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INTEGRATED COMMUNITY CASE MANAGEMENT OF MALARIA AND PNEUMONIA IN EASTERN UGANDA

CARE-SEEKING, ADHERENCE, AND COMMUNITY HEALTH WORKER PERFORMANCE

Joan Nakayaga Kalyango

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ABSTRACT

**Background:** Despite being easily preventable and treatable, malaria and pneumonia are major killers of children aged less than five years. Integrated community based interventions through which lay persons called community health workers (CHWs) can manage malaria, pneumonia, diarrhea and neonatal conditions are recommended by WHO and UNICEF. However, there is limited information on care-seeking and performance of CHWs in the context of integrated illness management.

**Main aim:** To assess care-seeking and quality of care in integrated community case management of malaria and pneumonia in children aged less than five years in Uganda so as to inform the implementation of integrated community case management of childhood illness strategy (ICCM).

**Methods:** Four studies (I-IV) were nested in a cluster randomized trial in Iganga-Mayuge demographic surveillance site in eastern Uganda. In this trial CHWs treated malaria and pneumonia (intervention arm) or malaria alone (control arm) in children aged 4-59 months. Performance of CHWs (I) was assessed using: questionnaires (with knowledge tests, case scenarios) and record reviews for 125 CHWs; observations among 57 CHWs in the intervention arm; and four focus group discussions with CHWs. Adherence to treatment was assessed using pill counts and caregiver reports among 1256 children treated by CHWs (II). Receipt of prompt and appropriate antibiotics for pneumonia symptoms and treatment outcomes were assessed among 1276 children treated by CHWs (III). Care-seeking and management of malaria and pneumonia were assessed among 1095 children and from 13 key informant interviews (IV).

**Results:** Care-seeking from CHWs was higher in the intervention than the control arm (31% vs 22%, p=0.01) (IV). CHWs’ performance on malaria symptoms was similar in the intervention and control arms on: overall knowledge, eliciting signs and symptoms, and prescribing (I). More children treated by CHWs received prompt and appropriate malaria treatment compared to other health providers (37% vs 9%, p=0.001) (IV). CHWs had high scores in prescribing for pneumonia but had lower: overall knowledge of pneumonia (40%), and scores on eliciting pneumonia signs and symptoms (25%). Only 35% of CHWs counted respiratory rates within two breaths of rates counted by the physician, and 12% of children without fast breathing received antibiotics while 82% with fast breathing received antibiotics (I). Children treated by CHWs in the intervention arm were more likely to receive prompt and appropriate antibiotics for pneumonia symptoms compared to the control arm (RR=3.51, 95% CI = 1.75-7.03) (III). There was also a higher reduction in the proportion of children with fast breathing from day one to day four in the intervention compared to the control arm (9.2% vs 4.2%, p=0.01); and a lower proportion of febrile children on day four (1% vs 4%; RR=0.29, 95% CI = 0.11-0.78) (III). Adherence to combined antimalarials and antibiotics was similar to adherence to antimalarials alone in the intervention arm (mean 99% both groups) (II).

**Conclusions:** CHWs’ performance on malaria was not affected by additional roles of pneumonia management, but they had challenges in assessment of pneumonia symptoms. CHWs should be supported with continued training, adequate supervision and provision of drugs, diagnostics and other supplies.

**Key words:** malaria, pneumonia, community health worker, community case management, Uganda
LIST OF PUBLICATIONS


The papers will be referred to by their roman numerals I-IV.
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<td>Artemisinin-based Combination Therapies</td>
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<td>AL</td>
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<td>ARI</td>
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<td>CI</td>
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<td>cRCT</td>
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<td>GOBI</td>
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<td>HSSIP</td>
<td>Health Sector Strategic and Investment Plan</td>
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<td>ICCM</td>
<td>Integrated Community Case Management</td>
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<td>OR</td>
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<td>Principal Components Analysis</td>
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<td>RDT</td>
<td>Rapid Diagnostic Test</td>
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<td>SP</td>
<td>Sulphadoxine-Pyrimethamine</td>
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<td>U5MR</td>
<td>Under Five Mortality Rate</td>
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<td>UN</td>
<td>United Nations</td>
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<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
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<td>VHT</td>
<td>Village Health Team</td>
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<td>WHO</td>
<td>World Health Organization</td>
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OPERATIONAL DEFINITIONS

Adherence to medicines: The extent to which a person’s behavior in taking medicines corresponds with agreed recommendations from a health care provider (WHO, 2003; Osterberg and Blaschke, 2005).

- **Level of adherence**: The percentage of prescribed medicines taken correctly over a three-day period based on caregiver reports and pill counts.

- **Non-adherence to medicines**: Missing some of the prescribed medicines or not taking the medicines appropriately (i.e. had less than 100% level of adherence) (Kachur et al., 2004). A further classification of non-adherence where patients who had taken all medicines as prescribed but who vomited within 30 minutes and did not have a replacement dose administered was made, as recommended by a previous study (Beer et al., 2009).

- **Optimal adherence**: This considered how antimalarials were taken and what they were taken with. Optimal adherence was taking all the medicines as prescribed and with a fatty meal as recommended for artemether-lumefantrine by the manufacturer; good adherence was taking all the antimalarials as prescribed but the medicines were either not taken consistently with a fatty meal or the medicines were not taken with a fatty meal at all; and non-adherence was defined as missing some of the medicines or not taking medicines in the correct schedule regardless of what they were taken with (Achan et al., 2009).

**Appropriate antibiotic**: Receiving a recommended antibiotic for pneumonia according to national (Ministry of Health (Uganda), 2010b) or community health workers’ guidelines (Department of Health Policy Planning and Management, 2010), or the British National Formulary (British Medical Association and Royal Pharmaceutical Society of Great Britain, 2012), a widely used reference in Uganda.

**Appropriate treatment**: Receiving the recommended drug, in the recommended dose, and for the recommended frequency, and duration (Nsungwa-Sabiiti et al., 2005).

**Community Health Workers (CHWs)**: These are persons selected from the communities in which they live and work; they are selected by and are answerable to the communities, are supported by the health system, and undergo shorter training than professional health workers (WHO, 2007a). They have also been referred to as community drug distributors, community medicine distributors, village health team, and village malaria workers, among others.

**CHW performance**: Ability to elicit signs and symptoms and classify illness, identify and respond to danger signs, prescribe medicines (dosing, medicines administration instructions), and store medicines appropriately.

**Fever**: Febrile to touch or history of ‘hot body’ in the last 24 hours as reported by the caregiver, or axillary temperature ≥37.5°C.

**Malaria**: Fever or history of fever in the last 24 hours in a high-risk malaria area (WHO and UNICEF, 2008).
**Pneumonia:** Acute infections of the lungs caused by viruses, bacteria or fungi presenting as cough and/or difficult breathing, with or without fever, with either fast breathing or lower chest in-drawing or noisy breathing in a calm child (WHO, 2013c; WHO and UNICEF, 2008).

- **CHW-classification of pneumonia:** Non-severe pneumonia was the presence of cough or difficult breathing and fast breathing similar to definition used in IMCI guidelines (WHO and UNICEF, 2008).

- **Pneumonia symptoms:** Caregiver reports of cough accompanied by fast and/or difficult breathing similar to definition used in multiple indicator cluster surveys and demographic health surveys (UNICEF, 2013b).

**Prompt treatment:** Receiving treatment within 24 hours from onset of symptoms (Roll Back Malaria / World Health Organization, 2003). In order to overcome the difficulty of counting 24 hours, this definition was modified to receiving treatment on the day of onset of symptoms or the next day if the onset of illness was at night, as has been used in other studies (Ajayi et al., 2008b; Rutebemberwa et al., 2009a).

**Quality of care:** The extent to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge (Institute of Medicine, 1990). In this thesis, quality of care focused on the caregivers’, community health workers’ and programme performance.

**Rapid/fast breathing:** Having $\geq 50$ breaths per minute in children aged 4-12 months and $\geq 40$ breaths per minute in children aged 12-59 months (WHO and UNICEF, 2008).

**Rational use of drugs:** Patients receive the appropriate medicine, in the proper dose, for an adequate period of time, and at the lowest cost to them and their community (WHO, 1985).

**Recommended drug:** Medicines recommended for illness based on national (Ministry of Health (Uganda), 2010b) and community health workers’ treatment guidelines (Department of Health Policy Planning and Management, 2010) as well as treatment recommendations of the British National Formulary (Joint Formulary Committee, 2007), a widely used reference in Uganda.
PREAMBLE

Every minute, six children below the age of five years in sub Saharan Africa die, mainly from preventable causes (WHO, 2012d). These are not mere statistics but children with faces and names, and for whom their families have great dreams. Every minute, six families in this region start on the painful journey of losing a child, pain which could have been prevented. The children are also robbed of the opportunity to contribute to the progress of their families, communities, and nations.

Commitment of nations to the Millennium Development Goals has reduced under-five mortality but the reduction is still insufficient to reach the set targets of a two-thirds reduction from the rate in 1990 by 2015. The countries that need to make the greatest reductions in mortality have not done so (WHO, 2012f). Many of the deaths could be prevented through full implementation of a few effective interventions, but coverage of these interventions is still low (Bryce et al., 2003; Boschi-Pinto et al., 2009).

Efforts to improve access to effective interventions for children initially targeted health facilities, but have recently expanded to involve communities in their health care. This two pronged approach is necessary because many children are either not taken to health facilities or are taken late resulting in increased deaths. Community interventions such as home management of malaria (HMM), community management of pneumonia, and more recently the integrated community case management of childhood illnesses (ICCM) are major steps towards improvement of access to health care in resource limited settings. ICCM was deemed necessary because many childhood diseases have overlapping symptoms and sometimes present together (English et al., 1996; Källander et al., 2004). ICCM implies more roles for the community health workers (CHWs), the first-level health workers with no formal medical training.

While this strategy seems ideal in solving the problems of poor access to health care for common childhood illnesses, a number of questions arise: (1) Will having CHWs that can treat multiple illnesses really improve access to effective care? Will it then lead to reduced mortality? (2) Can CHWs handle the complexity of multiple illnesses? Can they make proper diagnoses? Can they treat the children with appropriate medicines or refer them as required? Can they be good stewards of the antimicrobials that they are entrusted with, so that they are not misused? Is there a specific type of person that can perform as a CHW more effectively than another? How will the motivation and retention of CHWs (who are usually not paid salaries) be maintained? (3) Will the establishment of the CHW cadre of health worker be another self-defeating effort where drugs, diagnostics and other essential supplies will be out of stock, just as with formal health services? (4) What about the caregivers? Will they have sufficient trust in the care provided by the CHWs and seek care from them? Will they give the medicines as instructed? Will they comply with referral?

This thesis attempts to address some of these questions, and builds on previous work (Källander, 2006; Rutebemberwa, 2009; Hildenwall, 2009; Mukanga, 2012; Nsungwa-Sabiiti, 2009; Yeboah-Antwi et al., 2010; Degefie et al., 2009; Kelly et al., 2001); in an attempt to contribute to the health of children.
1 INTRODUCTION

1.1 GLOBAL HEALTH

Despite improvements in health over the last century that have seen people living longer and healthier lives, millions of people still die prematurely of diseases that are preventable or curable. Many of the deaths could be prevented at relatively little more expense (Carr, 2004). However, about one billion people lack access to health care, more so the poor for whom health services are often out of reach (Action for Global Health, 2010). A considerable number of people die from infectious diseases especially in resource-poor settings where access to care is inadequate. Infectious diseases caused about 34% of the deaths in Africa in 2011 compared with 2.6% in Europe (WHO, 2012b).

More than two million people, mostly in low and middle income (LMIC) countries, die annually from diseases which are preventable by vaccines recommended by the World Health Organization (WHO) (WHO, 2006b). An even greater number (about 36 million) die from non-communicable diseases (WHO, 2012i). These illnesses take their toll on the life expectancy of nations and great differences are seen between nations where people have better access to health care compared with those where access to health care is poor. In 2012, the life expectancy at birth in high-income countries was about 80 years compared to 60 years in low-income countries (WHO, 2012c). Life expectancy at birth is strongly dependent on infant and child mortality and therefore differences in life expectancy may reflect differences in infant and child mortality in these regions. All human beings have a fundamental right to enjoy the highest attainable standard of health and it should therefore be promoted and protected. Poor health also has a negative impact on economic and social development.

1.2 UNIVERSAL HEALTH COVERAGE

A key aspect that is necessary to the promotion and protection of health is timely access to health services, which needs a well-functioning health financing system in order to ensure that the services which people need exist, and that they can afford them when they need them (WHO, 2012h). In 2005 member states of the WHO committed to development of financing systems to ensure that all people have access to health services and do not suffer financial hardships due to payment for health services, a goal which was termed as “universal health coverage”. Universal health coverage is therefore defined as ensuring that all people have access to needed promotive, preventive, curative and rehabilitative health services, of sufficient quality to be effective, while also ensuring that people do not suffer financial hardship when paying for these services (WHO, 2005c).

Universal health coverage has become a major goal for health reform in many countries and a priority objective of the WHO (Rodin and de Ferranti, 2012; Holmes, 2012). However, the world is still a long way from universal health coverage, more especially in resource-limited settings. Service coverage is still low, with inequitable distribution of the available services. For example, global measles immunization coverage was 85% in 2010, with low-income countries having coverage of 78%. Children from poor families have a higher risk of death than those from richer families. In addition, up to 11% of people suffer financial hardships and about 5% of the population is forced into poverty due to payment for health services (WHO, 2012i).

1.3 HEALTH SYSTEMS

Progressing towards universal health coverage requires strong and efficient health systems (WHO, 2012g). WHO has defined health systems as consisting of all organizations, people and actions whose primary aim is to promote, restore or maintain health. The goals of the health system are to
improve the health and health equity of persons that are served, in ways that are responsive to
people’s expectations, financially fair, and make the best and most efficient use of available resources
(WHO, 2007b).

In order to achieve these goals, six interconnected pillars, referred to as building blocks, have been
identified, including: service delivery from well-maintained health facilities; well trained and
adequately paid health work force; reliable health information on which to base decisions and
policies; medical technologies, vaccines and drugs adequate to deliver quality health care; robust
health financing mechanisms; and leadership and governance (Figure 1) (de Savigny and Adam,
2009). The people participate in the health systems as beneficiaries and as actors in driving the health
system.

![Figure 1. Building blocks of a health system](image)

*Source: (de Savigny and Adam, 2009).*

Health systems especially those in resource-limited settings, are faced with several challenges. There
are reports of large gaps in coverage of crucial components of health services, low-quality services
that do not contribute optimally to improved health outcomes, and inequity in health outcomes. In
addition, many countries lack the human resources necessary to deliver essential health interventions.
Extreme shortages of health workers exist in 57 countries, 36 of which are in Africa. These shortages
are due to limited production capacity, migration of health workers within and across countries, a
poor mix of skills, and demographic imbalances (WHO, 2007a). In response, countries have turned to
shifting of some basic health care tasks to low-level or informal health workers providing
community-based interventions.

Funds to deliver health care are also still insufficient. Many people cannot access the health services
because they have to pay for them at the time of need, and a large number of those that are able to
access the services become impoverished. Each year an estimated 100 million people suffer financial
catastrophes because of payment for health care (WHO, 2012h). The financing for health in resource-
limited settings comes mainly from donor aid with little or no health insurance.

As a result of poor financial systems and poor leadership and governance, there is lack of essential
medicines and technologies to deliver the necessary health care. A survey done in 39 countries found
low availability of essential medicines, and this varied in the public (20%) and the private sector
There is also misuse of available resources (WHO, 2007b) and planning and resource allocation are not guided by appropriate health information, because many countries lack up-to-date information for these functions or the available information is not used appropriately. In over 60 countries, less than a quarter of deaths are recorded by vital registration systems (WHO, 2007a).

Given the prevailing situation, the health stewards need to find innovative ways of health care provision. A number of interventions have been set up to target specific conditions or age groups. However, the success of these interventions needs to be looked at in light of existing health systems. In addition, strengthening of health systems should be done in light of the context in which they exist (Commission on social determinants of health, 2008).

1.4 QUALITY OF HEALTH CARE

Quality of care is one of the intermediate outcomes of health systems. The inadequacies in many health systems have led to poor quality in health care. Quality of care has been defined as the extent to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge (Institute of Medicine, 1990). The care should be: effective (adherent to an evidence base and results in improved health outcomes for individuals and communities); efficient (maximizes resource use and avoids waste); accessible (timely, geographically reasonable, and provided in a setting where skills and resources are appropriate to medical need); acceptable/patient-centred (takes into account the preferences and aspirations of individual service users and the cultures of the community); equitable (does not vary in quality because of personal characteristics such as gender, race, ethnicity, geographical location or socio-economic status); and safe (minimizes risks and harm to service users). Although new interventions aimed at improving health will usually have high quality of care as an intermediate objective, it is not always certain to what extent this is achieved.

1.5 DRUG USE

Drugs are a major part of health care, with most diseases requiring drug treatment. It is important that the drugs are used appropriately in order to achieve adequate treatment while minimizing the development of resistance, and avoiding wastage of scarce resources as well as potential health hazards. The need for appropriate drug use has led to focus on the rational drug use concept. Rational use of drugs is defined as patients receiving the appropriate medicines, in doses that meet their own individual requirements, for an adequate period of time and at the lowest cost to both them and the community (WHO, 2002; WHO, 1985). Despite various efforts made to promote rational use of drugs, drug misuse is still a major problem worldwide. The problem is worse in the private compared with the public sector and in LMIC compared to the high-income countries (WHO, 2011c).

In many LMIC less than 50% of patients are treated according to standard treatment guidelines (WHO, 2009), and more than 80% of prescriptions are filled by unqualified health providers with poor dispensing practices (WHO, 2011c). In addition, the problem of self-medication often with inappropriate medicines is common (Geissler et al., 2000; Shankar et al., 2002; Awad and Eltayeb, 2007; Mbonye et al., 2008). There is misuse of medicines including antibiotics (Isturiz and Claude, 2000; Chandy et al., 2012; Byarugaba, 2004), and yet a large proportion of the people that need medicines do not receive them (WHO, 2011c; Pecoul et al., 1999; Kristiansson et al., 2009). Coupled with this is the problem of non-adherence; about half of patients do not take medicines as prescribed (WHO, 2011c).

Irrational use of medicines for malaria management has been reported in some studies with children receiving wrong drugs, wrong dosages or medicines for the wrong duration (Abuya et al., 2007;
Kemble et al., 2006; Oreagba et al., 2007; Osterholt et al., 2006; Nshakira et al., 2002; Baume et al., 2000; Nsungwa-Sabiiti et al., 2007; Nsungwa-Sabiiti et al., 2005). The proportion of children that receive prompt, effective treatment is much lower than the 80% target (Roll Back Malaria, 2005). Factors that influence drug use include: socio-demographic characteristics such as age, sex, education level, and mother’s occupation; illness perceptions; financial constraints leading to lack of access to medicines; inadequate knowledge of correct dosage; time of consultation; illness presentation; and in-service training of health workers coupled with availability of wall charts and guidelines in health facilities as well as more frequent support supervision (Chibwana et al., 2009; Osterholt et al., 2006; Santos et al., 2009; Baume et al., 2000; Nsungwa-Sabiiti et al., 2007; Sirima et al., 2003; Zurovac et al., 2004).

There have also been several reports of inappropriate management of respiratory infections in children. Some children receive antibiotics for respiratory illnesses in which antibiotics are not required while others do not receive antibiotics when they should. In LMIC less than one-third of children receive antibiotics for suspected pneumonia (WHO, 2013a; UNICEF, 2012). In addition, wrong doses, and drugs given in the wrong frequency and for the wrong duration, have been observed (Hui et al., 1997; Kristiansson et al., 2009; Del Fiol et al., 2012; Chuc et al., 2001; Bojalil et al., 1998; Gwimile et al., 2012). Inappropriate use of antimicrobials like antibiotics and antimalarials may lead to poor treatment outcomes and increase the risk of drug resistance.

1.6 DRUG RESISTANCE

Although increased access to medicines is expected to improve treatment outcomes, the increased use of antimicrobials also increases the risk of drug resistance due to increase in drug pressure, which leads to selection of resistant strains (McGarock, 2002; Ilic et al., 2012; Cars and Nordberg, 2005; Laxminarayan et al., 2006). The problem is further worsened by misuse of drugs with inadequate dosages and non-adherence which may lead to inadequate drug exposure and therefore increase the risk of resistance (Olofsson and Cars, 2007; Cars and Nordberg, 2005; Yeung and White, 2005).

Antimalarials have previously been hit with resistance (White, 1999). In 2000, reports of widespread resistance to chloroquine (CQ), the then first-line drug for uncomplicated malaria, led to its combination with sulphadoxine-pyrimethamine (SP) (Nanyunja et al., 2011). However, because there was already some resistance to SP, reports of clinical failures to the new combination soon became apparent. WHO recommended artemisinin-based combination therapies (ACTs) in 2001 (WHO, 2001) and many countries adopted this policy (WHO, 2012c). Uganda chose a combination of artemether-lumefantrine (AL) in 2005 (Ministry of Health (Uganda), 2005).

There is a need to protect these drugs from resistance because of the limitations in options for malaria treatment. Quinine, the alternative to ACTs has been associated with several adverse effects, and these noxious outcomes together with the long duration of administration make it less favourable to patients (Baird, 2005). Studies have shown varying levels of adherence to antimalarials (39-97%) with some very low levels likely to increase the risk of resistance (Onyango et al., 2012; Kachur et al., 2004; Ajayi et al., 2008a; Lawford et al., 2011; Lemma et al., 2011; Yeung and White, 2005). There are reports indicating that resistance to ACTs is emerging in south-east Asia and efforts to tackle the problem are under way through the global plan for artemisinin resistance containment (Bremann, 2012).

The first-line treatment for non-severe pneumonia in Uganda and a few other resource-limited countries has been cotrimoxazole (Ministry of Health (Uganda), 2010b; Grant et al., 2009). Cotrimoxazole suffers from gross misuse through self-medication (Enato and Uwaga, 2011; Sturm et
al., 1997; Oshikoya et al., 2007), and inappropriate prescribing and dispensing (Trap and Hansen, 2002). In addition, it is widely used for prophylaxis against opportunistic infections in HIV following recommendations by WHO and other bodies (WHO et al., 2005). It is thus not surprising that wide spread resistance to cotrimoxazole has been reported (Joloba et al., 2001; Hoa et al., 2010). Recommendations regarding change of the first-line treatment for non-severe pneumonia to amoxicillin were made following the changing sensitivity patterns to cotrimoxazole (Grant et al., 2009). The effectiveness of these medicines should be protected in order to avoid the need to move to more expensive medicines which may also have more adverse effects.

1.7 CHILD MORTALITY
The number of children worldwide that died before their fifth birthday was estimated at 6.6 million in 2012 (UNICEF, 2013a). Although this mortality is a considerable reduction from the 12.6 million deaths in 1990, it is still high and some areas have had much slower reductions in under-five mortality than others. Sub-Saharan Africa and south Asia have registered the lowest reductions in under-five mortality rates (U5MR) since 1990 at 45% and 54% respectively, and these regions bear the greatest proportion of under-five deaths. In 2012 these regions contributed about 82% of the global under-five mortality (UNICEF, 2013a). In addition, inequalities in mortality exist even within regions. The under-five mortality is higher in poor households, rural areas, and where the mother has not had basic education. Children born in the poorest households have twice the risk of death as those from the wealthiest households (United Nations, 2011).

1.8 CAUSES OF CHILD DEATHS
Worldwide, a few conditions account for a large proportion of deaths. In 2012 the five major causes of death were: pneumonia (17%), pre-term birth complications (15%), intrapartum-related complications (10%), diarrhoea (9%), and malaria (7%), with malnutrition a major underlying factor contributing to 45% of all under-five deaths (UN Inter-agency group for child mortality estimation, 2013; UNICEF, 2013a). Many of these causes of death could be prevented or treated with low-cost interventions. Although some reductions have been noted, mostly with the infectious causes of death, the conditions still cause considerable mortality.

In sub-Saharan Africa the major causes of death in 2012 were: neonatal conditions (30%), pneumonia (17%), malaria (14%), and diarrhoea (11%) (Figure 2) (UNICEF, 2013a). This thesis addresses pneumonia and malaria, some of the leading causes of mortality in sub-Saharan Africa.
1.8.1 Malaria

Malaria is a disease caused by the plasmodium parasite which is transmitted through the bites of infected female Anopheles mosquitoes. There are four types of plasmodium species that cause malaria in humans including: *Plasmodium falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. *P. falciparum* malaria is the most severe, causing most of the deaths (WHO, 2013c). Signs and symptoms of malaria include: fever, headache, and vomiting. Children with severe malaria may present with severe anaemia, respiratory distress in response to metabolic acidosis, or repeated convulsions which may be a sign of cerebral malaria.

Key interventions to control malaria include prevention through the use of insecticide-treated nets (ITNs) and indoor residual spraying, and early diagnosis and treatment. The recommended first-line treatment for uncomplicated malaria is currently ACTs (WHO, 2010a). Since 2010 WHO recommends that all cases of suspected malaria are confirmed by parasite-based diagnosis using either microscopy or rapid diagnostic tests (RDTs), and symptom-based diagnosis should only be used where the parasite-based diagnosis is inaccessible (WHO, 2010a). Prior to that, presentation with fever or a history of fever in malaria-endemic areas was presumed to be malaria and therefore treated with antimalarials (WHO and UNICEF, 2008).

1.8.2 Pneumonia

Pneumonia is a form of acute respiratory illness in which primarily the air sacs in the lungs (alveoli) are affected. The alveoli usually fill with air when a person without pneumonia breathes, but in a person with pneumonia they are filled with pus and fluid and this makes breathing difficult and painful, and limits the oxygen intake. Pneumonia can be caused by various infectious agents including viruses, bacteria, and rarely fungi. The most common causes of pneumonia in children are: *Streptococcus pneumoniae*, *Haemophilus influenzae*, respiratory syncytial virus (the most common viral cause) and, in the case of HIV-infected children, *Pneumocystis jiroveci* (WHO, 2013c).
and bacterial infections in children present in a similar way. The signs and symptoms of pneumonia commonly include: rapid breathing, fever, cough, nasal flaring, lower chest-in-drawing and low oxygen saturation.

The diagnosis of pneumonia may involve the use of chest x-rays, blood tests, sputum tests, and pulse oximetry to measure the oxygen levels. However, these methods may not be available in many resource-limited settings, and WHO has proposed a symptom-based classification of pneumonia. In children under five years who have cough and/or difficult breathing, with or without fever, presence of fast breathing or lower chest-in-drawing is classified as pneumonia (WHO and UNICEF, 2008). These suggestions for disease classification were made in the 1980s before the introduction of newer vaccines that target the common causes of pneumonia and before the effects of the HIV pandemic. The presentation of pneumonia could have changed during this time (English and Scott, 2008). The use of the suggested symptoms for pneumonia classification also creates challenges because they overlap with those of malaria and are therefore not specific (Graham et al., 2008).

Pneumonia can be prevented through: immunization with Haemophilus influenzae type b (Hib), pneumococcal, measles, and whooping cough vaccines; adequate nutrition with exclusive breastfeeding of infants for the first six months and giving vitamin A supplements; addressing environmental factors such as the minimization of indoor air pollution; and encouraging good hygiene, especially in crowded homes. H. influenzae vaccine currently reaches about half of the world’s children while the pneumococcal vaccine is mostly available in high-income countries. Measles vaccine is more widely used with coverage of about 84% in 2011 (WHO, 2013b).

1.9 CARE-SEEKING FOR CHILDHOOD ILLNESS

Prompt treatment (within 24 hours of onset of symptoms) of common causes of child mortality with effective medicines is critical for improvement of treatment outcomes (UNICEF, 2013c; UNICEF and WHO, 2006; WHO, 2005a). An important starting point is that caregivers seek appropriate health care. However, caregivers delay or do not take children to health providers. Home care of childhood illnesses is common, with most households taking children to health providers only after home care with medicines bought from a nearby drug shop or pharmacy, or left over from a previous illness or herbs has failed (Diaz et al., 2013; Smith et al., 2010; Nsungwa-Sabiti et al., 2005; Ukwaja and Olufemi, 2010). The sources of care outside the home are varied and may include: private drug shops and clinics, public health facilities, non-governmental health organization facilities and traditional health providers (Rutebemberwa et al., 2009b).

Care-seeking is influenced by caregiver recognition of symptoms, perceptions of illness severity and community-preferred practices towards illness as well as long distances to health facilities, financial constraints such as lack of transport or money for health care, availability of alternative sources of treatment (e.g. traditional healers), symptoms of the child’s illness, and perceptions and attitudes towards health providers (Getahun et al., 2010; Diaz et al., 2013; Najnin et al., 2011; Chibwana et al., 2009; Hildenwall et al., 2008; Tinuade et al., 2010; Das and Ravindran, 2010; Ahorlu et al., 2006; Maslove et al., 2009; Warsame et al., 2007; Taffa and Chepngeno, 2005; Njugwa and Zulu, 2008; Luque et al., 2008; Colvin et al., 2013; Comoro et al., 2003; Okeke and Okeibunor, 2010; Källander et al., 2008; Rutebemberwa et al., 2009a; Ukwaja and Olufemi, 2010).

Socio-economic status of households has a strong influence on when and where people seek care. Wealthier households are more likely to seek care for their children outside the home and are unlikely to be impeded by delays which arise from lack of money for transport or health care (Kristiansson et al., 2009; Colvin et al., 2013). Therefore strategies that increase availability of
affordable health care where people live are likely to influence the care-seeking practices for children especially for poor children.

1.10 GLOBAL TARGETS OF CHILD MORTALITY

In 2000 all UN member states made a commitment to the United Nations Millennium Declaration which had eight goals referred to as the Millennium Development Goals (MDGs). One of the goals (MDG4) was reduction of child mortality by two thirds between 1990 and 2015 (United Nations, 2000).

1.10.1 Progress towards MDG4

Some progress has been made regarding reduction of under-five mortality, but it is still insufficient to reach the MDG4 targets. Reduction in under-five mortality grew from 1.8% between 1990 and 2000 to 3.2% between 2000 and 2011 (United Nations, 2011). Sub-Saharan Africa, the region with the highest U5MR, also doubled its mortality reduction rate, from 1.5% in the period between 1990 and 2000 to 3.1% in the period 2000-2011. However, with its mortality still at 98 deaths per 1,000 live births in 2012, this reduction rate is insufficient to reach the target of 58 deaths per 1,000 live births (United Nations, 2013; UN Inter-agency group for child mortality estimation, 2013).

1.10.2 Global strategies to accelerate achievement of MDG4

In order to reduce child mortality there is need to ensure universal coverage of key effective and affordable interventions including appropriate care for newborns and their mothers; vaccines; infant and young child feeding; prevention and case management of pneumonia, diarrhea and sepsis; malaria control; and prevention and care of HIV/AIDS (WHO, 2013d). The WHO therefore promotes strategies on appropriate and timely treatment of complications for newborns, integrated management of common illnesses in under-fives, expanded programmes on immunization, and infant and young child feeding. Globally several other strategies and initiatives have been implemented to address the MDG4 and these include: the Global Strategy on Measles Initiative, Global Immunization Vision and Strategy 2006-2015 (GIVS) (WHO, 2011b), the Global Alliance for Vaccines and Immunization (GAVI) (GAVI Alliance, n.d.), and the Global Strategy on Women’s and Children’s Health (The Partnership for Maternal Newborn and Child Health, n.d.). There are other strategies that affect MDG4 but which were implemented to address MDG6 such as the Global Fund initiative on malaria, TB and HIV (The Global Fund to fight AIDS tuberculosis and malaria, 2005); the Stop TB strategy (WHO, 2006a); the Roll Back Malaria Initiative (WHO, 2005b) and President Obama’s Global Health Initiative (Global Health Initiative, 2009).

With two years left to 2015, the world is now looking to the post-2015 era. A number of areas have already been identified where emphasis is to be placed, including: providing a more holistic framework to address diseases and also putting into perspective the increasing burden of non-communicable diseases, going beyond focus on mortality but also addressing morbidity and quality of life issues; and strengthening health systems to address inequalities and ensure sustainable progress. Universal health coverage will be key in the post-2015 agenda (Save the Children, 2012; Task Team for the Global Thematic Consultation on Health, 2013).

1.11 STRATEGIES TO ADDRESS CHILD MORTALITY

Over the years a number of strategies have been developed to address, among other things, under-five mortality. These strategies include Primary Health Care (1978), the Child Survival and Development Revolution (1980), Integrated Management of Childhood Illnesses (IMCI) (1996), Home

1.11.1 Primary health care
Primary health care was adopted with the Alma-Ata Declaration of 1978 and its ultimate goal was Health for All. It made some achievements that reduced under-five mortality including increase in childhood immunization coverage and access to safe water and sanitation. However, it suffered setbacks to providing equitable access to essential health care due to financial barriers, health worker shortages and the HIV pandemic (WHO, 2008).

1.11.2 Child survival and development revolution
In the 1980s the global recession had severe negative impact on especially the poor. Infant and childhood mortality were selected as the major indices to address since they were used to measure the development of countries. Interventions with simple technologies were thus adopted in what was termed as GOBI including growth monitoring to keep regular check on child nutritional status, oral rehydration for diarrheal diseases, breast feeding as the perfect nutrition start in life and immunization. This strategy had saved the lives of about 12 million children by the 1990s (UNICEF, 1996). However, all these strategies were set up as vertical programmes, and in some countries immunization took the largest proportion of the budget.

1.11.3 Integrated management of childhood illnesses
IMCI was started in 1996 as a strategy that integrates key available measures for disease prevention and health problems during childhood, for their early detection and effective treatment, and for promoting healthy habits within the family and community. Its aims were meant to be achieved through: improving the skills of health workers for the prevention and treatment of childhood diseases, strengthening the health system, and improving family and community care practices (community IMCI, c-IMCI). Its aims were to reduce infant mortality and the incidence and seriousness of illnesses and health problems, as well as to improve growth and development of children during the first years of life (Pan American Health Organization and WHO, n.d.). IMCI has been shown to improve health worker performance, and to lead to better quality of care and rational drug use at costs that are lower or similar to investments in routine child health services in areas where it has been implemented (Nguyen et al., 2013; Gouws et al., 2004; Mason et al., 2009). However, it did not achieve the expected impact on mortality, mainly because of the poor health-seeking behaviour that made caregivers delay or not take sick children to health facilities (Chopra et al., 2012).

1.12 COMMUNITY CASE MANAGEMENT
The need to address the poor treatment seeking behaviors for children under IMCI led to the recommendation of community case management (CCM). There was low use of lifesaving interventions in areas with high child mortality resulting from: long distances to health facilities, inadequate knowledge of illness and sources of health care, and mistrust of the quality of care offered by the health facilities. CCM was therefore meant to complement the health-facility based services in expanding capacity to treat children with poor access to health facilities (CORE Group et al., 2012). It strengthens the treatment aspects of c-IMCI and not only includes the provision of treatment in communities but also promotes timely seeking of care, appropriate home care, and referrals to health facilities as well as supervision by the health facilities. CCM targets the conditions that cause most child deaths and has been implemented mostly for malaria and diarrhoea, but also for pneumonia, malnutrition and neonatal conditions (de Sousa et al., 2011). A key feature of CCM is the use of
trained and supervised community members, commonly referred to as ‘community health workers’ to deliver care with linkage to the health facilities. The health providers under CCM classify the children’s illness using symptom-based algorithms adopted from the IMCI guidelines. The WHO recommendation of universal parasite-based diagnosis in 2010 (WHO, 2010a) has necessitated the incorporation of rapid diagnostic tests (RDTs) for malaria into CCM. There is limited experience with integrated community care for the five target conditions.

1.12.1 Community health workers
CHWs have participated in the provision of primary health care in various parts of the world for several decades. There is a growing body of evidence supporting their contribution to the improvement of the health of communities, especially in areas with limited access to professional health providers (WHO, 2010b). Literature shows that CHWs can successfully provide care for childhood illnesses (Mubi et al., 2011; Ajayi et al., 2008b; Sazawal and Black, 2003; Theodoratou et al., 2010; Hopkins et al., 2007; Sirima et al., 2003; Baqui et al., 2009; Perry and Zulliger, 2012). However, many of these studies have involved CHWs who are managing single illnesses.

1.12.1.1 Definition of Community Health Workers
The term ‘community health worker’ comprises a variety of community health aides who are selected and trained to provide basic health care in their communities. The CHWs are referred to by a wide range of names such as community drug distributors (CDDs), village malaria workers, lay health workers, community medicine distributors (CMDs), village health teams (VHTs), to mention a few, but the basic defining characteristics are that the persons are members of the community where they work; selected by the communities; answerable to the communities for their activities; supported by the health system but not necessarily part of that health system; and trained for shorter durations than the professional health workers (WHO, 2007a).

The profiles of CHWs vary from setting to setting and are therefore difficult to generalize internationally. The CHWs may be men or women, young or old, literate or illiterate, paid workers or volunteers. The most important point is that the definition of the CHW is responsive to the societal norms to ensure community acceptance and ownership (WHO, 2007a; Prassad and Muraleedharan, 2007; Bhutta et al., 2010).

The roles of CHWs are diverse within and across countries and programs. In some cases they may perform a wide range of tasks that could be preventive, curative or developmental, while in other cases they are appointed for very specific tasks (WHO, 2007a). The training of the CHWs may also vary from a few days to several months (O’Brien et al., 2009; Prassad and Muraleedharan, 2007; de Sousa et al., 2011).

1.12.2 Home management of malaria
The home management of malaria strategy (HMM) was recommended by the WHO in order to improve access to care for malaria. Uganda was one of the first countries to implement this strategy, locally referred to as the home-based management of fever (HBMF), in 2002 (Uganda Ministry of Health, n.d.). The strategy aimed at availing antimalarials for prompt community treatment of fever in children. Some studies found that community management of fever with antimalarials significantly increased the proportion of children that received prompt treatment (Staedke et al., 2009; Nsungwa-Sabiti et al., 2007); and reduced under-five morbidity (Das et al., 2008; Sirima et al., 2003) and mortality (Kidane and Morrow, 2000; Hopkins et al., 2007). However, significant symptom overlap between malaria and pneumonia has been noted (English et al., 1996; Källander et al., 2004; Ukwaja
and Olufemi, 2010), which could have resulted in many patients with pneumonia perhaps being inappropriately managed with antimalarials only (Källander et al., 2008). The integrated management of malaria and pneumonia has been advocated for because of this symptom overlap.

1.12.3 Integrated community case management of common childhood illnesses

WHO and UNICEF have recommended the integrated community case management of common childhood illnesses (iCCM) in response to findings of multiple illnesses in children or symptom overlap of common illnesses (WHO and UNICEF, 2004). In this strategy CHWs assess children for symptoms of malaria, pneumonia, and diarrhea and give antimalarials, antibiotics or oral rehydration salts (ORS) and zinc as appropriate. The CHWs also identify and refer children with severe disease to health facilities. The success of ICCM also depends on the caregivers of sick children, who should be able to recognize symptoms, seek care from the CHWs promptly, adhere to treatment or referral, monitor the condition of the children and seek further care if the children do not get well (WHO and UNICEF, 2011).

However, there are a number of potential challenges to the implementation of ICCM. It is not clear whether the CHWs will effectively handle the more extensive roles they need to perform under ICCM. In addition, it is not clear if the caregivers will be able to perform their roles in this strategy effectively or whether the intervention will improve drug use as well as treatment outcomes. There have been limitations in medicines supply management in formal health systems and community-based programmes. These systems have been marred by frequent drug stock-outs (Blanas et al., 2013; Achan et al., 2011; Kangwana et al., 2009). The ICCM strategy fitting into this health system is likely to be similarly affected. Furthermore, community-based strategies are aimed at improving equity, but it not clear if this will be achieved under ICCM. Another major concern is the balance between increasing access to antimicrobials and their excess use. The effect of ICCM on rational use of drugs in the community is not certain.

1.12.3.1 Equity in child health programs

Equity in health care is currently of great concern globally because the populations that suffer the biggest burden of disease have the lowest access to effective health care. Low-income countries bear more than 50% of the global disease burden but have only about 2% of the total health expenditure (WHO, 2011a). These disparities are also visible within countries where the poorest people, those with lower education, and those living in rural areas have poor access to health care (United Nations, 2011). Many of the interventions aimed at reducing child mortality stress the need to ensure that the poor people access them. Community-based programmes are likely to address the gaps in equity for childhood interventions (de Sousa et al., 2011). It is important to ensure that this is achieved under ICCM.

1.13 UGANDA COUNTRY PROFILE

Uganda is a landlocked country in the eastern part of Africa. It borders Kenya to the east, Tanzania to the south, Rwanda to the southwest, the Democratic Republic of Congo to the west and South Sudan to the north. It covers an area of 241,038 square kilometres and has a population of 36 million people. About 48.5% of the total population is made up of children aged below 15 years. The life expectancy at birth was 56 years in 2011. The country is mainly rural, with about 16% of the population living in urban areas. The majority of the population is involved in agriculture. The gross national income per capita was 1,310 US dollars in 2011 (WHO, 2012a; United Nations Development Program, 2013; WHO, 2013f).
1.13.1 Uganda health indicators

Uganda is classified as a country with high child and very high adult mortality. Its infant mortality rate was 54 deaths per 1,000 live births in 2011 and the U5MR was 90 deaths per 1,000 live births. There has been a reduction in the death rate but the birth rate has continued to escalate resulting in a young age structure. The fertility rate has reduced slightly from 7.1 births in 2000 to 6.1 births in 2010 but this figure is still high. The maternal mortality ratio is also high at 310 deaths per 100,000 live births and a considerable number of children are stunted (38%) (WHO, 2013f; WHO, 2012a). In addition, the full immunization coverage in 2011 was at only 52% (Kasirye, 2012). Pneumonia and malaria are common causes of death in under-fives, contributing about 17% and 13% of under-five mortality respectively (Countdown to 2015, 2012).

Uganda has had slow progress towards achievement of MDG4. Although some reduction in under-five mortality has been noted, the country is not on track to achieving the set targets. In 2000 the U5MR was 152 deaths per 1,000 live births and this had reduced to 90 deaths per 1,000 live births by 2011. With only four years left to reach 2015 the U5MR in 2011 was still much higher than the MDG4 target of 56 deaths per 1,000 live births by 2015 (WHO and UNICEF, 2012).

1.13.2 Uganda health system

Health services in Uganda are provided by both public and private sectors with each sector having about 50% of the health service delivery outlets. The public sector is comprised of a tiered system with the range of services offered and staffing levels varying according to the level of the health facility. Highest in the level of health service outlets are the national referral hospitals, followed by the regional referral hospitals, general hospitals, health centre IVs, health centre IIs, health centre IIs and finally the health centre I/village health teams (VHTs). The VHT has no physical structure, but is a team of people who work at the community level and link the community and health facilities (Table 1) (Ministry of Health (Uganda), 2010b; Ministry of Health (Uganda) et al., 2012).

The Ministry of Health in Uganda provides leadership for the health sector and has the overall responsibility for the delivery and oversight of all health services in Uganda. The health services are decentralized to districts and sub-districts which are responsible for implementation of services. The health services in all public health facilities are free since the abolition of user fees in 2001.

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<th>Table 1. Structure of the Uganda National Health System</th>
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<td>Health unit</td>
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<td>National Referral Hospital</td>
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<td>Regional Referral Hospital</td>
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<td>General Hospital</td>
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<td>Health Centre IV</td>
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Although Uganda has most of the relevant health policies and regulations in place, there are still several challenges in the health system. The health sector is under-financed with per capita expenditure on health at only US$42 in 2011 which was lower than the sub-Saharan regional average of US$951.6 (World Bank, 2012). Public financing is low at only 22.6% of the total health expenditure whereas out-of-pocket expenditure is high at about 54% (Ministry of Health (Uganda) et al., 2012). The low financing implies that the country is unable to deliver the Uganda Minimum Health Care Package (a minimum package of services comprising the most cost-effective interventions for major causes of disease burden), and yet this is one of the ways that the country has articulated as a means to improve the health of the people.

Access to health services has improved over the past two decades but some people especially the poor and those living in the rural areas still find it difficult to access primary health care and the quality of services provided is still a major setback. There are frequent stock outs of drugs and supplies at many public health facilities (Tumwine et al., 2010; Achan et al., 2011; Ministry of Health (Uganda), 2011). In addition, although there has been some improvement in human resource generation there are still shortages, and the distribution of the health workers favours the urban areas (Healthy Child Uganda, 2011).

1.13.3 The role of the private sector

Uganda has a vibrant private sector covering about 50% of the health services in the country (Ministry of Health (Uganda) et al., 2012). The private health system comprises private not for profit (PNFP) facility- and non-facility-based health providers, private health practitioners and traditional and complementary medicine practitioners. The facility-based PNFP sector covers about 41% of the hospitals and 22% of the lower level health facilities. The PNFP health providers have about 70% of the health training institutions in the country and these are run with government support. The PNFP practitioners are more prominent in rural areas. The private for profit (PFP) health facilities focus mainly on primary level services and are based mainly in urban and semi-urban areas. The government of Uganda recognizes the role of the private sector and subsidizes the PNFP facilities, and a few private hospitals. The private sector efforts are coordinated through the public-private partnerships for health (PPPH) technical working group. In spite of this much of the private sector remains unregulated, leading to great variations in quality, capacity and availability of services (Interagency Health Team, 2011). At the top of the ladder are big private hospitals with specialized services, while at the bottom are the private clinics and drug shops which are often manned by unqualified personnel and often have poor quality services (Konde-Lule et al., 2010).

1.13.4 Community health workers in Uganda

Uganda has had some experience of using CHWs for provision of health-care related activities under various programmes including: providing malaria treatment under home-based management of malaria (HBMF) through CDDs or CMDs, providing nylon filters and educating communities to control spread of the guinea worm under the Uganda guinea worm eradication programme (UGWEP) by trained volunteers, distributing and directly observing tuberculosis treatment under the community-based directly-observed therapy-short-course (CB-DOTS) programme by community volunteers, distribution of ivermectin for onchocerciasis under the community-directed treatment with ivermectin (CDTI), and health education and promotion through the VHTs (WHO and Global Health Workforce Alliance, 2010). Some of the CHW programmes have had nearly country wide implementation while others have been implemented in a few areas.
1.13.4.1 Village health teams

The concept of the VHT became part of Uganda’s national health strategy in 2001 as Uganda’s commitment to the Alma Ata Declaration of 1978 and the 2008 WHO’s Ouagadougou Declaration on Primary Health Care and Health Systems in Africa (Ministry of Health (Uganda), 2010c). These declarations emphasize the involvement of communities in their health. The VHT is meant to serve as the primary (village level) health contact for all villages in Uganda. VHTs are volunteer CHWs who are involved in community information management, health promotion and education, mobilization of communities for utilization of health services and health action, community case management and follow-up of major killer diseases (malaria, diarrhoea, pneumonia) and emergencies, care of the newborns, and distribution of health commodities. The strategy aims to have five VHT members in each village. The VHTs are selected through a popular vote by the communities in which they live and serve. The district health teams together with Ministry of Health officials conduct the training for VHTs.

By 2009 about 77% of all districts had trained VHTs but in some districts the VHTs are inactive and the attrition rate is high (Ministry of Health (Uganda), 2009a). The target of the Health Sector Strategic and Investment Plan (HSSIP) 2010-2015 is to increase the active VHTs from 31% to 100% (Ministry of Health (Uganda), 2010a).

Sustainability of the activities of the VHTs is critical. The CHWs need to be motivated to perform their functions as well as continue in these roles for a sufficient length of time (retention). Furthermore conflicting commitments may affect performance since many of the CHW programmes are not salaried and the CHWs need to find other occupations for their sustenance.

1.13.4.2 Home based management of fever in Uganda

HBMF was introduced in Uganda in 2002 as a strategy for community case management of malaria (Batega et al., 2004). In this strategy CHWs who were commonly known as community drug distributors (CDDs) treated children with fever using a combination of chloroquine and sulphadoxine-pyrimethamine (CQ-SP) (also called Homapak®). Each village had two CHWs who were supervised by health workers from health facilities in the area served. Children with fever were presumptively treated for malaria.

HBMF was shown to improve access to prompt and appropriate treatment for malaria (Nsungwa-Sabiiti et al., 2007) but its utilization was low, mainly because CHWs were managing malaria only while some children had other illnesses or they had multiple illnesses. In addition, some caregivers perceived it as ineffective (Malimbo et al., 2006). HBMF ceased to be functional when the antimalarial policy in Uganda was changed from CQ-SP to ACTs (specifically artemether-lumefantrine (AL)) due to the widespread resistance to CQ-SP (Nanyunja et al., 2011). However, before HBMF with AL could be rolled out in Uganda, studies showed that there was a lot of symptom overlap between malaria and pneumonia (Källander et al., 2004) and mistreatment of children suffering from other illnesses with antimalarials (Källander et al., 2008) which necessitated the integrated management of malaria and pneumonia.

1.13.4.3 Integrated community case management of childhood illnesses

Uganda adopted the ICCM strategy in 2010 (Ministry of Health (Uganda) et al., 2010). ICCM in Uganda is part of the VHT strategy for promoting health and preventing deaths. Its goal is to reduce child morbidity and mortality by providing case management for malaria, pneumonia, and diarrhea to sick children in addition to identifying and referring sick newborns. The VHT will be supplied with a
kit containing: pre-packaged medicines including amoxicillin for non-severe pneumonia, ACTs for uncomplicated malaria, low osmolarity ORS and zinc for diarrhoea; rectal artesunate for pre-referral administration; diagnostic commodities and supplies such as respiratory timers, and mid-upper-arm circumference tapes. The VHTs will counsel mothers on home care and care-seeking and will mobilize communities to demand, support, and use the ICCM programme where children with fever, cough and diarrhea will be treated.

Newborns with danger signs and severely ill children will also be referred by the VHTs and pre-referral rectal artesunate will be given as appropriate. Trained staff at health facilities will manage the referred cases and supervise VHTs in their catchment area as well as monitor the programme’s progress. The program also includes peer supervision among VHTs (Ministry of Health (Uganda) et al., 2010). The ICCM strategy has been implemented in more than 25 districts in Uganda mainly by non-governmental organizations (NGOs).
2 RATIONALE FOR THE STUDIES

Uganda adopted the ICCM strategy in 2010 and its scale-up is still ongoing (Ministry of Health (Uganda) et al., 2010). For effective implementation of this strategy, some critical knowledge gaps need to be addressed.

Caregivers of children under five have to seek care from the CHWs promptly in order to realize the advantages of ICCM in providing integrated health care close to where people live. Caregivers have been found to seek care late (Ahorlu et al., 2006; Källander et al., 2008) or not to seek care at all (Diaz et al., 2013). Low utilization of the HMM strategy was reported (Kisia et al., 2012; Nsungwa-Sabiiti et al., 2007) and it is unclear if ICCM will be optimally utilized. Having ICCM in the community will be a waste of resources if caregivers do not seek care for their children from CHWs, and the desired impact of ICCM on mortality and morbidity will not be realized.

A key assumption of ICCM is that the CHWs will be able to elicit signs and symptoms related to the three illnesses of interest (malaria, pneumonia, and diarrhea), classify the illnesses, prescribe appropriate medicines and give appropriate instructions to the caregivers, or refer severely ill children to health facilities. However, it is unclear how CHWs will perform in the provision of care for multiple illnesses. The studies that have assessed performance of CHWs in provision of care for children less than five years old have mostly been in the context of management of single illnesses (Ashwell and Freeman, 1995; Ajayi et al., 2008b; Chinbuah et al., 2006; Nsungwa-Sabiiti et al., 2007; Nsungwa-Sabiiti et al., 2005). More complex algorithms will be used for diagnosis, treatment, and referral under ICCM which require more knowledge and skills from the CHWs. A few studies that have looked at management of multiple illnesses have shown some gaps in CHW management of multiple illnesses (Gilroy et al., 2012; Mukanga et al., 2011; Degefie et al., 2009; Kelly et al., 2001).

In order to complement the work done by the CHWs, caregivers have to ensure good adherence to the medicines received from CHWs in order to improve treatment outcomes as well as prevent development of resistance. It is uncertain what effect the complexity of having more drugs will have on the quality of counselling by CHWs and therefore adherence. In addition, it is uncertain what effect the increase in pill burden among children receiving antibiotics in addition to antimalarials will have on adherence to medicines. Another concern is whether the caregivers will adhere to referral advice which is important for minimizing mortality from severe disease.

The easy availability of antimalarials and antibiotics from the CHWs may lead to their over-prescription thus increasing drug pressure and the risk of drug resistance in the community. In addition, other health providers may increase their prescription of these medicines, further increasing drug pressure. It is not yet clear how the availability of medicines through the CHWs will affect community drug use patterns. In addition, although integrated care has been recommended to improve timeliness of appropriate treatment for common childhood illnesses, it is uncertain whether this will be achieved and what impact the integrated care will have on treatment failures.
3 CONCEPTUAL FRAMEWORK

A conceptual framework has been included in this thesis in order to define the key concepts and contexts that supported and informed this research (Leshem and Trafford, 2007). The conceptual framework used in this thesis is modified after the access framework employed in the setting of livelihood insecurity (Obrist et al., 2007). This conceptual framework, even though centred around access, has been considered suitable for this thesis, which goes beyond access to look at the outcomes of the access. This is because the conceptual framework has a broad overview of the contexts preceding access to care as well as the consequences of access to health care, which are the focus of this thesis. It looks at the care-seeking, the health services available and the livelihoods of the people in the setting. In addition, this conceptual framework has been designed to look at the broad aspects of care-seeking in resource-poor settings such as Uganda where the studies were based.

Although effective interventions for most of the common conditions causing morbidity and mortality exist, these interventions are not accessed and utilized by the people that need them, resulting in poor health outcomes (WHO, 2007b). The access to health interventions starts when the illness is recognized and treatment is sought. The recognition of illness and treatment seeking is influenced by access to livelihood assets, which include physical capital comprising of knowledge, skills, and local education; social capital comprising of social networks and affiliations; natural capital like land, water, and livestock; physical capital such as infrastructure, equipment and means of transport; and financial capital such as cash and credit. The livelihood assets of people are, however, influenced by forces over which people have little control, such as the economy, politics, or technology, climatic variability or shocks e.g. floods, landslides, etc. which are referred to as the vulnerability context.

At the centre of this conceptual framework are the five dimensions of health care access, including availability, accessibility, affordability, adequacy, and acceptability of health services. The extent of accessibility reached along the five dimensions depends on the interaction between (a) the health care services and the broader policies, institutions, organizations and processes and (b) the livelihood assets people in certain vulnerability contexts have access to. This interaction between factors will influence the utilization of health services. Coupled with the quality of care provided from different providers, this will influence the health status of the patients, the patient satisfaction with the care received as well as equity (Obrist et al., 2007).

In this thesis the access conceptual framework has been extended to include under-five mortality, which is the key target for many health care interventions in children less than five years of age, although it has not been studied in this thesis. The quality of care section has also been expanded to indicate the quality aspects that were focused on in this thesis, specifically the performance of CHWs, community drug use for malaria and pneumonia, and adherence to medicines. The thesis has in addition to the above addressed the health status and patient satisfaction as well as the influence of livelihood assets on utilization of health services and quality of care. Resistance has been included in the section on outcomes of care since it is a common concern for community use of antimicrobials (Marsh et al., 2008). The conceptual framework is subsequently used to provide the format against which the results are presented and discussed.
Figure 3. Conceptual framework showing ICCM in the context of the Access Framework
Adapted from the Access Framework (Obrist et al., 2007)
4 AIM AND OBJECTIVES

4.1 GENERAL AIM

To assess care-seeking and quality of care in integrated community case management of malaria and pneumonia in children aged less than five years in Uganda so as to inform the implementation of the ICCM strategy.

4.1.1 Specific objectives

1. To compare the performance of community health workers in the integrated community case management of malaria and pneumonia versus malaria management alone in under-five children and to assess the factors influencing their performance (Study I).

2. To compare adherence to antimalarials and antibiotics versus antimalarials alone in the integrated community case management of malaria and pneumonia in under-five children (Study II).

3. To determine the effect of integrated malaria and pneumonia management on receiving prompt and appropriate antibiotics for pneumonia symptoms and treatment outcomes as well as determine associated factors (Study III).

4. To determine the effect of the integrated community case management of malaria and pneumonia on utilization of community health workers and community drug use patterns in under-five children (Study IV).
5 METHODS
5.1 STUDY AREA AND POPULATION

The studies were carried out in Iganga-Mayuge Health and Demographic Surveillance Site (HDSS), which covers an area of 155 square kilometres in the two districts of Iganga and Mayuge in eastern Uganda. The districts are about 112 kilometres from Kampala, the capital city of Uganda.

![Figure 4. Map of Uganda showing Iganga and Mayuge districts with arrows](image)

The HDSS is made up of 65 villages with a total population of about 70,000 people living in 13,000 households, with the population of children below five years about 11,000. The area is predominantly rural; about 90% of the population lives in rural areas. The main causes of morbidity and mortality for children in the area are: malaria, pneumonia, and diarrhea. There are 13 health facilities, and 122 drug shops and private clinics. In addition, 131 CHWs were providing health care in the area to children aged 4-59 months since 2009 under a cluster randomized controlled trial (cRCT) that was designed to evaluate the impact of integrated management of illness with antimalarials and antibiotics on under-five mortality.

In this trial, the HDSS was divided into intervention (30 villages where CHWs treated both malaria and pneumonia) and control areas (35 villages where CHWs treated malaria only). There were two CHWs in each of the villages, except one village which had three CHWs because of its large size (initially it was two villages that had three CHWs but the third CHW in one of the villages withdrew from the area). The data collection for this thesis commenced about two years after the start of implementation of the cRCT.
5.2 DESCRIPTION OF THE CLUSTER RANDOMIZED TRIAL

Cluster randomized trials are types of randomized controlled trials in which groups of subjects rather than individuals are randomized to interventions. They are usually employed to study interventions: that cannot be directed towards individuals, where contamination is likely to occur from subjects sharing interventions, and where it is socially unacceptable to assign some subjects in a certain location to one group while others are assigned to another group. They could also be used for logistical reasons for the ease of ensuring that contamination does not occur (i.e. that only subjects randomized to the intervention use it). Although they minimize the risk of contamination of interventions, they involve greater complexity in the design and analysis (Hayes and Moulton, 2009). This cRCT involved CHWs that could treat children with malaria and/or pneumonia (intervention), or with malaria only (control) and referred children with pneumonia to health facilities. Cluster randomization was employed because it would have been socially inappropriate and difficult for the same CHW to treat some children with pneumonia in their locality and refer others who also had pneumonia to health facilities. In addition, cluster randomization eased assessment of the impact of the intervention on mortality and other outcomes.

5.2.1 Selection of CHWs

Although CHWs had been used previously in Uganda to provide home management of malaria under the HBMF strategy, they were not active at the time of commencement of the cRCT. This was because CHWs had previously used combinations of chloroquine and sulphadoxine-pyrimethamine (CQ-SP) for treatment of fever, but the change in antimalarial policy that occurred in 2005 necessitated a change in medicines to the recommended ACTs (Nanyunja et al., 2011). However, use of ACTs by CHWs had not yet been widely rolled out when recommendations were made to adopt the ICCM strategy. Therefore, as part of the cRCT, CHWs were selected from the communities where they were to serve. Persons were eligible for selection as CHWs if they were permanent residents of the areas where they were to serve, able to read and write, respectable members of the community, and good mobilizers. The selected persons were trained either in the management of malaria alone (if they were in the control areas) or in the integrated management of malaria and pneumonia (if they were in the intervention areas).

5.2.2 Training of CHWs

All the CHWs in the cRCT were trained for three days on various aspects of malaria including signs and symptoms, danger signs, transmission, prevention, and populations at risk of malaria. The training on malaria was done before randomization of areas into intervention and control areas. After randomization the CHWs in the intervention arm received three days’ training on integrated malaria and pneumonia management, thus receiving additional training on acute respiratory tract infections (ARI) that included: signs and symptoms, use of respiratory timers in counting breathing rates, danger signs, and prevention of pneumonia. During the training on malaria, all CHWs (including those in the control arm) had been informed about the signs and symptoms of ARI, but not how to assess and classify these signs and symptoms. CHWs in both the intervention and control areas were also trained on referral, filling in registers, managing drug supplies, counselling caregivers of children, and adverse reaction monitoring. In addition, the CHWs received refresher training at monthly meetings with the supervisors of the project and health workers.

Prior to the training of CHWs, members of the district health team; and health workers in public, NGO, and private health facilities received two days’ training on integrated community management of malaria and pneumonia, investigation and documentation of adverse events, as well as supervision of CHWs. The training was conducted by Ministry of Health officials.
5.2.3 Randomization
Cluster randomization was used in which randomization was done at the parish level (i.e. each parish was considered as a cluster). A parish is made up of several villages. The 65 villages of the HDSS make up 26 parishes and these parishes were randomized to the intervention and control arm using stratified block randomization. The parishes were stratified into eight urban and 18 rural clusters. The clusters were further stratified according to the population of children less than five years in each cluster.

In the rural area three strata based on the population of children less than five years were made, as follows: (i) 190-320 children, (ii) 321-390 children, and (iii) ≥ 391 children, resulting in six clusters in each of these strata. The clusters from the urban area were grouped into two strata also based on population sizes of (iv) 280-430, and (v) ≥431. Random numbers were generated in blocks of six for the rural clusters and in blocks of four for the urban clusters. In each of the three strata in the rural area, three clusters were randomized to the intervention arm and three to the control arm. In each of the two strata in the urban area, two clusters were randomized to the intervention arm and two clusters to the control arm. There were no buffer zones between the clusters.

5.2.4 Supervision of CHWs
The CHWs received monthly support supervision from health workers at the nearest health facilities. The health workers involved in supervision of CHWs were nurses, midwives, and clinical officers (holders of 3-year diplomas in medicine). They visited the CHWs’ homes and checked the CHWs’ records for completeness and correctness of dosing, as well as the medicines boxes for appropriateness of medicines storage.

5.2.5 Patient management in the cRCT
Diagnosis: The CHWs in the control arm treated children with non-severe malaria and referred children with severe disease and those with pneumonia symptoms of any severity to nearby health facilities. The CHWs in the intervention arm treated children with non-severe malaria and/or pneumonia and referred children with severe disease to nearby health facilities. The algorithm followed by CHWs is summarized in Figure 5. The CHWs in both the intervention and control arms classified children’s illnesses based on symptoms similar to IMCI guidelines (WHO and UNICEF, 2008). Specifically, the CHWs classified children with fever or a history of fever in the last 24 hours as having malaria. In the intervention arm, the CHWs classified children with cough or difficult breathing and fast breathing as having pneumonia. A child was considered to have fast breathing if their breathing rate was ≥50 breaths per minute if they were aged up to 12 months, or ≥40 breaths per minute if they were aged 12-59 months. Children were considered to have severe disease if they had any of the four general danger signs (repeated vomiting, convulsions, failure to feed or lethargy/unconsciousness) or other danger signs like chest in-drawing, noisy breathing, severe dehydration or pallor.
**Treatment provided:** The CHWs used dispersible AL tablets (Coartem® 20mg artemether, 120mg lumefantrine) manufactured by Novartis Pharma AG, for treatment of malaria in both the intervention and control arms. The AL was pre-packaged in two age-specific doses (6 tablets in yellow pack for children aged 4-35 months and 12 tablets in blue pack for children aged ≥36 months). In both age-groups, AL was given twice daily for three days.

In the intervention arm, the CHWs used pre-packaged amoxicillin tablets (125mg) manufactured by Medipharm, India or IDA Foundation, The Netherlands for treatment of pneumonia. The amoxicillin was procured in bulk packages and re-packaged by a local pharmaceutical industry (Kampala Pharmaceutical Industries) in three age-specific doses (6 tablets for children aged 4-11 months, 12 tablets for children 12-35 months and 18 tablets for children 36-59 months). Amoxicillin was administered twice daily for three days.
5.3 STUDY DESIGN AND DATA COLLECTION METHODS

5.3.1 Study design

The thesis comprises four studies (I-IV) which were nested within the cRCT. Both qualitative and quantitative methods were used to collect data. A cross-sectional study combined with focus group discussions (FGDs) was used to assess the performance of CHWs (study I) in June 2011. A cohort study was employed to assess adherence of children to antimalarial and antibiotic treatments (study II) and the effectiveness of integrated malaria and pneumonia management on prompt and appropriate treatment for pneumonia symptoms as well as treatment outcomes (study III) in October and November 2011. The same cohort study was employed for studies II and III, but some of the children that were included in study III did not participate in study II.

Cohort studies are types of studies where an investigator selects a group of persons with an exposure of interest and a comparison group without the exposure. The groups are then followed up for outcomes of interest (Gordis, 2000). The exposures of interest in study II were antimalarials and antibiotics (intervention arm), antimalarials only (intervention arm), and antimalarials only (control arm). In study III, the exposures of interest were seeking care from CHWs in the intervention or control arms of the cRCT. A cross-sectional study combined with key informant interviews (KIIs) was conducted in January to February 2011 to assess the utilization of CHWs and the effect of the intervention on community drug use patterns (study IV). However, data from KIIs was not included in the publication of study IV but has been presented in this thesis. The data collection methods for studies I-IV are described in more detail in sections 5.3.2 and 5.3.3.

5.3.2 Overview of the data collection methods

Study I and IV employed both qualitative and quantitative data collection methods. Combining qualitative and quantitative data has been said to strengthen research because each method compliments and minimizes the limitations of the other (Creswell et al., 2003; Bryman, 2004). The data from qualitative and quantitative methods were combined through triangulation. In addition, data obtained from various sources using quantitative methods have been combined to answer the study objectives. Triangulation is an approach to data analysis that synthesizes data from multiple sources for a single problem, often combining qualitative and quantitative data. Different types of triangulation exist, including combining data collected with different methods (methods triangulation), data from different sources within the same method (data triangulation), data from different observers (investigator triangulation) and using different perspectives or theories (theory triangulation) (Patton, 1999). In this thesis there was mainly methods and data triangulation.

Questionnaires/structured interviews were employed in studies I, II, III and IV. Questionnaires have been used to collect large amounts of data from a large number of people in a short time. Thus they were very handy in collecting data for the considerably large sample sizes in the various studies. Questionnaires/structured interviews can also be used by many people doing the interviewing with limited influence on the validity, especially when adequate training has been done. This was important because several research assistants were employed to collect the data. However, they are not suited to collecting certain types of information, e.g. skills. Some world views state that they are artificial creations by researchers where limited information without explanations is collected. The questions may also be interpreted differently or researchers may impose their views (Harden et al., 2004). The responses to questions, especially those on knowledge in the various studies, were unprompted to improve validity of assessment (Franco et al., 2002; Hwang et al., 2007). Prompted questions were only used to obtain information on the presenting signs and symptoms of the children’s illness.
Focus group discussions (FGDs) were employed in study I. They are a form of data collection method that capitalizes on interaction between research participants to generate data on a topic which the moderator helps to keep the group focused on. The method is particularly useful for exploring people’s knowledge, perceptions, feelings, and experiences and can be used to examine not only what people think but how they think and why they think that way (Kitzinger, 1995; Stewart et al., 1990). FGDs can provide naturalistic data, but the researcher’s influence on the interaction may affect this naturalism (Morgan, 1997). In addition, the data cannot be generalized (Liamputtong and Ezzy, 2005) in a similar manner to data from surveys. Furthermore, some people’s opinion may be suppressed through dominant voices taking over the discussion, and this calls for the moderator’s expertise at ensuring that all views including minority dissenting ones, are captured (Smithson, 2000).

Key informant interviews were employed in study IV. They are methods of data collection where individuals with specialized knowledge about the topic of interest are interviewed with semi-structured or unstructured interviews. They are used to assess people’s experiences, inner perceptions, attitudes and feelings of reality, which may not be possible to discern with observations (Bryman, 2004).

Observations
Structured observations were employed in study I to assess the performance of CHWs in the intervention arm while they assessed children for respiratory symptoms. Observations provide more reliable information about events than questionnaires (Bryman, 2004) and are very useful methods for assessment of skills and actual performance of health workers, but do not reflect the thought processes that guide decision making in the study subjects (Kak et al., 2001). In addition, the persons being observed may alter their behavior during the assessment and thus not reflect what they routinely do. Alteration of behavior is increased in cases where the study subjects are removed from their natural settings (Bryman, 2004). In this study the observations on CHWs were undertaken at a nearby health facility.

Use of existing data
Using data that were collected by someone else, usually for another purpose (i.e., secondary data) saves time and resources that would have otherwise been used to collect the data. Although large amounts of data become available in a very short time, one of the major drawbacks of this method is the completeness and comprehensiveness of the data to answer the current research question (Boslaugh, 2007). Some data used in this thesis already existed from the HDSS database. The data in the HDSS database are collected through six-monthly censuses of the population in the area. Data are collected on household characteristics, births, deaths, immigrations and emigrations. Through this data collection system every person in the population can be traced through their household and personal identification numbers. Data were extracted from the HDSS database on some household characteristics of CHWs (study I) and children (study IV). In study I CHWs’ records were also reviewed.

Methods for assessment of CHW performance
Several methods have been proposed for assessment of performance of health providers, including direct observations, record reviews, provider interviews or written exams (knowledge tests), exit interviews with patients, case scenarios, and simulated patients (Cardemil et al., 2012; Franco et al., 2002; Kak et al., 2001). The methods all have their strengths and drawbacks, which may influence the decision to use them. The knowledge tests provide information about what providers know and not necessarily what they do. However, they may be useful in assessing knowledge about rare
conditions (Franco et al., 2002). Case scenarios together with the knowledge tests are said to standardize interviews, have objectivity in scoring, minimize costs of data collection, and present rare cases of illness; however they have the disadvantage of not assessing skills well (Franco et al., 2002; Kak et al., 2001). Reviewing records provides reliable information for treatments given and enables fast data collection, but may provide insufficient information on diagnosis and counseling. The quality of the records also affects the data collected (Franco et al., 2002). Information obtained from observations by an independent person provides one of the most reliable and complete pictures of what health providers do (Franco et al., 2002); however, it could also be influenced by alteration of behavior due to being observed (Rowe et al., 2006). In this thesis knowledge tests, case scenarios, record reviews, interviews of caregivers of children treated by CHWs, and to some extent direct observations were used to assess CHW performance.

5.3.3 Sampling, sample size and data collection methods

5.3.3.1 Study I – Performance of CHWs

Quantitative data were collected from 57 of 61 CHWs in the intervention arm and 68 of 70 CHWs in the control arm of the cRCT using questionnaires with knowledge tests and case scenarios as well as questions on CHWs’ demographic characteristics, review of CHWs’ records, and interview of caregivers of two children treated by CHWs in the week prior to the interview. In addition, observations were conducted among 57 CHWs in the intervention arm while they assessed children with respiratory symptoms. The quantitative methods and sample sizes used are summarized in Table 2.

The study aimed to recruit all CHWs that were available during the study period and who consented to participate in the study. Since there was a fixed number of CHWs, power calculations were used to assess the adequacy of the number of available CHWs for answering the research objective. A formula for comparison of two proportions was used along with a two-sided 5% level of significance and 90.5% of CHWs able to adequately treat malaria (Kelly et al., 2001). The available number of CHWs was sufficient to detect 25% difference between the intervention and control arms with 85% power. The interviews were conducted by six trained field assistants supervised by the principal researcher, who also did the record reviews. The observations were conducted by two medical officers trained in IMCI. One of the medical officers observed the CHW and filled a checklist while the other counted the respiratory rates along with the CHW. Data on the wealth index of CHWs were extracted from the HDSS database.

Table 2. Summary of the quantitative data sources for study I with number of participants

<table>
<thead>
<tr>
<th>Data collection method</th>
<th>Intervention N</th>
<th>Control N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires</td>
<td>57</td>
<td>68</td>
</tr>
<tr>
<td>Review of records</td>
<td>57</td>
<td>68</td>
</tr>
<tr>
<td>Observations of respiratory symptoms assessment</td>
<td>57</td>
<td>-</td>
</tr>
<tr>
<td>Interview of children treated by CHWs</td>
<td>114</td>
<td>134</td>
</tr>
<tr>
<td>Extraction of data on CHW’s wealth index from HDSS database*</td>
<td>47</td>
<td>47</td>
</tr>
</tbody>
</table>

*Some CHWs missing wealth index data

The qualitative data were collected through four FGDs among CHWs. The FGDs were held separately for men and women in the intervention and control arms. Each FGD had 8-10 participants who were selected purposively to include the leaders of CHWs in each arm; CHWs with high or low patient turn-over as seen in the review of records, with several errors in their records or
questionnaires filled during the quantitative data collection; and CHWs that were active in the monthly meetings. This range of participants was thought to be broad enough to provide a diverse range of ideas (Powell and Single, 1996). The FGDs were conducted by a skilled moderator assisted by the principal researcher. The FGDs were conducted subsequent to quantitative data collection after identifying areas that needed further elaboration; these included training of CHWs for their roles, community support for the CHWs, referral, effect of CHWs’ roles on their lifestyle and factors perceived by CHWs to influence their work.

The outcome variable was performance of CHWs, which was based on eliciting signs and symptoms, classification of illness, identifying and responding to danger signs, prescribing medicines (dosing, giving instructions on how medicines should be administered) and storing medicines appropriately.

5.3.3.2 Study II – Adherence to medicines

Children that were treated by CHWs were consecutively sampled from the CHWs’ registers on the day they received treatment, and those whose homes were traced and their caregivers gave informed consent to participate in the study were enrolled. In the control areas 667 children were enrolled while in the intervention areas 323 children prescribed antimalarials only and 266 children prescribed antimalarials plus antibiotics were enrolled. The minimum required sample size was estimated using the formula for comparison of two proportions with adjustment for clustering (Adamchak et al., 2000). The assumptions used were 5% level of significance, 80% power, design effect of two, 81% adherence among children taking AL alone as seen in a previous study (Ajayi et al., 2008a), 20% reduction in adherence among children taking both AL and amoxicillin giving adherence of 64.8% in AL plus amoxicillin group, and 10% loss to follow-up. Based on these assumptions, a minimum sample size of 258 children in each group was sufficient.

The data were collected using a questionnaire that was administered to caregivers of the enrolled children. The questionnaire was divided into two parts. Part one of the questionnaire collected information on demographic and illness characteristics and was administered on day one of receiving treatment from CHWs. Part two of the questionnaire was administered on day four after receiving treatment from the CHWs and was used to collect information on understanding of medicines administration instructions, vomiting of administered medicines, and adherence to treatment. The day four visits were unannounced to minimize their influence on adherence as well as to minimize discarding of pills that may occur when patients expect their medicines to be checked (Minzi and Naazneen, 2008).

Adherence was assessed using pill counts and caregiver reports of how the treatment was administered over a three-day period (Osterberg and Blaschke, 2005). The caregiver report was used to compute the percentage level of adherence (i.e. the percentage of prescribed medicines that were taken appropriately) and was validated by checking the medicines’ packet to determine if there were any pills and the number of pills that were left on the day of evaluation (pill counts). The computed level of adherence was categorized into adherent (those that had taken all their prescribed drugs appropriately) and non-adherent (those that had not taken some of their prescribed drugs or had taken them inappropriately) (Kachur et al., 2004). The caregivers were also asked if the children had vomited any of the doses within 30 minutes of taking the medicines and whether they had administered replacement medicines for the vomited doses. Children that had been classified as adherent were considered as non-adherent if they were not re-administered doses after vomiting (Beer et al., 2009).
Further evaluations of adherence were made based on what the medicines were administered with or what foods were taken before the medicines were administered. Based on this, the participants were considered to have optimal adherence if they had taken all their medicines as prescribed and had taken them with a fatty meal; good adherence if they had taken all their medicines as prescribed but had either not taken the medicines consistently with a fatty meal or had not taken the medicines with a fatty meal at all; and non-adherence if some of the medicines were not taken or were not taken according to the correct schedule (Achan et al., 2009).

5.3.3.3 Study III – Effectiveness of integrated malaria and pneumonia management

The data for this study were the same as for study II, but a few more children were included in this study who did not participate in study II because they received amoxicillin only from the CHWs, which was not included in the groups to be compared on adherence. Study III included children treated by CHWs: 609 from the intervention arm and 667 from the control arm. The required sample size was estimated using the formula for comparison of two proportions in cRCTs (Hayes and Bennett, 1999). The assumptions used were proportions of children receiving prompt and appropriate pneumonia treatment of 13% in the control arm and 68% in the intervention arm, as seen in a previous study (Yeboah-Antwi et al., 2010), 90% power, 5% level of significance, coefficient of variation of 0.4 (estimated to fall in range of recommended values (Hayes and Bennett, 1999), minimum of 12 children per cluster, 20% of children having pneumonia symptoms, and a drop-out rate of 10%. Using these calculations 111 children with pneumonia symptoms were needed in each arm, translating to about 610 children treated by CHWs in each arm.

For this study the day one data included child and caregiver demographics, illness characteristics, and treatment seeking. In addition, the children’s temperatures were measured and their breathing rates were counted. The children were visited again on day four of treatment seeking and the caregivers were interviewed about additional treatment received, adherence, hospitalization, and illness resolution. Temperature and breathing rates were measured again.

The children were classified as having pneumonia symptoms if the caregiver reported cough accompanied by fast breathing and/or difficult breathing (Diaz et al., 2013; UNICEF, 2013b).

The primary outcome was receiving prompt and appropriate antibiotics for pneumonia symptoms and the secondary outcome was treatment outcomes. Prompt and appropriate antibiotics was defined as receiving the recommended antibiotic for pneumonia on the day of symptom presentation or the next day. Treatment outcomes were defined as: having high temperature (≥37.5°C) or raised respiratory rate (>30 breaths per minute in children aged 4-12 months and >40 breaths per minute in children 12-59 months) on day four; receiving additional antimalarials after treatment by CHW; receiving additional antibiotics after receiving treatment from the CHWs in the intervention arm or receiving additional antibiotics beyond those received from the health facility where referred children sought care in the control arm; hospitalization, or death (Yeboah-Antwi et al., 2010). A child with any of these treatment outcomes was considered to have treatment failure. Self-reported treatment failure was also assessed by the caregiver’s report on the child’s illness resolution.

5.3.3.4 Study IV – Effect of integrated management on utilization and community drug use patterns

Children aged 6-59 months were sampled from the HDSS database using random sampling to obtain 700 children from each arm of the cRCT. The households of the sampled children were visited and caregivers that were available at home and gave informed consent were interviewed (548 from the
intervention arm, 547 from the control arm). Questionnaires were used to collect data on knowledge of fever, malaria, and pneumonia, illness experienced in two weeks prior to the interview, health care-seeking for illness and treatment received. In addition, data on child, caregiver and household characteristics were extracted from the HDSS database. This data included a wealth index (in the form of quintiles) computed using principal components analysis based on household items similar to those used in the Uganda Demographic and Health Survey (Uganda Bureau of Statistics and Macro International Inc., 2007), which has been described elsewhere (Waiswa et al., 2010).

Illness classifications for malaria and pneumonia were made based on the symptoms reported by the caregiver. A child was considered as having had malaria if the caregiver reported fever in the previous two weeks (Gove, 1997). Self-reported pneumonia symptoms were defined as caregiver report of cough and fast breathing with or without fever; cough and difficult breathing with or without fever; difficult and fast breathing with or without fever; and fever with difficult breathing (UNICEF, 2013b; Department of Health Policy Planning and Management, 2010).

The treatment received was classified as appropriate if the child used the recommended drug, dose, frequency, and duration. In addition, if the child used appropriate treatment promptly, i.e. if it was administered on the day of onset of symptoms or the next day, (Ajayi et al., 2008b; Rutebemberwa et al., 2009a) it was categorized as prompt and appropriate (Nsungwa-Sabiti et al., 2007). The assessment for appropriateness of treatment was done for the first treatment given to the child (i.e. first treatment action) and for the second treatment given to the child if they needed further treatment (i.e. second treatment action).

Medicines used for treatment were assessed for appropriateness based on national (Ministry of Health (Uganda), 2010b) or CHWs' treatment guidelines (Department of Health Policy Planning and Management, 2010) or treatment recommendations of the British National Formulary (Joint Formulary Committee, 2007), a widely used reference in Uganda.

The KIIs involved health service providers found in the facilities within the area including health centres, drug shops and private clinics. The purpose of these KIIs was mainly to explore malaria and pneumonia treatment practices by health workers within the area. The findings from the KIIs were not included in the publication of study IV but have been included in this thesis.

5.3.4 Data management

The FGDs and KII involved note-taking in the field as well as tape recording. The notes were used mainly to record non-verbal communication while the tape recording allowed an accurate account of the discussions to be taken (Liamputtong and Ezzy, 2005). The notes were taken by the assistant moderator and this eased the moderator’s demanding task of conducting FGDs, allowing her to concentrate on moderation of the discussion. The FGDs with CHWs were recorded in Lusoga and then translated into English during transcription by two fluent Lusoga speakers. All the KII were recorded and transcribed in English.

The questionnaires used in all four studies were field edited for errors by members of the study team and corrections were made while still in the field. A further check for errors was done by the principal investigator and the data were corrected the next day. The data from questionnaires were entered into FoxPro computer software and then exported to STATA version 10 for statistical analysis.
The observations made during study I were recorded on an observation checklist by medical officers with IMCI training. The data from the record reviews were abstracted using a data extraction form. They were then entered into EPIDATA and subsequently exported to STATA 10 for analysis.

5.3.5 Data analysis

Content analysis: The data from the FGDs in study I and KIIs in study IV were analyzed using manifest content analysis. This analysis focused on what the text said, thereby dealing with the content aspect, and described the visible, obvious components (Graneheim and Lundman, 2004; Downe-Wamboldt, 1992). The units of analysis were the transcripts from the FGDs and KIIs. The transcripts were read through several times, and meaning units from which codes were generated were identified. The codes were subsequently grouped into categories.

Descriptive statistics were computed in all four studies for general description of the participants and performance of CHWs in study I.

Performance of CHWs: Scores on performance of CHWs were generated for various dimensions including knowledge of malaria or pneumonia, eliciting signs and symptoms for malaria or pneumonia, prescribing for malaria or pneumonia and giving instructions on how the medicines should be administered. Since these dimensions were assessed with different numbers of questions or had different numbers of possible responses, percent scores were obtained for each of the questions. The percent scores were summarized as means to give mean percentage scores on each of the dimensions assessed for each CHW (Kumar et al., 2009; Venkatachalam et al., 2011). Performance scores were also generated using principal components analysis (PCA) and they were compared with the mean percentages. Because the percentage scores are easier to interpret and compare between studies (Streiner and Norman, 2003), a decision was made to present the mean percentages for each dimension were then summarized separately for CHWs in the intervention or control arm as means or medians.

Comparative analysis: t-tests or Mann-Whitney U tests were used to compare numerical characteristics between the intervention and control arms in study I, II and IV, as well as scores for performance on malaria (study I). These tests are used to compare numerical characteristics between two groups. Performance on malaria and pneumonia in the intervention arm was compared using the Wilcoxon signed rank tests (study I). These tests compare paired numerical characteristics that are not normally distributed. In study II the three treatment groups were compared using analysis of variance (ANOVA) or Kruskal-Wallis tests. These tests compare three or more groups on numerical characteristics. Pairwise comparisons between the groups following ANOVA or Kruskal-Wallis tests were conducted using t-tests or Mann-Whitney U tests with adjustments of levels of significance using the Bonferroni correction. Chi-squared or Fisher’s exact tests were used to compare categorical variables between groups in study I, II and IV.

In study III study outcomes were compared in the intervention and control arms and unadjusted relative risks were estimated using Mantel-Haenszel methods, which considered the strata used in the randomization.

Multivariable analysis: Logistic regression was used in study II to determine the factors associated with non-adherence; and in study IV to determine the factors associated with the utilization of CHWs and appropriateness of treatment. Adjusted and unadjusted analyses were done. Factors that had p-
values less than 0.2 at unadjusted analysis were considered for multivariable analysis. All analyses in study II and III were adjusted for clustering.

In order to simultaneously control for the effect of covariates in study III, both cluster level and individual level analyses were done. The cluster level analysis was the recommended level of analysis since there were fewer than 15 clusters in each arm (Hayes and Moulton, 2009). However in order to simultaneously account and present results for other covariates, the individual level analysis was presented after checking that the conclusions drawn regarding the intervention effect were not different from those drawn after cluster level analysis. The individual level analysis was done using generalized estimating equations (GEE), while the cluster level analysis was done by estimating rates of the outcome in each cluster and then comparing the mean rates in the intervention and control arm using t-tests.

5.3.6 Summary of methods

The methods of the four studies in this thesis are summarized in Table 3.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Study population &amp; sample size</th>
<th>Data analysis</th>
<th>Period of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance of CHWs (I)</td>
<td>Mixed methods: FGDs, Questionnaires, Record reviews, Observations in intervention arm</td>
<td>CHWs (4 FGDs, 125 interviews, 57 observations), Caregivers of children treated by CHWs (248)</td>
<td>Descriptives, Chi-squared or Fisher’s exact tests, Mann-Whitney U tests, Wilcoxon signed rank tests, manifest content analysis</td>
<td>June 2011</td>
</tr>
<tr>
<td>Adherence to medicines (II)</td>
<td>Cohort within cRCT</td>
<td>Children treated by CHWs and their caregivers (1256)</td>
<td>Descriptives, ANOVA or Kruskal-Wallis, Chi-squared or Fisher’s tests, t-tests or Mann-Whitney U test, logistic regression</td>
<td>October to November 2011</td>
</tr>
<tr>
<td>Effectiveness of integrated malaria &amp; pneumonia management (III)</td>
<td>Cohort within cRCT</td>
<td>Children treated by CHWs and their caregivers (1276)</td>
<td>Descriptives, Mantel-Haenszel methods, GEE (individual level analysis), t-tests (cluster level analysis)</td>
<td>October to November 2011</td>
</tr>
<tr>
<td>Utilization of CHWs and effect on drug use patterns (IV)</td>
<td>Cross-sectional with KIs</td>
<td>1095 children under five and their caregivers, 13 KIs from health facilities</td>
<td>Descriptives, Chi-squared or Fisher’s tests, logistic regression, Content analysis</td>
<td>January to February 2011</td>
</tr>
</tbody>
</table>
5.3.7 Ethical Issues

Initial ethical approval and continuing review for all sub-studies were obtained from the School of Public Health Higher Degrees Research and Ethics Committee (IRB00005876) and the Uganda National Council of Science and Technology (HS898). In addition, sub-study IV received ethical approval from the Regional Ethics Committee of Karolinska Institutet, Sweden (Dnr 2011/1679-31/4).

Written informed consent was obtained from each participant involved in the quantitative studies while verbal consent was obtained from the participants in the FGDs. The participants also consented to the use of a tape-recorder.

Permission to conduct the studies was also obtained from the local administration of the villages.

Confidentiality was maintained throughout data collection, management and analysis.

Potential ethical risks from this study included the possibility of creating misunderstandings between CHWs and the community they serve, because the CHWs would know when people from their villages were enrolled into the study. However, attempts were made to mitigate this by maintaining confidentiality of the information given by the caregivers.
6 RESULTS

The results are presented in line with the modified access framework (Figure 3). They include utilization of services (study IV), quality of care (studies I, II, III and IV), health status (study III), patient satisfaction (studies I, III and IV), equity (study IV), and influence of livelihood assets and other factors on utilization of services and quality of care (studies II, III and IV).

6.1 UTILIZATION OF SERVICES (STUDY IV)

Children that were ill in the two weeks prior to the interview were assessed for promptness of care-seeking, and the source of first and second treatment outside the home.

Promptness of care-seeking: About 94% (689/732) of caregivers that sought care outside the home (from any type of health provider) did so promptly: 93% (354/382) in the intervention arm, and 96% (335/350) in the control; p=0.11.

Sources of care: For the first source of treatment outside the home, about 26% of caregivers sought care for their children from CHWs and this was higher in the intervention (29%) compared with the control arm (21%; p=0.01). Overall, caregivers mostly sought treatment from the private sector (32% private clinics, 25% drug shops) (Figure 6).

![Figure 6. First source of care among children in intervention and control areas](image)

When the second source of treatment outside the home was considered, the utilization of CHWs increased to 31% in the intervention arm and 22% in the control arm (adjusted OR=1.60, 95% CI=1.09-2.35; adjusted for wealth index, knowledge of malaria prevention, knowledge of danger signs, and child’s symptoms, i.e. not having fever).
6.2 QUALITY OF CARE

This section includes the performance of CHWs in management of malaria and pneumonia and factors perceived by the CHWs to influence performance; community drug use for malaria and pneumonia; and adherence to medicines.

Performance of CHWs (studies I and IV)

It was hypothesized that addition of pneumonia management to malaria management would lower performance on malaria and that CHWs managing pneumonia would find this a challenge because of the more complex diagnostic algorithm and additional medicines to prescribe. Performance of CHWs on knowledge of malaria, eliciting signs and symptoms, and prescribing was compared between the intervention and control arms (study I). In addition, performance of CHWs on pneumonia management was determined in the intervention arm and compared with malaria management. Drug use for malaria symptoms was compared between children treated by CHWs and those treated by other health providers (study IV). Drug use for self-reported pneumonia symptoms was compared between children treated by CHWs and those treated by other health providers in the intervention arm.

CHWs’ performance on malaria management

CHWs in the intervention and control arms had similar scores on knowledge of malaria (intervention 72%, control 70%), eliciting malaria signs and symptoms (50% both groups), prescribing antimalarials based on case scenarios (80% both groups), and prescribing antimalarials based on records (99% intervention, 100% control) (study I). Table 4 summarizes findings on performance on malaria in study I.

<table>
<thead>
<tr>
<th>Percentage score</th>
<th>Intervention</th>
<th>Control</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of malaria, median</td>
<td>72%</td>
<td>70%</td>
<td>0.37</td>
</tr>
<tr>
<td>Eliciting signs and symptoms, median</td>
<td>50%</td>
<td>50%</td>
<td>0.74</td>
</tr>
<tr>
<td>Prescribing antimalarials, case scenarios, median</td>
<td>80%</td>
<td>80%</td>
<td>0.70</td>
</tr>
<tr>
<td>Prescribing antimalarials, record reviews, mean</td>
<td>99%</td>
<td>100%</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Comparison of children treated by CHWs with those treated by all other health providers (study IV) showed that a higher proportion of children treated by CHWs (37%) received prompt and appropriate treatment of malaria symptoms than those treated by other health providers (9%; p<0.001). The children treated by CHWs were more likely to receive the recommended drug (100% vs 38%; p<0.001), recommended drug and dose (71% vs 22%; p<0.001), recommended drug and frequency of administration (78% vs 22%; p<0.001) and recommended drug for recommended duration (79% vs 21%; p<0.001).

CHWs’ performance on pneumonia management in the intervention arm

Assessment of CHWs in the intervention arm in study I showed median overall pneumonia knowledge of 40% from questionnaires, and median scores on prescribing of 82% from case scenarios and 96% from record reviews. The mean percentage of children with fast breathing that received antibiotics was 82% and that of children without fast breathing that received antibiotics was 12%. About 49% and 35% of CHWs were observed to count respiratory rates within five breaths and two breaths respectively of those counted by the physician, and 75% of them correctly classified children as having pneumonia or not (Table 5). This level of correct classification of pneumonia status was observed even though there was a lot of discordance between the breath counts made by the CHWs and physicians, because the breath counts of many children were far from the cut-off
points such that gross over- or under-estimation by CHWs would not change the “pneumonia” classification of the child.

Table 5. Performance of CHWs in intervention arm on pneumonia in study I

<table>
<thead>
<tr>
<th>Source</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Questionnaires</strong></td>
<td></td>
</tr>
<tr>
<td>Overall knowledge, median score</td>
<td>40%</td>
</tr>
<tr>
<td>Eliciting signs &amp; symptoms (integrated)*, median score</td>
<td>25%</td>
</tr>
<tr>
<td>Prescribing from case scenarios (integrated)*, median score</td>
<td>82%</td>
</tr>
<tr>
<td><strong>Records</strong></td>
<td></td>
</tr>
<tr>
<td>With fast breathing received antibiotics, mean percent</td>
<td>82%</td>
</tr>
<tr>
<td>Without fast breathing received antibiotics, mean percent</td>
<td>12%</td>
</tr>
<tr>
<td>Correct doses of antibiotics, mean score</td>
<td>96%</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td></td>
</tr>
<tr>
<td>Counted respiratory rates ±5 breaths of physician</td>
<td>49%</td>
</tr>
<tr>
<td>Counted respiratory rates ±2 breaths of physician</td>
<td>35%</td>
</tr>
<tr>
<td>Correctly classified children as ± pneumonia</td>
<td>75%</td>
</tr>
<tr>
<td>Misclassified children as having pneumonia</td>
<td>14%</td>
</tr>
<tr>
<td>Misclassified children as not having pneumonia</td>
<td>4%</td>
</tr>
<tr>
<td>Could not decide if child had pneumonia or not</td>
<td>7%</td>
</tr>
<tr>
<td>Showed correct position for evaluation of chest in-drawing</td>
<td>88%</td>
</tr>
</tbody>
</table>

* Integrated refers to combining malaria and pneumonia.

Comparison of malaria (Table 4) and pneumonia management (Table 5) in the intervention arm, showed higher scores for malaria than for pneumonia on overall knowledge (72% vs 40%; p<0.001) and correct doses of medicines from record reviews (99% vs 96%; p<0.001). The performance on eliciting signs and symptoms from case scenarios fell from 50% for malaria to 25% when pneumonia signs and symptoms were integrated (study I).

When CHWs were compared with other health providers on pneumonia (study IV), the proportion of children that received an antibiotic for self-reported pneumonia symptoms did not differ between the children treated by CHWs and those treated by other health providers (42% vs 45%; p=0.39). There was also no statistically significant difference in the proportion that received prompt and appropriate treatment of pneumonia symptoms (CHW-users 7%, non-CHW-users 13%; p=0.18).

**Factors perceived to influence CHW performance (study I)**

The factors perceived by CHWs as influencing performance were grouped into community-, programme-, and health facility-related factors. The community factors included mobilization of communities to seek care from CHWs by local leaders, community members seeking care from CHWs because of their confidence in medicines used (which mainly arose from finding CHWs with medicines that were similar to medicines children would receive from public health facilities), and caregivers’ non-compliance with referral:

“The LCs [local councils] [local leaders] also play very important roles here. They tell people to come for treatment from me and as a result they come whenever the children are sick.” (FGD with female CHWs, control arm)
There was also lack of community appreciation for age restrictions of children treated. The caregivers usually wanted children older than five years also to be treated. This finding was also reflected in the interviews with caregivers of children treated by CHWs:

“Sometimes the people say that it seems these health workers want to kill our children with those drugs reason being that why are we very strict on who we treat? They said that it would be good if everyone is treated. If possible we could increase the age group to 7 years.” (FGD with female CHWs, control arm)

Programme factors included reinforcement of knowledge through continued training during monthly meetings, interrupted supply of medicines, transport refund for collecting medicines, difficulty of working at night and during rainy weather, lack of transport for follow-up of treated children, and large coverage areas making follow-up difficult:

“The three days [of initial training] weren’t enough for us because we trained to treat malaria and pneumonia at the same time. When we were trained to treat pneumonia, it was a bit difficult for us so what they decided to do was to put monthly meetings where we meet as CHWs and we share experiences on how we are handling situations in our villages.” (FGD with female CHWs, intervention arm)

“When we don’t have drugs, everything goes down. Also transport to do follow up of the children that you treated is really hard. Sometimes you even use your own personal money to do follow up.” (FGD with female CHWs, control arm)

The health facility-related factor influencing performance was the lack of cooperation from health workers at facilities:

“There are times when you refer a person to the health centre but when this patient reaches there, he/she doesn’t get the needed attention. They say that they look at the referral note over and over again instead of treating the patient.” (FGD with female CHWs, control arm)

Community drug use for malaria and pneumonia in intervention and control arms (studies III & IV)

Overall medicines use (IV)
There was no difference in the mean number of medicines received by children in the intervention and control arms (mean=2, SD=1.1 in both arms). However, the mean number of medicines used was lower among children treated by CHWs in both the intervention (1.6 vs 2.4; \(p<0.001\)) and control arms (1.4 vs 2.3; \(p<0.001\)) compared to children treated by other health providers.

Medicines use for malaria symptoms (study IV)
About 62% of the children in the intervention arm and 59% in the control arm with fever received antimalarials. However, 54% in the intervention arm and 49% in the control arm received recommended antimalarials. Overall, 18% of the children with fever in the intervention arm received prompt and appropriate treatment for malaria symptoms compared with 12% in the control arm (\(p=0.03\)).

Malaria management practices by non-CHW health providers
Through KII in study IV, exploration of medicines used for treatment of malaria revealed that some of the KIs use artemether-lumefantrine to treat malaria while several others still use the old antimalarials that are no longer recommended. In particular, some health providers said they use
chloroquine as a first-line treatment for malaria alone while others follow it with sulphadoxine-pyrimethamine, and they use quinine in case the treatment with chloroquine fails:

“I treat according to the age of the child let’s say if a mother brings a child at the age between two and four months I can use chloroquine syrup, I don’t have tablets to give children at that age. And if they are five months and above I can give chloroquine or quinine tablets. If the child completes the dose of quinine or chloroquine I accompany with Fansidar® [sulphadoxine-pyrimethamine] according to the age and body weight.” (KI, nursing assistant, private health facility)

A few KIs mentioned that they use quinine in cases of severe malaria or as a second line in case the first line treatment failed to work:

“Okay, in the facility normally they are treated with the first line of Coartem® [artemether-lumefantrine], if they don’t respond they are put on the second-line quinine.” (KI, health worker, public health facility)

One KI said that she can use sulphadoxine-pyrimethamine alone for treatment of fever depending on how the child presented:

“If a child has fever, normally I treat using Lornat® [artemether-lumefantrine] tablets or Fansidar® [sulphadoxine-pyrimethamine] or quinine basing [it] on how the child has presented.” (KI, nurse, private facility)

In addition to antimalarials, many KIs said they use other drugs including antipyretics, hematinics and anti-emetics, depending on the symptoms the child presented with or if the caregiver could afford the drugs. Some KIs said they use dexamethasone as an antipyretic while others use it to boost the child’s strength, as shown by these quotes below:

“I do give it in conditions like high temperature. I mix chloroquine tablets and Fansidar®. I also give dexta [dexamethasone].” (KI, nursing assistant, drug shop)

“You will look at this child and she or he will be very weak and without energy so in order for this child to get energy, I add dexta [dexamethasone] in the treatment I give her/him.” (KI, nursing assistant, drug shop)

**Medicines use for pneumonia symptoms**

Assessment of use of antibiotics for pneumonia symptoms in the community regardless of the source showed that the proportion of children with self-reported pneumonia symptoms that received antibiotics was not significantly different in the intervention and control arms (45% vs 37%; p=0.44). About 11% of the children in the intervention arm and 5% in the control arm (p=0.10) received prompt and appropriate treatment of pneumonia symptoms (study IV).

In study III, assessment of use of antibiotics for pneumonia symptoms focused on children that were treated by CHWs in the intervention and control arms. About 63% of the children in the intervention arm with self-reported pneumonia symptoms received antibiotics from the CHWs, while in the control arm 51% of such children were referred to health facilities for further care. The proportion of children that received prompt and appropriate antibiotics for self-reported pneumonia symptoms was higher in the intervention arm (45%) than in the control arm (10%), with a relative risk of 3.51 (95% CI = 1.75-7.03) after adjusting for education of caregiver, urban or rural residence, and child’s presenting symptoms.
Pneumonia management practices by non-CHW health providers

Most of KIs cited cotrimoxazole as the drug used in pneumonia treatment. Some of them used it alone as the first drug while others used it as a continuation drug after giving injections. Benzyl penicillin injections were cited for the treatment of pneumonia and were usually followed with oral drugs such as cotrimoxazole or amoxicillin owing to the difficulty of continuing injections especially for health facilities that do not admit patients. Other KIs said they use oral drugs only, e.g. amoxicillin or ampicillin plus cloxacillin.

Another KI mentioned that when patients get to his health facility, they have usually been treated with many drugs such as cotrimoxazole and amoxicillin so he treats pneumonia with amoxicillin plus clavulanate. Chloramphenicol was also cited as medicine commonly used for pneumonia.

From the quantitative data collection in study IV, some children had received medicines that were crushed and mixed by the health provider, with no labels showing the constituents. KIIIs revealed that these mixtures were prepared by the health providers and the constituents varied depending on the illness. The quote below shows the typical mixture that was prepared for a 3-year-old child with pneumonia:

“We make the whole mixture once and it’s the mother to get a small portion of the mixture on the spoon and give the child for about 3 days and gives twice a day ….we mix 2 capsules of amoxicillin [total of 500mg amoxicillin] with 1 Panadol® [paracetamol 500mg] and 1 prednisone [5mg].” (KI, drug shop)

Adherence to medicines (study II)

Adherence to medicines in the intervention arm did not differ among children taking antimalarials only (mean adherence 99.2%) and those taking a combination of antimalarials and antibiotics (mean adherence 98.5%). However, adherence to medicines in the intervention arm was higher than in the control arm (antimalarials only) (mean 96%; p<0.001). Although the proportion of children that were adherent to their medicines (i.e. took all medicines as recommended) was high, most of them did not take the artemether-lumefantrine with a fatty meal as recommended by the manufacturers (i.e. optimal adherence was much lower) (Figure 7). In addition, some of the children that vomited within 30 minutes of taking the medicines did not receive replacement doses, and this also lowered adherence.

The reasons given for missing medicines or not giving them according to the prescribed schedule included forgetfulness (38.1%), the child improved or recovered (14.3%), vomiting (12.7%), the tablets were too many (11.1%), not having food or drink to give the child (4.8%), not understanding the medicines administration instructions well (4.8%), and other reasons such as caregiver being away from home, the child experiencing adverse reactions, and having other medicines to take.
There was no difference in overall treatment failure between the intervention and control arms. However, the proportion of children with temperature ≥ 37.5°C on day four since seeking care from CHWs was lower in the intervention arm (1%) compared with the control arm (4%). The reduction in fast breathing from day one to day four was higher in the intervention (9%) compared with the control arm (4%) (Table 6).

### Table 6. Treatment outcomes of children treated by CHWs

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention</th>
<th>Control</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All children treated by CHWs</td>
<td>N=609</td>
<td>N=667</td>
<td></td>
</tr>
<tr>
<td>Overall treatment failure</td>
<td>90 (14.8%)</td>
<td>101 (15.1%)</td>
<td>0.88 (0.67-1.18)</td>
</tr>
<tr>
<td>Received additional* antibiotics</td>
<td>7 (1.2%)</td>
<td>13 (2.0%)</td>
<td>0.77 (0.32-1.86)</td>
</tr>
<tr>
<td>Received additional** antimalarials</td>
<td>4 (0.7%)</td>
<td>10 (1.5%)</td>
<td>0.44 (0.15-1.28)</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>10 (1.6%)</td>
<td>9 (1.4%)</td>
<td>1.47 (0.64-3.38)</td>
</tr>
<tr>
<td>Temperature ≥ 37.5°C on day 4</td>
<td>7 (1.2%)</td>
<td>23 (3.5%)</td>
<td>0.29 (0.11-0.78)</td>
</tr>
<tr>
<td>Had fast breathing on day 4</td>
<td>66 (10.8%)</td>
<td>48 (7.2%)</td>
<td>1.29 (0.87-1.92)</td>
</tr>
<tr>
<td>Difference in fast breathing, day 1 &amp; 4†</td>
<td>9.2%</td>
<td>4.2%</td>
<td>p-value=0.01</td>
</tr>
<tr>
<td>Deaths</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Self-reported treatment failure</td>
<td>83 (13.7%)</td>
<td>170 (25.5%)</td>
<td>0.58 (0.46-0.74)</td>
</tr>
</tbody>
</table>

* Additional antibiotics received after CHW treatment in intervention arm or after treatment from other source where children were referred in control arm.

** Additional antimalarials received after treatment by CHWs.

† Difference between percentage of children with fast breathing on day one and four, p-value comparing difference in intervention and control.

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6.3 HEALTH STATUS (study III)

There was no difference in overall treatment failure between the intervention and control arms. However, the proportion of children with temperature ≥ 37.5°C on day four since seeking care from CHWs was lower in the intervention arm (1%) compared with the control arm (4%). The reduction in fast breathing from day one to day four was higher in the intervention (9%) compared with the control arm (4%) (Table 6).
6.4 PATIENT SATISFACTION (STUDIES I, III AND IV)
Caregivers rated the care provided by CHWs highly in all studies. In study I, 90% (103/113) in the intervention arm and 84% (113/135) of caregivers in the control arm rated the quality as good, with only one (0.7%) caregiver in the control arm rating care as poor. In study III, 99.5% (605/608) of caregivers in the intervention arm rated the care from CHWs as good and 0.5% (3/608) rated it as fair while in the control arm 97% (657/667) rated the care as good, 2.8% (19/667) rated the care as fair, and only one caregiver (0.2%) rated the care received from CHWs as poor. In study IV, some caregivers of children seen in government facilities (6/125, 4.8%), private clinics (3/231, 1.3%) and drug shops (1/180, 0.6%) rated the quality of care as poor while no caregivers rated the CHWs’ care as poor.

6.5 EQUITY (STUDY IV)
Utilization of CHW services was compared across the five wealth quintiles in study IV. There was a tendency for more children in the lower four wealth quintiles to seek care from CHWs compared with the highest quintile (p=0.05) (Figure 8).

Figure 8. Utilization of CHWs according to wealth index among children in Iganga-Mayuge HDSS
6.6 **INFLUENCE OF LIVELIHOOD ASSETS ON UTILIZATION OF SERVICES AND QUALITY OF CARE**

Some livelihood assets including human capital such as post-primary education, increasing knowledge of malaria, pneumonia, and danger signs and caregivers’ perception that illness was severe and financial capital, such as the wealth index, were associated with different outcomes in various studies (studies II, III and IV) (Table 7). Children whose caregivers had attained post-primary education were more likely to receive prompt and appropriate antibiotics (study III), while increasing knowledge of malaria prevention was associated with utilization of CHWs (study IV). Knowledge of how malaria is transmitted, knowledge of danger signs, and knowledge of pneumonia signs were associated with receiving prompt and appropriate malaria treatment (study IV). Non-adherence was higher among children whose caregivers perceived the illness as not severe and caregivers who did not understand the medicines administration instructions (study II). Poorer children were more likely to utilize the services of CHWs (study IV).

**Table 7. Influence of livelihood assets on utilization of CHWs' services and quality of care**

<table>
<thead>
<tr>
<th>Variable grouping</th>
<th>Predictor</th>
<th>Outcome</th>
<th>Measure of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human capital</td>
<td>Post primary education</td>
<td>Prompt and appropriate antibiotics (III)</td>
<td>RR=1.56, CI=1.04-2.36</td>
</tr>
<tr>
<td></td>
<td>Knowledge of malaria prevention</td>
<td>Utilization of CHWs (IV)</td>
<td>OR=1.39, CI=1.12-1.73</td>
</tr>
<tr>
<td></td>
<td>Knowledge of malaria transmission</td>
<td>Prompt and appropriate malaria treatment (IV)</td>
<td>OR=2.05, CI=1.23-3.41</td>
</tr>
<tr>
<td></td>
<td>Knowledge of danger signs</td>
<td>Prompt and appropriate malaria treatment (IV)</td>
<td>OR=1.22, CI=1.03-1.43</td>
</tr>
<tr>
<td></td>
<td>Knowledge of pneumonia signs</td>
<td>Prompt and appropriate malaria treatment (IV)</td>
<td>OR=1.40, CI=1.14-1.72</td>
</tr>
<tr>
<td></td>
<td>Perception that illness was not severe</td>
<td>Non-adherence (II)</td>
<td>OR=2.0, CI=1.1-3.8</td>
</tr>
<tr>
<td></td>
<td>Not understanding medicines use instructions</td>
<td>Non-adherence (II)</td>
<td>OR=24.5, CI=2.7-224.5</td>
</tr>
<tr>
<td>Financial capital</td>
<td>Wealth index (poorest to less poor vs least poor)</td>
<td>Utilization of CHWs (IV)</td>
<td>OR=1.92, CI=0.99-3.71</td>
</tr>
</tbody>
</table>

RR = relative risk, OR = odds ratio, CI = confidence interval
6.7 OTHER FACTORS ASSOCIATED WITH UTILIZATION OF CHWS AND QUALITY OF CARE

Other factors that were associated with utilization of CHWs’ services (study IV), adherence (study II), and receiving prompt and appropriate malaria and pneumonia treatment (studies III and IV) included presenting symptoms of the child’s illness, and age of the household head and child as well as residence (Table 8). Children that had no fever were more likely to utilize the services of CHWs (study IV) and not adhere to medicines (study II) compared to children that had fever. Children that were vomiting were more likely to be non-adherent (study II), while those that had no diarrhoea were more likely to receive prompt and appropriate antibiotics (study III). Increasing age of the household head was associated with the child receiving prompt and appropriate treatment for pneumonia symptoms (study IV) and for malaria symptoms (study IV). In addition, younger children were less likely to receive prompt and appropriate malaria treatment (study IV). Children that were staying in urban areas were more likely to receive prompt and appropriate antibiotics (study III).

Table 8. Influence of presenting symptoms and age on CHW utilization and quality of care

<table>
<thead>
<tr>
<th>Variable grouping</th>
<th>Predictor</th>
<th>Outcome</th>
<th>Measure of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenting symptoms</td>
<td>No fever</td>
<td>Utilization of CHWs (IV)</td>
<td>OR=2.55, CI=1.26-5.16</td>
</tr>
<tr>
<td></td>
<td>No fever</td>
<td>Non-adherence (II)</td>
<td>OR=3.3, CI=1.6-6.9</td>
</tr>
<tr>
<td></td>
<td>Vomiting</td>
<td>Non-adherence (II)</td>
<td>OR=2.6, CI=1.2-5.5</td>
</tr>
<tr>
<td></td>
<td>No diarrhoea</td>
<td>Prompt and appropriate antibiotics for pneumonia symptoms (III)</td>
<td>RR=1.33, CI=1.01-1.76</td>
</tr>
<tr>
<td>Other factors</td>
<td>Age of household head</td>
<td>Prompt and appropriate pneumonia treatment (IV)</td>
<td>OR=1.05, CI=1.01-1.08</td>
</tr>
<tr>
<td></td>
<td>Urban residence</td>
<td>Prompt and appropriate antibiotics for pneumonia symptoms (III)</td>
<td>RR=1.56 (1.20-2.00)</td>
</tr>
<tr>
<td></td>
<td>Age of household head</td>
<td>Prompt and appropriate malaria treatment (IV)</td>
<td>OR=1.02, CI=1.00-1.04</td>
</tr>
<tr>
<td></td>
<td>Age of the child</td>
<td>Prompt and appropriate malaria treatment (IV)</td>
<td>OR=0.98, CI=0.96-0.99</td>
</tr>
<tr>
<td></td>
<td>Seeking care after ≥2 days</td>
<td>Non-adherence (II)</td>
<td>OR=2.2, CI=1.3-3.7</td>
</tr>
</tbody>
</table>
7 DISCUSSION

7.1 MAIN FINDINGS

The additional responsibility of pneumonia management by CHWs did not affect their performance on malaria management. The good performance of CHWs on malaria was reflected in the community drug use patterns where children treated by CHWs had more rational drug use for malaria compared with children treated by other health providers. However, the CHWs had some difficulties in assessment of pneumonia symptoms. Care-seeking from CHWs that provide integrated malaria and pneumonia treatment increased prompt and appropriate antibiotic use for pneumonia symptoms compared with care-seeking from CHWs that treated malaria alone and referred children with pneumonia symptoms to health facilities. Care-seeking for childhood illnesses was, however, mostly from private facilities (clinics and drugs shops), although utilization of CHWs was higher in areas where CHWs could treat both malaria and pneumonia and among children of lower socio-economic status. High adherence was observed in both children who received antimalarials only from CHWs and those who received combinations of antimalarials and antibiotics.

The key findings are presented and discussed in relation to the Obrist Access Framework, which has been adapted in this thesis (Figure 3), and are sequenced as follows utilization of CHWs; quality of care including performance of CHWs, community drug use for malaria and pneumonia management, and adherence; health status; patient satisfaction, equity; resistance; and influence of livelihood assets on utilization of CHWs and quality of care. This section is followed by a discussion of health systems and methodological considerations in this thesis.

Utilization of services

The proportion of children that sought treatment from CHWs (26%) was lower than what was seen in another study in eastern Uganda (40%) (Mukanga et al., 2012a) and one in Ghana (59%) (Ajayi et al., 2008b), but was higher than that in a study in the same area where treatment seeking from CHWs was only 2% (Rutebemberwa et al., 2009b). The higher treatment seeking from CHWs in Ghana could result from familiarity of the community with the CHWs, since they had previously performed this role. In contrast, the previous study in the same area by Rutebemberwa et al. was done at the time when the malaria policy in Uganda had changed from use of CQ-SP to ACTs and the CHWs at the time did not have ACTs.

The relatively low care-seeking from CHWs reported in this thesis is possibly due to the high competition for market share between the CHWs and other health providers especially the private clinics and drug shops which are numerous (n=122) within the area and provide a wider range of drugs than the CHWs. Most children received treatment from these private clinics and drug shops. The caregivers may prefer to seek care from these health providers, who can treat a wide range of illnesses as well as treat all age groups including adults and children. In addition, the interrupted supply of medicines that CHWs experienced from time to time may have affected treatment seeking from them. Low care-seeking from CHWs implies that positive effects of the integrated community illness management may not have sufficient impact in the community. Quality of care received by the children may be lowered by seeking care from sources with inappropriate practices.

Some inappropriate malaria and pneumonia treatment practices were noted among some health providers in the area, including the use of drugs that are no longer recommended, inappropriate use of steroids, and crushing medicines together before dispensing to the caregivers, which would make the measurement of appropriate dosages difficult.
Care-seeking from CHWs was higher in areas where CHWs provided integrated malaria and pneumonia treatment, suggesting that increasing the roles of CHWs may increase the likelihood of caregivers seeking care from them. Similar findings were noted in Cambodia (Hasegawa et al., 2013). Having CHWs that treat only one illness has been identified as a limitation to their utilization, because children often suffer from multiple illnesses for which they need a holistic intervention (Nsabagasi et al., 2007; Nsungwa-Sabiti et al., 2007; Källander et al., 2004).

Quality of care

Performance of CHWs on malaria: The CHWs managing malaria alone and those managing malaria and pneumonia performed equally well on malaria management, suggesting that CHWs’ additional roles may not affect established knowledge and skills negatively. The findings could be due to the long familiarity with malaria in the general population in Uganda (Batega, 2004). In addition, there has been some experience in using CHWs to manage malaria under the HBMF strategy in Uganda (Uganda Ministry of Health, n.d.). CHWs have been found to be effective in managing malaria in previous studies (Kamal-Yanni et al., 2012). The performance of the CHWs in prescription of medicines was higher than that in eliciting signs and symptoms and overall knowledge of malaria suggesting that the major weakness for CHWs is malaria diagnosis as opposed to prescription. The use of pre-packaged medicines by CHWs may have improved their prescription practices, since these have been reported to improve drug use (Yeboah-Antwi et al., 2001). The performance scores obtained by the CHWs on malaria were comparable to those from a study done in Kenya (Kelly et al., 2001) and Rwanda (MoH Republic of Rwanda, 2009). Contrary to the current recommendation by WHO for universal parasite-based diagnosis of malaria (WHO, 2010a), RDTs were not used in the cRCT on which this thesis is based because the trial commenced before the recommendation was made. It is not clear what impact the RDTs would have had on the performance of CHWs. Some studies have suggested that RDTs minimize over-use of antimalarials (Yeboah-Antwi et al., 2010; Mukanga et al., 2012b).

The CHWs’ performance on malaria was reflected at community level, where a higher proportion of children treated by CHWs (37%) compared with those treated by other health providers (9%) received prompt and appropriate malaria treatment, similar to a study in western Uganda (Nsungwa-Sabiti et al., 2007). The other source of treatment was mainly the private sector, including drug shops and clinics which are commonly manned by unqualified personnel (Ministry of Health (Uganda), 2009b). The better malaria treatment practices among CHWs compared with other health providers, coupled with the increased use of CHWs in the intervention compared with the control arm, could explain why the intervention arm (18%) had a higher proportion of children that received prompt and appropriate treatment for malaria than the control arm (12%).

However, the proportion of children with prompt and appropriate malaria treatment was much lower than the WHO targets of 80% (Roll Back Malaria, 2005) but this malaria classification was based on symptoms and not parasite-based diagnosis as recommended (WHO, 2010a). Thus, many of the children may not have had malaria and therefore it was not desirable to have a 100% treatment rate. However, some studies done in high malaria transmission areas of Uganda similar to the HDSS have found high RDT-positivity (79-88%) in febrile children (Mukanga et al., 2012b; Batwala et al., 2011), implying that many of these febrile children seen in Iganga-Mayuge HDSS would probably have been positive on RDTs. In addition, the proportion of children with prompt and appropriate treatment of malaria symptoms could have been under-estimated due to misreporting of the dosing schedule by the caregivers. The data was collected on treatment of illnesses experienced over a period of two weeks prior to the interview and the caregivers could have forgotten how the medicine...
was given. CHWs dispense complete doses of pre-packaged medicines and therefore higher proportions of children treated correctly are expected.

**Performance of CHWs on pneumonia:** The CHWs’ performance on management of pneumonia was lower than that for malaria, with lower overall knowledge (70% vs 40%), prescribing from record reviews (100% vs 96%) and performance on eliciting signs and symptoms, which fell from 50% to 25% when pneumonia assessment was added. Pneumonia assessment could be particularly difficult since it involves a complex algorithm with counting and categorization of breathing rates, a task of some difficulty even among formal health providers (Gadomski et al., 1993). There may also be less familiarity with pneumonia compared with malaria.

In Uganda, previous efforts at illness control in children at community level have focused largely on malaria. The use of CHWs to manage pneumonia has been mainly through small pilot studies. The main areas of weakness for the CHWs were in assessment and classification of pneumonia symptoms as opposed to prescribing medicines, a trend similar to that for malaria. This difficulty in assessment of pneumonia was further shown by challenges exhibited in counting breathing rates. Only 35% of CHWs counted breathing rates within two breaths of those counted by the physician, similar to the proportion observed in Malawi (39%) (Gilroy et al., 2012). However, the proportion of CHWs that counted breathing rates within five breaths of those counted by the gold standard in the current study (49%) was lower than the 71% found in another study in Uganda (Källander et al., 2006a). The difference in findings could be explained by differences in lapse of time between training and CHW assessment. The latter study was done within two weeks of CHW training while the current study was done about two years after initial training. Other studies have also reported difficulties in respiratory assessments among CHWs (Mukanga et al., 2011; Kelly et al., 2001). It is important that efforts are made towards improving diagnosis of pneumonia.

There was no significant difference in the proportion of children that received prompt and appropriate treatment for pneumonia symptoms when children treated by CHWs were compared with children treated by other health providers, and neither was there a difference between the intervention and control arms. This may have resulted from insufficient power to detect differences or from insufficient impact of the intervention on pneumonia treatment practices in the community. Contrary to the expectation that CHWs would over-use antibiotics, the proportion of children that received antibiotics did not differ significantly among children treated by CHWs and those treated by other health providers. However, it is important to ensure that health providers are not missing pneumonia. When comparisons were focused on children treated by CHWs in the intervention and control arms, a three-fold difference was found in proportions receiving prompt and appropriate antibiotics in the two arms, suggesting that CHWs who provide integrated malaria and pneumonia care increase the promptness of appropriate antibiotics compared with CHWs who treat malaria only and refer children with pneumonia symptoms to health facilities. These findings are similar to those in a study in Zambia (Yeboah-Antwi et al., 2010).

Several methods were used to assess the performance of CHWs, but although some results are not conclusive on pneumonia, some useful information was obtained including that CHWs perform highly on prescription of antibiotics, as seen from case scenarios and record reviews. However, they have lower scores on assessment of signs and symptoms of pneumonia and classifying them, as shown by the relatively lower scores on overall knowledge of pneumonia (40%), on eliciting signs and symptoms (25%) and counting breathing rates (35% able to count within two breaths of the gold standard). When breathing rates are determined, a higher proportion is able to categorize them correctly into fast breathing or otherwise. In addition, having a CHW who provides integrated care increases promptness of appropriate antibiotics compared with a CHW who treats malaria only and
refers children with pneumonia symptoms to nearby health facilities. This effect was, however, not apparent at the community level, and this may be due to the small number of children with pneumonia symptoms in the community that were treated by CHWs, the problems of recall that were inherent in the survey that was used in study IV to evaluate community drug use, and the use of self-reported symptoms. Over-prescription of antibiotics by CHWs was not apparent.

The CHWs are contributing to the use of effective medicines in a setting where children continue to receive medicines such as chloroquine and sulphadoxine-pyrimethamine that are no longer recommended for malaria treatment. Some children also receive drugs such as cotrimoxazole which although not yet replaced in Ugandan treatment guidelines for pneumonia, has widespread resistance (Hoa et al., 2010; Joloba et al., 2001). CHWs were the most common source of amoxicillin, a drug that is currently recommended for treatment of pneumonia in the community (Grant et al., 2009). To corroborate this finding, several health providers in the qualitative study mentioned as first-line drugs for treatment of malaria or pneumonia drugs that are no longer recommended. They also had other inappropriate practices such as routine use of dexamethasone, a steroid for treatment of respiratory symptoms.

Misuse of corticosteroids in respiratory infections has been reported in India (Raveenthiran, 2008; Shrivastava, 2009) and it may predispose children to many complications including Cushing’s syndrome (Rajendra et al., 2013). Other inappropriate practices included crushing and mixing of all medicines into powder, of which the caregivers were directed to measure off small quantities to administer to the children. This may cause unwanted chemical reactions between different drugs, resulting in inactivation of medicines or toxic reactions in children. Inadequate quantities of medicines were also likely to be administered. ICCM is likely to reduce such practices through provision of pre-packaged and dispersible medicines which may be easier for caregivers to administer (Yeboah-Antwi et al., 2001; Abdulla and Sagara, 2009), and by availing a limited range of drugs which minimizes misuse of other drugs. Children treated by CHWs in both the intervention and control areas received fewer drugs on average than children treated by other health providers, suggesting more rational use of medicines by CHWs.

**Adherence**: Caregivers performed well in adherence to medicines. Contrary to the hypothesis that increased pill burden would lower adherence (Osterberg and Blaschke, 2005), there was high adherence in children that received both antimalarials and antibiotics and in children that received antimalarials alone. Caregivers of children that received both antimalarials and antibiotics may have perceived the children’s illness as severe and thus they may have made more effort to adhere to medicines. Perceived severity of illness has been found to influence medicines use (Bush and Iannotti, 1990). However, adherence could have been over-estimated, since the exact timing of doses was not assessed. The timing rather than the complete omission of doses has been reported as a very common aspect of non-adherence (Lemma et al., 2011). The adherence found in this study is similar to that in previous studies of CHWs (Ajayi et al., 2008a; Ajayi et al., 2008b; Chinvuah et al., 2006). The main reasons cited for non-adherence including forgetfulness, improvement of the child and vomiting have also been reported in previous studies (Beer et al., 2009; Kolaczinski et al., 2006). Appropriate caregiver counselling should be undertaken to ensure that all the medicines administration instructions have been understood, that caregivers continue to give medicines even when children seem well, and that additional doses are given to the children when they vomit medicines. High adherence should be maintained so as to protect the medicines against resistance.

**Health status**

There was no difference in overall treatment failure among children treated by CHWs in the intervention and control arms (study III), similar to a study in Zambia (Yeboah-Antwi et al., 2010).
In contrast to that study, children treated by CHWs in the intervention arm were less likely to have high temperature (i.e. ≥ 37.5°C) on day four compared with children in the control arm. Furthermore, the reduction in the proportion of children with fast breathing between day one and four in the intervention arm (9%) was more than twice that in the control arm (4%), suggesting that integrated management of illness improves health status compared with single illness management. In the Zambian study, high temperature, fast breathing, and difficult breathing on day four were grouped together, and differences on the specific outcomes could have been missed. The treatment outcomes for pneumonia treatment reported in this thesis may have been lower than what the intervention could achieve because of the three-day doses of amoxicillin used in the cRCT, rather than the five-day doses recommended for high HIV prevalence areas like Uganda (Grant et al., 2009). In addition, the age-specific doses were lower than the recommended 50mg per kilogram of body weight daily (Grant et al., 2009), mostly for the older children in each age category who were likely to be heavier. Children may not have had adequate drug exposure for good treatment outcomes. However, self-reported treatment failure was lower in the intervention arm compared to the control arm suggesting improved treatment outcomes from the caregivers’ perspective.

Patient satisfaction
Caregivers of children that sought care from CHWs rated the care they received highly (study IV). There were slightly higher proportions of caregivers in the intervention arm that rated the quality of care received from CHWs as good compared with the control arm, although it was not significantly different. In studies I and III, only one caregiver from each study rated care from CHWs as poor (both times from the control arm), while in study IV some caregivers who sought care from government facilities (4.8%), private clinics (1.3%) and drug shops (0.6%) rated the care received as poor. Another study in Uganda also found high levels of caregivers’ satisfaction with CHW-care (Mukanga et al., 2012a). Caregivers’ high rating of health care may reflect its acceptability or patient-centredness, which is one of the attributes of quality of health care (Institute of Medicine, 1990).

Equity
Children in the lower wealth quintiles were more likely to utilize the services of the CHWs (study IV). This is a positive finding since it suggests that the CHW programme in this setting is reaching the poorer children as planned for community-based programs (de Sousa et al., 2011). The findings are in agreement with studies that found the poorest people more likely to utilize CHWs’ services compared to the least poor (Hasegawa et al., 2013; Kisia et al., 2012) but contrast with findings in western Uganda where children from richer households utilized CHW services more than the poor (Nsungwa-Sabiiti et al., 2007).

Resistance
In this thesis resistance was not directly studied, but some drivers of resistance were studied and are outlined here. There was higher appropriate use of antimalarials among children treated by CHWs compared with other health providers (study IV) and this may reduce the risk of resistance to antimalarials (Bloland, 2001). However, no RDTs were used in malaria diagnosis, which may contribute to an unnecessary increase in drug pressure and result in increased risk of resistance to antimalarials (Bloland, 2001). Resistance to antibiotics would also be increased by over-use of antibiotics and inadequate drug exposure (Cars and Nordberg, 2005) which could occur through use of poor quality antibiotics, use of inadequate doses of antibiotics or non-adherence. The CHWs did not use antibiotics more than other health providers and thus may not be increasing drug pressure unnecessarily. However, to further reduce this risk, they should have adequate knowledge and skills in respiratory assessment, together with reliable instruments to aid diagnosis, so that only children that need antibiotics receive them. This area, as shown in study I, needs further improvement with increased training and provision of necessary diagnostic aids.
Influence of livelihood assets

Social capital: In study I, the performance of CHWs was influenced by community support. The local leaders in the areas where the CHWs did their work helped to mobilize caregivers to seek care from the CHWs, and this enhanced the CHWs’ performance. This is in contrast to a study in western Uganda where CHWs felt that the community was not supportive at all (Uganda Program for Human and Holistic Development (UPHOLD), 2007). This difference in findings could stem from differences in contexts. In the current study, the local leaders were the first persons sensitized about the programme and they may have continued with the responsibility of sensitizing the community.

The caregivers sometimes did not comply with the referral advice given by the CHWs and this negatively impacted on their work. Caregiver’s non-compliance with referral has been reported in another study in western Uganda (Källander et al., 2006b). In addition, the caregivers’ lack of appreciation of age cut-offs for children treated sometimes created conflicts. These findings are similar to what was reported in Uganda under HBMF where caregivers would lie about the ages of their children so that they could be treated by the CHWs (Uganda Program for Human and Holistic Development (UPHOLD), 2007). Furthermore, there was lack of cooperation from health workers at the health facilities where some of the children were referred; they did not treat the referred children promptly. There is need for strong collaboration and cooperation between the CHWs, the communities that they serve, and the formal health providers if the ICCM strategy is to succeed. The lack of support from the formal health system was also reported in Mali (Callaghan-Koru et al., 2013).

Human capital: In study IV knowledge of malaria and pneumonia was associated with improved malaria treatment practices and care-seeking from CHWs, while in study III caregiver education was shown to influence prompt and appropriate pneumonia treatment. Children whose caregivers had received post-primary education were more likely to receive prompt and appropriate pneumonia treatment. In study II caregivers’ perception that illness was not very severe, as well as their not understanding the medicines administration instructions, were associated with increased non-adherence. These factors have been associated with treatment practices in other studies (Hwang et al., 2007; Assefa et al., 2008).

Financial capital: The wealth index of households influenced treatment seeking from CHWs (study IV) and has been discussed under the section on equity.

The financial capital also affected the CHWs because they felt that the money they were given to enable them collect medicines, although helpful, was not sufficient for them to do their work effectively. This factor linked to physical capital, because the CHWs reported that they lacked transport to follow up treated children, as well as materials such as torches or weather-proof wear that would enable them to do their work at night or during rainy weather. The CHWs also reported that sometimes they had to use their money to follow up treated children because of lack of transport. This may demotivate the CHWs and lower their performance. Dissatisfaction with remuneration was also reported among CHWs in India (Bajpai and Dholakia, 2011).

Influence of other factors on utilization of CHWs and quality of care

Presenting symptoms: Children who did not have fever were more likely to utilize the services of CHWs and they were also more likely not to adhere to treatment. Caregivers may perceive illness without fever as ‘not severe’ and therefore may seek care from the CHWs who are nearby. This could
also explain the non-adherence to treatment. Fever may be perceived by the caregivers as a serious illness and therefore seek care from other health providers whom they perceive to be more qualified than the CHWs. A study in western Uganda reported that caregivers considered care from CHWs as ‘first aid’ treatment which they gave to their children as they monitored them to determine if they needed further care (Nsabagasani et al., 2007). Another study in Kenya found that caregivers whose children had fever were more likely to seek care for those illnesses (Taffa and Chepkeno, 2005).

7.2 CONSIDERATIONS FOR THE HEALTH SYSTEMS

This thesis has assessed a model of health service delivery for under-five children that integrates malaria and pneumonia management using volunteer CHWs. The findings show that integrated care increases utilization of CHW services and increases prompt and appropriate antibiotics for pneumonia symptoms. The CHWs continue to perform well on malaria despite their added roles of pneumonia management, and their performance translates to better community drug use patterns for malaria among the children they treat compared with other health providers. The findings have been presented according to the modified access framework by Obrist (Figure 3). I would now like to turn to the constituent building blocks of the health system as presented by WHO (Figure 1). In order to successfully implement and scale up ICCM, some aspects of the building blocks of health system need to be addressed as outlined below.

The CHWs are contributing to the health workforce and are important sources of health services especially in areas that are under-served by formal health facilities. However, there are still questions regarding their motivation and retention. CHWs in Uganda and some other countries are volunteer workers and a question arises as to whether it is possible to sustain the CHWs providing care under ICCM as volunteers. Some countries have used paid CHWs (Bhutta et al., 2010) but can countries like Uganda, which already have difficulties in remunerating their formal health workers (Hagopian et al., 2009; Kanyesigye, 2003; Nalugo, 2013), be able to pay CHWs? And if the CHWs cannot be paid, what will be the motivation for them to provide high quality health care. Studies to find how CHWs could be motivated were conducted under HBMF and they reported that CHWs could be motivated with monetary and/or non-monetary incentives (Ludwick et al., 2013; Uganda Program for Human and Holistic Development (UPHOLD), 2007) and further studies are still ongoing that may provide more information regarding motivation of CHWs (Innovations at Scale for Community Access and Lasting Effects (inSCALE), 2013).

For the information management, strategies for linking the CHWs’ data to the health management information system that already exists in the country should be devised. Otherwise challenges of lack of accurate data on diseases will be increased.

There is need for consistent availability of medical products and supplies required by the CHWs. This has been a major problem of the formal health system with frequent shortages of drugs and supplies (Achan et al., 2011). There will be more CHWs than health facilities, requiring innovative ways of maintaining drugs and other supplies. Drugs and supply shortages have also been encountered in CHW-programmes (Stekelenburg et al., 2003), and they not only interrupt health service provision but also affect the community’s trust in the CHWs (Puett et al., 2013). In addition the appropriate supplies and technologies that have high accuracy in diagnosis should be made available to the CHWs.

The financial implications of maintaining the CHWs whether paid or volunteers and maintaining the medical products and supplies will be great, requiring innovative financing mechanisms. Questions arise as to whether the services should be free or they should be paid for. One study has estimated
that $3,750 per year is required to train, equip and support each CHW in sub-Saharan Africa (McCord et al., 2012). Can the government of Uganda afford to consistently provide the ICCM services free-of-charge given the current funding rates? There is need for more data on the costing of ICCM and studies are ongoing in response to this need (Kasteng, 2013).

Another area that will need to be strengthened is leadership and governance. Strong leadership will be required to ensure high quality of care and efficient resource use. Supervision of the CHWs has to be strengthened and questions on the best modality of supervision of the CHWs arise. A study in Malawi reported low supervision of CHWs mainly arising from having clinician supervisors that found it difficult to leave their clinical duties to supervise CHWs (Callaghan-Koru et al., 2013). In addition, health facilities have critical roles to play in terms of treating referred children and supervising CHWs, and will they be able and willing to support the system? The ICCM strategy might require a stronger health system than the facility-based system of care, and this creates a dilemma because the community-based systems were started to support the weak health systems that existed especially in hard to reach areas (de Sousa et al., 2011). The scale-up of ICCM should proceed cautiously until all of the important pillars in the health system have been addressed. Or perhaps conversely, ICCM implementation needs to come with health systems strengthening components.

**Should antibiotics be available through CHWs?**

One of the common concerns of community case management involving the use of antibiotics has been putting antibiotics out into the community through persons with no formal medical training (Marsh et al., 2008). This could increase drug pressure and thereby the risk of resistance. In addition, if the drugs were misused through inadequate dosages and non-adherence, the risk of resistance would increase further. This thesis did not substantiate such fears. There was high adherence reported to medicines from CHWs. The CHWs also provide complete dosages of pre-packaged medicines which combined with appropriate counselling of caregivers should improve drug use compared with the common practice of caregivers buying incomplete doses of medicines (Minzi and Manyilizu, 2013; Wafula, 2013). The CHWs could also contribute to the rational use of antibiotics through respiratory rate assessment prior to their prescription. The key issue is whether they are able to do respiratory rate assessments and classify children into those that require antibiotics and those that do not. The CHWs need a lot of support in this area and there is need for technical innovation of better respiratory rate counting devices. The alternatives to CHWs in most of these hard to reach areas are the drug shops and small private clinics; these are often manned by unqualified personnel whose quality of care is questionable (Awor et al., 2012; Konde-Lule et al., 2010). These private clinics will also need to be addressed, and ICCM tools could have a positive effect on private sector quality. There is ongoing research to evaluate implementation of ICCM in drug shops, and findings from baseline evaluations have been published (Awor et al., 2012).

Another fear is whether the CHWs will not give in to pressure from caregivers to prescribe antibiotics. The CHWs are accountable to the communities that they serve and may therefore feel compelled to give in to such demands. In addition to strengthening the CHWs with credible diagnostics and good support supervision, the communities should be adequately sensitized about the principles of rational use of drugs, so that they do not expect to receive medicines for every illness.

**7.3 METHODOLOGICAL CONSIDERATIONS**

**Measurement errors**

In study I CHWs’ performance was assessed using knowledge tests, case scenarios and review of records. This may not have reflected the actual practice and therefore performance. However, the use of several methods may have strengthened the assessment. Although direct observation with re-
examination by an expert is the most valid method of assessing performance, it is often not feasible because it requires a lot of time and money to have the experts stationed at the CHWs’ posts, waiting for patients with varied illness presentations as well as assessing a large number of CHWs (Cardemil et al., 2012). The knowledge tests and case scenarios are likely to show the clinical knowledge of the CHWs and their ability to apply knowledge, rather than actual practice (Kak et al., 2001). They are however, able to present a wide range of illness possibilities, including rare conditions that might not have been encountered in the course of the study, if real cases of sick children had been used (Cardemil et al., 2012). However, these scenarios also had to be limited so as to minimize the length of the questionnaire, and therefore they did not assess all situations comprehensively. The record reviews present a larger number of cases seen over a longer period of time than can be seen with direct observation but they still lack sufficient information to make adequate assessment of performance (Cardemil et al., 2012). The record reviews were, however, able to show that some CHWs would record high respiratory rates for children and not give antibiotics, while other children with low respiratory rates were given antibiotics. They also showed some CHWs giving wrong doses of medicines according to the age in the records, as well as some gaps in respiratory assessment; some CHWs had one value of respiratory rate recorded for all children, which is unlikely to occur in real life.

The methods used do not assess skills well but an attempt was made to assess the skills of CHWs in assessing respiratory symptoms through observations of CHWs in the intervention arm. However, CHWs may have altered their practice as a result of being observed (Hawthorne effect) (Rowe et al., 2006) or as a result of being removed from the setting where they usually practise, since the observations were done at health facilities. In addition, the IMCI-trained medical officers used to observe counting of respiratory rates may not have been true gold standard.

The performance scores were generated using mean percentage scores from each of the items assessed. This method gave equal weight to each of the responses, and yet some responses may have been more important in prediction of performance than others. To overcome this problem, methods such as PCA, which can take into account this relative importance, are recommended (Streiner and Norman, 2003). Performance scores generated using PCA had fairly high correlations with scores generated as mean percentages (0.64-0.88). The mean percentages were thus chosen for their relative ease of interpretability (Streiner and Norman, 2003). The mean percentage scores may mask deficiencies in performance on specific tasks (Agency for Healthcare Research and Quality (AHRQ), n.d.), but given the high number of items assessed it was not possible to present each item separately.

Problems of recall could have occurred in studies II, III and IV which could have led to misclassification of children. In study II, the caregivers were asked to recall the way medicines had been taken since the day they got the treatment from the CHWs. However, this problem was most likely minimized due to the short duration of time over which they were required to recall, since the interview was conducted on day four. In studies III and IV the caregivers were required to recall the symptoms that the child had, and how long they had taken before seeking care. This problem was more likely to occur in study IV, where the caregivers were supposed to recall illness over the two weeks prior to the interview. Recall of illness over a two-week period has been shown to underestimate disease rates (Feikin et al., 2010). Surprisingly there was a very high fever illness rate reported (69%, study IV), higher than that previously reported in the same area (Rutebemberwa et al., 2009a). Fever illness may have been over-estimated and this may explain the low overall prompt and appropriate malaria treatment reported. In addition, caregivers in study IV had to recall the treatment that the child had received. Posters bearing the most commonly used medicines for childhood illnesses in the study area were used to aid the caregivers to recall the medicines the child had taken.
for the illness. The misclassifications in all three studies were more likely to be non-differential rather than differential.

Reporting bias in study II, arising from use of caregiver reports of how medicines were administered, could have led to over-estimation of adherence. Caregivers may have reported what they thought the interviewer wanted to hear and not what they actually did. Self-reports of adherence lead to over-estimation of adherence (Osterberg and Blaschke, 2005). The validity of adherence assessment, however, was improved by combining caregiver reports with unannounced pill counts, which have been shown to be better than announced pill counts (Minzi and Naazneen, 2008). However, the HDSS is a unique setting where lots of studies have been done and caregivers may have experienced similar studies, making them more likely to give answers that they expect interviewers to like (i.e. social desirability bias). Nevertheless, some caregivers reported non-adherence and factors associated with this non-adherence were determined, which offers opportunities for intervening to improve adherence.

Caregiver reports of illness symptoms were used in the classification of pneumonia in studies III and IV, which could also have led to misclassification. The algorithm used in IMCI and also by CHWs to classify pneumonia involves counting breathing rates and categorizing them at different thresholds into fast breathing or otherwise. Caregivers’ reports of fast breathing may not have met the thresholds. Caregiver reports of pneumonia symptoms have been used in demographic health surveys and in multiple indicator cluster surveys (UNICEF, 2013b) and in other studies (Diaz et al., 2013) to identify children with suspected pneumonia, but they are likely to over-estimate the number of children with pneumonia (Campbell et al., 2013). However, this over-estimation is unlikely to have differed between the intervention and the control arm, thus providing valid comparisons of antibiotic use for the two arms.

Caregivers may have changed their behaviour in study II due to the day one visit, which does not occur routinely. They may have increased their adherence. In addition, the correct timing of doses was not assessed in adherence assessment and could therefore have led to over-estimation of adherence. Incorrect timing of medicines has been shown to contribute significantly to non-adherence (Mace et al., 2011).

Selection bias
In study I a small number of CHWs could not be contacted for inclusion into the study. This may have led to selection bias, since CHWs who were difficult to find may have been inactive in their CHW roles and therefore had poor performance due to lack of experience. However, the impact of this non-participation on the findings is likely to have been small, since they were few (five).

Study IV had a number of children with missing information, mostly of data extracted from the HDSS database. This missing information could have led to selection bias during the analysis of data that involved these variables. The wealth index of CHWs extracted from the HDSS database in study I was similarly affected. The missing data did not differ between the intervention and control arms, thus affected both groups similarly. In addition, it was unlikely to be related to the study outcomes, i.e. performance of CHWs in study I and utilization of CHWs and drug use in study IV.

Clustering
Clustering could have occurred in studies II, III and IV owing to the designs of the studies. In studies II and III clustering was anticipated at the CHW level, with children treated by the same CHW likely to have similar care, which could affect adherence and treatment outcomes similarly. In addition, study III had clustering at the level of the sub-parishes that were used in randomization to the
intervention and the control arm, since it was in the setting of a cRCT. In study IV clustering was adjusted for at the village level. It is necessary to adjust for clustering when it exists in order to estimate valid standard errors and therefore valid confidence intervals. If not adjusted for, clustering can cause narrow confidence intervals and therefore erroneous conclusion of statistical significance when it does not exist (Hayes and Moulton, 2009; Wears, 2002). The sample sizes estimated for these studies were also adjusted for the anticipated clustering.

**Triangulation**

This thesis has involved triangulation of data and methods to answer the various objectives (Patton, 1999). Sometimes qualitative and quantitative methods have been combined and other times several data sources within the quantitative methods have been combined, either from the same study or even across different studies. Study I included information obtained through qualitative (FGDs) and quantitative methods. The quantitative methods also used a multi-method approach (knowledge tests, case scenarios, record reviews and observations) to assess performance, as well as interviews with caregivers of children that had been treated in the week prior to the interview. Study IV also used information from qualitative (KIIs) and quantitative methods. Data from the four studies have been combined as much as possible to answer objectives. The triangulation has helped to highlight the good performance of CHWs on malaria (studies I and IV). It has also highlighted one reason why the performance of other health providers was lower than of CHWs, i.e. use of antimalarials that are not recommended (KIIs in study IV). Through the several methods used to assess performance, triangulation has helped to highlight where the CHWs’ challenges in performance on pneumonia are.

**Use of diagnostics**

The cRCT in which studies for this thesis were nested did not employ RDTs which are currently recommended for inclusion into the CHWs’ illness management. In addition, the CHWs in the intervention arm used watches to count respiratory rates instead of respiratory timers as has been recommended. The impact of lack of these diagnostics on the performance of CHWs is unclear, but it is likely that non-use of RDTs could have led to over-treatment with antimalarials. However, Iganga and Mayuge are in high malaria transmission areas of Uganda and the RDT positivity in this area is likely to be high, implying that most children would still be eligible to receive antimalarials. There is literature suggesting that parasite-based diagnosis may not be cost-effective in areas of high malaria transmission (Graz et al., 2011; English and Scott, 2008). In addition, it is important to note that health facilities and programmess in Uganda and other resource-limited areas experience frequent drug and supplies shortages, and there might be times when CHWs are faced with such situations (Githinji et al., 2013; Achan et al., 2011; Mubi et al., 2013; UNICEF, 2013a). The lack of respiratory timers is one of the possible reasons why performance on counting respiratory rates was low.
CONCLUSIONS AND POLICY IMPLICATIONS

- CHWs continue to perform well on malaria management despite the additional duties of pneumonia management (studies I and IV). Higher proportions of children treated by CHWs received prompt and appropriate treatment for malaria symptoms compared to children treated by other health providers (study IV).
- Management of pneumonia presents some difficulties for CHWs, mainly in assessment of symptoms (study I). However, contrary to thinking that CHWs will over-use antibiotics, the use of antibiotics in children treated by CHWs was not higher than that among other health providers (study IV).
- CHWs that provided integrated malaria and pneumonia management increased the likelihood of children receiving prompt and appropriate antibiotics for pneumonia symptoms compared with CHWs that provided malaria treatment only and referred children with pneumonia symptoms to health facilities (study III).
- The utilization of CHWs is higher among children from poorer households and where CHWs can provide integrated malaria and pneumonia management compared to areas where CHWs treat malaria only (study IV). However, most caregivers seek care from the private sector.
- High adherence to medicines was observed and was not lowered by the additional pill burden of antibiotics. However, adherence was lower among children that were vomiting and those whose caregivers did not understand medicines administration instructions (study II).

Policy implications for Ministry of Health and ICCM implementing partners

CHWs may take on additional roles without lowering their performance in already established roles. However, they should be supported with more training, with special emphasis on pneumonia assessment and treatment, provision of necessary drugs, diagnostic materials and other supplies, and by ensuring a supportive health system.

The scale-up of CHW programmes should include strategies aimed at improving their utilization.

Given the high rate of care-seeking from the private sector, strategies that improve management of childhood illnesses should also address the private sector.

Health service providers especially in the private sector should implement policy recommendations so that medicines that are no longer recommended are not used by patients. In addition, efforts should be made to provide the recommended, but more expensive medicines at subsidized prices.
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