health Organization Department of Child and Adolescent Health and Development. She is responsible for research, development and promotion of community interventions to support child health. Her most recent work has focused on publishing evidence of the impact of the key family practices on child survival growth, and development, on programming for community child health, and on research on interventions to promote care-seeking and home care. Prior to this she was the UNICEF/WHO Communication Officer for the Programme for the Control of Diarrhoeal Disease (CDD). She has worked extensively in North Africa, West Africa, Tanzania, Egypt and Vietnam. [Address: Department of Child and Adolescent Health and Development, World Health Organization, 20 Av Appia, 1211 Geneva 27, Switzerland]

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