

REVIEW

The community case management of pneumonia in Africa: a review of the evidence

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Pneumonia causes around 750 000 child deaths per year in sub-Saharan African (SSA) countries. The lack of accessibility to prompt and effective treatment is an important contributor to this burden. Community case management of pneumonia (CCMp) uses trained community health workers (CHWs) to administer antibiotics to suspected child pneumonia cases in villages. This strategy has been gaining momentum in low- and middle-income countries, and the World Health Organization and United Nations children's fund have recently encouraged countries to broaden community case management to other diseases. Recommendations in favour of CCMp are based on three meta-analyses showing its efficacy to reduce childhood mortality and morbidity attributable to pneumonia although most of the studies in the meta-analyses were conducted in Asian countries. This is problematic as community case management strategies have been implemented in very different ways in Asian and SSA countries, partly due to differences in malaria prevalence. Therefore, we conducted a narrative synthesis to systematically review the evidence on CCMp in SSA. Results show that there is a lack of evidence concerning its efficacy and effectiveness in SSA, irrespective of whether case management is integrated with other diseases or not. CHWs encounter difficulties in counting the respiratory rate. Their adherence to the guidelines is poorer when they are required to manage several illnesses or children with severe signs. CCMp thus encompasses issues of over-treatment and missed treatment, with potentially negative consequences such as increased lethality in severe cases and antibiotics resistance. The current lack of evidence concerning its efficacy, effectiveness and the factors leading to successful implementation, coupled with CHWs' poor adherence, demand a thorough examination of the legitimacy of implementing CCMp in SSA countries.

Keywords Case management, community health, systematic reviews, acute respiratory infections

Abbreviations C-RCT, cluster-randomized control trial; CCMm, community case management of malaria; CCMp, community case management of pneumonia; CHW, community health worker; iCCM, integrated community case management; IMCI, integrated management of childhood illnesses; MMAT, mixed methods appraisal tool; RDT, rapid diagnostic test for malaria; SSA, sub-Saharan Africa; UNICEF, United Nations children's fund; WHO, World Health Organization

KEY MESSAGES

- There is a lack of evidence concerning the impacts of community case managements of pneumonia on childhood mortality and morbidity in African countries, irrespective of whether the management is integrated to other diseases or not.
- Community health workers' (CHWs) performance in managing pneumonia suffers from challenges associated with counting the respiratory rate, which entails severe issues of over-treatment and miss-to-treat.
- African policy planners should use great caution in interpreting the efficacy of community case management of pneumonia extrapolated from the scientific literature because most of the studies have been conducted in Asian countries.
- Innovative approaches to increase CHWs' adherence to the guidelines must be tested before integrating community case management to other diseases, namely malaria.

Introduction

Pneumonia is the leading cause of death in children under 5 years old (WHO 2008b). In sub-Saharan Africa (SSA) alone, ~750 000 child deaths were caused by pneumonia in 2008 (Black *et al.* 2010). The lack of prompt and accessible treatment for vulnerable populations is a major and well-known contributor to this burden (Kallander *et al.* 2008). In 1982, the World Health Organization (WHO) launched the acute respiratory infections programme with the objective of establishing clinical guidelines to help healthcare personnel diagnose and treat pneumonia (Riley 1982). A decade later, these guidelines would be broadened to other diseases (namely malaria, diarrhoea and malnutrition) in the integrated management of childhood diseases (IMCI) strategy (Gove 1997).

In the meantime, studies suggested that primary healthcare personnel could also manage pneumonia with the help of a simplified algorithm (Shann *et al.* 1984). This led the WHO and United Nations children's fund (UNICEF) to launch in 1986 the strategy known as the community case management of pneumonia (CCMp), which consists in the selection, training and supervision of community health workers (CHWs) who administer antibiotics in simple pneumonia cases (WHO 1986). Studies conducted in Asia have shown that under good implementation conditions (defined as those with regular supervision, support from the health sector and adequate initial training), CHWs can significantly reduce childhood mortality and morbidity attributable to pneumonia in countries with insufficient human resources for health care (Winch *et al.* 2005). A 2008 survey showed that 12 of the 16 Asian countries who had been recommended for this strategy had at that time implemented the CCMp (Marsh *et al.* 2008)—some of them at a large-scale level (Dawson *et al.* 2008).

Until recently, CCMp had received less attention in SSA, both from researchers and programme planners (Winch *et al.* 2005; WHO and UNICEF 2006; Marsh *et al.* 2008; Yeboah-Antwi *et al.* 2010). In SSA countries where malaria is endemic, the WHO had recommended from 1992 until recently that primary healthcare personnel administer presumptive antimalarial treatments for non-complicated fevers in children (WHO Regional Office for Africa 1992; WHO 2004). The malaria prevalence and mortality in SSA countries (WHO 2010b;

Meyrowitsch *et al.* 2011) combined with the lack of resources for laboratory diagnosis (Ukwaja *et al.* 2011) justified this presumptive strategy. But the systematic association of fever with malaria limited the diagnosis of pneumonia and the adoption of community-based interventions against it. Consequently, many pneumonia cases remained untreated, worsening the burden of the disease (Kallander *et al.* 2008). In 2008, a WHO report entitled *Community-directed interventions for major health problems in Africa* still did not mention pneumonia (WHO 2008a)—the combination of malaria and pneumonia management at the community level had been envisaged in 2004 (WHO and UNICEF 2004), but was not officially endorsed until 2012 when the WHO and UNICEF issued a statement promoting integrated community case management (iCCM) (WHO and UNICEF 2012).

In 2010, the fear of resistance to artemisinin-combination therapy (WHO 2010a) and the spread of rapid diagnostic tests (RDTs) (D'Acremont *et al.* 2009) led the WHO to recommend that antimalarial treatment be administered only after parasitological confirmation, even in febrile children (WHO 2010a). As a result, the issue of non-malarial acute undifferentiated fevers—febrile illnesses with no indication of an organ-specific disease after diagnosis of malaria has been excluded (Joshi *et al.* 2008)—has been emerging and is a potential avenue to further promote efforts against pneumonia in SSA (Rutebemberwa *et al.* 2009; Baiden *et al.* 2011b; Chanda *et al.* 2011). A UNICEF-piloted survey in the 'countdown to 2015 countries' found that out of the 40 SSA countries with available data, 28 had implemented CCMp programmes in 2010—compared to only 11 in 2005 (UNICEF 2012).

While there are increasingly more countries implementing CCMp, the consequences for this strategy in SSA countries where malaria is endemic are still being debated among scientists, healthcare professionals and community health programme planners. Based on recent studies indicating that community case management of malaria (CCMm) is effective in several SSA countries (Ghana, Uganda, Nigeria, Ethiopia, Malawi and Burkina Faso) and acceptable to local communities (Chinbuah *et al.* 2006; Ajayi *et al.* 2008a,b; Akweongo *et al.* 2011), that CHWs can perform malaria RDTs (Harvey *et al.* 2008; Chanda *et al.* 2011; Ishengoma *et al.* 2011; Mubi

et al. 2011), and on meta-analyses showing that CCMp is effective in reducing child mortality (Sazawal and Black 1992; Sazawal *et al.* 2003; Theodoratou *et al.* 2010), the potential impacts of a combined malaria and pneumonia CCM are under investigation (Hildenwall *et al.* 2007; Kallander *et al.* 2008; Marsh *et al.* 2008). Some go further and see an opportunity to implement iCCM, which replicates the IMCI strategy at the community level (Perez *et al.* 2009; Ukwaja *et al.* 2011; Chopra *et al.* 2012; WHO and UNICEF 2012). In this context they highlight CHWs' effectiveness to treat or prevent the deadliest diseases, and explore their contribution to reducing childhood mortality and reaching the '2015 Millennium Development Goals' (Haines *et al.* 2007; Lewin *et al.* 2010). There are some reservations concerning iCCM because of the numerous barriers and difficulties to sustainably implement such interventions at a large scale (Liu *et al.* 2011). The negative prospect associated with creating a parallel, second-rate, health system—with dangerous consequences in severe cases—is also anticipated (Aubouy 2011). Finally, the introduction of malaria RDTs could trigger a non-rational use of antibiotics if they become routinely administered to febrile cases with negative results (Baiden *et al.* 2011b). This inappropriate use may increase resistance to antibiotics (English and Gaur 2010). If CHWs are to use diagnostic tests at the community level, these should arguably better distinguish between parasitological, viral and bacterial infections.

To our knowledge, there has been no systematic examination of CCMp interventions implemented in SSA countries. Three meta-analyses have examined CCMp impacts (Sazawal and Black 1992; Sazawal *et al.* 2003; Theodoratou *et al.* 2010), but only one of the 15 included studies took place in SSA (Mtango and Neuvians 1986)—its results are discussed below. This is problematic since community health programmes have been implemented in different ways in Asian and SSA countries, partly due to distinct epidemiological, socioeconomic and political contexts. Indeed, the African context is characterized by a higher prevalence of malaria, by lower overall literacy rates and by fewer public services, with more limited access (Winch *et al.* 2005; Marsh *et al.* 2008).

Consequently, the aim of this article is to produce a review of the evidence on CCMp programmes in SSA. Adhering to the instructions for producing a narrative synthesis (Popay *et al.* 2006), we delimited our review question to: 'What is the current state of knowledge concerning the effects and the implementation of a CCMp intervention in SSA?'

Methodology

We chose to produce a narrative synthesis, which can be defined as 'approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and texts to summarize and explain the findings of the synthesis' (Popay *et al.* 2006). In contrast to 'narrative reviews' and 'evidence syntheses', narrative syntheses entail a systematic and pre-defined search strategy, but they are more focused on producing a textual synthesis than other types of systematic reviews such as quantitative meta-analyses. However, narrative synthesis can be used to review quantitative as well as qualitative data justifying its use in the current study. In the present case, a quantitative meta-analysis was not an option because there were very few experimental or quasi-experimental studies and their study outcome varied.

We followed the steps suggested in the Popay *et al.* (2006) framework to improve the quality of our narrative synthesis. Once our review question was defined, we conducted a systematic review of studies evaluating or describing CCMp interventions in SSA countries. We considered all types of evaluations (impact, effectiveness, efficacy, implementation, feasibility and acceptability) and study outcomes. Broader interventions—implementing an integrated management of several diseases—were included in our review as long as pneumonia management was specifically addressed.

Search strategy

Twelve databases were searched for free-text words (Medline, Embase, CAB Abstracts, Popline, Web of Knowledge, African Journals on line, Business Source Premier, Cumulative Index to Nursing and Allied Health Literature, Banque de données en santé publique, Educational Resources Information Center, Evidence-Based Medicine Reviews and Current Contents). The exact expression 'CCMp' was systematically searched for, as well as a combination of terms using two Boolean logic operators (AND, OR) and a truncation sign (*) as an open-ended term (Box 1). The language used in the search was English, but articles written in French were also included. When available, we used filters to limit the search from January 1986—year of the introduction of the CCMp strategy—to present (September 30, 2012). We also looked for cross-references in three literature reviews and a WHO database on acute respiratory infections (<https://apps.who.int/chd/-publications/ari/aripub.htm>). Duplicates were identified and removed by listing all citations in an Excel spreadsheet.

Box 1 Search terms used for systematic review on CCMp evaluations in Africa.

Exact expression [all fields]

- community case management of pneumonia.

Boolean expression [all fields]

- (community health worker* OR lay health worker* OR village health worker* OR community health volunteer* OR lay health volunteer* OR village health volunteer*) AND
- (pneumonia OR acute lower respiratory infection*) AND
- (antibiotic* OR amoxicillin OR cotrimoxazole).

Box 2 Inclusion and exclusion criteria.**Exclusion criteria (stage 1)**

- The document was not published in a peer-reviewed journal.
- The title or abstract of the document mention that the focus is a disease other than acute lower respiratory infections or pneumonia.
- The title or abstract of the document mention that the study was conducted in a country outside Africa.

Inclusion criteria (stage 2)

- The article presents original empirical data.
- The article concerns community health workers who respect the three basic criteria of the WHO definition.
- The article evaluates a community CCMp intervention.

Eligibility criteria

Papers were screened in a two-stage process (Box 2). First, we screened titles and abstracts using three exclusion criteria. Papers that undoubtedly met at least one exclusion criterion were removed. Two inaccessible papers were also discarded. Second, we read retained papers in their entirety to determine if they respected all three inclusion criteria. Screening the papers for inclusion criteria required establishing three definitions.

First, we used the WHO definition of CHWs as actors (1) working in the community in which they live, (2) with shorter training than professional workers and (3) partially integrated or supported by the formal health sector (WHO 1989). We did not take into consideration two common CHW's characteristics (selection by and answerable to their community) as most studies do not give information about those. Second, we defined a CCMp intervention as the management by CHW (with antibiotics administration) of children with acute lower respiratory infections, including pneumonia. Evaluations of interventions implementing an integrated management of several diseases were included if acute lower respiratory infections or pneumonia was one of them. Third, we defined a child as an individual ranging from 1 to 59 months of age. We therefore purposely excluded neonatal infections, for which different programmes of CHW management exist.

In this second stage of the screening process, all studies meeting the four inclusion criteria were included regardless of their design or methodology; we assessed quality in a subsequent stage (see 'Analysis' section). We retrieved original articles from the relevant meta-analyses and checked their conformity to the exclusion and inclusion criteria. We also hand-searched the reference list of eligible papers for additional references. Then, we listed all references and looked for the citation using the Thomson Reuters Web of Knowledge® (formerly ISI) database.

Analysis

Following the Popay *et al.* (2006) framework, we focus on three elements. First, we conducted a preliminary analysis of the content. This allowed us to identify three recurrent themes of evaluation: impact on mortality/morbidity attributable to pneumonia, CHWs' adherence to the guidelines and implementation issues including contextual factors. We relied upon this 3-fold categorization to separate study outcomes (impact/effects,

adherence of CHWs to the guidelines, implementation) and organize the results. We chose to separate CHWs' adherence from the implementation theme due to the importance given to the former in the material. Second, we extracted and presented as much information as possible on the design study and evaluation procedures allowing for the comparison of results across different studies. Design descriptions follow evaluation conventions presented in Shadish *et al.* (2001). Links between the study authors and the implementers of the intervention were either mentioned in the article or induced by reading the affiliations, acknowledgments and methodology sections. Third, we considered the quality of the studies by applying the 'Mixed methods appraisal tool (MMAT)' (Pluye 2013), because some studies mixed quantitative and qualitative analysis of data. Despite the absence of an uncontested tool to assess simultaneously the quality of quantitative, qualitative and mixed methods studies, the MMAT showed intra-class correlations ranging from 0.7 to 0.9 (Pluye *et al.* 2009; Pace *et al.* 2012). In addition, our desire to influence policy led us to reflect deeply on the current debate about the relevance of combining the community management of pneumonia with other diseases.

Results**Description of the material**

Results of our research strategy are detailed in Figure 1. We retained 15 articles that we coded from 1 to 15 (for the coding assignment, see 'References' section), presenting the results originating from nine distinct research sites (Table 1). The selected studies varied widely in terms of their design, objective and hypotheses, scope and duration and the type of programme considered (Table 2). Only one study evaluated a programme implemented under real-life conditions [2]. In most of the studies (8 of 15), the evaluation was not entirely independent—the implementer (co-)authored the study [1, 6, 7, 10–14].

One study combined two designs to evaluate the same outcome [10]. The majority of studies (11 of 15) examined primarily the CHWs' performance, and all but one of these was observational. Of the four experimental or quasi-experimental designs, two measured the impact on mortality (they took place more than 20 years ago), one evaluated the effects on treatment failures and health-seeking practices and one compared CHWs' performance in CCMm vs CCMm+p interventions.

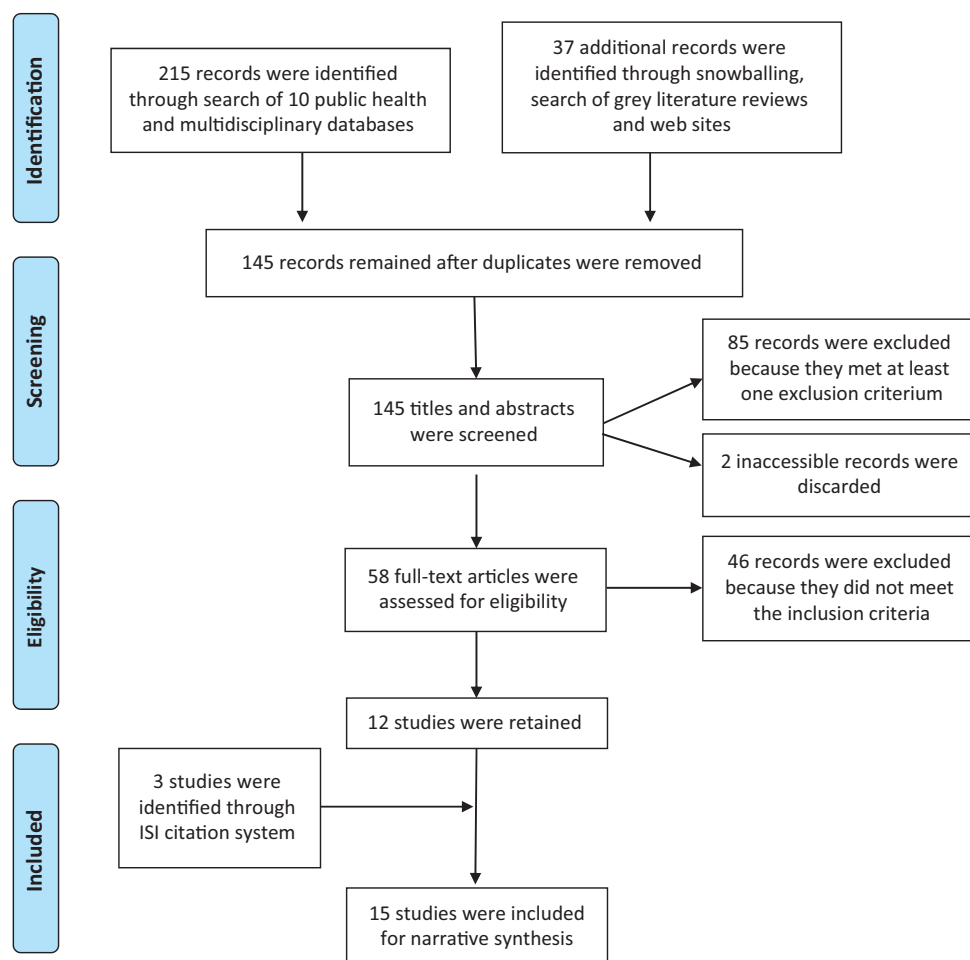


Figure 1 Flow chart of the research strategy.

Longitudinal studies lasted from 3 months to 4 years. Essential characteristics of CCMP interventions showed considerable heterogeneity across studies—e.g. the length of the CHWs' training ranged from 2 to 42 days. A summary of main results is available in the Supplementary File 1.

The small number of studies, the fact that all but two were conducted in East Africa and their methodological heterogeneity call for caution concerning the comparability and generalizability of the results to other contexts. Most of the studies provided very little information on CHWs' characteristics and the context of implementation. While the performance of CHWs was the most frequent study outcome, measurement methods were not always similar—the evaluation was either made by clinicians in unusual work conditions for CHWs or by the examination of inconsistencies in CHWs' registries. In addition, the management algorithms and the type of antibiotics administered varied.

Results of the review of study quality are presented in Table 2. Based on the mixed methods evaluation tool, five studies had a score equal or inferior to 50% [2, 5, 7, 13, 14], which means that they met two or fewer of the four criteria used to appraise quality (for details, see the Supplementary File 2) (Pluye 2013). However, these scores should be considered with caution, given the aforementioned diversity of the studies.

Moreover, the tool used is still under development and may not consider the same elements of methodological quality as other tools developed for quantitative studies. Results are therefore presented to allow for the reader's own critical assessment. Due to the absence of an undisputed definition of quality, the small number of studies included and the congruence of their results, we chose not to exclude any of the 15 studies on the grounds of their quality appraisal or time of publication. The reader should keep in mind that most of the studies were observational.

CHWs' adherence to guidelines

To evaluate CHWs' adherence to guidelines, three studies relied upon their registries [3, 12, 14], six directly observed CHWs in a health facility [1, 4, 6, 8, 11, 13] and two did both [5, 10]. One specifically compared the two methods of assessment, revealing that CHWs evaluated under direct observation changed their management practices and provided treatment more consistent with the guidelines compared to their classifications in routine conditions [10]. While some only presented average overall adherence scores [11, 12], the majority of studies separated the process into four chronological steps: assessment, classification, treatment and referral.

Table 1 Description of the programmes under study

#	First author	Year of publication	Country	Type of programme	CHW's training	Implementer of the programme/intervention	Programme scope	# CHWs under study
7	Mtango	1986	Tanzania	CCMp	?	A co-operation agency and WHO	1 district	?
2	Greenwood	1990	Gambia	Integrated intervention	42 days	National authorities	National	41
6	Kelly	2001*	Kenya	Integrated intervention	21 days	An NGO	1 district	322
13	Sylla	2004**	Senegal	CCMp	3 days	UNICEF	4 districts	107
4	Kallander	2006	Uganda	CCMp	2 days	Research team	1 district	96
10	Rowe	2006*	Kenya	Integrated intervention	15 days	An NGO	1 district	103
11	Rowe	2007*	Kenya	Integrated intervention	15 days	An NGO	1 district	125
14	Sylla	2007**	Senegal	CCMp	3 days	UNICEF	4 districts	107
12	Rowe	2007b*	Kenya	Integrated intervention	15 days	An NGO	1 district	114
1	Degefie	2009	Ethiopia	Integrated intervention	7 days	An NGO	1 district	38
15	Yeboah-Antwi	2010***	Zambia	CCMp + m	5 days	Research team	1 hospital catchment area	37
8	Mukanga	2011****	Uganda	CCMp + m	8 days	Research team	1 sub-county	14
3	Hamer	2012***	Zambia	CCMp + m	5 days	Research team	1 hospital catchment area	18
9	Mukanga	2012****	Uganda	CCMp + m	8 days	Research team	1 sub-county	7
5	Kalyango	2012	Uganda	CCMp + m	6 days	Research team	1 health and demographic surveillance site	125

Asterisks indicate studies coming from an identical research site.

#, number attributed to the paper; NGO, non-governmental organization.

Assessment

If a child shows difficulty in breathing or coughs, the IMCI guidelines classify a child with one sign (high respiratory rate) as having moderate pneumonia and a child with two signs (chest in-drawing and stridor) as having severe pneumonia (Benguigui and Stein 2006). Studies assessing the ability of the CHWs in identifying these signs showed that CHWs had difficulty assessing fast breathing in children, even when performed at the end of training in a clinical setting—between 29% and 51% of respiratory counts were more than 5 breaths per minute different from the gold standard, i.e. the assessment by a trained physician [4, 5]. CHWs correctly assessed 41–81% of children with fast breathing [6, 8]. The concordance rate between the gold standard and CHWs in discriminating between normal and fast breathing in children ranged between 79% and 84% [4, 8]. Assessment of severe pneumonia was somewhat difficult for CHWs—the average sensitivity of chest in-drawing detected by CHWs varied between 19% and 60% [6]. No study evaluated the CHWs' ability to assess stridor; apparently the majority of interventions did not include that symptom during the CHWs' training.

Classification

When they had to differentiate between simple and severe pneumonia, CHWs correctly classified 32–55% of children having non-severe pneumonia (as defined by the gold standard), and 18–53% of children having severe pneumonia [6]. This sensitivity score increased to 75–84% if there was no differentiation of severity in pneumonia diagnosis [4, 8]. The concordance rate between CHWs' classification and the gold standard varied between 75% and 78% [4, 5]. Arguably, misclassification was mainly due to assessment errors, since

more than 95% of children having pneumonia (as assessed by the CHW) were correctly classified [1, 3, 14]. However, this was not the case for children having severe pneumonia (as assessed by CHWs), for whom the sensitivity score of CHWs' classification was 63% [14].

Treatment

About 80% or more uncomplicated pneumonia cases (as classified by CHWs) were coherently prescribed antibiotics [3, 5, 8, 14]. CHWs' treatment scores were lower when compared to the gold standard, i.e. the treatment recommended by a trained physician using the guidelines, especially if they had to make distinctions between severe and moderate pneumonia. In these cases, 50–65% of children with moderate pneumonia (as defined by the gold standard) were given an appropriate treatment by the CHWs [6]. Dosage errors are an additional concern—in one study, 85% of antibiotics prescriptions were correctly dosed [14], while another mentioned that dosage errors were frequent [6].

Referral

In the Sylla *et al.* study [14], CHWs referred to the nearest facility 88% of the children they had classified as having severe pneumonia or a danger sign. In another study, three successive evaluations showed that 11–60% of children classified by the gold standard (a trained physician using the guidelines) with severe pneumonia were appropriately referred by CHWs [6].

Adherence determinants

It is not clear from this literature review what determines CHWs' adherence to the CCMp or IMCI guidelines. One study found a significant association between CHWs' education level

Table 2 Description of the evaluation approach

#	First author	Beginning of the study compared to the intervention introduction	Study design ^a	Follow-up duration	Study outcome	Links between the implementer and the authors	MMAT score ^b
7	Mtango	Identical	CR X O O	2 years	Impact on mortality	One of the authors is the implementer	0%
2	Greenwood	1 year before	CR O X O O X O	4 years	Impact on mortality	None	33%
6	Kelly	10, 31 and 47 months later	X O ₁ O ₂ O ₃	NA	CHWs' performance	One of the authors is the implementer The implementer funded the study	100%
13	Sylla	Identical	X O	NA	CHWs' performance	Two of the authors are the implementer	50%
4	Kallander	Identical	X O	NA	CHWs' performance	Same (interventonal research)	75%
10	Rowe	5 years later	X O _{i=1} O _{i=90}	3 months	CHWs' performance	One of the authors is the implementer	100%
11	Rowe	5 years later	X O	NA	CHWs' performance	The implementer funded the study	100%
11	Rowe	4 years later	X O	NA	CHWs' performance	One of the authors is the implementer	100%
14	Sylla	Identical	X O _{i=1} O _{i=365}	1 year	CHWs' performance	The implementer funded the study	0%
12	Rowe	2 years later	X O _{i=1} O _{i=1825}	5 years	CHWs' performance	Three of the authors are the implementer	100%
1	Degeffe	1 year later	X O	NA	Impact on care-seeking practices CHWs' performance	Five of the authors are the implementer	75%
15	Yeboah-Antwi	Identical	CR X O	1 year	Implementation determinants Impact on morbidity	Same (interventonal research)	75%
8	Mukanga	3 days later	CR O X O	NA	CHWs' performance	Same (interventonal research)	100%
3	Hamer	?	X O _{i=1} O _{i=365}	1 year	Impact on knowledge CHWs' performance	Same (interventonal research)	75%
9	Mukanga	1 year later	X O	NA	Implementation determinants	Same (interventonal research)	100%
15	Kalyango	Identical	CR X O	2 years	CHWs' performance	Same (interventonal research)	33%
			CR O				

#, number attributed to the paper; NA, not applicable; CR, cluster-randomized.

^aDesign descriptions follow evaluation conventions presented in Shadish *et al.* (2001). O represents an outcome measure, and X indicates the introduction of the intervention. For experimental or quasi-experimental designs, control groups are represented on the line below.

^bMMAT scores were calculated following methods explained by Pluye (2013). Details are available in the Supplementary File 2.

and the quality of care [11], in contrast to two others that did not [4, 13]—however, these two recruited only literate CHWs. In integrated interventions, adherence was lower when children had several concurrent classifications, when they were <2 years old or when a danger sign was present [11]. In addition, the use of treatment cards, the number of CHWs' benefits and the recording of complaints during the assessment phase were positively correlated to adherence [11]. Surprisingly, supervision and refresher training sessions were not always beneficial. A longitudinal analysis showed that they can have a direct negative effect on adherence scores, and even a negative long-term impact [12]. An interaction was observed between refresher training sessions and the severity of a child's illness—the refresher session increased the adherence score of CHWs for patients with a severe classification but decreased it in cases of patients with a non-severe classification.

Antibiotic misuse

Antibiotic misuse, including over-treatment and failure-to-treat, is a major concern from a public health perspective. There are different situations in which the inappropriate use of antibiotics by CHWs occurs. The first occurs when the treatment is in disagreement with the CHW's own classification—between 2% and 23% of CHW-classified non-pneumonia cases were administered antibiotics [5, 8, 14] while up to 18% of children classified as having pneumonia received no antibiotics at all [5]. In the Kalyango *et al.* study [5], 9% of all antibiotic treatments were administered to children with no pneumonia symptoms. A second possibility is that a CHW provides antibiotic treatment consistent with his diagnosis, but the diagnosis is incorrect according to that made by a trained physician using the IMCI guidelines, i.e. 'the gold standard'. Mukanga *et al.* [8] report that 16% of all antibiotic treatments were given to children without pneumonia (as established by the gold standard). In contrast, 16% of children diagnosed with pneumonia by a physician received no antibiotics because the CHWs did not classify them as such [8]. The third type of antibiotic misuse concerns situations where the diagnosis according to the gold standard mistakenly administers a treatment; indeed, the case management guidelines have limited specificity and sensitivity (Weber *et al.* 1997). Taking these cumulative risks into consideration, Kallander *et al.* [4] estimate that the proportion of over-treatment of pneumonia could reach 40% depending on the local pneumonia prevalence as could the risk of failure-to-treat. Thus, as the true prevalence of pneumonia increases, the risk of failure-to-treat grows and the risk of over-treatment diminishes.

CCMp implementation and uptake of CHW services

A house survey examined implementation obstacles to an integrated intervention and revealed difficulties with drug and cash management [1]. Despite these obstacles and the presence of modest user fees, community care-seeking practices for pneumonia symptoms increased from 30% to 84% during the intervention [1]. Another survey showed that CHWs were the first option of treatment for 40% of sick children and that 98% of mothers were satisfied with the services they provided; in this context, using respiration rate timers and RDTs apparently reinforced CHWs' credibility [9]. However, caregivers in the

households also mentioned several key reasons for not consulting a CHW: frequent shortages of drugs, dislike of CHW services and their lack of availability. These factors were also cited in other studies, in addition to the sickness perceived as too severe [2, 5, 15]. Furthermore, proximity of the households to the CHW is a determinant in favour of their use, while the presence of a primary health centre in close proximity to the households is a deterrent against their use [9, 15].

Impacts on mortality and morbidity attributable to pneumonia

Two studies evaluated the impact on mortality [2, 7]. The first one measured mortality at the outset and 1 year following intervention by CCMp. It revealed that the overall childhood mortality rate dropped from 40 per thousand to 35 per thousand and that the mortality attributable to pneumonia fell from 14 per thousand to 12 per thousand [7], though there was no mention if this was statistically significant. The second study evaluated the impact of an integrated intervention 3 years following its introduction. It found no significant reductions in overall childhood mortality rates between the intervention area and a control area with no community intervention [2]. The child mortality rate attributable to acute respiratory infections decreased from 10.7 per thousand to 6.8 per thousand, but this change was not statistically significant. Repeated clinical measures showed no significant variation in the prevalence of acute lower respiratory infection and fever.

In a cluster-randomized control trial (C-RCT) conducted in Zambia, Yeboah-Antwi *et al.* [15] compared the impact on morbidity in two arms: (1) an intervention group where CHWs (equipped with malaria RDTs) treated childhood malaria and pneumonia vs; (2) a control group where CHWs (without RDTs) presumptively treated malaria and referred children with pneumonia symptoms to a health centre. Children classified with pneumonia experienced significantly less treatment failures in the intervention group (11%) than in the control group (20%)—treatment failures were defined as the persistence of pneumonia symptoms 5–7 days after initial visit to the CHW. The probability of receiving early and appropriate treatment for non-severe pneumonia cases was also significantly higher in the intervention group (68%) than in the control group (13%).

The combined management of pneumonia with others diseases

The five most recent articles (presenting results from three study sites) examined the combined management of malaria and pneumonia. These studies showed that CHWs' performance was consistently better if the child presented only with malaria rather than the combination of malaria and pneumonia or pneumonia alone. One experimental study showed that CHWs managing both diseases (with RDTs) significantly reduced treatment failure at Day 5 for children with non-severe pneumonia compared to CHWs managing malaria only (without RDTs) and did so without generating any differences in treatment or outcome for children with malaria [15]. Another experimental study comparing CCMm and CCMm + p showed no significant difference between the two groups of CHWs concerning their knowledge and performance to manage malaria [5]. The combined use of diagnostic tools

(thermometer, malaria RDT and respiratory rate timer) was appropriate and acceptable in the Mukanga *et al.* studies [8, 9], but they observed more frequent difficulties in counting the respiratory rate than in measuring the temperature or using the RDT.

The integrated management of several diseases (mainly malaria, pneumonia, diarrhoea and malnutrition) has rarely been evaluated. A natural experiment showed that an integrated intervention had no positive impact on childhood mortality or morbidity (general or disease-specific) [2]. Rather, 1-year after its introduction, the authors observed an increase of incidence of marasmus (children with weight-for-age <60%) in both arms of the study, and this increase was significantly higher in the intervention area compared to the control area. In two other evaluations of integrated interventions, the complexity of IMCI guidelines was deemed the cause for the poor performance of CHWs and low adherence levels [6, 12].

Discussion

The aim of this article is to synthesize the evidence on the CCMP at a turning point in the fight against infectious diseases for children in SSA. Indeed, while RDTs for malaria are increasing in availability and utilization, and presumptive antimalarial treatment is no longer recommended for febrile children, the issue of non-malarial acute undifferentiated fevers is emerging (Joshi *et al.* 2008). The management of pneumonia by CHWs—key actors in the ‘renewed primary healthcare’ approach currently promoted by the WHO—is a potential answer to this challenge that has attracted a lot of attention, as shown by the increasing number of SSA countries implementing it (de Sousa *et al.* 2012; UNICEF 2012).

Our review shows that there have been very few studies in SSA evaluating CCMP interventions or interventions where CHWs simultaneously manage several diseases (including pneumonia). A disproportionate number of them focus on the performance of CHWs in following the guidelines and all but one of the studies considered in this review took place under controlled conditions comparable to pilot project evaluations. In addition, countries where these studies were conducted were limited in their number and regional location. The consequent paucity of evidence is striking, especially when compared with the evidence coming from studies piloted in Asian countries. However, the publication of a Supplement by the *American Journal of Tropical Medicine and Hygiene* in November 2012 on the iCCM interventions in Africa indicates that research is growing on the topic.

The evidence of impact on mortality is particularly poor and over 20 years out-of-date. In fact, we found only one evaluation of a CCMP intervention that observed a significant change in child mortality [7]. This is the only study conducted in SSA out of the 15 included in the last two meta-analyses on CCMP impacts on mortality (Sazawal *et al.* 2003; Theodoratou *et al.* 2010). Since differences have been pointed out between Asian and African community case management strategies (see ‘Introduction’ section), policy planners from SSA countries should use great caution in interpreting the efficacy of CCMP extrapolated from this scientific literature. There may be ‘stronger evidence for this model [CCMP] than for any of the

other[s] [models of community case management]’ (Winch *et al.* 2005), but generalizing the model to the context of malaria-endemic African countries is questionable.

We observed a similar lack of evidence regarding the efficacy of combined or integrated case management models to reduce mortality or morbidity in countries where malaria is prevalent. In terms of the combined management of malaria and pneumonia, the Yeboah-Antwi study [15] suggests that CCMP+p might have a positive effect on child morbidity related to pneumonia. However, its efficacy on mortality remains to be proven—a C-RCT conducted in SSA but published after our review found no significant differences between CCMP and CCMP+p interventions in terms of childhood mortality reduction (Chinbuah *et al.* 2012). Concerning the iCCM strategy, our review reveals that there is no evidence of a positive impact on the pneumonia-related burden in SSA. This corroborates a previous review documenting the lack of evidence concerning the efficacy of this strategy in reducing child mortality or morbidity (Winch *et al.* 2005). Henceforth, there are little indications that using CHWs as ‘mini-doctors’ (Walt and Gilson 1990) to prescribe or administer treatments for multiple conditions is an appropriate answer to the challenge of extending child survival interventions at the community level (Bryce *et al.* 2005). In spite of the limited evidence, the combined and integrated models are already being implemented and promoted in several African countries (Marsh *et al.* 2008; Chanda *et al.* 2011).

Depending on the methods of evaluation, the phase of the diagnostic process, and the complexity of the guidelines, adherence to the pneumonia classification and treatment guidelines by the CHWs varied considerably across studies. CHWs generally obtained high adherence scores (around 80% or above) to classify, treat and refer children in accordance with their initial assessment in the diagnostic algorithm. A multi-country C-RCT conducted in Africa after the review showed similar performance of CHWs in administering antibiotic treatments to children they had classified as having pneumonia (Mukanga *et al.* 2012). However, our review reveals that when compared with the gold standard, these scores diminished, notably because CHWs experienced numerous difficulties during the first phase (assessment). Accurately counting the respiratory rate remains a major problem for them, despite the use of respiratory timers that were expressly developed by the WHO and UNICEF to address this challenge (Rasmussen *et al.* 2000).

Our analysis revealed two key findings in terms of low adherence by CHWs. The first factor relates to the integrated management of several diseases. We observed that adherence scores were lower in integrated interventions than in CCMP interventions. In addition, in integrated interventions, these scores decreased when a child had several concurrent illnesses diagnosed by the CHW. Moreover, CHWs managing both malaria and pneumonia cases tended to miss treating a large proportion of children with pneumonia only—echoing the difficulties in distinguishing pneumonia from malaria on clinical grounds that have been reported for decades, even in hospitals (Bassat *et al.* 2011). While the debate concerning the number of roles or functions a CHW can effectively perform is still open (Haines *et al.* 2007), these results suggest that CHWs

might encounter difficulties in managing several diseases, particularly if they are concomitant. Given the high prevalence of co-morbidities in children in these contexts and their lethality (Fenn *et al.* 2005; Gwer *et al.* 2007), this is of great concern.

The second key finding is that CHWs' performance when following both the CCMp and IMCI guidelines was weaker for severe pneumonia than for non-severe pneumonia. Because of their potentially fatal outcomes the algorithms usually demand that severe forms of diseases are referred to the nearest health facility. Therefore, failures-to-refer by CHWs are of grave concern and research should establish that there is no additional risk of mortality associated with those community interventions for children with severe pneumonias. A recent randomized controlled trial conducted in Pakistan has just demonstrated the safety of CHWs treating severe cases of pneumonia (instead of referring them to the health centre) (Soofi *et al.* 2012). This might be an opportunity to test a simplified protocol of pneumonia management in the SSA context, with the prospect of improving adherence to the guidelines.

To our knowledge, no evaluation of a CCMp intervention has ever established that CHWs' low performance could be detrimental to the intervention's efficacy to reduce child mortality. This relation may not be straightforward, as suggested by studies that found no statistical association between clinicians' low performance to follow IMCI guidelines and clinical outcomes (Rowe *et al.* 2001; Baiden *et al.* 2011a). But a noteworthy consequence of the low adherence by CHWs is the misuse of antibiotics. A study comparing CHWs' treatments to the gold standard [8] found that 16% of antibiotics treatments prescribed by CHWs were unnecessary—by comparison, a study conducted in Nepal reported only 3% of antibiotics misuse (Dawson *et al.* 2008). Admittedly, the practice of overprescribing antibiotics in pneumonia management is not limited to CHWs; it is also a concern with IMCI-trained health personnel in primary care facilities or hospitals (Schellenberg *et al.* 2004; Osterholt *et al.* 2009). However, the fact that the guidelines are simplified to suit CHWs is likely to further reduce their specificity and sensitivity [4], increasing the number of unnecessary treatments. The resulting unnecessary costs and increased risk of antibiotics resistance call for caution concerning CCMp (Simoes 2012), especially as the proportion of cases due to bacterial pneumonia varies significantly from region to region and is not always precisely known (Cashat-Cruz *et al.* 2005; Rudan *et al.* 2008). Furthermore, no research has demonstrated that equipping CHWs with RDTs for malaria does not increase the proportion of antibiotics prescribed unnecessarily. In its present form, the CCMp + p with RDTs might reflect an unfortunate paradox—the modification of antimalarial treatment recommendations in an effort to slow down the development of artemisinin resistance could increase the emergence of antibiotic resistance by introducing the algorithm-based treatment of pneumonia by CHWs.

We are not arguing that CHWs managing pneumonia cases should be categorically proscribed or that they should not use malaria RDTs to help their diagnosis. The potential positive outcomes for children's health should be evaluated—for example, the increased use of antibiotics after the introduction

of malaria RDTs in health facilities was associated with a reduction of treatment failures (Mselle *et al.* 2009). Despite poor adherence to the guidelines, the algorithm-based administration of antibiotics by CHWs might be appropriate depending on the local epidemiological context or the level of child vulnerability—for instance, the lethality of bacterial pneumonia is much higher in cases of concurrent HIV infection or malnutrition (Graham *et al.* 2008). On the other hand, as discussed earlier, the more complex the algorithm, the worse the CHWs' adherence to guidelines. Research should address these issues and trade-offs to ensure that the administration of antibiotics, either presumptive or algorithm-based in the CCMp strategy, is not based on weak evidence—as was apparently the policy promoting systematic antibiotic treatments to children with simple malnutrition (Alcoba *et al.* 2013).

Three additional important issues require further elucidation. First, very little is known about CCMp implementation, while serious problems have been previously identified in similar CHWs interventions. These include drug supply and preservation, motivation and retention of CHWs, power dynamics inside the community, integration with the health system and competition with local drug distributors. Intervention research on CCMp effectiveness and implementation in real-life conditions is needed. Second, an assessment of the unintended impact of CCMp on other healthcare(-seeking) practices is needed. In particular, it is plausible that the administration of antibiotic treatments in villages alters prescribing practices in primary care centres, and undermines decade-long endeavours to promote a rational use of antibiotics (le Grand *et al.* 1999). Finally, impacts of CCMp on health inequities have not been examined yet, even though it is known that population interventions can increase the burden carried by vulnerable populations (Ridde 2007). Evaluations of CCM of malaria showed mixed results concerning the equitable distribution of benefits among households of different socioeconomic status (Nsungwa-Sabiiti *et al.* 2007; Siekmans *et al.* 2013).

The current lack of evidence concerning the efficacy, effectiveness and factors of successful implementation coupled with poor CHWs' adherence results, demand a thorough examination of the legitimacy of implementing CCMp in SSA countries, whether integrated with other diseases or not. Before further implementation, innovative approaches to increase CHWs' adherence must be tested. Diagnostic tests distinguishing between viral, bacterial and parasitological infections are also needed (Baiden *et al.* 2011b). Meanwhile, other options than CHWs prescribing antibiotic treatment—or mothers, as has just been tested (Sangho *et al.* 2012)—should be considered. Their use as actors of social change inside their community to increase impacts of interventions to prevent pneumonia could be promising (Holloway *et al.* 2009).

Limits

The search process, data extraction and assessment of study quality were primarily done by only one of the authors. We opted for this strategy because the ideal procedure (two authors reviewing the data independently and comparing their results) was not feasible, and we preferred that at least one author reviews material in its entirety. In addition, reports from non-governmental organizations and international organizations

were not considered if not published in peer-reviewed journals. The absence of a methodical gathering of non-published material prevented us from proceeding to a systematic review, which is an essential element of narrative syntheses.

One limitation comes from the fact that this systematic review was conducted a few months before a Supplement was issued in the *American Journal of Tropical Medicine and Hygiene*. The Supplement covers several aspects of iCCM in SSA countries and presents some empirical studies that would have passed through the selection criteria. We reflect as much as possible on the implications of these studies in our discussion.

Conclusion

This review showed that there is a lack of evidence concerning CCMP impacts on childhood mortality and morbidity in SSA. Similarly, the efficacy of combined or integrated interventions to reduce the burden attributable to pneumonia remains to be evaluated. CHWs' performance in managing pneumonia suffers from challenges associated with counting the respiratory rate. In integrated interventions, performance scores in managing pneumonia were always lower than for the other diseases. In addition, very few studies evaluated the capacity of CHWs to distinguish severe from moderate pneumonia cases, and the available results suggest there are major problems in doing so. Consequently, CCMP encompasses issues of over-treatment and missed treatment. A more comprehensive and contextual understanding of CHWs' performance is needed, which requires evaluations of CCMP implementation in natural conditions. While the integrated case management of several diseases is currently recommended for CHWs, this review shows important issues and lack of evidence concerning the management of pneumonia, and calls for more context-specific research.

Supplementary Data

Supplementary data are available at *HEAPOL* online.

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Conflict of interest

None declared.

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Coding table of the 15 studies included for narrative synthesis

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