Community case management of acute malnutrition by community health workers in southern Bangladesh: Examining quality of care and cost-effectiveness

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Abstract

Severe acute malnutrition (SAM), evidenced by severe wasting and/or edema, reflects recent illness or nutrient deficits and is the cause of one to two million preventable child deaths each year. Recent advances in the treatment of SAM have enabled severely wasted children to recover at home, rather than in crowded therapeutic feeding centers or under-resourced, over-burdened health facilities. Due to its promising performance in promoting quick recovery and decreasing mortality rates in emergency situations, the community-based management of acute malnutrition (CMAM) has received much attention in international nutrition policy. In 2007, the United Nations promoted its global expansion into areas with a high burden of SAM and its integration with other community-based health and nutrition activities. However, there is limited evidence regarding the potential impact of this integration.

This dissertation addressed key debates and operational concerns around integrating CMAM into existing community-based health and nutrition programs by researching aspects of a pilot intervention implemented by Save the Children USA (SCUS) in southern Bangladesh. As part of a child survival program using a cadre of community health workers (CHWs) to deliver preventive and curative care to children in areas underserved by the formal health system, the community case management (CCM) of SAM was introduced to the CHW workload using an adapted CMAM classification algorithm. Study results were compared between the intervention upazila implementing the CCM of SAM and a comparison upazila implementing the facility-based treatment of SAM according to WHO protocol. This dissertation was comprised of three analyses.

The first analysis evaluated the capacity of CHWs to effectively identify and treat children suffering from SAM without complications. This analysis found that 89% of assessed CHWs achieved 90% error-free case management or higher. The second analysis examined the association between the quality of care provided by CHWs and their number of work responsibilities by comparing the performance of two groups of CHWs with different workloads: one group providing preventive care in addition to implementing CCM of pneumonia and diarrhea, and another group additionally treating SAM. This analysis found that the CHWs who were managing cases of SAM worked significantly more hours than those who were not, but maintained quality of care on both curative and preventive work tasks. The third analysis investigated the cost-effectiveness of community-based treatment of SAM compared to facility-based treatment by estimating costs incurred by both care providers and participating households in the two study upazilas, and coupling this analysis with effectiveness evidence generated in another arm of the study. Results from this research revealed that community-based treatment of SAM was more cost-effective than facility-based treatment, and resulted in considerably lower costs for participant households.

This research provides a timely investigation into the opportunities and challenges of integrating CMAM into existing community-based health and nutrition infrastructure. Findings suggest that CHWs are capable of managing cases of SAM at community level, and that this service delivery mechanism is cost-effective. Results from this dissertation support the use of CHWs in the community-based management of SAM in Bangladesh, in order to expand access to treatment for children in areas underserved by the formal health system.

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1 Chapter 1: Introduction

1.1 Summary of the problem and its significance

Childhood undernutrition is a serious problem throughout the developing world, impacting current and future growth and development, and contributing to over half the deaths in children under five (Black et al., 2003, Caulfield et al., 2004, Rice et al., 2000). Severe acute malnutrition (SAM), defined by severe wasting and/or nutritional edema (WHO, 1999), reflects recent illness or nutrient deficits and is the cause of one to two million preventable child deaths each year (Collins et al., 2006a).

Traditional treatment models confined children with SAM to hospitals or therapeutic feeding centers, with a caregiver taking several weeks away from work to accompany the child. In often crowded inpatient settings, center-acquired infection was prevalent and inhibited a child's full recovery, leading to mortality rates of up to 60%. Further, in countries with high SAM caseloads, facility capacity was overwhelmed with coverage commonly under 10% (Collins et al., 2006a).

1.1.1 The CMAM model

Recent advances in the treatment of SAM have enabled severely wasted children to recover at home, rather than in crowded therapeutic feeding centers or under-resourced, over-burdened health facilities (Collins et al., 2006b). Due to its promising performance in promoting recovery from SAM in emergency situations, along with greatly improving treatment coverage for those suffering from SAM even when delivered through primary health care infrastructure, the community-based management of acute malnutrition (CMAM) has received much attention in international nutrition policy (Collins et al., 2006a). In 2007, the United Nations promoted its

global expansion into areas with a high burden of SAM and its integration with other community-based health and nutrition activities (WHO et al., 2007).

1.1.1.1 Remaining issues for resolution

The community-based management of SAM is an evolving area of international nutrition policy, and there is limited evidence regarding the impact of adding this delivery mechanism to existing community-based nutrition infrastructure, particularly when it is delivered by a cadre of community-based workers with very little formal training and support. As CMAM is rolled out into poor countries around the world, there are implications for current community practices, including the quality of care provided by community-level health workers, and the relative cost-effectiveness of this delivery mechanism.

1.1.2 Policy and practice in Bangladesh

Acute malnutrition is a major concern in Bangladesh. With 16% of its children moderately and severely wasted, it ranks among the five countries with the highest prevalence of acute malnutrition in the world (UNICEF, 2009, NIPORT et al., 2009). In October 2008, the Institute of Public Health Nutrition (IPHN), the Director General of Health Services (DGHS) and the United Nation Children's Fund (UNICEF) approved a national protocol for the treatment of SAM in Bangladesh. This protocol followed the World Health Organization (WHO) guidelines for the facility-based inpatient management of SAM (IPHN et al., 2008, Ashworth et al., 2003). Although this was an important step forward, there are a number of limitations to this approach.

Public sector health care in Bangladesh is underfunded, and rural hospitals in particular are challenged to fill postings for professional medical staff (Standing and Chowdhury, 2008). This environment promotes poor staff morale and low quality of care. The public sector is estimated

to provide only 20% of curative health care in Bangladesh, with the non-state sector providing the majority of health services for both poor and wealthy households (Standing and Chowdhury, 2008). Within this context, the capacity of public facility-based care in Bangladesh to treat SAM is not sufficient to cover all those children that require care (Faruque et al., 2008). In addition, caretakers incur high opportunity costs during long stays at inpatient units (Collins et al., 2006a, Collins et al., 2006b, Ashworth, 2006). This means that it is common for caretakers both to delay presentation until a child's condition is critical, and to leave facilities before treatment is complete (Collins et al., 2006a). An evaluation of the Integrated Management of Childhood Illness (IMCI) strategy in Bangladesh showed that even where quality of facility-based services was improved, children from the poorest families were significantly less likely to be brought to health facilities, and may receive lower quality care once they arrive (Arifeen et al., 2004).

Bangladesh's National Nutrition Program (NNP), which delivers maternal and child health and nutrition (MCHN) interventions through community nutrition promoters, does not give adequate attention to addressing SAM in the community. Current standard practice is identification of SAM according to community IMCI (i.e. visible severe wasting and/or edema), with identified cases referred to the nearest health facility for inpatient treatment (Rosales, 2003, WHO, 2000). However a recent evaluation found that the linkages between NNP's Community Nutrition Centers and formal health facilities were not functioning; therefore, in practice, there are no existing community-based mechanisms in Bangladesh for referring and managing cases of SAM (Faruque et al., 2008). Health and nutrition officials in Bangladesh are eager to develop a mechanism for more effective identification and treatment of the condition at community level, which could be feasibly scaled up and that would complement the recently endorsed National Guidelines for the inpatient management of SAM.

1.2 The dissertation project

This dissertation research addressed key debates and operational concerns around the community-based management of SAM by conducting a series of studies in conjunction with a program implemented by Save the Children USA (SCUS), part of the larger Title II Development Assistance Program (DAP) entitled "Jibon o Jibika" ("Life and Livelihoods" in Bangla). This program was implemented in three districts of Barisal Division in southern Bangladesh; this is one of the poorest areas of Bangladesh, with low access to health care and among the highest rates of child malnutrition in the country (NIPORT et al., 2009).

Aiming to expand coverage of care for basic childhood illness through existing primary health care delivery systems, SCUS' child survival program employed a cadre of community health workers (CHWs) to deliver care to children in remote communities with limited access to health services. CHWs screened children at community level, using simplified treatment algorithms to deliver community case management (CCM) of basic childhood illnesses including diarrhea and pneumonia. In addition to supplying curative care, CHWs counseled on health, nutrition and sanitation during Courtyard sessions, monthly Growth Monitoring and Promotion (GMP) sessions and household visits. This program offered a unique opportunity to study the impact of adding the treatment of SAM to routine preventive care in a setting with chronically high rates of undernutrition, using existing health care delivery infrastructure.

1.2.1 The CCM of SAM

This field trial tested an innovative delivery model for the treatment of SAM, introducing the CCM of SAM to the CHW workload using an adapted CMAM classification algorithm and treatment protocols developed by Valid International (Collins, 2004). The CCM of SAM is an approach similar to CMAM employing CHWs for active case-finding and treatment. It differs

from CMAM in that services—including regular provision of Ready to Use Therapeutic Foods (RUTF), counseling, and monitoring with mid upper arm circumference (MUAC) measurements—were delivered by CHWs in the community rather than from a primary health care center as is common practice in CMAM programs currently. Throughout this dissertation, the term "CMAM" will be used to refer to general protocols established for CMAM programs (Valid International, 2006); "CCM of SAM" will be used to refer specifically to the management of SAM as it was implemented by CHWs at community level within the CCM package of interventions (Save the Children USA, 2009).

The CCM of SAM was piloted in Borhanuddin upazila (the "intervention upazila") in one of the program's target districts (Bhola District). In neighboring Lalmohan upazila (the "comparison upazila"), the Upazila Health Complex (UHC) was supported to provide inpatient care for children with SAM according to National Guidelines. Treatment outcomes (in terms of recovery, default, and mortality rates) were compared between the community- and facility-based treatment of SAM for an overarching effectiveness study (Sadler et al., 2011).

1.3 Research objectives

To date, research on CMAM programs has focused on effectiveness, in terms of recovery rate, when services are delivered from a health facility. There is limited evidence regarding the potential for other service delivery mechanisms for CMAM, including quality of care provided by CHWs. This research examined the quality of CHWs' service delivery process when managing cases of SAM, and assessed which aspects of this service delivery were most valued by caretakers. Results from this research contribute evidence of CHWs' ability to effectively manage cases of SAM in Bangladesh and beyond. This has implications for the further decentralization of SAM treatment from current CMAM delivery models.

Quality of care depends, in part, on the number of tasks a CHW is asked to perform, and there is a risk that increasing tasks might overwhelm workers with limited training. However, there is limited evidence regarding the association between CHW workload and quality of care. One important concern is that CHWs' preventive care will receive less attention when curative tasks are added to their workload (Gilson et al., 1989, Haines et al., 2007, Mason et al., 2006). This research examined the effect of work time on quality of preventive and curative care by comparing the work performance of two groups of SCUS CHWs with different workloads: one group implementing CCM of pneumonia and diarrhea, and another group additionally treating SAM. Findings provide insight into whether adding SAM to a CHW workload would yield lower quality of preventive and curative care than that achieved by CHWs with a lesser workload.

The cost of CMAM programs, particularly of the RUTF used to rehabilitate cases of SAM, is a source of concern and debate in the international nutrition community. To date there is limited evidence regarding the cost-effectiveness of CMAM and how this varies with program structure and setting. There is even less understanding of the relative cost to caretakers of different mechanisms for treating SAM. This analysis employed an activity-based cost model using an "ingredients" approach to quantify and cost all program inputs (Tan-Torres Edejer et al., 2003). The societal perspective was taken, with data collected on household costs incurred for participation in community- and facility-based treatment of SAM. This research provided a disaggregated cost analysis of the integration of SAM treatment into an existing community-based health and nutrition program. Further, it provided policy-makers in Bangladesh with evidence as to whether CMAM was cost-effective in this country context.

1.3.1 Hypotheses

This study evaluated three hypotheses related to the quality of care achieved by CHWs in the provision of SAM treatment, and the cost-effectiveness of this service delivery model:

- Hypothesis 1: CHWs can effectively identify and treat children suffering from SAM without complications, achieving at least 90% error-free case management.
- Hypothesis 2: CHW quality of care decreases as number of work responsibilities increase.
- Hypothesis 3: Community-based management is more cost-effective in treating SAM than facility-based management.

1.4 Structure of the dissertation

The structure of this dissertation is as follows. The next chapter (2) presents a review of the literature surrounding the history and effectiveness of CMAM programs, followed by the history of CHW programs, and opportunities and challenges to their effectiveness. It concludes with a review of cost-effectiveness methods commonly used in public health and a discussion around the cost-effectiveness evidence for CMAM programs. The following chapter (3) outlines the research methods used in this dissertation. Three subsequent chapters (4-6) address each of the research questions in turn. A final chapter (7) discusses implications of and recommendations based on the research conducted for this dissertation, along with suggestions for future research projects.

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2 Chapter 2: Review of the Literature

2.1 Introduction and scope of the review

As CMAM programs expand across the developing world, service delivery models are rapidly evolving. There is relatively little evidence around the integration of CMAM programs into existing community-based infrastructure, or the cost-effectiveness of these new delivery models. This literature review was conducted to examine the existing evidence around use of community health workers (CHWs) for community-level service delivery, and to examine opportunities for use of CHWs in CMAM programs. Further, various methodological considerations in conducting cost-effectiveness analyses were explored in order to determine key considerations for analyzing the CCM of SAM program.

The literature review is organized as follows. Section 2.2 presents a review of the history of the management of SAM, from facility-based management to the community-based management of acute malnutrition (CMAM). Section 2.3 presents a review of the history of CHW programs, along with potentials and limitations for use of CHWs, with particular focus on the quality of care these workers have been shown to provide for various illnesses. Section 2.4 presents a review of the use of cost-effectiveness data for decision-making in public health and nutrition programs, including an overview of methods used in conducting cost-effectiveness analyses, and evidence around cost-effectiveness of CMAM programs.

2.2 Community-based management of acute malnutrition

Childhood undernutrition contributes to over half the deaths in children under five (Black et al., 2003, Caulfield et al., 2004, Rice et al., 2000). Severe acute malnutrition (SAM), or “severe

wasting" is defined as weight-for-height below -3 SD, less than 70% of the median NCHS/WHO reference values and/or bilateral edema (Ashworth et al., 2003, WHO, 1999). It reflects recent illness or nutrient deficits and is associated with one to two million preventable child deaths each year (Collins et al., 2006a).

Risk of mortality is high for children suffering from SAM, commonly between 20-30% (Collins et al., 2006b); this risk increases with severity of the condition (Collins et al., 2006a). While treatment of SAM was historically focused on emergency contexts, high SAM prevalence levels are common in populations experiencing chronic poverty and food insecurity in countries such as Bangladesh (Gross and Webb, 2006). The need for an effective treatment for SAM in these areas is now acknowledged (Gatchell et al., 2006).

2.2.1 History of treatment of SAM

Beginning in the 1950s, SAM was treated with therapeutic milk products (i.e. F75 and F100) by doctors and other trained health staff in inpatient facilities (Ashworth, 2006, Collins et al., 2006a). This approach has several limitations. These centers take time to establish—a disadvantage in emergency situations—and carry high operating costs, especially for medical staff salaries (Guerrero et al., 2010, Tectonidis, 2006). In practice, the capacity at inpatient centers in poor areas of the developing world is limited by lack of sufficient trained staff and adequate beds to effectively treat the large numbers of children needing care. Further, overcrowded centers promote cross-infection of disease amongst immunosuppressed children suffering from SAM (Collins et al., 2006a). These hospitals are centralized, far from the areas where most families with malnourished children live. This means that households delay the presentation of malnourished children until the disease has progressed to a serious state which is more difficult to cure (Collins et al., 2006a). Facility-based programs require that caretakers stay

with their child for several weeks during rehabilitation. Studies have shown this commitment to put a strain on households due to the high opportunity costs of leaving work and arranging care for other children at home (Tectonidis, 2006, Guerrero et al., 2010). All of this leads to high case fatality and relapse rates, low rates of weight gain and low coverage in center-based programs (Collins et al., 2006a, Collins et al., 2006b).

As a response to the limitations of inpatient treatment, a community-based treatment model for SAM has evolved over the past decade. The community-based management of acute malnutrition (CMAM) decentralizes treatment for the vast majority of children with SAM for whom medical treatment is unnecessary, thereby reducing barriers to access and increasing coverage (Guerrero et al., 2010). CMAM is based on the premises that: (1) if programs promote early presentation of children with SAM, only dietary treatment is needed; (2) to promote early presentation, communities must understand and accept the program; and (3) high levels of community participation are necessary for program sustainability, and are directly related to program effectiveness (Collins et al., 2006b). CMAM programs strive to reduce barriers to access in order to provide treatment before complications arise which require medical attention (Collins et al., 2006a).

In CMAM programs, children with SAM are categorized into two groups: those with medical complications such as severe illness or lack of appetite, and those without complications (Collins et al., 2006a). Cases of SAM with medical complications are managed at inpatient units for a short stabilization period of approximately five days, according to adapted World Health Organization (WHO) treatment protocols (WHO, 1999, Valid International, 2006). Cases without complications are managed according to outpatient treatment protocols using take-home rations of ready-to-use therapeutic foods (RUTF), a course of antibiotics, vitamin A, folic acid,

anthelminthics and antimalarials when necessary (Collins et al., 2006a). Outpatient therapeutic protocols are delivered weekly or bimonthly from peripheral health facilities or in communities (Valid International, 2006).

The development of RUTF has been a key factor in moving treatment of SAM out of the hospital and into the community. RUTF is an energy-dense food containing oil, peanuts, powdered milk, sugar and a multi-vitamin powder, but no water; it therefore carries minimal risk of bacterial contamination and can be safely consumed at home (Collins et al., 2006a, Tectonidis, 2006, Diop et al., 2003). RUTF has been found to promote higher recovery rates and more rapid weight and height gains than other commonly-used supplemental food therapies such as maize/soy flour (Manary et al., 2004).

The CMAM approach limits inpatient care only to those cases that need it, and reduces the need for trained medical staff (Collins et al., 2006a, Manary and Sandige, 2008). In these decentralized settings where height boards might not be readily available for anthropometric measurements, a mid-upper arm circumference (MUAC) measurement is used to identify cases of SAM (Manary and Sandige, 2008). MUAC measurements are indicative of lean body mass, which is linked with mortality risk, and are simple and acceptable for use in community settings (Myatt et al., 2006, Briend et al., 1989).

2.2.2 Effectiveness of CMAM

There is a large body of literature that now demonstrates that CMAM's decentralized approach minimizes costs to households and promotes access to effective treatment; this has been a main factor in the effectiveness of these programs (Guerrero et al., 2010, Collins et al., 2006a). The core principles of CMAM, including community consultation and mobilization, have been found

to promote understanding of and participation in these programs (Collins et al., 2006a, Collins et al., 2006b). Among poor agrarian communities in Malawi, caretakers of children with SAM were found to be satisfied with outpatient treatment, and more willing to accept it than inpatient treatment (Ciliberto et al., 2005). This focus on community mobilization is thought by some to address the roots of health inequality, rather than only attempting to improve health services (Rosato et al., 2008).

CMAM programs have consistently achieved successful outcomes in line with Sphere Standards for humanitarian interventions, with higher coverage and recovery rates, and lower mortality, default and relapse rates compared to inpatient treatment; this has been demonstrated in several settings (Collins et al., 2006a, Guerrero et al., 2010, Tectonidis, 2006, Ashworth, 2006, Sadler et al., 2007). One randomized, controlled trial in Malawi demonstrated that SAM with edema, which carries a higher risk of death than wasting alone (Collins et al., 2006b), could be treated with outpatient therapeutic protocols with high recovery (83%) and low mortality (5%) rates (Ciliberto et al., 2006). Another study in Malawi compared recovery rates among children with moderate and severe wasting and edema, finding outpatient treatment with RUTF to be associated with better outcomes than inpatient treatment (Ciliberto et al., 2005). In Niger, community-based treatment of SAM achieved lower mortality rates compared to inpatient treatment (1.7% versus 18.9% respectively) (Gaboulaud et al., 2007).

The evidence base around CMAM to date has been on effectiveness when delivered from health facilities by trained staff. This has left gaps with regard to delivery through other mechanisms and assessing specific aspects of program delivery including quality of care and cost-effectiveness.

Studies specifically testing the effectiveness of community management of SAM by CHWs are limited. Two studies in Malawi demonstrated that community-based workers with no medical training achieved good recovery rates when managing cases of SAM (Linneman et al., 2007, Amthor et al., 2009). One of these studies compared outcomes for cases of acute malnutrition treated by medical professionals to cases handled by community health aids with no medical training. No differences in recovery rate were found between the two groups, with an average 89% recovery rate: an acceptable outcome by international standards (Linneman et al., 2007). The other study demonstrated good recovery rates (93.7%) in children with SAM during a famine in Malawi using a CMAM approach delivered by trained community health aids alone (Amthor et al., 2009). Further research will be necessary to examine whether these recovery rates can be maintained with different program structures and in different cultural settings. Moreover, these analyses reported outcome effectiveness in terms of recovery rates. This suggests scope for more detailed analyses of quality of care provided by non-professional health workers, including evaluations of the service delivery process and of caretaker satisfaction with services. There is also scope to contribute a more nuanced assessment of CHWs' barriers to delivering quality of care by exploring their own perceptions of their workload through qualitative methods (Rowe et al., 2005, Mumtaz et al., 2003).

2.2.3 Integration of CMAM

Due to its promising performance in promoting recovery from SAM, CMAM has been widely adopted as the most appropriate model of care for children with SAM in emergencies. The United Nations has promoted its integration with other community-based health and nutrition activities in areas with a high burden of SAM (WHO et al., 2007, Collins et al., 2006a).

Preventing malnutrition is considered by many to be a public health priority (Briend et al., 2006, Schroeder and Martorell, 1997); in the context of chronic malnutrition and poverty, some children participating in existing preventive programs will become severely malnourished and will need more intensive treatment (Briend et al., 2006). Linking the identification and treatment of SAM into existing community-based child health interventions, such as integrated management of childhood illness (IMCI) and growth monitoring and promotion (GMP) programs, would enable early presentation, increase coverage and promote integration (Gatchell et al., 2006, Collins et al., 2006a). Many of these community-based services are delivered by community health workers.

2.3 Community Health Workers

2.3.1 History of CHW programs

Community Health Workers (CHWs) are commonly defined as non-professional workers, having a basic level of primary education and limited training, who serve their own communities with basic preventive and curative health and nutrition services (WHO, 1987, Walt et al., 1989, Berman et al., 1987). The WHO suggests that CHWs should be involved in a wide range of activities—from health care to community development—based on the needs of their communities in order to ensure community acceptance and ownership (WHO, 1987).

In the decades following the second World War, health systems proved inadequate to reach rural poor populations, especially in postcolonial countries (Standing and Chowdhury, 2008). Starting in the 1960s, the strong performance of national health programs in countries such as China, Cuba, Sri Lanka and Tanzania, and smaller-scale pilot programs in India and Kenya, influenced policy-making groups such as the WHO and UNICEF to promote community-oriented primary

health care (PHC) (Rosato et al., 2008, CHW Technical Taskforce, 2011). In 1978, the Alma-Ata Declaration advocated “health for all” by promoting global access to community-based health services (WHO and UNICEF, 1978). In the PHC approach, CHWs were envisaged as a way to expand access to healthcare with equity (WHO, 1981, WHO, 1987).

Implementing this vision of “health for all” proved to be challenging. Many national CHW programs were initiated in the post-Alma-Ata optimism (Standing and Chowdhury, 2008); however they failed to achieve the same success as the numerous small-scale programs on which the expectations around PHC were based (Berman et al., 1987, Standing and Chowdhury, 2008, CHW Technical Taskforce, 2011, Bhattacharyya et al., 2001). Popular perceptions of CHWs as an inexpensive way to scale-up health care led to an insufficient allocation of resources for their support (Berman et al., 1987). There emerged a tension between two conflicting images of CHWs as agents of health care extension and agents of change (Berman et al., 1987, Haines et al., 2007). Integration into state-led programs created contradictory pressures for these community-based agents; they became overburdened with work tasks while equipped with inadequate training (Standing and Chowdhury, 2008). In the 1980s, CHW programs fell into a progressive decline due to a vicious cycle of poorer-than-expected performance, along with global factors such as diminishing investments in the context of a global economic recession, increasing political and economic instability and neoliberal economic policies advocating privatization of social services (Standing and Chowdhury, 2008, Lehmann and Sanders, 2007, CHW Technical Taskforce, 2011, Hall and Taylor, 2003).

The 1990s heralded a move away from the participatory approaches of the post-Alma Ata experience towards increasing coverage of health programs treating specific diseases with proven effectiveness, such as oral rehydration solution (ORS) for diarrhea, co-trimoxazole for

pneumonia, vitamin A supplementation, insecticide-treated bed nets and vaccinations (Rosato et al., 2008, Bhattacharyya et al., 2001). The proven effectiveness of these programs fit well within new donor requirements for evidence-based programming, and were perceived to be more easily and affordably scalable than comprehensive, longer-term community-based development efforts (Rosato et al., 2008, Bhutta et al., 2010).

In spite of their past failure to meet high expectations, evidence from the last two decades indicates nevertheless that CHWs can contribute to the reduction of morbidity and mortality (Bhattacharyya et al., 2001). Their ability to reach remote populations with essential services has been identified as particularly relevant in the context of achieving the Millennium Development Goals (Haines et al., 2007, Liu et al., 2011). The introduction of the community component of the integrated management of childhood illness (C-IMCI) heralds new opportunities for CHWs in the prevention of disease, promotion of healthy behaviors, and in some places, case management of sick children (Bhattacharyya et al., 2001, Winch et al., 2005, USAID, 2007, CORE Group, 2009). Community case management (CCM) is another strategy to compliment facility-based management of childhood diseases by delivering life-saving curative care by community agents such as CHWs in areas where access to facility-based services is low (Marsh et al., 2009). Further, with the AIDS epidemic causing an understaffing crisis in human resources for health, and increasing the need for treatment of HIV/AIDS and other infectious diseases, there is renewed interest in asking CHWs to extend health services, and to take on more specialized healthcare tasks (also known as “task shifting”) (Bhutta et al., 2010, Lehmann and Sanders, 2007, Lewin et al., 2010, Schneider et al., 2008, Phillips et al., 2008, WHO, 2007a, WHO, 2007b).

If properly supported and empowered, CHWs are thought by many to have the potential to improve the health and development of their own communities (Werner, 1981). However, given their limited training and education, and the large demand and scope of work to be done across the developing world, the question of what can reasonably be expected from CHWs is in dispute (Lehmann and Sanders, 2007).

2.3.2 Challenges, opportunities, and potential effectiveness of CHWs

Much of the literature on CHWs highlights a central strength as their ability to increase the utilization and acceptability of services through supportive interactions with communities. Where CHWs are well-selected and functioning, they have served as a trusted, familiar point person to explain new messages in a way that people can understand, and to promptly treat or refer any urgent health matters (Rosato et al., 2008, Standing and Chowdhury, 2008, CHW Technical Taskforce, 2011, Gilson et al., 1989, Curtale et al., 1995, Bhattacharyya et al., 2001, Bang et al., 2005a, Bang et al., 1994, Lehmann and Sanders, 2007). They can act in their own communities as role models of positive health practices, self-improvement and empowerment (Bhattacharyya et al., 2001, Werner, 1981, Mumtaz et al., 2003). Further, CHWs' direct access to communities can promote the expanded coverage of proven effective interventions such as vaccinations, oral rehydration therapy and insecticide treated bed nets, along with referrals for more complicated illnesses (CHW Technical Taskforce, 2011, Berman et al., 1987, Curtale et al., 1995, Haines et al., 2007, Liu et al., 2011, George et al., 2009, Walt et al., 1989, Guerrero et al., 2010). These elements of accessibility, friendliness, communication and trustworthiness exhibited by CHWs are often in stark contrast to services provided at hospitals and clinics, towards which communities may feel mistrust (Escott and Walley, 2005, George et al., 2009, Sauerborn et al., 1989b, Fergusson et al., 2010, Paine and Wright, 1989).

2.3.2.1 Defining and measuring CHW effectiveness

Quality of care is commonly defined in terms of impact on easily quantifiable health outcomes such as morbidity and mortality, with the assumption being that a high quality program will produce positive outcomes (Roemer and Montoya-Aguilar, 1988, Brown et al., 1998, Lehmann and Sanders, 2007). However, outcome effectiveness alone is not illustrative of the service delivery process, and does not assist managers in identifying the problems or obstacles in successfully implementing a program (Nicholas et al., 1991). More nuanced analyses of CHW performance, assessing correctness of technical procedure on individual tasks (Roemer and Montoya-Aguilar, 1988), are useful for management purposes but less commonly found in the quality of care literature. One reason for this gap in the literature is the difficulty in developing widely acceptable standards for measuring performance on the various types of CHW tasks (Berman et al., 1987). As Berman *et al* (1987) note, "it is more complicated to measure whether a CHW has explained the importance of oral rehydration to a mother in a fashion which conveys both information and motivation than to count the number of fever cases given chloroquine." Further, the process of observing service delivery interactions may influence CHW behavior (Rowe et al., 2002, Rowe et al., 2006), and be expensive or otherwise challenging to measure at scale. Patient satisfaction, a pre-requisite for outcome effectiveness (Gilson et al., 1994), is even less commonly reported.

CHW technical skill underpins caretakers' acceptance of and compliance with a program (George et al., 2009, Bruce, 1990). Quality of care assessments ignoring community or caretaker satisfaction therefore miss what is considered by some to be a key element factoring into program utilization and effectiveness (Bhattacharyya et al., 2001, Prasad and Muraleedharan, 2007). Community perceptions of quality often differ substantially from a health provider's

perceptions, focusing more on the respect and politeness with which they are treated, and the frequency of contact (Lundberg, 2008, George et al., 2009, Gilson et al., 1994, Bruce, 1990); the importance of these perceptions increases as more services are delivered at community, or even household level (van Campen et al., 1995). Conceptual frameworks have been developed to understand and assess community perceptions of quality in the family planning literature (Bruce, 1990); these frameworks are less commonly applied to nutrition programs. Use of such frameworks to evaluate CMAM programs would improve understanding of factors contributing to community participation and caretaker compliance, which are important determinants of the effectiveness of these programs.

2.3.2.2 CHW effectiveness and quality of care

CHWs are commonly used in health services focused on preventive care (Prasad and Muraleedharan, 2007, Winch et al., 2005), and their ubiquity at the community level has also made them a viable candidate for performing simple, life-saving curative tasks. In recent years the focus of CHW programs has moved towards formal training on specific clinical tasks, using simplified and standardized treatment algorithms, with CHWs acting as a first point of community contact with the health system via provision of basic care at structured household visits, community centers or their own homes (CHW Technical Taskforce, 2011, UNICEF, 2004).

A review by Haines *et al* (2007) cited renewed interest in the possible use of CHWs to achieve reductions in child mortality; this is further evidenced by the publication of several comprehensive reviews in the past year. Two recent Cochrane reviews examined evidence regarding the effectiveness of CHW involvement in a variety of preventive and curative community-based activities (Lewin et al., 2010, Lassi et al., 2010). The WHO published a global

systematic review and country case studies of interventions with proven health effects delivered by CHWs, along with a focus on operational concerns including training and supervision (Bhutta et al., 2010). Lastly, the Earth Institute at Columbia University convened a CHW Technical Taskforce which produced recommendations for best practices and future directions based on experience in CHW programs through their Millennium Villages Project (CHW Technical Taskforce, 2011, Liu et al., 2011). These documents review a wide variety of evidence regarding CHW effectiveness in various settings.

There is a large body of literature documenting CHWs' success in managing a broad range of common diseases at community level, including pneumonia (Mehnaz et al., 1997, Bang et al., 1994, Fagbule and Kalu, 1995, Fagbule et al., 1994, Zeitz et al., 1993, Pandey et al., 1991, Hadi, 2003), tuberculosis (Chowdhury et al., 1997, Escott and Walley, 2005, Kironde and Klaasen, 2002), neonatal infection (Baqui et al., 2008, Baqui et al., 2009), and the overlapping clinical manifestations of pneumonia and malaria (Yeboah-Antwi et al., 2010, Kallandar et al., 2006). Recently studies have generated evidence of their ability to successfully diagnose and treat SAM (Amthor et al., 2009, Linneman et al., 2007). Further, many communities demand curative care for the illnesses from which they commonly suffer, and their estimation and utilization of a CHW increases when she provides it (Bhattacharyya et al., 2001, UNICEF, 2004, Gilson et al., 1989, Curtale et al., 1995).

However, these integrated curative strategies are complicated (CHW Technical Taskforce, 2011), and require several years of formal education to implement (Bhutta et al., 2010), which may not be available to CHWs in all settings. This indicates the need for a cautious approach in scaling up these types of programs using CHW cadres.

Field trials testing delivery of curative care by CHWs to date have found that they can effectively diagnose and treat neonatal sepsis according to a clinical algorithm, and treat severe disease in neonates with a lower case fatality rate than other treatment options available (Bang et al., 2005b, Baqui et al., 2009). Village health workers in India correctly diagnosed 89% of neonatal sepsis cases (Bang et al., 2005b). In Nepal, community members trained in the antimicrobial treatment of pneumonia achieved significant reductions in child mortality due not only to pneumonia but also to diarrhea and measles (Pandey et al., 1991).

Some evidence indicates that the integration of preventive care with curative practices such as community case management (CCM) can increase community support for CHWs, lending credibility to their preventive work while expanding access to live-saving treatment (Bhutta et al., 2010, George et al., 2009). In Nicaragua, "health personnel and project staff…felt that CCM fostered greater community mobilization, leadership, and empowerment, resulting in, for example, more community participation in preventive measures such as child-weighing sessions" (George et al., 2009).

Notwithstanding these successes, other studies show more mixed results. Research in Kenya found that CHWs were able to achieve 80% adherence with clinical guidelines when performing multiple preventive and curative tasks, although only around one half of CHWs prescribed all appropriate treatments to ill children (Rowe et al., 2007a). Similarly, diagnosis of acute respiratory infections (ARI) by CHWs agreed highly with gold-standard research physicians in Bangladesh (89%) and western Uganda (79%), although they experienced challenges in distinguishing between severe and very severe cases, and in using the cut-off rates referred to in their treatment algorithm (Hadi, 2003, Kallandar et al., 2006). A study in Bolivia showed that

after refresher training, CHWs could achieve an average score of 83% in classifying ARI, although they had difficulty in classifying and treating more severe cases (Zeitz et al., 1993).

High community demand for curative care can frustrate CHWs' preventive work, making them feel less supported by their community (Bhattacharyya et al., 2001). Some studies have linked an irregular supply of drugs to low CHW work activity (Stekelenburg et al., 2003, Bhattacharyya et al., 2001). In other studies, CHWs were found to focus their efforts on households using health facilities, rather than seeking out the perhaps more vulnerable households that do not visit these facilities (Gilson et al., 1989). In some large-scale programs, curative tasks have co-opted preventive nutrition tasks (Rohde, 1993). Where training and supervision are weak, particularly in national programs, there is a tendency for CHWs to emphasize simple curative tasks and to neglect preventive activities (Berman et al., 1987). These experiences raise concerns that, when working closely with clinic-based professional health workers, CHWs may undervalue their own worth in providing preventive care and counseling (Haines et al., 2007). One area of concern is that preventive care provided by CHWs will get less attention if curative care is added to their workload (Gilson et al., 1989, Haines et al., 2007). There is a scarcity of research confirming or denying this supposition.

Several potential factors constrain the quality of care CHWs are able to provide. One study in Kenya found that due to the complexity of the treatment guidelines, CHWs feared the social and professional repercussions of misclassification of children; accordingly, they hesitated to classify illnesses as severe or to suggest referral of children classified as severely ill (Kelly et al., 2001). In Pakistan, 26% of CHWs in a national program suffered from mental distress, the main causes of which were socioeconomic status and the time needed for work-related travel (Haq et al., 2008). Another qualitative study in Pakistan revealed a number of cultural constraints faced by

CHWs that affected their job satisfaction and quality of care (Mumtaz et al., 2003). These included disrespect from male colleagues, cultural taboos around their use of public transportation for field visits, and conflict between domestic and work responsibilities as they developed career aspirations. This nuanced picture of the determinants of quality of care suggests, as other studies do (Rowe et al., 2005), that there is much to learn about factors promoting and inhibiting CHW performance, and that qualitative methods are an appropriate tool for exploring these factors.

2.3.2.3 CHW workload

Quality may depend, in part, on the number of tasks a CHW is asked to perform. As Bhattacharyya (2001), Phillips (2008) and the CHW Technical Taskforce at Columbia University's Earth Institute (2011) argue, there is a risk that increasing tasks overwhelms workers with limited training. Institutions have long recognized CHWs' need for a focused workload in order to provide quality care and avoid being overwhelmed by multiple demands at community level (WHO, 1987). Recommendations include placing limits on the number of tasks they are given, and the size of their catchment areas (Bhattacharyya et al., 2001, Phillips et al., 2008). Many programs have designated CHWs to one specific task, suggesting that a limited workload is better suited to CHWs' abilities than broad-based activities like health education (UNICEF, 2004). However, this approach limits opportunities for integration of services delivered at community level, and has implications for supervision, funding, training and coordination of workers (Bhattacharyya et al., 2001, CHW Technical Taskforce, 2011, Prasad and Muraleedharan, 2007).

Few studies have examined the association between workload and quality of care provided by CHWs. Time use studies with IMCI-trained professional health workers in Brazil and Tanzania

found that receiving IMCI training was associated with increased time spent per consultation with children under five, compared to non-IMCI trained health workers (Adam et al., 2005a, Adam et al., 2005b). However, this difference attenuated as workload increased, bringing into question whether the celebrated gains in quality of care that are attributed to IMCI training can be sustained under high workloads (Adam et al., 2005a). It is difficult to extrapolate the behavior of facility-based workers to community-based workers, who have lower levels of training, education, and wages. CHWs often work on a part-time basis, and their workload and travel time required to reach the remote communities they serve can detract from the quality of care they provide (Baqui et al., 2008, Mumtaz et al., 2003). Even where CHWs' workload is light, the opportunity costs of their time may be too high to justify working for little or no pay (Haines et al., 2007, Haq et al., 2008). In general, there is little consensus around the optimal workload and mixture of tasks that CHWs are able to manage in various settings.

In terms of the optimal CHW workload, it is difficult to generalize across programs given the diversity of workloads and work hours in various settings (Bhattacharyya et al., 2001). Experience suggests that an optimal supervisory ratio ranges from 1:10-20 (Mason et al., 2006), with ratios of up to 1:25 seen in successful programs in Pakistan and Bangladesh (Bhutta et al., 2010). Based on evidence from several large-scale CHW programs in India, Jamaica, Bangladesh, Thailand and the Philippines, the optimal ratio of households (or mother/child pairs) per CHW catchment area is from 1:10-20 for part-time volunteers, and up to 1:200-500 for full-time workers (Mason et al., 2006, Prasad and Muraleedharan, 2007, Berman et al., 1987). This corresponds to a population size of between 100 and 700 per CHW (Berman et al., 1987, CHW Technical Taskforce, 2011), requiring between 5 and 10 household visits per day for full-time workers, and ensuring that each household is visited roughly every two months (Mason et al.,

2006, Bhutta et al., 2010). In programs with higher CHW to population ratios (between 1:2000-5000 for example) (Gilson et al., 1989, Prasad and Muraleedharan, 2007), it has proven difficult to achieve a contact frequency sufficient to impact health outcomes in more vulnerable, remote areas (Gilson et al., 1989, Mason et al., 2006).

2.3.2.4 Motivation

CHW performance can be helped or hindered by their levels of motivation. Franco *et al* define work-related motivation as "an individual's degree of willingness to exert and maintain an effort towards organizational goals" (2002). Learning new skills often motivates CHWs in the early stages of a program or pilot project (Bang et al., 2005b, Bhattacharyya et al., 2001, George et al., 2009); however motivation has proven more difficult to sustain over time in large national programs (Berman et al., 1987, Gilson et al., 1989).

Health worker performance is a multidimensional concept, and there are a dearth of measurement tools to assess the contextual aspects of a CHWs' working environment that impact the quality of care they provide (Menon et al., 2008, Rowe et al., 2005). While motivation has no single reliable metric, there is a general consensus in the literature as to the main components capturing various aspects of CHW motivation, including training, supervision, remuneration, incentives (both financial and non-financial), opportunities for career advancement, having appropriate job aids, family support and community appreciation (UNICEF, 2004, Bhattacharyya et al., 2001, Rowe et al., 2005, Walt et al., 1989, Bhutta et al., 2010). These aspects will be discussed in more detail below.

CHW effectiveness is determined, to some extent, by the tasks they undertake and their own individual skills and dedication (WHO, 1987, Gilson et al., 1989, Berman et al., 1987). For

example, Kelly *et al* (2001) found that CHWs in an area of Kenya with high malaria prevalence effectively treated 90% of cases of malaria, despite deficiencies in care for several other illnesses, suggesting that addressing high-priority illnesses motivated their effective performance. There are also many ways in which programs can promote CHWs' effectiveness (Bhutta et al., 2010, Bhattacharyya et al., 2001, Berman et al., 1987, CHW Technical Taskforce, 2011). The provision of appropriate supplies of drugs and equipment, such as hanging scales and breath counters, can make CHWs more effective (Bang et al., 1994, Bhutta et al., 2010, Stekelenburg et al., 2003). Reasonable expectations in terms of workload given the status and payment of the workers (Phillips et al., 2008, Haines et al., 2007, Haq et al., 2008), including work tasks reflecting the actual needs of the community (Sauerborn et al., 1989a, Walt et al., 1989, Abbatt, 2005), have helped to avoid overburdening CHWs. Supportive supervision and training of appropriate duration and content for the tasks involved have been shown in many cases to be an effective way for programs to support CHWs and improve their work performance (Rowe et al., 2005, Zaman et al., 2008, Hadi, 2003, Berman et al., 1987, Fagbule and Kalu, 1995, Sauerborn et al., 1989a, Haines et al., 2007, Haq et al., 2008, Schneider et al., 2008, Liu et al., 2011, George et al., 2009, Bhutta et al., 2010, Bhattacharyya et al., 2001). Continuing in-service education and refresher training have further contributed to maintaining their skills over time (Ashwell and Freeman, 1995).

Several analyses of CHW performance in a project run by CARE in Siaya district, Kenya, have highlighted the need for a nuanced understanding of CHW behavior in order to better assess the factors affecting their quality of care (Kelly et al., 2001, Rowe et al., 2006, Rowe et al., 2007a, Rowe et al., 2007b). Results of these analyses have challenged the assumption that more training necessarily leads to better performance (Rowe et al., 2005, Rowe et al., 2007b), and suggest the

need for programs to consider the effectiveness of different training modalities—for example, the mix of practical and didactic sessions—and to determine the optimal frequency, content and structure of supervisory visits (Bhutta et al., 2010, Kelly et al., 2001, Gilson et al., 1989). Identified priorities for future research in this area include determining the mix of tasks CHWs can be expected to perform in different settings, with different levels of population coverage and incentives (Rowe et al., 2005, Bhattacharyya et al., 2001).

A key debate in the discussion around sustaining CHW motivation is whether or not to pay them (Phillips et al., 2008, Haines et al., 2007, Schneider et al., 2008, UNICEF, 2004); a review conducted by Bhattacharyya *et al* (2001) for USAID's Basic Support for Institutionalizing Child Survival project provides a focused examination on the topic. While CHW salaries are often seen as unsustainable by ministries and donors (Bhattacharyya et al., 2001), there is also no evidence of the long-term sustainability of volunteerism in CHW programs (Haines et al., 2007, Bhutta et al., 2010). Demand for their skills in underserved communities often requires full-time working hours from CHWs (Bhattacharyya et al., 2001). They come from poor communities, are often poor themselves, and have opportunity costs for their time (Bhutta et al., 2010, Bhattacharyya et al., 2001). Recognizing the problems with attrition in large-scale volunteer programs, and considering the increasing need for expansion of basic health services, recent recommendations have supported payment of CHWs that is commensurate with their workload (Bhutta et al., 2010, Phillips et al., 2008). For unpaid volunteers, for whom financial remuneration is not a primary incentive, common motivators have been identified as enthusiasm, altruism and the desire for personal gain through social recognition (Walt et al., 1989, Bang et al., 2005b, Bhattacharyya et al., 2001).

Paying CHWs results in lower attrition rates (Bhutta et al., 2010, Bhattacharyya et al., 2001), an important consideration for programs given that high drop-out rates have effects on program stability, and carry high costs in terms of continuous re-training of new batches of workers (Haines et al., 2007, UNICEF, 2004). Paid CHWs can be held more accountable for their work performance. For the workers themselves, regular compensation is a sign of respect and recognition allowing them to earn a living (Bhattacharyya et al., 2001).

From a programmatic perspective, the main challenge to paying CHWs is the difficulty in securing a sustained source of funding (UNICEF, 2004, Bhattacharyya et al., 2001). Dedicating resources for a cadre of community-based workers in the longer-term (specifically, beyond a typical five-year program cycle) requires political commitment that is, in itself, difficult to sustain. Payment can also cause problems if CHWs employed by different organizations receive different levels of remuneration, or if some are paid and some are not (Escott and Walley, 2005, Bhattacharyya et al., 2001). Some evidence suggests that paying CHWs can drive a wedge between them and the communities they support, making them more accountable to the organization paying them (Glenton et al., 2010, Bhattacharyya et al., 2001, Franco et al., 2002). If CHWs do not perceive their salaries to be adequate, this may also negatively impact their performance (Escott and Walley, 2005, Bhattacharyya et al., 2001). A mixture of both financial and non-financial incentives (e.g. visual identifications like bags and t-shirts, or fee-for-service payments and drug sales), appropriate to the local context, is often suggested as optimal (Haines et al., 2007).

2.3.2.5 Sustainability and potential for scaling up CHW programs

Inherent in the discussion of CHW motivation is the question of how to sustain programs employing CHWs in the longer term. A common recommendation for sustainably scaling up

CHW programs is to integrate them into the formal health system (CHW Technical Taskforce, 2011, Liu et al., 2011), through which CHWs could deliver integrated health care at community level (Winch et al., 2005). The formalization of CHWs' position within the health system would support referral mechanisms and supervision by facility-based health staff, and enable their professionalization (CHW Technical Taskforce, 2011, Bhutta et al., 2010, Liu et al., 2011, Baqui et al., 2008, Haines et al., 2007). This integrated approach has demonstrated success in countries like Nicaragua that have a promotive policy environment, and strong ownership and coordination of community-based programs by the health system (Gilson et al., 1989, George et al., 2009).

However, in many developing countries the formal health system is of poor quality. This places constraints both on the feasibility of providing integrated care within these systems, and on a community's confidence in and utilization of the care provided (Ashworth, 2006, Gatchell et al., 2006). CHWs cannot be expected to fill in these gaps on their own (Phillips et al., 2008, Berman et al., 1987, Abbatt, 2005). In the poorest countries the capacity and commitment for scale-up remains weak (Hanson et al., 2003). Notwithstanding this lack of commitment, evidence strongly suggests that community-based programs implemented by CHWs must be adequately supported in order to achieve success (UNICEF, 2004, Phillips et al., 2008, Bhutta et al., 2010, Haines et al., 2007, Gatchell et al., 2006), and require more resources than have been allocated to them in the past to achieve this success (Berman et al., 1987). This gap points to the need for increased policy support for CHWs, reinforcing their important role in extending health services and their need for institutional support to maintain their efforts.

Financial constraints are a common challenge to many health programs, especially during times of economic instability. However, a common framework for action is emerging among the international nutrition community, recognizing the need for both capacity-building and securing

of dedicated resources to realize the potential impact of key health and nutrition interventions (Bezanson and Isenman, 2010). Initiatives are currently underway to assess which health and nutrition programs would perform best at scale, and how to finance these programs (Horton et al., 2010). Given the renewed interest in use of CHWs to expand coverage of many life-saving interventions, these new initiatives and frameworks offer significant potential for expansion of CHW programs. In the meantime, data regarding effectiveness and cost-effectiveness of CHW programs could be used at country level to advocate for appropriate financing and support for CHWs as a mechanism to extend coverage of health services.

2.4 Cost-effectiveness

2.4.1 Using cost-effectiveness data for decision-making

Cost-effectiveness is an important measure of an intervention's performance, providing evidence for informed policy decisions regarding resource allocation and priority setting (Hutubessy et al., 2003, Tan-Torres Edejer et al., 2003, Musgrove and Fox-Rushby, 2006, Johns et al., 2003). Nearly twenty years ago, the Panel on Cost-Effectiveness in Health and Medicine, convened by the US Public Health Service, set forth recommendations for standards in cost-effectiveness analyses, including necessary components to include in the numerator and denominator of cost-effectiveness ratios, and the inclusion of a reference case, using standard methods and assumptions, to promote comparability of cost-effectiveness analyses (Russell et al., 1996). Notwithstanding such norm-setting initiatives, there is currently no standard approach to cost analysis (Hutubessy et al., 2003, Weinstein et al., 1996). Even where studies use common assumptions and parameters, they often differ in scope of target population, geographic location, and methods of cost estimation, each carrying implications for comparability and generalizability of results (Musgrove and Fox-Rushby, 2006, Weinstein et al., 1996).

2.4.2 Cost-effectiveness methods

The objective of cost-effectiveness analysis (CEA) is to assess the costs and outcomes of an intervention. The results of analyses are typically expressed as a cost-effectiveness ratio (CER), with total program resources divided by the "effectiveness"—or reduction in disease burden caused by an intervention—in terms of number of individuals served or health outcomes achieved (Musgrove and Fox-Rushby, 2006).

The Disease Control Priorities Project (DCPP)—an initiative by the World Bank to evaluate the cost-effectiveness of various health-related interventions in developing countries—defines an intervention as "an activity using human, physical, and financial resources in a deliberate attempt to improve health by reducing the risk, duration, or severity of a health problem" (Musgrove and Fox-Rushby, 2006). Interventions can also be clustered into groups, as is often the case with packages of interventions delivered at community level. The WHO-CHOICE project (*CHO*osing *I*nterventions that are *C*ost *E*ffective) proposes generalized CEA (GCEA) methods to assess combinations of interventions within and across countries and regions, with a dual goal of (1) understanding whether the mix of current or proposed interventions represents an efficient use of resources and (2) maximizing generalizability of results across settings (Tan-Torres Edejer et al., 2003). These methods are currently under expansion for defining efficient mixes of interventions at the global and regional level (Tan-Torres Edejer et al., 2003, Hutubessy et al., 2003).

This review will focus on cost-effectiveness methods commonly used to analyze individual interventions rather than intervention packages. The scope of methods considered reflects the costing methodologies used for maternal and child health and nutrition programs, and can be applied in either community or facility settings (Waters, 2000). This review discusses the various methods for estimating costs, considerations in choosing and calculating an effectiveness

measure, and methods for handling uncertainty in estimates with sensitivity analyses. Considerations for conducting cost-effectiveness studies will be explored and different determinations and cut-offs for defining cost-effectiveness will be discussed. The final section of this review discusses the cost-effectiveness of community-based programs delivered by CHWs, and reviews existing CEAs of CMAM programs.

2.4.2.1 Estimating costs

There are several methodological considerations involved in estimating costs. First is the choice of which costs to include. In any CEA it is important to include all pertinent costs, such as capital costs and the indirect costs of management, supervision and administration (Waters, 2000, Tan-Torres Edejer et al., 2003). Determining which costs are pertinent is a matter of debate, as will be discussed below. Depending on the stakeholders for whom the analysis is conducted, it may be useful to separate start-up and capital costs from recurrent costs, as these may be funded separately by donors and ministries of health (Waters, 2000).

Johns, Baltussen and Hutubessy (2003) from the Global Programme on Evidence for Health Policy at the WHO recommend use of economic costs rather than accounting costs in valuations for a CEA; these represent the full social value of all resources used whether actually paid in cash or not. This consideration is especially pertinent when calculating a "shadow price" for goods that do not have a market value, such as the opportunity costs of volunteer time or the value of space in a venue for which rent is not paid (Tan-Torres Edejer et al., 2003). A common recommendation is to value capital investments such as buildings and transportation using their rental price where applicable, or to annualize their costs taking into account purchase value, resale value, interest rate and working life (Tan-Torres Edejer et al., 2003, Drummond et al., 1987). Costs are discounted to reflect uncertainty about the future and the opportunity costs of

investing resources, commonly at the rate of 3% per year used for social investments (Musgrove and Fox-Rushby, 2006, Murray, 1994). Costs of interventions lasting multiple years are deflated to a common year to make costs comparable over time (Tan-Torres Edejer et al., 2003, Weinstein et al., 1996). Cost estimates can be reported in local currency, a reserve currency (e.g. US Dollars) or a hypothetical currency (e.g. International dollars), depending on whether study objectives require comparability of results or accurate costing of local inputs (Musgrove and Fox-Rushby, 2006).

The choice of which costs to include depends upon whether the analysis is conducted from the perspective of the health care system or society as a whole. A cost analysis taking the health care systems approach includes all institutional costs. Those taking the societal perspective, as is recommended by the WHO-CHOICE project and the US Panel on Cost-Effectiveness, consider all costs of an intervention regardless of who incurs them (Russell et al., 1996, Tan-Torres Edejer et al., 2003). Societal CEAs generally include direct costs such as travel expenses and indirect costs such as the value of time spent by household members in accessing care (Musgrove and Fox-Rushby, 2006, Russell et al., 1999).

The handling of opportunity costs of time in CEA depends upon whose time is being measured. Conventionally, the denominator of a cost-effectiveness ratio captures the health outcome while the numerator reflects resource use. Patient morbidity time is considered part of the health outcome and is therefore accounted for in the denominator. The US Panel on Cost-Effectiveness recommends that time spent by caregivers seeking health care or participating in an intervention should be valued in monetary terms and included in the numerator (Weinstein et al., 1996). Further, there is disagreement around the optimal method for valuing opportunity costs of patients and caretakers' time. The US Panel on Cost-Effectiveness recommends that a common

shadow wage rate be used that is not dependent on race, ethnicity, or other specific characteristics (Weinstein et al., 1996). However, the WHO argues that any method to value opportunity cost of time is an imperfect approximation since the welfare effects of this time are rarely estimated. They do not recommend including these opportunity costs as they are determined to be too difficult to measure with accuracy, and are unlikely to be substantial on average. Nonetheless, where these costs are anticipated to be considerable, such as for interventions requiring long hospital stays, the WHO recommends including and reporting them separately (Tan-Torres Edejer et al., 2003).

Decisions made using societal CEAs do not ignore the opportunity costs of participating in an intervention, and thus they are likely to support interventions that are fair to patients in terms of wait time, travel time or other health system inefficiencies (Russell et al., 1999). This is in contrast with CEAs which assume that interventions are delivered by a functional health system which does not burden patients with excessive time costs, a critical and often inaccurate assumption in developing countries (Musgrove and Fox-Rushby, 2006). Many analyses have shown that "hidden costs", particularly distance and cost of travel, are important determinants in utilization of health services in developing countries (Sauerborn et al., 1989a, Guerrero et al., 2010, Ayieko et al., 2009, Nahar and Costello, 1998, Saksena et al., 2010, Islam et al., 2002, Mirzoev et al., 2008, Floyd et al., 1997). These and other costs (i.e. of hospital stay, drugs and other related supplies) are often more than households can afford, and several studies have documented that caretakers resort to borrowing or selling assets to pay for them (Ayieko et al., 2009, Borghi et al., 2006, Nahar and Costello, 1998, Saksena et al., 2010). The opportunity costs of caretaker time are especially high for treatment requiring a long inpatient stay, such as facility-based treatment of SAM (Collins et al., 2006a, Collins et al., 2006b, Ashworth, 2006,

Tekeste, 2007, Ashworth and Khanum, 1997). Recommended practice leaves the decision to include opportunity costs up to the judgment of the analyst and the purpose of the assessment. In assessments of programs where opportunity costs are likely to represent a significant proportion of total social resource use, they should be included and reported separately as recommended by the WHO-CHOICE project and the US Panel on Cost Effectiveness (Tan-Torres Edejer et al., 2003, Russell et al., 1996). Reporting of outcomes in such a way enables the interpretation of analyses from either a societal or health care systems perspective, as desired (see Kim et al., 2009).

Cost estimates may be compiled using predictive or actual costing methods. Predictive costing, also referred to as "gross costing", is useful for program planning and uses existing estimates of the component costs of programs to build a total predicted cost of an intervention (Waters, 2000, Muennig, 2008). These estimates are often based on historical budget information or estimates from published literature (Muennig, 2008). This method for cost estimation is useful when relevant cost data for planning is limited; its proper execution enables inclusion of all projected costs (including startup and training). However predictive cost estimates are subject to several flaws. They are often incomplete, as it can be difficult to predict all pertinent costs. Further, they represent a snapshot of costs at one point in time, and do not take into account the dynamic context of program implementation (Waters, 2000), including the potential costs of scale-up and replication (Fiedler, 2009).

Where program expenditure data is available, actual program costs can be analyzed (Waters, 2000). This method involves less guesswork, since it provides an inventory of all costs specific to the program under analysis. Data coming from institutional financial systems is typically based on standard accounting centers (e.g. overhead, personnel, transport, etc.). These centers

provide a format for conventional budget analysis across programs. However, the organization and aggregation of cost centers can make it difficult to separate fixed and startup costs from recurrent costs, and to determine which costs should be allocated to a program, especially if some costs are shared among several programs (e.g. capital costs such as buildings and cars, or support staff) (Caldes et al., 2006). This approach produces more accurate and detailed cost estimates than does predictive costing, however only budgeted financial costs are included, and not economic costs, meaning that some program resources are unaccounted for in this costing method (Fiedler, 2009).

Actual program costs, including budget and expenditure data, can be used to conduct micro-costing analyses, using an ingredients approach (Tan-Torres Edejer et al., 2003, Waters, 2000). In this method, each program input is costed and quantified (Johns et al., 2003). Algorithms are then constructed to reflect total program resource usage (Fiedler, 2003, Fiedler, 2009). The WHO-CHOICE project recommends the ingredients approach for estimating costs as it provides a thorough and transparent account of the costs and quantities of program inputs, allowing analysts and policy-makers to judge the appropriateness of cost estimation and to assess whether costs from one analysis can be modified for use in another setting (Tan-Torres Edejer et al., 2003). Recent global costing initiatives, including two from the World Bank—the High Level Taskforce on Innovative Financing for Health Systems and the Scaling Up Nutrition costing exercise—have used the ingredients approach for estimating resource requirements for financing of maternal and child health initiatives (Horton et al., 2010). One disadvantage of this method is that ingredient cost estimates often come from a comprehensive source (such as the WHO-CHOICE database), which assumes efficiency in program implementation. The “program experience” approach takes the median of ingredient costs from actual program implementation

data in various countries, accounting for inefficiencies in implementation, and therefore yielding higher cost estimates than the ingredients approach (REACH 2008, cited in Horton 2010). Another disadvantage of the ingredients approach is that it lacks an inherent organizing structure for the many cost estimates it yields.

Activity-based costing (ABC) helps to organize unit costs generated by the ingredients approach (Fiedler, 2009). Using program activities as a basis for cost assessment allows a more nuanced understanding of program resource use, and how this might vary with program structure and setting (Caldes et al., 2006). This method builds estimates of program costs from the "bottom up" and enables an assessment of costs when accessing accounting records is not possible or practical (Fiedler, 2003). In the ABC approach, costs are allocated based on the key activity for which they are incurred, according to the actual personnel time allocation on these activities gathered via key informant interviews (Waters, 2000). Personnel time allocation guides the assignment of overhead and other indirect costs to the various program activities (Waters et al., 2001). This method originated in the private sector in order to obtain more accurate cost estimates by analyzing the cost for each component step or activity in the production process (Cooper, 1988a, Cooper, 1988b, Cooper, 1989), and has been used in the public sector to provide disaggregated cost estimates and to analyze efficiency of public programs (Waters et al., 2001, Waters et al., 2006, Fiedler, 2003, Fiedler and Chuko, 2008, Fiedler et al., 2008). Drawbacks to the ABC approach include the subjectivity involved in defining and categorizing program activities and their components, and the approximation of resource use via qualitative methods such as interviews and focus group discussions (Caldes et al., 2006). Further, the difficulty in capturing all of the activities and associated costs incurred by the program's central office can potentially result in underestimation of total costs (Caldes et al., 2006). However, if carefully

executed, the combination of ABC with the gold-standard ingredients approach (ABC-I) results in a comprehensive costing of the ingredients required for the main activities in a program (Fiedler, 2003), thus providing "estimates and insights that are policy relevant" and useful for program management and operation (Fiedler, 2009). Cost of activities can then be compared with other similar programs.

2.4.2.2 Effectiveness measurements

Cost-effectiveness analysis is designed to measure cost per impact of an intervention using ratios often stated in terms of an individual beneficiary, such as cost per child cured of a disease (Levinson et al., 1999). Measures using outputs achieved, such as cost per child treated regardless of treatment outcome, are "cost-delivery" ratios, and provide information on the relative costs of delivering a program, accounting for coverage and other relevant factors, rather than measuring effectiveness *per se* (Levinson et al., 1999).

Disability-adjusted life years (DALYs) are a standard metric for disease outcomes, developed to aid global comparisons in the Global Burden of Disease (GBD) study, an effort initiated by the WHO in 1992 to provide policy-makers with a quantitative basis with which to measure disability related to disease and injury (Murray et al., 2001). DALYs combine the years of life lost (YLL) due to premature mortality and the years lived with disability (YLD) (Murray, 1994), and one DALY represents "one lost year of 'healthy' life" (Murray et al., 2001). Total DALYs attributable to a disease represent "the sum of the present value of future years of lifetime lost through premature mortality, and the present value of years of future lifetime adjusted for the average severity (frequency and intensity) of any mental or physical disability caused by a disease or injury" (Fox-Rushby and Hanson, 2001). DALYs are therefore a negative measure of healthy life lost, not gained, and interventions aim to reduce them (Fox-Rushby and Hanson,

2001). The WHO recommends their use in measuring effectiveness in CEAs (Tan-Torres Edejer et al., 2003). The major benefit of using DALYs is the comparability of measurement across disease states, allowing analysis of comparative effectiveness among interventions addressing different health outcomes (Murray, 1994, Musgrove and Fox-Rushby, 2006). However, they are also conceptually complex and abstract, and are based on several key assumptions (Fox-Rushby and Hanson, 2001, Murray, 1994).

DALYs incorporate a mixture of assumptions and measurements, from published literature or program data, about the severity and duration of a condition, age at onset, and remaining life expectancy at that age (Musgrove and Fox-Rushby, 2006). Disability weights represent the quality of life experienced in a variety of disease states (WHO, 2004). These estimates range from 0 to 1, with 0 representing perfect health and 1 representing death (Murray et al., 2001). Lives saved at different ages yield a different number of years saved. This difference is captured via age-weighting, which values some years of life more than others and is a controversial aspect of the GBD estimates reflecting social roles, dependency and productive capacity at different ages (Musgrove and Fox-Rushby, 2006, Murray, 1994). Future years of life are discounted at a rate of 3% (the same rate as the discounting of costs in the numerator of the CER)—reflecting greater value placed on years lived in the present than those in the future—with a maximum value at age 25, declining to nearly zero at advanced age (Musgrove and Fox-Rushby, 2006, Murray, 1994). It is recommended that local life expectancy be used in the calculation of DALYs in a particular country (Fox-Rushby and Hanson, 2001).

Averting DALYs represents the ability of an intervention to cure or prevent negative health outcomes such as death and lasting disability. Calculating cost per DALY averted facilitates comparison between health interventions. There are several ways to compare effectiveness of

interventions using DALYs averted, depending upon whether the intervention is new, an incremental modification of an existing intervention, or a complete shift from one intervention to another (Musgrove and Fox-Rushby, 2006). Calculating a cost per DALY averted compared to a "no treatment" scenario allows outcomes to be compared with other health interventions, and across different populations with varying levels of health system infrastructure (Hutubessy et al., 2003, Tan-Torres Edejer et al., 2003). The incremental cost-effectiveness ratio (ICER) is a standard comparative measure calculating the difference in costs of two interventions divided by the difference in outcomes (Briggs et al., 1997). The ICER represents the additional cost of one DALY averted by an intervention compared to its next best alternative.

2.4.2.3 Handling uncertainty with sensitivity analyses

As demonstrated in this review, estimation of both costs and effects requires many assumptions to be made. The World Bank's Disease Control Priorities Project (DCPP) concedes that, "although calculations are often reported to several significant digits, such precision is not really feasible given the uncertainties in the original data: 'economics is a one- or at most a two-digit science'" (Musgrove and Fox-Rushby, 2006). In other words, the parameter estimates used in a CEA can be assumed to be imprecise to some degree. It is important to understand to what extent results are sensitive to changes in the underlying estimates and assumptions.

Sensitivity analyses are used to observe the magnitude of change in the CER when varying different parameters in order to determine whether, for any parameters, there is some value past which the intervention would not be considered cost-effective (Tan-Torres Edejer et al., 2003, Musgrove and Fox-Rushby, 2006). Sensitivity analyses can be conducted on one parameter at a time (univariate or one-way analyses), or on all parameters at once (probabilistic uncertainty analysis) using statistical methods to create a confidence interval around the CER (Tan-Torres

Edejer et al., 2003, Weinstein et al., 1996). The WHO recommends using probabilistic uncertainty analysis to explore the impact of variability in measurable parameters which have an underlying probability distribution, including cost estimates and disease incidence. Statistical methods such as bootstrapping, in which repeated draws are taken from the distribution around each variable, can be used to create a confidence interval around data that has not been sampled. In order to do this, the analyst needs to specify the upper and lower limits for each parameter, and the likely shape of its distribution (Tan-Torres Edejer et al., 2003, Musgrove and Fox-Rushby, 2006).

2.4.3 Cutoffs for "cost-effective" interventions

There is no standard cut-off point to discern when an intervention is too costly (Musgrove and Fox-Rushby, 2006). The relative cost-effectiveness of two interventions can be assessed by comparing costs per outcome and choosing the less costly options (Tan-Torres Edejer et al., 2003). In terms of determining an absolute value for cost-effectiveness, the WHO considers interventions highly cost-effective that are able to avert a DALY for less than the per capita GDP of a country (Commission on Macroeconomics and Health, 2001). Other measurements offer a standard comparative cost, for example Bobadilla *et al* deem any intervention to be "very cost-effective" which averts a DALY for less than $100 (around $150 when adjusted for inflation) (1994). Another option is to compare results (i.e. cost per DALY or per life year saved) with previous studies ranking the relative cost-effectiveness of various health interventions (Jamison et al., 2006, Jha et al., 1998, Tan-Torres Edejer et al., 2005).

Intervention outcomes from studies which calculate DALYs using similar methods can be compared in terms of cost per DALY averted (Jamison et al., 2006, Tan-Torres Edejer et al., 2005). A study by Jha *et al* (1998) compared the cost-effectiveness of several basic health

interventions in Guinea, ranking them in terms of cost per life year saved. Interventions were grouped into “cost bands”, i.e. less than $50 or between $50 and $100 per life year saved; cost-effective interventions were recommended for inclusion in a basic package of health services (Jha et al., 1998). These simple groupings and comparisons provide useful guidance in decision-making.

2.4.4 Cost-effectiveness of community based service delivery by CHWs

Interventions delivered by CHWs are generally considered to be cost-effective, because of the expanded coverage they enable, the lower costs of their salary and training compared to clinic-based services, and the minimal infrastructure they require for service delivery (Waters, 2000, Berman et al., 1987, Lehmann and Sanders, 2007, Abbatt, 2005). However, few studies report cost-effectiveness outcomes for CHW programs (Walker and Jan, 2005, Lehmann and Sanders, 2007, Lewin et al., 2010, Corluka et al., 2009, Bhutta et al., 2010). This is due to two primary challenges. First, there are many intangible benefits arising from a CHW program which traditional economic analyses are not designed to capture, such as altruism, community mobilization, equity and duty (Walker and Jan, 2005, Lehmann and Sanders, 2007, Berman et al., 1987, Corluka et al., 2009). A community that produces willing volunteers is very different from one that does not, and this can affect how a particular level of resources might produce different outcomes in different locations (Corluka et al., 2009, Walker and Jan, 2005). Second, CHWs often deliver a bundle of interventions together at community level, the costs and benefits of which can be difficult to disentangle (Bang et al., 2005a, Berman et al., 1987). Providing services that reduce one risk factor—malnutrition for example—can impact the cost-effectiveness of other interventions by reducing the underlying risk of mortality (Mason et al., 2006, Tan-Torres Edejer et al., 2003). The WHO recommends, where possible, that groups of

interventions having significant interactions in either costs or health effects be evaluated together (Tan-Torres Edejer et al., 2003).

Taking these challenges into account, an early analysis of the cost-effectiveness of several CHW programs by Berman *et al* deemed that:

> A rigorous assessment of CHW program cost-effectiveness is not feasible. In particular, the standard cost-effectiveness approach which measures only one outcome of a single intervention is not up to the task. This does not, however, rule out the possibility of saying anything at all. For there are several studies which provide information about both the outputs and the costs of CHW programs. For all its inadequacies, this information can be quite illuminating when placed in a cost-effectiveness framework; and it can serve to start progress toward more careful assessments. (Berman et al., 1987)

Berman *et al* devised an analytical framework to comment on various elements supporting or detracting from CHW cost-effectiveness, rather than calculate cost-effectiveness ratios. This framework consisted of both process and outcome indicators, including selection of tasks, quality of care, coverage and equity, health impact, and low cost (Berman et al., 1987). According to this framework, CHWs increased cost-effectiveness of programs by expanding coverage to necessary services with good quality and equity at a lower cost than clinic-based services. In this review, Berman *et al* made several important points regarding the connections between resource use and effectiveness of CHW programs. One key observation was that while CHW services achieved lower average costs than clinic-based services, the higher community demand for their services and higher coverage they achieved could yield high total costs; these costs should be expected and included in program budgets. Additionally, the high coverage which CHWs could achieve was only meaningful if services were effective; therefore (sometimes substantial) resources would be required to maintain CHW quality of care and motivation, including supervision, training, supplies, and recognition and encouragement from the health system and the communities in which they worked (Waters, 2000, Rosato et al., 2008, Gilson et al., 1989).

The analysis by Berman *et al* contributed evidence towards the cost-effectiveness of CHWs during a time when policy makers doubted their investments in large-scale CHW programs. Their reluctance to calculate cost-effectiveness ratios stemmed from the aforementioned nature of CHW programs along with a lack of rigorous data on costs and effects of CHW programs at that time (Berman et al., 1987). More than twenty years later, there is less hesitancy around calculating cost-effectiveness ratios for CHW programs and, using effectiveness data generated by program monitoring systems and surveys, several cost-effectiveness analyses of individual CHW programs have been conducted. These assessments have found that, for home-based care of tuberculosis and HIV for example, CHWs delivered effective services and achieved lower costs, both overall and to participating households, compared to clinic-based care (Islam et al., 2002, Floyd et al., 1997, Waters, 2000). CHWs have also delivered immunization services in remote communities for substantially lower costs than facility-based services (San Sebastián et al., 2001). These savings are largely due to reduced use of clinical staff, reduced duration of hospital stay and increased coverage achieved by CHWs.

2.4.4.1 Cost-effectiveness of CMAM

The community-based treatment of SAM introduces potential cost savings by limiting use of expensive inpatient services. However, there is concern in the international nutrition community that the cost of a critical ingredient of CMAM programs, RUTF, is "too" costly (Golden, 2007, Prasad, 2009, Sachdev et al., 2010, Gupta et al., 2006) when compared to inputs for other child survival programs (Horton et al., 2010, Ashworth, 2006). A recent study by the World Bank found the treatment of SAM with RUTF to be the most costly option relative to other existing nutrition-related programs in developing countries, at $200 per child treated, compared with vitamin A supplementation which averages $1.20 per child per year, deworming at $0.25 per

round of treatment per year and universal salt iodization at $0.05 per person per year (Bachmann, 2009, Horton et al., 2010). This cost comparison contributed to the impression that, notwithstanding its effectiveness at saving the lives of children at high risk of death (Collins et al., 2006a), CMAM would be too costly to implement at scale given current delivery capacity, particularly in high-prevalence regions like South Asia (Horton et al., 2010). Adequately addressing these cost-related concerns will be instrumental in promoting the acceptance of CMAM among the international nutrition community, continuing to improve its effectiveness, and scaling up to prevent unnecessary deaths in countries where SAM predominates.

The institutional context in which CMAM is implemented has serious implications for its cost-effectiveness. However, research is limited in this area, as the integration of CMAM into existing health infrastructure is a relatively new practice (Gatchell et al., 2006). Further analysis is needed not only to determine the cost-effectiveness of CMAM compared to existing inpatient services in developing countries, but also to test the effectiveness of and ascertain barriers in integrating CMAM into routine health services (Ashworth, 2006). Specifically, the social costs of CMAM relative to its alternatives should be quantified to determine the resource burden of these programs on participants as well as providers (Russell et al., 1999, Weinstein et al., 1996).

In 2006, Ann Ashworth conducted a review assessing the effectiveness of community-based rehabilitation for treatment of severe malnutrition, for the period 1980-2005. This review covered a wide range of programs and found that rehabilitation at home with family foods was generally more cost-effective than inpatient care (Ashworth, 2006). Considering the high costs of RUTF, this review recommended further research to compare the cost-effectiveness of treating a child at home with RUTF, with treating a child in a hospital.

The present review focuses on CEAs providing detailed cost data for interventions treating SAM outside of health facilities, of which there are four in the published and grey literature. The first is a comparative analysis of three different methods of SAM treatment in Bangladesh, conducted before the development of RUTF (Ashworth and Khanum, 1997). The second is an unpublished study, conducted as part of a Master's thesis, which compares inpatient treatment and CMAM in rural Ethiopia (Tekeste, 2007). The two most recent analyses compare the cost-effectiveness of the CMAM strategy as it is practiced today with a no treatment alternative in Zambia (Bachmann, 2009), and with existing standard health services but no CMAM in Malawi (Wilford et al., 2011). Full descriptions of each analysis can be found in Appendix Seven.

The first study, conducted in Bangladesh a decade before the subsequent studies, differs from the others in several ways (Ashworth and Khanum, 1997). The sickest children were excluded from the study, and one week of inpatient day care was provided before community treatment. This study did not use RUTF but asked caretakers to provide home-cooked meals for children undergoing domiciliary care. Several costs are unaccounted for, including training for management of SAM, and the opportunity costs of caretakers' time beyond the inpatient stay (i.e. time spent seeking other care or buying other medicines). Additionally, although home visitors were described as being well-supervised, there was no explicit mention as to whether costs associated with monitoring and supervision (e.g. supervisor and home visitor salaries spent in supervision visits) were included in the analysis. For these reasons, the cost estimates from this study are low compared to the other studies (Table 2.1), and do not represent comparable cost assessments, as outlined below.

Table 2.1 presents a summary of outcomes from CMAM cost-effectiveness analyses. The three studies from Africa assess CMAM programs as they are currently implemented, using RUTF and

providing treatment at health facilities. Cost data collected for these studies comes from institutional accounts and includes isolated input estimates derived via the ingredients approach and additional estimations of economic costs. Outcomes for these studies are clustered between $150-200 per child treated or recovered, and around $50 per DALY averted, suggesting CMAM to be highly cost-effective according to common measures (Commission on Macroeconomics and Health, 2001, Jha et al., 1998). Findings also indicate that community treatment of SAM yields cost-effectiveness outcomes comparable with other basic health interventions in developing countries, such as childhood immunization (US$8 per DALY averted), insecticide-treated bed nets (US$19-85 per DALY averted), and treatment for infectious tuberculosis (US$5-10 per DALY gained) (Jamison et al., 2006), and commensurate with the most cost-effective health interventions identified by a World Bank study (US$50 or less per life year saved) (Jha et al., 1998).

Table 2.1: Comparison of cost-effectiveness results for CMAM (USD)

Cost outcome	Bangladesh	Ethiopia	Malawi	Zambia
Per recovery	$29	$145		
Per treated case				$203
Per DALY			$42	$53

CMAM costing studies have become progressively more comprehensive and technically sophisticated in terms of estimation of costs and health effects. While Bachmann's analysis helped to fill the void of published evidence regarding the cost-effectiveness of CMAM programs as they are currently implemented, the comparison of CMAM with a do-nothing alternative did not tell the whole story. CMAM was developed as an alternative to facility-based treatment of SAM. Even where facility-based treatment is low quality and not institutionalized according to WHO protocol, it is often an existing option for SAM treatment in developing

countries. Wilford *et al*'s analysis addressed this gap by incorporating assumptions for costs and utilization of existing health services including therapeutic feeding.

Gaps remain in the evidence base around resources required for management of SAM. Gathering actual expenditure data for the facility-based treatment of SAM and conducting a comparative costing analysis with a CMAM program would provide relevant evidence to policy makers about the relative cost-effectiveness of these two treatment methods. Further, neither of the two most recent CMAM cost studies assessed household costs. Considering the evidence of savings to program participants from CEAs in Bangladesh and Ethiopia, the cost of CMAM to participating households deserves further investigation. Additionally, the three recent CMAM CEAs investigated programs that were delivered from health centers, and there are no studies assessing the effect on program cost-effectiveness when CMAM service delivery is further decentralized with treatment delivered at community level. There is also a lack of published data on the cost-effectiveness of CMAM in the Asian context. Considering the population density in South Asia, where SAM predominates, it is possible that CMAM service delivery and resource usage might change in these settings. Lastly, existing CMAM cost analyses were based on a review of accounting systems. Thus far, no CEAs have taken an activity-based approach to costing CMAM programs. This exercise would provide a nuanced assessment of program resource use during a time when the costs and cost-effectiveness of CMAM programs are a matter of great interest and debate.

2.5 Conclusion

CMAM is an intervention with proven effectiveness in addressing a common childhood illness with high risk of mortality. Previous research has demonstrated the potential for health workers without formal education to deliver effective treatment for SAM. CMAM programs exhibit

equivalent cost-effectiveness to other priority child survival interventions. With the development of simplified treatment algorithms for management of SAM, there is scope for further decentralizing treatment to the community level using CHWs. There is limited evidence around the quality of care for SAM when delivered by non-professional workers, whether adding this task to their workload would affect quality of care on other tasks, and whether having CHWs deliver treatment for SAM is cost-effective. Therefore this dissertation seeks to address several gaps in the literature around quality of care and cost-effectiveness of the community-based treatment of SAM using CHWs.

A nuanced analysis of CHW quality of care, focusing on technical competence on individual case management components, would address a critical gap in the literature regarding the potential for community-based workers with limited training to deliver high quality treatment for SAM. Further, the effect of adding this task to a CHW workload on the quality of care they provide for other tasks deserves examination. Assessing community perceptions of quality of care would provide contextual evidence regarding CHW skill and acceptability.

Existing assessments of the cost-effectiveness of CMAM have not explored the resource usage entailed in more decentralized service delivery models. Considering the potential cost savings introduced to households via decentralized services, a societal CEA would be an appropriate and timely contribution to the literature. Further, providing an assessment of CMAM activity costs in an Asian setting would provide evidence around whether such an approach is feasible in this under-studied regional context.

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3 Chapter 3: Methods

3.1 Introduction

This Chapter describes the methods used in this dissertation: Section 3.2 briefly describes program methods and procedures, Section 3.3 provides justification for selected measurement techniques, Section 3.4 describes quality of care research methods and Section 3.5 describes cost-effectiveness research methods. Ethical approval for this study was obtained from the Institutional Review Board of Tufts University and from the Bangladesh Medical Research Council (BMRC). Approval was also obtained from the Director General for Health Services (DGHS) in Dhaka, Bangladesh.

3.2 Program Procedures

This section presents a brief description of program procedures and methods. A more detailed account can be found in the full report for the overarching program effectiveness study (Sadler et al., 2011).

3.2.1 CHW recruitment

At the beginning of the MCHN program, SCUS recruited CHWs from the communities in which the program was to be implemented. Initial CHW selection was merit-based, with SCUS program personnel ranking candidates on the basis of an exam score and choosing the candidate with the highest score in her EPI area.

3.2.2 CHW Training

All CHWs in the intervention upazila received training in SAM treatment protocols. In the comparison upazila, CHWs were trained to identify children with SAM and refer them to the

UHC while continuing to provide routine counseling and treatment for pneumonia and diarrhea. Clinical staff at the UHC in the comparison upazila received training covering inpatient protocols for treatment of SAM according to National Guidelines (IPHN et al., 2008). In the intervention upazila, the UHC was outfitted with the necessary support, including training and supplies, to provide a few days of stabilization care (typically two five days) to cases of SAM with medical complications (lack of appetite, edema or severe illness).

3.2.3 Case identification

CHWs identified SAM in children under two with a MUAC measurement during monthly GMP sessions. During her rounds, each CHW also visited the households of any children she suspected to be sick or malnourished, thereby providing coverage to all children under three. Where CHWs identified a child as sick or having a MUAC less than 110 mm and/or edema, they were assessed according to IMCI procedure (Rosales, 2003, WHO et al., 2007). Cases of SAM with complications were referred to the UHC; cases of SAM without complications received treatment by the CHW. In comparison communities, all cases of SAM were referred to the UHC for inpatient treatment according to National Guidelines.

3.2.4 Treatment and discharge criteria

All children treated by CHWs received weekly rations of RUTF in proportion to the child's weight. For cases of SAM with complications in intervention communities, after complications were resolved at the UHC, the child returned to the community for weekly outpatient treatment with RUTF provided by CHWs until recovered. Children with no complications were monitored, given counseling and provided RUTF each week by the CHW until discharge.

In intervention communities, children were discharged once their MUAC was assessed as more than 110 mm, any edema was resolved, and they had gained at least 15% of their admission weight for two consecutive weeks (WHO et al., 2007).

All medical treatment followed protocols specified in the "National Guidelines for the Management of Severely Malnourished Children in Bangladesh" (IPHN et al., 2008), including a dose of folic acid, the broad-spectrum antibiotic Cotrimoxazole oral, and use of F-75 and F-100 therapeutic milk.

CHWs followed up with children after discharge from the UHC in both intervention and comparison communities.

3.2.5 Monitoring and quality assurance

CHWs received ongoing program monitoring by a special team of SCUS Project Officers (POs) hired for technical oversight of activities related to the treatment of SAM. Additionally, all CHWs received regular supervision and monthly refresher trainings, where they were given the chance to ask questions and receive feedback from the POs.

3.3 Justification of methods

A major focus of this research was the quality of care and time use of CHWs; it is therefore important to discuss how they were measured. This section provides justification for the choice of selected techniques used in this dissertation to measure quality of care and time use.

3.3.1 Measuring quality of care

Several methods are commonly used to assess health worker quality of care. These include observing case management of actual or simulated cases, assessing knowledge and competency via case scenarios (or "clinical vignettes"), comparing assessment with a gold-standard clinician,

and reviewing workers' registers to characterize their service (Degefie et al., 2009, Hadi, 2003, Baqui et al., 2009, Darmstadt et al., 2009, Zurovac et al., 2004, Kelly et al., 2001, Amaral et al., 2004, Tanzania IMCI Multi-Country Evaluation Health Facility Survey Study Group, 2004). Comparing a health worker's assessment with that of a clinician enables analysis of their agreement with a gold standard medical professional (Peabody et al., 2000). No clinicians were available for this study; however CHW supervisors (called Field Officers or "FOs" in the SCUS management structure) had a strong understanding of CHW case management protocols and provided a competent alternative to physicians for quality assessment. Next, observation while managing a sick child case allows a direct assessment of the quality of clinical practice, including interviewing and physical examination. However, several logistical complications are involved in direct clinical observation. First, sick children must be located, either at a health facility, or by searching in the community (George et al., 2009). An additional challenge is the high variability among observed cases, including time available for physical examination and interviewing, which challenges the standardization of scores achieved in assessing these cases (McGraw and O'Connor, 1999).

Considering the challenges related to direct case management, several methods have evolved to assess quality of care using standardized approaches. The "practical gold standard" of these approaches is the use of standardized patients, where non-physicians trained to play the role of a patient portray simplified clinical scenarios for assessment (McGraw and O'Connor, 1999, Peabody et al., 2000). In some settings, use of standardized patients has been proven to be more feasible than using actual cases, and to produce similar scores on a clinical skills evaluation as assessments of actual cases (McGraw and O'Connor, 1999). However, this method is costly, and the identification and training of standardized patients can present limitations for research

conducted in outpatient settings (Peabody et al., 2000). One alternative is to assess knowledge and competency via case scenarios, an option which is easier and less costly to administer. This method has been shown to produce quality of care scores closer to the standardized patient "gold standard" than other assessment techniques, and is thought to be a useful and valid measure not only of health worker knowledge and competence but also of clinical practice in an outpatient setting (Peabody et al., 2000).

Assessment of CHWs' ability to correctly manage cases of SAM was a primary objective of this research initiative. Therefore, efforts were made to observe management of actual cases of SAM, despite the low SAM prevalence and subsequent reduced likelihood of locating a SAM child in each CHW's catchment area during the time of the study. The assessment of CHW competency in CCM of childhood illness was a secondary objective. To simplify data collection logistics, the assessment of CHW competency in assessing pneumonia, diarrhea and severe disease used case scenarios. This research was conducted in the community, not at a hospital; therefore access to sick children was limited. The likelihood of locating a sick child for assessment by CHWs during a supervision visit is low (George et al., 2009), and video technology was unavailable to show sick child cases to CHWs for assessment as other studies have done (Zeitz et al., 1993). Routine household visits were assessed via case management observation as this was standard supervision practice, and locating eligible cases (i.e. children who were not ill, but due for a routine household visit) did not unduly complicate data collection logistics.

3.3.2 Measuring time use

Time allocation is an important indicator in assessing workload, and there are several methods used to measure it. Direct observation of time use through time-motion studies is considered to be the "gold standard", and provides accurate and precise estimates of both productive and non-

productive time (Bratt et al., 1999). These methods are resource-intensive, requiring direct observation of workers and documentation of individual actions, and producing time allocation estimates with high levels of precision. One time-motion study of IMCI-trained health workers calculated their consultation time down to the minute and second (Adam et al., 2005a). Depending on the purpose of the study, this level of precision is not always practicable or necessary.

Self-administered time diaries provide accurate estimates of health worker contact time with patients, however compiling the data they generate is time-intensive (Bratt et al., 1999). Self-administered time diaries were piloted for this study and found to be easily completed by CHWs. These diaries created an exhaustive account of CHWs' time, whereas this study aimed only to assess time spent on selective work tasks. Selective time allocation data can be collected more simply via self-recall in survey questionnaires, a method used in the World Bank's Living Standards Measurement Surveys (Harvey and Taylor, 2000).

The benefits of time allocation data collected via survey questionnaires and other provider recall methods are that they entail lower costs to administer and to process the data compared to time diary methods, and that the reference period can be adjusted according to the activity in question. The drawbacks are the dependence of this method on subjective calculation of time use, which can result in underreporting of concurrent activities; this is an issue particularly for occupations where it is difficult to separate activities into work and non-work components (Harvey and Taylor, 2000). One study found provider recall methods to overestimate patient contact time and underestimate non-productive time compared to the gold-standard time-motion method (Bratt et al., 1999).

This study employed provider recall methods, as time diary data were determined to be too intensive in terms of time and resources required. Given the limitations of the recall method, results from the analysis presented in this dissertation may represent an overestimation of CHW contact time with caretakers and their children. However, time allocation estimates collected via the same method can be compared to assess relative differences in work time allocation between groups of workers. To ensure data quality, the Researcher employed several techniques to improve accuracy of recall and limit overestimation of time allocation. Recall methods were used for this study in a variety of formats, including surveys (detailed in Section 4.2.2.1), key informant interviews (Section 5.3.1) and focus group discussions (Section 5.3.2). For survey questions regarding time allocation on specific tasks, data collectors were trained to walk the CHW through her work activities in order to improve accuracy of recall. In key informant interviews and focus group discussions, the Researcher endeavored to improve accuracy through a number of efforts, including walking the informant through their work activities, calculating and verifying time estimates during the interview based on the answers given, and revising the estimate as needed after verification with the participant.

3.4 Quality of care analysis

3.4.1 Research design

This research took a mixed methods approach to assess quality of care achieved by CHWs implementing CMAM protocols within the SCUS health and nutrition program, using quantitative and qualitative methods concurrently to triangulate findings (Creswell et al., 2003). Qualitative data from focus group discussions provided context for results from the quantitative research. Two analyses assessing quality of care were conducted: a CMAM quality of care analysis and a comparative analysis of quality of curative and preventive care delivered by two

groups of CHWs with different workloads. CHWs were divided into two groups based on their job responsibilities, and the nomenclature used to distinguish these two groups is outlined below:

1. “CCM”: CHWs that delivered CCM of pneumonia and diarrhea with preventive tasks
2. “CCM SAM+”: CHWs that delivered CCM of SAM in addition to CCM of pneumonia and diarrhea with preventive tasks

As a function of their number of job tasks, CCM SAM+ CHWs had more work responsibilities than the CCM group.

Preventive tasks included nutrition counseling, communicating with caretakers and negotiating improved child feeding practices. These were based on the “Promise Sheet” communication tool developed by SCUS, which aided CHWs’ communication with caretakers by tracking progress and roadblocks to adapting desired health and feeding practices. Each Promise Sheet recorded the history of that caretaker’s interactions with the CHW, providing helpful visual aids for the process of negotiating feasible improvements in a caretaker’s practices. The Promise Sheet can be found in Appendix Eight.

3.4.2 Quantitative data

This section reviews quantitative methods used to collect and analyze data, including development of instruments, data collection, sample size and participant selection, and data entry and analysis.

3.4.2.1 Development of instruments

Three quantitative tools were developed to assess quality of care: (1) a CHW survey, (2) a routine household visit checklist, and (3) a CMAM quality of care checklist. A cross-sectional survey of both CHW groups was conducted using the CHW survey and the routine household

visit checklist. During this same period, CCM SAM+ CHWs who currently had a child with SAM in their catchment area were also assessed in a case management observation using the CMAM quality of care checklist.

3.4.2.1.1 CHW Survey

The aim of the CHW survey was to collect descriptive information on CHWs; it contained questions regarding their demographic, socioeconomic and professional characteristics such as history of trainings, frequency of supervision, prior work experience, duration of employment with SCUS, and perceived support from community and family. Several survey questions related to CHWs' time allocation on work-related tasks including household visits and GMP sessions. The survey ended with an assessment of CHWs' knowledge and competency in CCM methods, with questions about general danger signs and three curative case scenarios for severe disease, pneumonia and diarrhea. The CHW survey can be found in Appendix One.

3.4.2.1.2 Routine household visit checklist

The aim of the routine household visit checklist was to assess the quality of care delivered by CHWs on basic routine tasks. This checklist was adapted from normative literature on a gold-standard series of tasks and assessments to be performed by a CHW in a household visit (Marsh et al., 2009). This includes negotiating feasible improvements and providing clear, focused counseling along with answering questions and troubleshooting any problems. Although there is no internationally-accepted method to measure CHWs' counseling and service delivery in a routine household visit, this checklist was very similar to the supervision checklist developed by SCUS for monitoring CHW performance during household visits. Actions captured in this checklist also resemble those in the IMCI checklist used for maternal counseling (Zaman et al., 2008). The routine household visit checklist can be found in Appendix Two.

3.4.2.1.3 CMAM quality of care checklist

The aim of the CMAM quality of care checklist was to assess the quality of care delivered by CHWs on specific tasks involved in managing a case of SAM. This checklist was based on a CMAM classification algorithm and treatment protocols (Collins, 2004). For each task involved in SAM case management—such as measuring MUAC, checking edema, and delivering education messages—the checklist includes all actions necessary to perform the task with high quality. The CMAM quality of care checklist can be found in Appendix Three.

3.4.2.1.4 Piloting and translation

The Researcher spent one month piloting tools and research procedures before starting data collection (November – December 2009). Each tool was reviewed with program staff to ensure that it was technically sound and complete. Then tools were field-tested with FOs, program beneficiaries and CHWs as appropriate, to verify that questions were worded clearly, and to receive feedback on specific questions as well as the process of administering the tools.

During piloting, FOs suggested ways in which many questions on the CHW Survey could be clarified or changed if they did not cohere with field-level realities. For example, it was decided that the interview should happen during working hours since the interview requires a random check to see if the CHW is carrying her guideline documents with her, and SCUS policy states that she only needs to do this on working days. They also suggested that CHW's education should be subdivided into general and madrasa-based education. Both education systems were thought to differ in terms of quality, and FOs estimated that approximately 70% of CHWs in Bhola would have received Madrasa-based education.

The household visit checklist was determined to be similar to standard supervision checklists used in CHW monitoring, and these checklists were used in lieu of the existing supervision

checklists during the months of data collection.

The CMAM quality of care checklist was reviewed with head SCUS health and nutrition staff in Dhaka to confirm that it was technically sound and complete. In Bhola, the checklist was translated into Bangla and reviewed with field supervisory staff. They gave initial feedback on the checklist, suggesting alternate word choice in English and in Bangla, additional details to add in terms of danger signs and other technical aspects of CCM, and details that could be taken out of the checklist. FOs piloted the checklist on a few CHWs, and gave feedback on the process of using the tools, including any particular questions that were confusing to them or the CHW, and any questions that could be edited to better reflect field reality. Examples of changes made to this tool during piloting are as follows:

- The algorithm was clarified, and danger signs were added to the CMAM quality of care checklist.
- SCUS-specific protocol, such as how to assess for edema, were clarified and added to the training guideline for data collectors.
- Aspects of the checklist that weren't feasible were removed (i.e. "tell caretaker to go to a quiet place and offer RUTF to child" during appetite check).

Final tools were translated into Bangla by a member of the Study Team. Translations were reviewed with program staff and Study Team, to make sure initial translation cohered with original wording of tools. Then tools were back translated to English by a third party unfamiliar with the study or program. Final changes and clarifications were made to produce the official tools used for data collection.

3.4.2.2 Data collection

3.4.2.2.1 Timeline

Data collection occurred between February and April 2010.

3.4.2.2.2 Selection of surveyors

Data collection was conducted by 19 FOs working in Bhola district who supervised the CHWs participating in this analysis. They were employed as surveyors (or "enumerators") due to their pre-existing relationship with the CHWs. FO responsibilities included routine monitoring and observation of CHWs during household visits; therefore CHWs were accustomed to being observed by them. They were expected to put CHWs at ease compared to an unfamiliar third party observing their work. Further, the FOs were very familiar with the protocols involved in the CHWs' work and were thought to represent a gold-standard observer of CHW work quality.

3.4.2.2.3 Surveyor training

In order to ensure that quality of care was measured in a reliable way among data collectors, standardization training was conducted before data collection started. During the two-day training, each data collection tool was reviewed and simulations were conducted. After each simulation, FOs shared their impressions, generating discussion on how best to standardize and define "good" versus "poor" practice for each step in the checklists. The Study Team determined a "gold standard" set of correct observations; these were recorded and circulated among FOs for their reference during data collection.

There is no internationally-accepted method to measure quality of CHWs' delivery of preventive services at a routine household visit for a non-sick child (i.e. one not requiring treatment for illness, for which there are more standardized treatment indicators). Many of the tasks on the routine household visit checklist focused on the qualitative aspects of the interaction between CHW and caretaker, including non-verbal communication, clear counseling, problem-solving

and negotiation skills. The “Promise Sheet” communication tool developed by SCUS aided CHWs’ communication with caretakers by tracking progress and roadblocks to adapting desired health and feeding practices. Each Promise Sheet recorded the history of a caretaker’s interactions with the CHW, providing helpful visual aids for the process of negotiating feasible improvements in a caretaker’s practices. Anchoring definitions of “quality care” with progress on the Promise Sheets facilitated FOs’ measurement of good practices in a standardized manner. The Promise Sheet can be found in Appendix Eight; points for standardizing measurement of quality using the routine household visit checklist can be found in Appendix Nine.

In addition to receiving instruction in assessing quality, surveyors were also trained in techniques for asking various questions on the CHW survey. This training included assisting the CHW in recalling her time allocation in the previous week by walking her through different components of her work days. Surveyors were instructed not to prompt the CHW during the case scenarios, but to let her recall on her own as many practices as she was able.

Finally, during training a discussion was held regarding the importance of “negative” outcomes in research, and how poor performance by CHWs would not reflect poorly on their own job performance as CHW supervisors.

3.4.2.2.4 Supervision and monitoring

The Researcher and a Study Assistant monitored surveyors for the first month of data collection. During monitoring visits, the surveyor was observed conducting a CHW interview. Based on this observation, surveyors were given feedback and an opportunity to ask any questions about the research process, including questions about specific items on the data collection instruments. During these monitoring visits, completed data collection tools were reviewed for inconsistencies

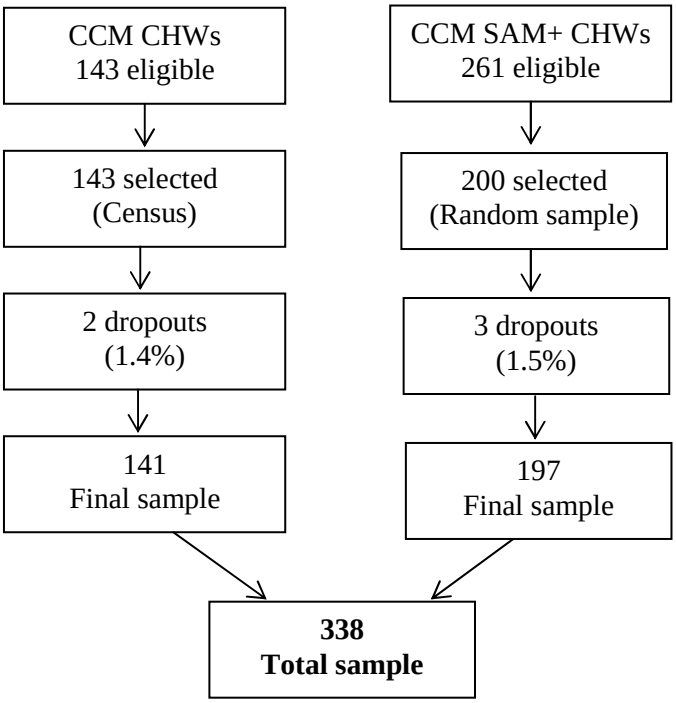
and missing values, and any issues with data input on the survey forms were discussed with the surveyor.

3.4.2.3 Sample size and participant selection

3.4.2.3.1 Quality of care comparison

The sampling universe for the quality of care comparative analysis was CHWs implementing CCM activities in Bhola district. In order to be eligible for inclusion in the sample, CHWs needed at least five months of work experience in the MCHN program before beginning their current curative responsibilities. Accordingly, CCM CHWs must have started work by May 2007, providing only routine preventive care for at least five months before being trained to manage pneumonia and diarrhea cases in September 2007. CCM SAM+ CHWs must have started work by February 2009, practicing CCM of pneumonia and diarrhea for at least five months before being trained to manage cases of SAM in June 2009. There were 143 CCM CHWs and 261 CCM SAM+ CHWs eligible for inclusion in the sample. Figure 3.1 outlines the sample selection process.

Figure 3.1: Selection of participants



In calculating the required sample size, conservative estimates were assumed for the expected average percent of error-free case management for the first group at 40% and the second group at 50%. The standard deviations also represent a conservative estimate of 75% of the mean. Using Russ Lenth's sample size calculation for a difference in two means resulted in a required sample size of 182 (Lenth, 2009). Allowing for a possible 10% sample attrition (due to missing data, or non-response), the final total sample size was 200 per group, or 400 CHWs total. The sample size was calculated to detect a minimum difference of ten percentage points in the routine quality of care score between the two groups of CHVs, if such a difference existed.

There were not 200 CHWs available in the CCM group; therefore a census of all 143 CHWs in this group was selected to participate. Two hundred CCM SAM+ CHWs were randomly selected from the 261 CHWs implementing CCM of SAM in one upazila using systematic sampling with

a random start. CCM CHWs came from different locations within Bhola district, which is a more or less homogeneous rural area with fishing and agriculture being common livelihoods.

All selected CHWs in both groups participated in the quality of care comparative analysis.

3.4.2.3.2 CMAM quality of care

The CMAM quality of care analysis was conducted only with CCM SAM+ CHWs. All 197 randomly selected CCM SAM+ CHWs used in the comparative analysis were eligible for inclusion in the sample (Figure 3.1).

A separate sample size calculation was conducted for this analysis. No studies were found in the literature that measured quality of care for SAM provided by unskilled workers. For these reasons, the sample size for this analysis was an estimate based on the following assumptions.

Sample size for CHWs' capacity to deliver CMAM protocols was determined for detecting a single population mean, based on a review of results from the literature on quality of care in terms of IMCI protocol delivered by health workers. IMCI literature was considered comparable in that it measures health workers' performance on simple curative tasks. In various studies, the mean proportion of correct case management ranged from 56.9% to 79.8% (Amaral et al., 2004, Schellenberg et al., 2004, Ashwell and Freeman, 1995, Naimoli et al., 2006, Rowe et al., 2007a, Tanzania IMCI Multi-Country Evaluation Health Facility Survey Study Group, 2004, Zurovac et al., 2004). As a worst-case scenario, the expected mean percentage of error-free case management was set at 50, and the alternative mean at 60 (University of Surrey Department of Mathematics, n.d.). When variance is unknown, Magnani suggests using a conservative estimate of 60-80% of the mean as a standard deviation (Magnani, 1997). Using a standard deviation of 75% of the mean, with an alpha of .05 and a power of 80, results in a sample size of 87.

Due to low SAM prevalence during the months of data collection, it was not possible to meet the required sample size. Efforts were made to observe all CHWs who had a child with SAM in her catchment area during this time. In total, 55 CHWs were assessed. As these CHWs were not randomly selected, but rather represented a subsample of randomly selected CHWs implementing the CCM of SAM, their personal characteristics could potentially have influenced their score outcomes, a possibility that was explored during data analysis.

3.4.2.4 Data entry

Data was entered by Data Analysis and Technical Assistance (DATA) in Dhaka using a database system with logical range rules for data input to avoid incorrect data entry. On a 5% subsample, the data were double-checked and re-entered to check for data entry mistakes. After entry, logical checking was conducted on a random sample of hard copies to check again for any errors in data entry. Once the Researcher received the dataset, any implausible values or missing data were double-checked with the hard copy survey forms by the Study Assistant. For values of variables (particularly time allocation variables) which seemed implausible, members of the program team in Bangladesh were requested to follow-up with surveyors and confirm with them whether the values were correct. This was done soon enough after data collection that the surveyors were able to remember the specific case in most instances.

3.4.2.5 Data analysis

3.4.2.5.1 Quality of care scores

A maximum possible score was calculated for each CHW as total correct responses divided by total applicable items. Adherence scores for each curative case scenario were calculated as percentage of recommended treatments prescribed. Each item on the checklists had a possible

response of “yes” or “no” reflecting performance on completed items, or “not applicable” if a checklist item did not apply during that visit. For example, if a caretaker had no questions then a CHW would not need to answer the caretakers’ questions, nor be held accountable for items 10-12 on the household visit checklist. A maximum possible score was calculated for each individual CHW as total correct responses divided by total applicable items. Each individual score was therefore calculated with a different number of items in the denominator.

While this could make a CHW’s potential score dependent on the nature of the particular household visit on which she was evaluated (and whether or not she was able to show her full range of counseling and communication abilities), we maintain that on average this measurement of quality would not be biased. A poor quality of service delivery would manifest in several different ways, many of which the checklist was designed to capture. For example, if a caretaker did not ask questions at a household visit because in the past the CHW has discouraged this, then the CHW would also likely fail to use encouraging non-verbal communication or listen to the caretaker’s concerns.

3.4.2.5.2 Statistical analysis

Descriptive statistics were calculated for CHWs’ demographic characteristics and perceptions of work support. Time allocation was calculated for CHWs’ work tasks. Significance tests were conducted using Stata statistical software version 11 (StataCorp, 2009) to detect any differences between CHW groups for demographic and support variables, time allocation and quality of care scores. The data were analyzed using the chi-square test and Fisher’s exact test for dichotomous variables and Wilcoxon’s rank sum test and Student’s t test for equal or unequal variance for continuous variables. For the CMAM quality of care analysis, checklist scores were compared against a 90% quality standard; a Wilcoxon signed-rank test was used to assess the difference

between median checklist score and the standard quality score of 90%. A binomial test was used to calculate a 95% confidence interval for the proportion of subjects scoring 90% or better on the checklist. The statistical software "R" was used for binomial tests (R Development Core Team, 2010).

3.4.3 Qualitative data

Qualitative data was used to provide context to quantitative measures of CHW quality of care. Focus group discussions (FGDs) were used for data collection in both analyses regarding quality of care, engaging different groups of participants.

3.4.3.1 Development of instruments

Semi-structured questionnaires were developed to guide FGDs with both CHWs and caretakers of children with SAM.

3.4.3.1.1 Quality of care comparative analysis

For the quality of care comparative analysis, semi-structured questionnaires were developed to contextualize the performance of CHWs in both groups by examining their perceptions of challenges related to their workload. During FGDs, CHWs were asked to contrast their past workload and current work responsibilities. CCM CHWs were asked about their workload and time allocation when delivering preventive care only, compared to CCM of pneumonia and diarrhea; CCM SAM+ CHWs were asked about delivering preventive care plus CCM of pneumonia and diarrhea, compared to their workload with the addition of SAM. First CHWs developed a list of challenges related to their workload and then ranked them as a group. Then they generated a list of areas of work and domestic life that had changed with their increased workload, and estimated time allocation for each area before and after their workload increased.

Proportional piling methods with stones were used to facilitate the group's estimation of changes over time (Catley et al., 2008).

3.4.3.1.2 CMAM quality of care analysis

For the CMAM quality of care analysis, semi-structured questionnaires were developed to contextualize CHWs' performance by assessing aspects of service delivery that were valued by caretakers of children with SAM. Caretakers were asked for their perceptions of aspects of the CCM of SAM program that were important to them, and their knowledge about SAM-related caring tasks as conveyed by the CHW. During discussions, caretakers developed a list of components of the CHW's work that were valuable to them, and a picture representing each was drawn. Caretakers were asked to agree on a ranking order for these program elements in terms of relative importance, by laying the pictures on a ranking line in order from "most important" to "least important", a method recommended by the International HIV/AIDS Alliance (2006).

3.4.3.1.3 Piloting

All semi-structured questionnaires used in FGDs were piloted before starting data collection. FGDs were piloted in cooperation with program management to determine clarity of questions and to identify the participatory methods that were most conducive to stimulating discussion. Supervisory staff with a strong field presence assisted in conveying the questions from the discussion guides in a way that caretakers would understand. Particular attention was paid to the Bangla words used to convey "quality of care" as this had created some confusion amongst caretakers in the first pilot sessions. Initially, caretakers were asked to score (in an exercise involving proportional piling with stones) the CHWs' activities from the indicator ranking. However it was difficult to get any variation in their scoring, with all groups assigning 100% quality to the program, regardless of how the questions were approached. Considering the difficulties in conveying this conceptual information, the focus of these sessions shifted to

discussing and ranking the aspects of the program that caretakers most valued, with the scoring as a side exercise. After the formal start of data collection, when SCUS staff were not present, caretakers felt more comfortable in assigning scores of less than 100%. Then the challenge became that they assigned lower scores because they wanted more of a particular service (even if they agreed that the current amount of services were adequate, "but if she visited more frequently/gave more RUTF it would be better"). So the scores reflected a mixture of program quantity and program quality. For these reasons, the scoring information was not included in the final analysis.

3.4.3.2 Data collection

Data was collected in March 2010. The Researcher and a Study Assistant facilitated FGDs using semi-structured questionnaires. Participants were informed that the research team was not affiliated with SCUS, that all comments would be kept anonymous, and that the purpose of the research was for a general interest in their experiences. Consent was obtained to tape record and to take notes during the sessions.

3.4.3.3 Sample size and participant selection

Four FGDs were conducted with between six and eight participants each (Krueger and Casey, 2008) for a total of 29 caretakers. CHWs or FOs selected between one and three caretakers per CHW catchment area using convenience sampling. Caretakers living near the community site where the FGD was held were favored since transportation costs were not reimbursed. The sample represented caretakers receiving services from a variety of CHWs. No identifying or socio-demographic information was collected from caretakers; however many were illiterate, and were believed to have low education and income levels.

CHW FGDs were conducted with CCM CHWs (four FGDs, 34 CHWs total) and CCM SAM+ CHWs (six FGDs, 49 CHWs total). Each FGD included between seven and nine CHWs (Krueger and Casey, 2008). FOs were requested to randomly select participants from the list of CHWs participating in the study.

3.4.3.4 Data entry

Hand-written notes were translated into English by Data Analysis and Technical Assistance (DATA) in Dhaka. Audio recordings were translated into English by a Sociology Masters student from the University of Dhaka who was hired as a translator.

3.4.3.5 Data analysis

Results from caretaker FGDs were coded and themes were compiled into a comprehensive matrix in Microsoft Word (Microsoft, 2010b) to observe patterns related to caretakers' perceptions of CHW service delivery (Miles and Huberman, 1994). Similarly, findings from ranking exercises were compiled into a matrix and then simplified by including only those indicators mentioned in two or more FGDs and sorting indicators by median rank. Results were organized by, and described according to, the elements in the quality of care framework. More details on this framework can be found in Chapter Four.

Transcriptions of CHW FGDs (both transcriptions of audio recordings and translation of hand-written notes) were categorized using provisional codes developed during piloting and initial analysis (e.g. workload, time allocation, pay/incentives, family stress, income generation, responsibility to community) (Saldaña, 2009). The categorized data were then analyzed for themes related to CHWs' work challenges and the processes they employed in addressing these challenges, using an iterative approach to identify a discrete number of themes (Saldaña, 2009,

Corbin and Strauss, 2008). Four manifest themes emerged from discussions: “stretching their time to accommodate increased workload”, “low pay causes shame and problems with family”, “prestige gained from work” and “limitations to usefulness of their services (i.e. treatment, advice, and referrals).” A comparative analysis highlighted differences between groups. Challenges from ranking exercises were compiled into one matrix for each group and then simplified by including only those challenges mentioned in two or more FGDs and sorting these by median rank.

3.5 Cost-effectiveness analysis

3.5.1 Research design

This analysis was conducted to compare the costs and effects of the facility-based management of SAM with CMAM protocols delivered by CHWs. Information on costs was collected in both the intervention upazila where the CCM of SAM was implemented with CHWs treating cases of SAM without complications and referring cases with complications to the UHC for a brief stabilization period, and in the comparison upazila where SCUS CHWs identified and referred all cases of SAM to the UHC. This analysis took a societal perspective, capturing not only costs to health care providers, but also direct and indirect costs incurred by participating households when accessing care for their child with SAM.

Program costs were estimated to isolate, to the extent possible, the incremental costs incurred in adding the CCM of SAM to the existing community-based health and nutrition program over the course of one year. An activity-based cost model was used wherein detailed program cost data was gathered and applied to activity-based cost centers. Effectiveness data were taken from

program monitoring databases used for the overarching study (Sadler et al., 2011). DALYs were calculated using program data and several assumptions.

3.5.2 Development of instruments

Several semi-structured questionnaires were developed to guide both key informant interviews with program officials and FGDs with caretakers of children who had accessed treatment for their child with SAM.

3.5.2.1 Key informant interviews

Provider cost information in terms of institutional costs (e.g. trainings, equipment, transportation, overhead, rent and utilities), personnel costs (and time allocation) and management structure was gathered via semi-structured key informant interviews with program officials and administrative and accounting staff from SCUS and the UHC, and review of key program, administrative and financial documents.

Time allocation was assessed during key informant interviews, taking a retrospective approach. During these interviews, the program timeline was reviewed, with major events and different periods of less or more intensive time allocation noted. Program and clinical staff at SCUS and UHC were asked about their regular activities related to management of SAM by day and week, then were asked the typical percentage of their time spent on these activities. The percent quoted was then translated into hours, and the interviewee was asked whether this sounded like an accurate estimate of time spent specifically on SAM-related activities. This would usually result in them revising their percentage slightly downwards to more accurately reflect their time allocation.

Where possible, time allocation was assessed for multiple employees with the same job description in order to triangulate time allocation estimates among particular types of staff. For example, Field Officers from unions of low and high SAM prevalence were interviewed and trends were used to estimate an overall time allocation percentage for field staff in each area. Further, time allocation estimates for CHWs in the intervention upazila were obtained from the CHW survey and focus group discussions, and for CHWs in the comparison upazila, the median value was used from key informant interviews with CHWs from unions with high, medium and low SAM prevalence.

Estimates from time allocation interviews were triangulated also with supervisory staff where possible, however due to the inherent nature of recall data, slight over- or under-estimations are possible. For those staff with whom a time allocation interview was not possible or impractical, an estimate of program-related time use was taken from administrative staff in charge of grant budgeting.

3.5.2.2 Focus group discussions

Participant cost estimates were obtained during focus group discussions conducted separately with caretakers of children with SAM receiving treatment in the intervention and comparison upazilas. A semi-structured discussion guide was used to ensure that all possible costs were covered. Caretakers were asked to discuss the time they spent in accessing SAM treatment, along with personal costs incurred in this process. When questions produced a range of estimates, the reasons for the discrepancy were discussed.

3.5.2.3 Piloting

Focus group discussions were piloted with caretakers to determine whether questions and discussion points were expressed clearly, and to identify which Bangla words should be used to

convey concepts. While it was not feasible to pilot key informant interview documents, they were reviewed with program staff to assess clarity and identify any major omissions.

3.5.3 Data collection

Data was collected in March and April 2010. The Researcher and a translator facilitated key informant interviews and FGDs using the semi-structured questionnaires. Participants were informed that the research team was not affiliated with SCUS, and that all comments would be kept anonymous. Caretakers in FGDs were informed that the purpose of the research was for a general interest in their experiences and the costs they incurred while accessing treatment for their child with SAM. Consent was obtained to tape record and to take notes during the sessions.

3.5.4 Sample size and participant selection

3.5.4.1 Key informant interviews

To capture provider costs, all relevant key informants were identified both at SCUS and the UHC, with a total of 32 interviews conducted. Key informants are listed below:

Ministry of Health (10 interviews total):

- 7 hospital staff at comparison UHC (including doctors, nurses, medical assistants and Upazila Health and Family Planning Officer) *
- 1 Upazila Health and Family Planning Officer at intervention UHC
- 1 civil surgeon at Divisional health headquarters in Barisal District Office
- 1 Health Engineer for Construction Maintenance Management Unit (CMMU) (for valuation of UHC buildings)

SCUS (22 interviews total):

- Field-level implementing staff in Bhola:
    - 3 Community health workers in comparison upazila (from unions with high, medium and low SAM prevalence)*
    - 2 Field Officers (FOs) in comparison upazila (from unions with high and low SAM prevalence) *
    - 1 Program Officer (PO) in comparison upazila (the direct manager of Field Officers) *
    - 2 Field Officers in intervention upazila (from unions with high and low SAM prevalence) *
    - 1 Program Officer in intervention upazila*
    - 3 Program Officers hired for the CMAM Study (2 in intervention upazila, 1 in comparison upazila) *
    - 1 Senior Program Officer hired for the CMAM study*
    - 1 Senior Program Officer for the overarching MCHN program*
    - 1 Assistant Finance Officer at Bhola District Team Office*
    - 1 Administrative Officer at Bhola District Team Office*
- Administrative/finance/management staff in Barisal and Dhaka:
    - 1 Deputy Program Manager for the MCHN program in Barisal Divisional Office*
    - 1 Development Assistance Program (DAP) Manager in Dhaka Central Office*
    - 1 Deputy Director of Grants and Budgets in Dhaka Central Office*
    - 1 Supply Chain Manager in Dhaka Central Office
    - 1 Deputy Program Manager for Nutrition in Dhaka Central Office*
    - 1 Deputy Country Director in Dhaka Central Office*

During key informant interviews, time allocation assessments were also conducted with all relevant staff, marked with asterisks "*" in the list above.

3.5.4.2 Focus group participants

To capture household costs, caretakers of children with SAM from participating households were selected from a range of unions (the lowest tier of regional administration) within the study area. This resulted in a sample of 28 participants in community treatment (four FGDs), 21 in inpatient treatment (four FGDs), and 25 in other outpatient care (three FGDs).

Participants were selected by FOs, who were instructed to randomly select, where possible, caretakers whose children had received SAM treatment in the community or facility. However random selection was not always possible in practice.

For discussions with caretakers who had attended the UHC in the comparison upazila, unions were chosen from which the most SAM cases had been admitted to the UHC. This was done for logistical purposes and for convenience of the caretakers as transportation was not provided. For discussions with caretakers who had received outpatient care from CHWs in the comparison upazila, participants were selected from various CHWs' catchment areas.

For discussions with caretakers of children who had received community case management of SAM in the intervention upazila, participants were chosen in different ways. In some FGDs, those who were close to the discussion site but from different CHW catchment areas were included. In other FGDs, caretakers were drawn from all nearby unions. In half of the FGDs, caretakers were selected from catchment areas of CHWs who were categorized into different "grades" (weak, medium, strong).

3.5.5 Data entry

Cost data were entered and cleaned using Microsoft Excel software (Microsoft, 2010a). All costs were converted from Bangladesh Taka to US Dollars using the exchange rate of 1 USD to 67.941 BDT (OANDA, 2010).

3.5.6 Data analysis

3.5.6.1 Cost center allocation

To apply activity-based costing, program activities were grouped into cost centers for analysis (Fiedler, 2003, Waters et al., 2001). Cost centers were comprehensive and mutually exclusive, providing a total cost of SAM treatment in intervention and comparison areas without double counting any of the resources used to produce the program. Cost centers were developed and finalized with support from relevant SCUS staff. For each cost center, costing algorithms were created in Microsoft Excel (Microsoft, 2010a) reflecting "standardized relationships between the quantities of and types of inputs required and the activities they produce that can be expressed as arithmetic relationships or equations" (Fiedler, 2009). Further detail on allocation of costs to cost centers can be found in Appendix Four.

3.5.6.2 Cost center error estimation

Errors were modeled for each cost center using the Researcher's estimations of uncertainty around the data sources, assuming normal errors to calculate a 95% credible interval on the baseline estimates for each cost center total (Tan-Torres Edejer et al., 2003). Minimum levels of uncertainty (5%) were estimated for cost centers which were based on hard copies of budget or expenditure information. Higher levels of uncertainty (20-40%) were estimated for cost centers incorporating data from time allocation interviews and focus group discussions. Further details on these estimates can be found in Table 3.1, and in Chapter Six.

Table 3.1: Cost center error estimates

Cost center	Intervention area cost & error est.	Comparison area cost & error est.	Source of Uncertainty
1. Monitoring	$16,075 (15-20%)	$7,685 (15-20%)	Time allocation est.
2. Trainings	$14,423 (5%)	$9,929 (5%)	
3. Supervision	$47,721 (15-20%)	$24,046 (15-20%)	Time allocation est.
4. GMP sessions	$3,043 (10%)	$1,803 (10%)	Time allocation est., GMP site shadow cost
5. Household visits	$1,981 (10%)	$3,512 (10%)	Time allocation est.
6. Curative care	$30,016 (5%)	$2,456 (10%)	BOR: medicines LAL: time allocation est., medicines
7. Household costs	$6,226 (35-40%)	$32,682 (35-40%)	Cost/time estimates from FGDs

3.5.6.3 Estimation of household costs

Household costs were estimated separately for households accessing community and inpatient treatment of SAM. Cost estimates from FGDs with caretakers were used to create costing algorithms based on standard patterns of treatment-seeking behavior in both areas, including length of stay in community and inpatient treatment, average number of visits to doctors, pharmacists and village doctors, and average costs incurred for medicines, doctor's fees and transport. Median values were used to calculate direct costs for each study upazila. To estimate indirect costs to households in terms of time spent accessing SAM treatment, the shadow wage used for CHWs was multiplied by the median time allocated for various activities.

3.5.6.4 Shadow price determination

During FGDs and key informant interviews, questions were asked to determine shadow prices of various input costs that did not have a market value. The value of CHW time was a key component of the costing for this community-based program. All CHWs were paid an honorarium of 800 Taka per month (slightly less than $12 USD), equating to less than five Taka per hour. In community discussions it was found that while for religious reasons not all women

worked outside the home, they usually had the option to participate in public works. This included food for work and cash for work programs that often entailed building roads or dams for basic remuneration in cash or kind. The average wage for this work was 100 Taka for a five hour workday, or 20 Taka per hour. This unskilled labor would be available to all women in the communities included in this study and reflects an opportunity cost for their time. In this costing analysis the 20 Taka wage was used as the shadow wage for both CHWs and caretakers of SAM children.

Shadow values were also estimated for rental of rooms in which meetings and trainings took place, if no estimates were available in official budgets.

3.5.6.5 DALY estimation

Disability-adjusted life years (DALYs) are a common metric used to compare the cost-effectiveness of programs treating different health outcomes. DALYs were calculated using the following key assumptions:

- Age at death: assumed that most deaths would occur within one year of admission, or six months after date of program admission
- Life expectancy: based on local life-tables separated by gender for age group 1-4 (WHO, 2009)
- Age of onset: age at admission
- Duration of disability: 6 months on average
- Discount rate: 0.03
- Age weight: 0.04
- Disability weight: Death=1, wasting=0.053 (WHO, 2004)

- Deaths and survivals in absence of treatment: A value appropriate for our mean admission MUAC (106.7 mm) was calculated using linear interpolation and published data with cohorts of patients similar to those in our program. (Briend and Zimicki, 1986, Briend et al., 1987, Vella et al., 1994, Pelletier et al., 1993)

Additional detail on DALY estimation can be found in Appendix Five.

3.5.6.6 Cost-effectiveness analysis

The information in this section describes aspects of the analysis which were not recorded in the full analysis. Further details on cost-effectiveness analysis methods can be found in Chapter Six.

3.5.6.6.1 'Base case' versus 'Best case' modeling

As demonstrated by the number of refused referrals in the comparison area (see Chapter Six), even if the UHC were functioning efficiently many caretakers would not want or be able to attend for personal reasons. However, the Study Team felt that the observed program results did not provide an accurate reflection of how the UHC could manage SAM given adequate personnel and beds. To this end, a "best case" scenario was modeled.

Studies testing the improvements in facility-based outcomes gained by implementing WHO guidelines for inpatient management of SAM in developing countries have shown a decrease in SAM case fatality rates by 40-50% (Ahmed et al., 1999, Ashworth et al., 2004). It is plausible that with increased capacity including beds, personnel and supervision, a modest improvement in coverage, recovery and default might be observed at facility level in Bhola. We modeled this by marginally increasing coverage and recovery rates (+20%), and decreasing default rates (-20%). This "best case" might represent costs and effects possible given significant inputs and support to expand capacity for inpatient care in UHCs in Bangladesh.

3.5.6.6.2 Probabilistic sensitivity analysis

Uncertainty for all parameters—except for those with standard assumptions (discount rate, age weight, and disability weight)—was estimated using Monte Carlo simulations, also called "bootstrapping" (Efron and Gong, 1983, Briggs et al., 1997). This is a non-parametric method which generates multiple samples by sampling with replacement from the available data. For each parameter, one million replicates were drawn from the defined distributions (see Appendix Five for more details regarding assumptions and distributions used in DALY estimations). These replicates simulated one million "programs", estimating sample variability and creating a 95% confidence interval around each estimate.

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4 Chapter 4: Article #1: Quality of care for severe acute malnutrition delivered by community health workers in southern Bangladesh

By Chloe Puett, Jennifer Coates, Harold Alderman and Kate Sadler

Abstract: This study assessed the quality of care provided by community health workers (CHWs) in managing cases of severe acute malnutrition (SAM) according to a treatment algorithm. A mixed methods approach was employed to provide perspectives on different aspects of quality of care, including technical competence and acceptability to caretakers. Children were screened at community level using a mid-upper arm circumference (MUAC) measurement and cases without medical complications were treated by CHWs. 55 case management observations were conducted, with 89.1% (95% CI: 77.8 – 95.9%) of CHWs achieving 90% error-free case management or higher. Caretakers perceived CHWs' services as acceptable and valuable, with doorstep delivery of services promoting early presentation in this remote area of Bangladesh. Integration of the treatment of SAM into community-based health and nutrition programs appears to be feasible and effective. In this setting, well-trained and supervised CHWs were able to effectively manage cases of SAM. These findings suggest the feasibility of further decentralization of treatment from current CMAM delivery models.

Keywords: community-based management of acute malnutrition; community health workers; child nutrition; severe acute malnutrition; quality of care; mixed methods; Bangladesh.

1. Introduction

Severe acute malnutrition (SAM), defined by severe wasting and/or nutritional edema (WHO, 1999), reflects recent illness and nutrient deficits and is the cause of one to two million preventable child deaths each year (Collins et al., 2006a). The South Asia region has among the highest burdens of SAM (Black et al., 2008), with Bangladesh experiencing a SAM prevalence of 3% (NIPORT et al., 2009). A prevalence of 1% has been indicated as a threshold for crisis due to high associated mortality (Mason, 2002). Recent advances in the treatment of SAM have enabled children suffering from the condition to recover at home, rather than in crowded therapeutic feeding centers or under-resourced, over-burdened health facilities (Collins et al., 2006b). Due to its promising performance in promoting recovery from SAM, community-based management of acute malnutrition (CMAM) has been widely adopted as the most appropriate model of care for children with SAM in emergencies; the United Nations supports its integration with other community-based health and nutrition activities in areas with a high burden of SAM (WHO et al., 2007, Collins et al., 2006a).

Until recently, outpatient treatment in CMAM has been delivered by trained health workers from primary care facilities. While this has improved coverage in many settings, there are still challenges for the poorest people to access this level of care (Guerrero et al., 2010).

Community health workers (CHWs), defined as non-professional workers having limited education and coming from the communities they serve (Lehmann and Sanders, 2007), have direct access to some of the most underserved communities. Health services focused on preventive care commonly rely on CHWs, and their ubiquity at the community level makes them a viable candidate for performing simple, life-saving tasks. With the development of community-

based strategies such as community case management (CCM) and community-based integrated management of childhood illness (C-IMCI), the role of the CHW has further expanded to include the provision of curative care (Marsh et al., 2008, Marsh et al., 2009, CORE Group, 2009), and the World Health Organization has started to explore the possibility of incorporating treatment of SAM into its IMCI protocols (Dr. André Briend, personal communication).

Studies contributing research on models for best service delivery practices in this area are therefore timely.

However, there is limited evidence regarding quality of care outcomes when adding the treatment of SAM to existing community-based services, particularly when delivered by a cadre of CHWs with limited formal training and support. One study in Malawi compared outcomes for cases of acute malnutrition treated by medical professionals to cases handled by community health aids with no medical training. No differences in recovery rate were found between the two groups, with an average 89% recovery rate: an acceptable outcome by international standards (Linneman et al., 2007). Another study demonstrated good recovery rates (93.7%) in children with SAM during a famine in Malawi using a CMAM approach delivered by trained community health aids alone (Amthor et al., 2009).

Quality of care has different meanings, ranging from technical competence to the interpersonal dimensions of care, and the perceived importance of these dimensions often varies by context and stakeholder (Bruce, 1990). Program beneficiaries' awareness of, and satisfaction with, a program are important components of quality of care, influencing participation, compliance and program effectiveness (Gilson et al., 1994, Guerrero et al., 2010). Therefore it is crucial to understand quality of care both from the perspective of care providers and recipients.

This study, the first trial of its kind in Asia, assesses the quality of care provided by CHWs in the provision of CMAM protocols. It takes a mixed methods approach to provide perspectives on different aspects of quality of care. The first objective of the study was to measure CHWs' technical competence in managing cases of SAM according to a treatment algorithm. The second objective was to examine subjective aspects of quality of care, by assessing elements of CHW service delivery that were valued by caretakers. The results contribute evidence of the effectiveness of CHWs in the management of SAM, with implications for the further decentralization of treatment from current CMAM delivery models.

2. Methods

2.1 Description of the program

This study was conducted to assess an innovative service delivery model for CMAM implemented as part of a broader maternal and child health and nutrition (MCHN) initiative by Save the Children (US) (SCUS) in southern Bangladesh. Initial CHW selection was merit-based, with SCUS program personnel ranking candidates on the basis of an exam score and choosing the candidate with the highest score in her EPI area. CHWs provided routine preventive care, including counseling and growth monitoring and promotion (GMP). In September 2007 they received an additional three-day training to implement community case management (CCM) of pneumonia and diarrhea, which included diagnosis of illness and treatment protocols that used antibiotics. In June 2009, all CHWs in one upazila (the second lowest tier of regional administration) of Bhola district, Barisal division, participated in a two-day training in the CCM of SAM, which included the diagnosis of SAM and treatment protocols that used ready to use therapeutic foods (Valid International, 2006). CHWs screened for cases of SAM in children less

than three years by measuring mid-upper arm circumference (MUAC) during household visits and monthly GMP sessions.

Children identified as having SAM, defined by a MUAC measurement less than 110 mm and/or presence of edema (WHO et al., 2007), were classified into two groups. Those children suffering from SAM with complications (defined by absent or poor appetite and/or severe illness) received inpatient treatment at the upazila health complex (UHC) according to National Guidelines (IPHN et al., 2008). After complications were resolved, the child returned to the community for weekly outpatient treatment with ready to use therapeutic foods (RUTF) provided by CHWs until recovered. Children suffering from SAM with no complications were monitored and provided RUTF each week by the CHW until recovery (defined by 15% weight gain and MUAC>110 mm), according to study protocol.

Supervision and program attributes are outlined in Table 4.1. CHWs received support from their regular supervisors in addition to a team of Program Officers (POs) hired by SCUS specifically to provide technical guidance for CCM of SAM activities. All CHWs received routine supervision, monthly refresher trainings with a per diem of 200 Taka (US$2.94), and a monthly stipend of 800 Taka (US$11.80). Refresher trainings included a bimonthly two-day intensive session on technical aspects of the MCHN program, providing a forum for CHWs to ask questions and receive feedback.

2.2 Conceptual framework

The inquiry was guided by an adapted quality of care framework (Bruce, 1990) incorporating caretaker satisfaction as a critical factor influencing program participation, compliance and effectiveness (Gilson et al., 1994, Guerrero et al., 2010). This framework, originating from the

family planning literature, shares the focus of CMAM programs on alleviating factors constraining community participation in order to increase acceptability and utilization of services (Collins et al., 2006a, Guerrero et al., 2010). All elements in the framework represent dimensions of patient satisfaction that are commonly used to measure patients' perceived quality of care (van Campen et al., 1995). The framework was adapted to include factors related to CMAM programming, and to include impacts expected from achieving intermediate program outcomes such as caretaker awareness and satisfaction. This adapted framework provides a structure with which to describe both subjective and objective aspects of CHWs' quality of care. Figure 4.1: The quality of care framework displays the adapted framework and the hypothesized connections between the quality of program services received and program outcomes and impacts.

Service quality is conceptualized as having five interrelated elements that are of importance to care recipients. *Appropriate array of nutrition services* refers to all activities undertaken by the CHW to prevent malnutrition and to manage cases of SAM at community level. This includes monthly weight measurement at GMP sessions, screening for SAM and diagnosis with a MUAC measurement, provision of antibiotic and folic acid for cases of SAM, and delivery of RUTF until child's recovery from SAM. *Information given* refers both to preventive and curative nutrition counseling with caretakers, and the CHWs' ability to answer caretakers' questions. *Technical competence* refers both to an objective assessment of CHWs' ability to manage cases of SAM using a quality of care checklist, and caretakers' impressions of CHWs' ability to manage cases of SAM. *Interpersonal skills* encompass the caretakers' trust and willingness to listen to the CHW. *Follow-up mechanisms* include points of interaction with CHWs and caretakers to follow-up on the child's nutrition status, including household visits and GMP sessions. All five elements were evaluated in this analysis.

2.3 Quantitative methods

Trained surveyors assessed CHWs' performance with a quality of care checklist during observation of management of a case of SAM.

2.3.1 Sample description

One hundred ninety seven (197) CHWs were randomly selected out of a total population of 261. Due to low SAM prevalence during the months of data collection, it was not possible to conduct a case management observation with every CHW in this sample. Efforts were made to observe all CHWs who had a child with SAM in their catchment area during this time. In total, 55 CHWs were assessed. As these 55 CHWs were not randomly selected, but rather represent a subsample of randomly selected CHWs implementing the CCM of SAM, the possibility that their personal characteristics influenced their score outcomes was explored during data analysis.

2.3.2 Data collection

A cross-sectional survey of CHWs and case management observations were conducted between February and April 2010. The survey contained questions regarding CHWs' demographic and professional characteristics. The case management observation used a quality of care checklist based on a CMAM classification algorithm and treatment protocols adapted to this program (Collins, 2004). Each checklist item had a categorical score ("correct" or "incorrect") with an option to mark "not applicable" if an item did not apply to a particular case. Informed consent was obtained from all CHWs participating in the study.

Data were collected by 19 surveyors, who were also CHW supervisors. They were chosen for their existing relationship with CHWs, and were expected to put CHWs at ease compared to an unfamiliar third party observing their work. Standardization training was conducted prior to data

collection with role plays and discussion around “good” versus poor practice for each checklist item. Training included a discussion around the importance of “negative” outcomes in research, to assure surveyors that negative scores from CHWs would not reflect poorly on their own job performance.

2.4 Qualitative methods

FGDs with caretakers were used to contextualize CHWs’ performance by assessing aspects of service delivery that were valued by caretakers.

2.4.1 Sample description

FGDs were conducted with caretakers of children accessing SAM treatment. Each FGD included between six and eight caretakers (Krueger and Casey, 2008) resulting in 29 caretakers total. CHWs or supervisors selected between one and three caretakers per CHW catchment area using convenience sampling. Caretakers living near the community site where the FGD was held were favored since transportation costs were not reimbursed. The sample represents caretakers receiving services from a variety of CHWs. No identifying or socio-demographic information was collected from caretakers; however many were illiterate, and were believed to have low education and income levels.

2.4.2 Data collection

Participants developed their own indicators of quality of care and ranked them according to perceived importance. The researcher and a study assistant facilitated discussions using a semi-structured questionnaire. Each session was tape-recorded, and notes were taken. Caretakers were informed that the research team was not affiliated with SCUS, that all comments would be kept

anonymous, and that the purpose of the research was for a general interest in their views. Informed consent was obtained from all caretakers participating in the study.

2.5 Data analysis

2.5.1 Quality of care checklist scoring

Based on their performance on the checklist, a maximum possible score was calculated for each CHW as total correct responses divided by total applicable items. “Good quality” was defined as achieving at least 90% error-free case management, a standard used in other CCM quality of care analyses (Degefie et al., 2009). Edema and SAM with complications was rare; therefore checklist items assessing CHWs’ competency in measuring edema grades and referring complicated cases were not included in final score calculations.

2.5.2 Statistical analysis

Descriptive statistics were calculated for CHWs’ demographic and professional characteristics. Significance tests were conducted to determine whether there were statistical differences in these variables between assessed and non-assessed CHWs that could bias the findings. A Wilcoxon signed-rank test was used to assess the difference between median checklist score and the standard quality score of 90%. A binomial test was used to calculate a 95% confidence interval for the proportion of subjects scoring 90% or better on the checklist. The statistical software “R” was used for binomial tests (R Development Core Team, 2010). Stata statistical software version 11.0 was used for significance tests (StataCorp, 2009).

2.5.3 Qualitative analysis

Results from FGDs were coded and themes were compiled into a comprehensive matrix in Microsoft Word (Microsoft, 2010b) to observe patterns related to caretakers' perceptions of CHW service delivery (Miles and Huberman, 1994). Similarly, findings from ranking exercises were compiled into a matrix and then simplified by including only those indicators mentioned in two or more FGDs and sorting indicators by median rank. Finally, results were organized by, and described according to, the elements in the quality of care framework (Figure 4.1: The quality of care framework).

3. Results

3.1 Sample characteristics

Table 4.2 presents demographic and socioeconomic characteristics of the overall sample, and compares CHWs who were assessed with the quality of care checklist and those who were not. On average, CHWs were 28.5 years old, married, and had completed at least eighth grade education. One quarter attended madrasa schools. Their households had five to six members, including two children. Less than one quarter of these women did other work for pay; those that did were mainly engaged in semi-skilled labor such as poultry rearing and tailoring. One half of the sample had electricity in their homes, while nearly all had a rudimentary tin roof.

Due to low SAM prevalence during the months of data collection, not all randomly-selected CHWs could be assessed while managing a case of SAM. There were few significant demographic differences between assessed and non-assessed CHWs. Occupation patterns differed between groups, with a higher percentage of assessed CHWs engaged in paid work outside the home. Differences in husbands' occupation were significant, with spouses of non-

assessed CHWs engaged in more professional and technical work than spouses of assessed CHWs, who undertook more unskilled and semi-skilled labor. These findings suggest that the assessed CHWs in this analysis may come from poorer households than their non-assessed counterparts. Further, assessed and non-assessed CHWs did not differ significantly in their perceptions of work support and other professional characteristics (data not shown). In summation, assessed and non-assessed CHW groups may be different from one another; however these differences do not suggest that assessed CHWs were more skilled.

3.2 Quantitative results

CHWs' management of cases of SAM without complications according to algorithm was of high quality, with 58.2% of the sample (32 out of 55 CHWs) achieving 100% error-free case management. The median score of 100% was significantly different from the standard high quality score of 90% (Wilcoxon signed rank: $z=5.56$, $p<0.001$). A majority of assessed CHWs (89.09%; 95% CI for proportion: 77.75 – 95.89) achieved scores above 90% on the checklist. Results are summarized in Table 4.3.

CHWs assessed MUAC accurately, and delivered the correct education messages to caretakers of children with SAM. Small numbers of CHWs did not administer antibiotics and folic acid when they should have; similarly some forgot education messages such as reminding to breastfeed before giving RUTF.

3.3 Qualitative results

3.3.1 Indicator ranking matrix

Table 4.4 summarizes aspects of CHW services that were valued by caretakers, ranked according to their perceived importance, with one being very important and eight being less important.

Items prioritized by caretakers reflect several elements of service provision from the quality of care framework (Figure 4.1: The quality of care framework). The provision of RUTF was ranked first in all but one FGD, suggesting that caretakers found the nutritional treatment provided by the CHW to be appropriate. Other ranked indicators representing nutrition services and follow-up mechanisms included monthly weighing sessions and check-up activities during household visits for sick children. Caretakers appreciated CHWs' friendly, inclusive demeanor, indicating a value placed on interpersonal skills. They also valued information given by the CHW in terms of both general counseling and specific feedback on feeding and hygiene practices.

3.3.2 Caretaker perceptions of service delivery

Several themes emerged during discussions with caretakers related to their perceptions of the quality of services received, many of which support findings detailed by the indicator ranking exercise above.

3.3.2.1 Interpersonal skills and technical competence:

CHWs came from the same community, and caretakers felt they were "*very close to us mentally*." But being literate, CHWs could also "*read papers*" and subsequently "*know many systems*." This combination of familiarity and learnedness inspired the community's trust. The CHW gave "*good answers*" to questions about the unfamiliar treatment their children received. Caretakers expressed their appreciation through actions like saying prayers for CHWs at mosque.

3.3.2.2 Information given and follow-up mechanisms:

Caretakers regularly praised CHWs' dedication to sharing their knowledge. This indicated a trusting relationship with the CHW, developed over the five-year program. The CHW gave

information about feeding and hygiene that was "*new*" and "*different*" to that which they had heard from their families, and explained the health benefits of these practices. She provided practical demonstrations, and helped husbands and other family members to understand the advice. CHWs made regular household visits to share this advice and follow up on questions: "*sometimes she came two times per day to our houses to help us. Our children are well now*."

3.3.2.3 Appropriate array of nutrition services

In general, caretakers had no trouble understanding and applying the CHW's advice. Their children found RUTF to be acceptable and enjoyable, eating it more easily than their regular food. However they found it difficult to spend the amount of time with their child that the CHW recommended, especially for responsive feeding. "*Sometimes we cannot follow apa's advice because we forget it, and we have lack of time to follow it.*" Further, for those complicated cases of SAM that the CHW referred to the health facility for treatment, caretakers said they "*feel pleasure*" if they can avoid going to the hospital.

Caretakers were pleased about their children's fast recovery from SAM. Previously "*attacked*" by illness, their thin children were "*corrected quickly*" and "*became round*" after treatment. However, for many it was a challenge to maintain the child's weight gain after discharge. Children "*still want RUTF, but not other food*", and families couldn't "*give other food to their mouths*". According to caretakers, after discharge their children "*became thin*" "*like earlier*" due in part to a return to regular household food, lack of time for responsive feeding and exposure to infection.

4. Discussion

This study demonstrates that in this context, well-supervised and trained CHWs were able to deliver CMAM with high quality of care, and were trusted by the community. The high quality service provision and community satisfaction and demand cohere with effectiveness outcomes from a linked analysis of outcome data for this program, including high coverage (89%), low default (7.5%), high recovery (92%) and low mortality rates (0.1%) (Sadler et al., 2011).

4.1 CHW technical competence

CHWs managed cases of SAM without complications according to algorithm with high quality of care. A majority of CHWs (89.09%, 77.75-95.89) achieved 90% or higher error-free case management. This supports findings from other studies suggesting that community-level workers can successfully manage SAM (Amthor et al., 2009, Linneman et al., 2007). Field trials have also found CHWs to be capable of effectively diagnosing and treating neonatal sepsis according to a clinical algorithm, and treating severe disease in neonates with a lower case fatality rate than other available treatment options (Bang et al., 2005b, Baqui et al., 2009). Village health workers in India correctly diagnosed 89% of neonatal sepsis cases, and correctly treated 81% (Bang et al., 2005b). One study in Bangladesh validating CHWs' ability to correctly identify sick neonates and manage certain illnesses according to a clinical algorithm showed strong agreement between CHWs' and physicians' classifications (Darmstadt et al., 2009). In Nepal, community members trained in the antimicrobial treatment of pneumonia achieved significant reductions (28%) in child mortality due not only to pneumonia but also to diarrhea and measles (Pandey et al., 1991).

4.2 Caretaker perceptions of service delivery

High scores on the quality of care checklist demonstrate the strong technical competence of CHWs; positive caretaker perceptions of quality of care support these results. Several aspects of quality were particularly important to caretakers. Their prioritization of CHWs' provision of RUTF in ranking exercises suggests that communities saw the need for this treatment and recognized that RUTF was appropriate for the condition. This was due in part to the rapid recovery of children with SAM, which has been found in other studies to influence positive community perceptions of CMAM programs and to enhance participation (Collins et al., 2006b). Further, services were delivered to the doorstep, an important factor given women's limited mobility in these areas. These elements supported awareness of and access to the program, which have been found to be key determinants of community participation (Rosato et al., 2008), and therefore program utilization and coverage, in other studies (George et al., 2009, Guerrero et al., 2010).

One complaint was linked to caretakers' perceived inability to maintain their child's weight after program exit, although re-admission to the program occurred in only 2.5% of admissions (Sadler et al., 2011). While their children may not have relapsed into SAM, some caretakers were displeased that they could not maintain their discharge weight. This finding points to the utility of delivering care for SAM within a broader package of community-based MCHN interventions, all aiming to prevent malnutrition and sustain good nutritional status, thereby complementing efforts to treat acute malnutrition in those few children for whom this is necessary.

Discussions of CHW competence often referred to their trusting relationship with caretakers. Other studies have also found that care recipients are most comfortable with health workers with

whom they share common attributes (Bruce, 1990, Bang et al., 1994, Rosato et al., 2008), and that care recipients place greater importance on care providers' attitudes and length of contact time than on more traditional elements of quality care such as technical skills (Bruce, 1990, Sung, 1977, Gilson et al., 1994, George et al., 2009). Further, CHWs visited the houses of children with SAM once a week or more. These regular follow-up visits, a common factor in community perception of high quality care (Bruce, 1990), may also be particularly important for SAM treatment in that they provide a continued mechanism to raise awareness about the importance of proper care and treatment (Guerrero et al., 2010).

4.3 Generalizability

This intervention built on the skills of a cadre of CHWs with more than three years' experience in the MCHN program, and two years' experience implementing CCM of pneumonia and diarrhea. They had encountered severely malnourished children via monthly weighing sessions, and knew that these children did not always recover with counseling alone. Training them in the CCM of SAM expanded their understanding of malnutrition and provided an option for effectively treating these children.

CHW motivation is a complex phenomenon, resulting from many contributing intrinsic and extrinsic factors including training, payment, socioeconomic status and a supportive work environment (Bhattacharyya et al., 2001). This program supported CHW technical competence via training and supervisory mechanisms. Further, CHWs received remuneration, and were respected by their communities. Taken together, these factors contributed to a motivated and mobilized cadre of workers, a critical factor for promoting community participation and program effectiveness (Rosato et al., 2008).

The level of support required by CHWs went through two distinct phases. In the first two to three months of implementation, they required more supervision. During this period they received regular supervisory visits, and were further encouraged to call supervisors for assistance if needed when managing a case of SAM. Additionally, technical issues were discussed during monthly refresher trainings. After this initial phase, according to discussions with program management, CHWs were technically sound and confident, and support shifted more to administrative aspects like record-keeping. During discussions, program managers suggested that quality of care could be maintained with fewer supervisors, if tasks such as data entry were shifted from supervisor's workloads, allowing them more time for direct CHW supervision. Supervisory ratios in this program were below optimal levels, at 1:25-40 (Table 4.1) compared to 1:10-20 (Mason et al., 2006). Further research could determine optimal supervisory workloads to maintain quality of care at reasonable costs.

This study has several limitations. First, data were collected during a dry season with low SAM prevalence. It is possible that increases in caseload during the rainy season may impact quality of care, although individual CHWs experienced low SAM caseloads on average over the course of the year (Table 4.1). The presence of researchers during FGDs may have introduced some observer bias into the qualitative data collection process (Campbell et al., 1995). However, discussions were structured in such a way as to evoke honest responses, with opinions elicited from all participants and any differences in opinion discussed. Additionally, it is possible that the observation of case management sessions by supervisors may have affected CHWs' quality of care outcomes (Rowe et al., 2006, Rowe et al., 2002). However, CHWs in this program were accustomed to supervisory observation during household visits. Further, given lack of variability in quality of care outcomes in this analysis, we were unable to statistically analyze factors related

to quality. Finally, this work was enabled by CHWs' ability to prescribe antibiotics, an important component of the medical protocol to treat SAM without which effectiveness and therefore quality might suffer. As this is not yet the case in many other countries, this issue would need to be addressed at policy level and limits generalizability of these findings.

5. Conclusions and future directions

Integration into the CCM package of services appears to support high quality of care for cases of SAM, and therefore to promote program effectiveness. CHWs achieved good quality of care while managing cases of SAM without complications according to a treatment algorithm. A high level of trust for CHWs among caretakers contributed to community participation and compliance with the program. This suggests that well-trained and supervised CHWs can effectively manage SAM, and that policy change such as enabling CHWs with training and resources that supports this intervention should be promoted.

CHWs could provide a mechanism for delivery of high quality treatment to large numbers of children in countries like Bangladesh where prevalence of SAM is high but access to health facilities is low for poor families.

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7. Tables and Figures

Table 4.1: CHW supervisory structure and workload

Program characteristic	
Number of CHWs per supervisor	25 – 40
Monthly supervision visits (excluding questions via phone)	1 – 2
Frequency of refresher trainings	1/month
Proportion (hours) of refresher training spent on management of SAM	25% (2-4 hours)
Number of households per CHW	150 – 225
Average household and population size per CHW catchment area	175 HH, 875 pop'n.
Average monthly SAM caseload *	1-2
Number of SAM cases per CHW identified over course of one-year project	1-4

* Includes new and follow-up cases.

Table 4.2: Demographic and socioeconomic characteristics of CHWs

Characteristic	*Overall* *N*=197	*Assessed* *N*=55	*Non-assessed* *N*=142
	100%	27.9%	72.1%
Background			
Age – mean ± SD	28.5 ± 6.0	28.4 + 5.8	28.5 + 6.1
Marital status:			
Married	96.4%	96.4%	96.5%
Widowed	2.5%	1.8%	2.8%
Divorced	0.5%	0	0.7%
Separated	0.5%	1.8%	0
Highest completed education:			
Primary (0-5)	0.5%	0	0.7%
Lower Secondary (6-8)	54.3%	67.3%	49.3%
Secondary (8-10)	36.0%	29.1%	38.7%
High Secondary (11, 12)	7.6%	3.6%	9.2%
Graduate (Bachelors)	1.5%	0	2.1%
Education system:			
General	71.1%	63.6%	73.9%
Madrasa	28.9%	36.4%	26.1%
Household size – mean ± SD	5.4 ± 2.4	5.7 ± 3.1	5.3 ± 2.1
No. of children – mean ± SD	2.0 ± 0.9	2.1 ± 1.0	1.9 ± 1.0
No. of male children – mean ± SD	1.0 ± 0.8	0.9 ± 0.8	1.0 ± 0.8
Socioeconomic Status			
CHW does other work for pay *	(*N*=195)	(*N*=55)	(*N*=140)
No other paid work	83.6%	72.7%	87.9%
Skilled/semi-skilled work	13.3%	20.0%	10.7%
Professional work	3.1%	7.3%	1.4%
Husband's occupation level ***	(*N*=144)	(*N*=43)	(*N*=101)
Does not work for money	5.6%	4.7%	5.9%
Unskilled work	10.4%	23.3%	5.0%
Semi-skilled/Skilled work	68.8%	72.1%	67.3%
Professional/technical work	15.3%	0	21.8%
	(*N*=196)	(*N*=55)	(*N*=141)
Homestead has electricity	48.0%	50.9%	46.8%
Homestead has rudimentary roof (tin)	99.5%	100%	99.3%

* $p < .05$, ** $p < .01$, *** $p < .001$; for significance of difference between CHW groups (Wilcoxon Mann-Whitney test, Pearson's Chi Square, Fisher's exact test or t-test for independent samples as appropriate).

Table 4.3: Management of cases of SAM without complications

Checklist item	N[¥], % correct
Overall % error-free case management: N, median (range)	55, 100%[***] (66.7-100)
1. *Type of child:*	
a) New SAM case	32, 58.2
b) Follow-up SAM case	23, 41.8
2. *MUAC measurement*	
a) Keep work at eye level.	55, 100
b) Remove clothing covering arm.	55, 100
c) Find approximate midpoint of child's arm.	55, 100
d) Make sure arm is relaxed at child's side and wrap tape around arm.	55, 100
e) Make sure tape is flat and not too tight or loose.	55, 96.4
f) Read measurement number on MUAC strip.	55, 96.4
3. *Edema check (in sick children only):*	
a) Press firmly on top of child's feet for 3 seconds.	24, 100
b) Release, and feel pressed spot for indentation	24, 95.8
4. *SAM diagnosis:*	
a) MUAC <110.	55, 98.2
b) Presence of Edema.	45, 100
c) Check for SAM with or without complications according to algorithm.	
1. Check for danger signs.	55, 100
2. Check for chest indrawing.	55, 100
3. Count respiratory rate according to protocol.	55, 100
4. Take temperature.	55, 98.2
5. Examine for dehydration.	55, 92.7
5. *Check appetite:* Give packet of RUTF to child.	55, 98.2
6. *If SAM without complications identified:*	
• Antibiotic given according to protocol	55, 89.1
• Folic acid given according to protocol	55, 92.7
• RUTF given and amount calculated according to protocol	55, 96.4
7. *Delivery of education messages:*	
a) RUTF should replace the regular diet (except for breast milk)	55, 92.7
b) RUTF should not be shared with siblings or other children.	55, 96.4
c) Give frequent feedings with small amount of RUTF (up to 8x/day)	55, 98.2
d) Any child 6-12 months who is breastfed should receive breast milk first then RUTF.	54, 87.3
e) Give adequate amounts of safe water with RUTF.	55, 96.4

Checklist item	N[¥], % correct
f) Do not mix water in the RUTF packet.	55, 92.7
g) Give the medicine provided by your CHW 2 x per day for 5 days.	55, 92.7
h) Seek immediate advice from the CHW if your child experiences any allergic reactions after consuming RUTF.	55, 92.7

*** p < .001; for significance of difference between reported median score and a hypothesized median score of 90% (Wilcoxon signed-rank test).

[¥]Because some items were designated "not applicable" for a particular case, not every CHW implemented every measure on this checklist and for some items N<55.

Table 4.4: CHW services indicator ranking matrix

Indicators of CHW services	Median rank (range)	# FGDs reporting
Brings RUTF for child	1 (1-2)	4
Gives us advice for our children[1]	1.5 (1-2)	2
Treats everyone nicely	3 (2-4)	2
Comes to our house and takes care of our children	3 (2-7)	4
Checks for problems in child (temperature, breathing count, edema)	4 (4-6)	4
Helps us understand how to feed child, using the Promise Sheet[2]	5 (3-7)	3
Taught us to wash hands before feeding child	5.5 (5-6)	2
Weighs child monthly at GMP session	7.5 (7-8)	2
Tells us to give oil and khichuri to child	8 (6-8)	3

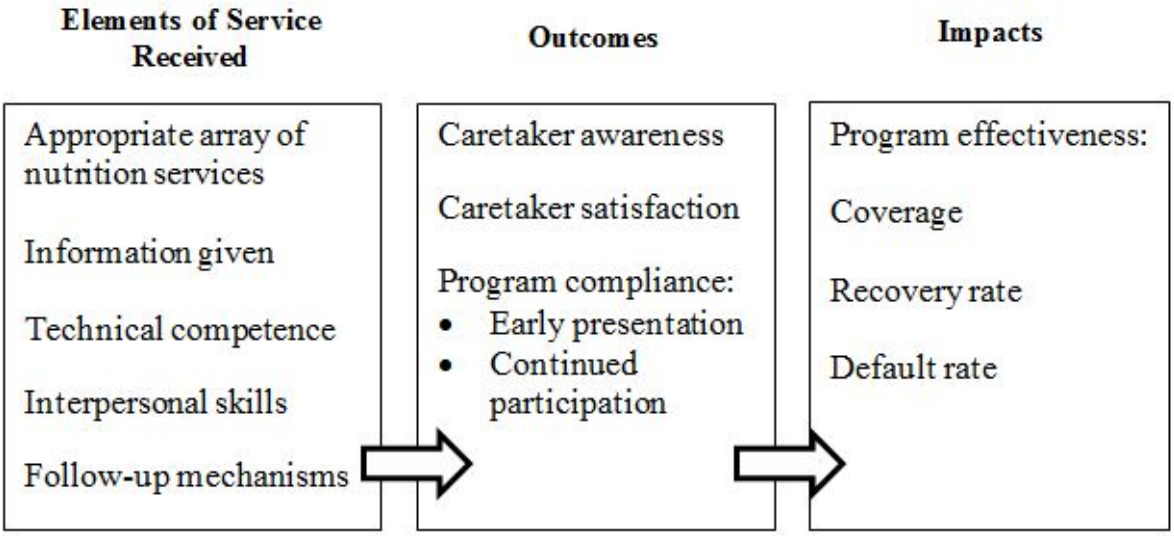
Number of FGDs=4

Each group listed 7-9 indicators for ranking. Only those indicators mentioned in two or more FGDs were included.

[1]This represents general advice, not specifically related to feeding.

[2]A communication tool about feeding practices developed for CHWs by SCUS.

Figure 4.1: The quality of care framework



Adapted from Bruce (1990)

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5 Chapter 5: Article #2: Does greater workload lead to reduced quality of preventive and curative care among CHWs in Bangladesh?

By Chloe Puett, Jennifer Coates, Harold Alderman, Salim Sadruddin and Kate Sadler

Abstract: This study analyzed the quality of preventive and curative care provided by two groups of community health workers (CHWs) with different workloads in southern Bangladesh: one group providing preventive care in addition to implementing community case management (CCM) of pneumonia and diarrhea, and another group additionally treating severe acute malnutrition (SAM). Preventive care was measured via case management observation at a routine household visit, in terms of CHWs' ability to provide nutrition counseling, to communicate with caretakers and to negotiate improved practices. Curative care, in terms of adherence to CCM guidelines, was measured via case scenarios. Qualitative methods were used to contextualize CHWs' performance by examining their perceptions of challenges related to their workload. 338 CHWs were assessed. The CHWs who were managing cases of SAM worked significantly more hours than the other group, but maintained quality of care on curative and preventive work tasks. The additional trainings and increased curative practice appeared to reinforce their basic curative knowledge and skills. Effectively treating cases of SAM appeared to motivate CHWs. However, CHW workloads had consequences for their domestic life, and further increases in workload may not be possible without additional incentives. This was one of the first trials adding the treatment of SAM to a CHW workload and suggests that adding SAM to a well-trained and supervised CHW's workload, including preventive and curative tasks, does not necessarily yield lower quality of care.

Keywords: community health workers; quality of care; time allocation; community-based management of acute malnutrition; child nutrition; severe acute malnutrition; mixed methods; Bangladesh.

1. Introduction

Community health workers (CHWs) are often defined as non-professional health providers, typically having some level of primary education, who come from the communities they serve (Lehmann and Sanders, 2007). Valued as frontline workers, they are asked increasingly to carry out diverse tasks at the community level (Winch et al., 2005). This study analyzed a project in southern Bangladesh using CHWs to deliver a package of health services including routine preventive care and curative treatment for pneumonia, diarrhea and severe acute malnutrition (SAM). This was one of the first trials adding the treatment of SAM to a CHW workload. This study therefore provides one of the first opportunities to examine the marginal changes in CHWs' time allocation and quality of care resulting from adding SAM treatment to other curative and preventive tasks.

1.1 CHW workload and quality of care

The development of community-based strategies for treating illnesses such as community case management (CCM) and community-based integrated management of childhood illness (C-IMCI) supports the expansion of CHWs' involvement in curative practices (Marsh et al., 2008, Marsh et al., 2009, CORE Group, 2009). Further, many communities demand curative care and their estimation and utilization of a CHW increases when she provides it (Bhattacharyya et al., 2001, UNICEF, 2004, Gilson et al., 1989). However, the quality of treatment that can be expected from a cadre of time-constrained workers receiving little or no pay is still in dispute (Haines et al., 2007).

Quality is often conceptualized as a process indicator, with high quality performance by health workers contributing to an effective program (Nicholas et al., 1991, Roemer and Montoya-

Aguilar, 1988, Brown et al., 1998). CHWs' motivation to deliver quality services is dependent on several intrinsic and extrinsic factors such as education, socioeconomic status, family size, training, supervision, remuneration and incentives (UNICEF, 2004, Bhattacharyya et al., 2001, Rowe et al., 2005). As their services are used for an expanding number and variety of tasks, the sustainability of CHWs' motivation and quality of care has been questioned (UNICEF, 2004, Lehmann and Sanders, 2007). One pressing concern is whether quality of care suffers as a CHW's workload increases.

Few studies have examined the association between workload and quality of care provided by CHWs. Studies with IMCI-trained professional health workers in Brazil and Tanzania determined IMCI training to be associated with increased sick child consultation time (Adam et al., 2005a, Adam et al., 2005b). In Brazil, this difference attenuated as workload increased, bringing into question whether quality of care could be sustained under high workloads (Adam et al., 2005a). It is difficult to extrapolate the behavior of facility-based workers to community-based workers, who have lower levels of training, education, and wages. CHWs often work on a part-time basis, and their workload and travel time required to reach the remote communities they serve can detract from the quality of care they provide (Baqui et al., 2008, Mumtaz et al., 2003). One concern is that preventive care provided by CHWs will receive less attention if curative care is added to their workload (Haines et al., 2007, Gilson et al., 1989, Mason et al., 2006).

1.2 Objectives of the study

This study examined the effect of work time on quality of care by comparing two groups of CHWs with different workloads in southern Bangladesh: one group implementing CCM of

pneumonia and diarrhea, and another group additionally treating SAM. Results provide insight into whether adding SAM to a CHW workload including preventive and curative tasks yields lower quality of care than that achieved by CHWs with a lesser workload.

2. Methods

2.1 Description of the intervention

This research was conducted within the context of a maternal and child health and nutrition (MCHN) program implemented by Save the Children US (SCUS). CHWs delivered preventive health and nutrition counseling, and community case management (CCM) of childhood illness. For the latter, CHWs used treatment algorithms at growth monitoring and promotion (GMP) sessions and household visits, and provided treatment for pneumonia, diarrhea and SAM. Pneumonia was classified based on respiratory rate cut-off for two age groups ($\geq$50 breaths per minute in children 2-11 months; $\geq$40 breaths per minute in children 12-59 months), and treated with oral co-trimoxazole twice daily for five days. Diarrhea was classified as having three or more stools per day and treated with oral rehydration solution (ORS). Children showing signs of severe illness, as defined by IMCI protocols, were referred to a health facility for treatment. CHWs in several upazilas (the second lowest tier of regional administration) of Bhola district, Barisal division, were trained in the CCM of pneumonia and diarrhea in September 2007. In June 2009, CHWs in one upazila were additionally trained in the CCM of SAM, which included the diagnosis of SAM using a mid-upper arm circumference (MUAC) measurement and treatment protocols that used ready to use therapeutic foods (Valid International, 2006, Sadler et al., 2011).

This programmatic context enabled the comparison of two groups of CHWs delivering community case management (CCM) and receiving similar levels of support, but whose

workloads differed with the addition of SAM. The nomenclature used to distinguish these two groups and their job responsibilities are outlined below:

1. "CCM": CHWs that delivered CCM of pneumonia and diarrhea with preventive tasks
2. "CCM SAM+": CHWs that delivered CCM of SAM in addition to CCM of pneumonia and diarrhea with preventive tasks

As a function of their number of job tasks, CCM SAM+ CHWs had more work responsibilities than the CCM group. CHWs in both groups received regular monitoring and supervision, one-day monthly refresher trainings with an associated per diem of 200 Taka (US$2.94), and a monthly stipend of 800 Taka (US$11.80). Each CHW was responsible for approximately 200 households, and each supervisor managed between 25 and 40 CHWs.

2.2 Analytical strategy

Quality of care was defined as technical competence on preventive and curative work tasks (Brown et al., 1998, Roemer and Montoya-Aguilar, 1988), and was measured using (a) a checklist of preventive tasks to be performed at a routine household visit, and (b) curative case scenarios to measure adherence to CCM guidelines. To simplify data collection logistics, this analysis used case scenarios rather than direct observation to assess CHW curative competencies. The likelihood of locating a sick child for assessment by CHWs during a supervision visit is low (George et al., 2009), and video technology was unavailable to show sick child cases as other studies have done (Zeitz et al., 1993). Routine household visits were assessed via case observation as this was standard supervision practice. CHW workload was measured as self-reported time allocation for specific work tasks via survey questionnaires (Harvey and Taylor,

2000). Qualitative methods were used to provide additional insights to quantitative results, particularly around CHWs' perceptions of challenges related to their workload.

2.3 Quantitative methods

2.3.1 Sample size and selection of participants

In order to be eligible for inclusion in the sample, CHWs needed at least five months of work experience in the MCHN program before beginning their current curative responsibilities. Accordingly, CCM CHWs must have started work by May 2007, providing only routine preventive care for at least five months before being trained to manage pneumonia and diarrhea cases. CCM SAM+ CHWs must have started work by February 2009, practicing CCM of pneumonia and diarrhea for at least five months before being trained to manage cases of SAM.

A sample size of 200 CHWs was estimated for each group. There were not 200 CHWs available in the CCM group; therefore a census of eligible CHWs in this group was taken. CCM SAM+ CHWs were randomly selected from the 261 CHWs implementing CCM of SAM in one upazila. CCM CHWs were selected from different locations within the same district. Bhola district is a rural area with fishing and agriculture being common livelihoods. Figure 5.1 outlines the sample selection process.

2.3.2 Data collection

Data was collected between February and April 2010. CHW supervisors were employed as surveyors due to their pre-existing relationship with the CHWs. They were expected to put CHWs at ease compared to an unfamiliar third party observing their work.

To assess workload and quality of care, a cross-sectional survey and observation at a routine household visit were conducted with CHWs in both groups. The survey contained questions regarding their background and professional characteristics, including their self-reported work time allocation and perceptions of work support. To measure quality of curative care, the survey contained three case treatment scenarios—one each depicting severe disease, pneumonia and diarrhea (Institute of International Programs, 2009). Surveyors read each scenario to the CHW and recorded their responses. Informed consent was given by all participating CHWs.

To measure quality of preventive care, CHWs were observed by surveyors during a routine household visit that included follow-up on issues around child feeding or care identified during the GMP session. During this visit, surveyors assessed CHWs with a quality of care checklist which was adapted from normative literature on a gold-standard series of tasks and assessments to be performed by a CHW during a routine household visit (Marsh et al., 2009). These tasks included nutrition counseling, communication skills and negotiating feasible practices with caretakers, as outlined in Table 5.3. The household visit checklist was similar to standard supervision checklists used in CHW monitoring, and these checklists were used in lieu of the existing supervision checklists during the months of data collection. Surveyors marked each item on the household visit checklist as having been performed correctly, incorrectly or "not applicable" if an item did not apply to a particular case.

All tools were reviewed with program staff, field-tested, and then translated and back-translated before finalizing.

Surveyors received two days of standardization training. To assess surveyors' ability to accurately observe routine consultations at household visits and record CHW responses, role-

plays of consultations and interviews were conducted in which the study team determined a "gold standard" set of correct observations. To facilitate standardized measurement, definitions of "quality" for routine tasks were based on a communication tool used in the program to aid CHW counseling, called the "Promise Sheet". Training also included a discussion around the importance of "negative" outcomes in research, to assure surveyors, who were also CHW supervisors, that negative scores from CHWs would not reflect poorly on their own job performance.

2.4 Qualitative methods

2.4.1 Sample description

Focus group discussions (FGDs) were conducted with CCM CHWs (four FGDs) and CCM SAM+ CHWs (six FGDs). Each FGD included between seven and nine CHWs (Krueger and Casey, 2008). Supervisors were requested to randomly select participants from the list of CHWs participating in the study.

2.4.2 Data collection

CHWs were asked to contrast their past workload and current work responsibilities. CCM CHWs were asked about their workload and time allocation when doing preventive work only, compared to CCM of pneumonia and diarrhea; CCM SAM+ CHWs were asked about doing preventive work plus CCM of pneumonia and diarrhea, compared to their workload with the addition of SAM. First CHWs developed a list of challenges related to their workload and then ranked them as a group. Then they generated a list of areas of work and domestic life that had changed with their increased workload, and estimated time allocation for each area before and

after their workload increased. Proportional piling methods were used to facilitate estimations of changes over time (Catley et al., 2008).

The researcher and a study assistant facilitated discussions using a semi-structured questionnaire. Each session was tape-recorded, and notes were taken. CHWs were informed that the research team was not affiliated with SCUS, that all comments would be kept anonymous, and that the purpose of the research was for a general interest in their work practices. All tools were piloted and notes and recordings translated into English. Informed consent was given by all participating CHWs.

2.5 Data analysis

2.5.1 Quantitative analysis

2.5.1.1 Quality of care scores

A maximum possible score was calculated for each CHW as total correct responses divided by total applicable items. Adherence scores for each curative case scenario were calculated as percentage of recommended treatments prescribed.

2.5.1.2 Statistical analysis

Descriptive statistics were calculated for CHWs' demographic characteristics and perceptions of work support. Time allocation was calculated for CHWs' work tasks. Significance tests were conducted using Stata statistical software version 11 (StataCorp, 2009) to detect any differences between CHW groups for demographic and support variables, time allocation and quality of care scores. Data were analyzed using the chi-square test and Fisher's exact test for categorical

variables and Wilcoxon's rank sum test and Student's t test for equal or unequal variance for continuous variables.

2.5.2 Qualitative analysis

Transcriptions of FGDs were categorized using provisional codes developed during piloting and initial analysis, then analyzed for themes related to CHWs' work challenges (Saldaña, 2009). A comparative analysis highlighted differences between groups. Challenges from ranking exercises were compiled into one matrix for each group and then simplified by including only those challenges mentioned in two or more FGDs and sorting these by median rank.

3. Results

3.1 Quantitative results

3.1.1 Sample characteristics and perceptions of work support

As shown in Table 5.1, the two CHW groups did not differ significantly in terms of demographics. On average, women were 29 years of age, married, and had completed at least eighth grade. One quarter had attended madrasa schools. On average, their households had five to six members, including two children. Of the CHWs sampled, less than 20% did other work for pay, engaging in semi-skilled labor such as poultry rearing and tailoring. All CHWs' husbands did work of a similar skill level, with the most common livelihoods being farming, non-farm business and private service. One half of the sample had electricity in their homes, while nearly all had a rudimentary tin roof.

CCM SAM+ CHWs had received additional training in the past year for instruction on the management of SAM. CCM SAM+ CHWs had gone a week longer on average without a supervisory visit; however, most CHWs in both groups had received a visit within the past

month. Additionally, both groups had monthly refresher trainings with their supervisors, and participated in intensive refresher trainings every two months. All CHWs were found to carry the appropriate work documents necessary to complete their jobs, with CCM CHWs being significantly more likely to have the necessary referral slips with them at the time of their interview.

CHWs felt that their work was valuable (100% in both groups), and that their family found their work to be socially acceptable (99-100% in both groups). Forty percent of CHWs in both groups felt that they did not receive fair pay compared to other employed women.

3.1.2 Workload and time allocation

The two CHW groups demonstrated significant differences in workload. Table 5.2 presents CHW time allocation data. On average, CCM SAM+ CHWs worked 16.7 (SD=6.9) hours per week, over three hours more than CCM CHWs (13.3 hours, SD=4.6). Much of this time was spent following-up cases of SAM in household visits (2.4 hours, SD=2.3). CCM SAM+ CHWs spent more time each week in household visits (12.8 hours, SD=5.0 versus 9.7, SD=3.2 for CCM CHWs), and visited significantly more households per week than CCM CHWs (maximum of 14.2 households, SD=4.8 versus 10.9, SD=4.4). The addition of SAM to a CHW's workload also added 1.5 hours (SD=0.5) to the monthly GMP sessions, for screening with a MUAC strip and giving advice and treatment to any caretaker of a newly-diagnosed or follow-up case of SAM. CCM SAM+ CHWs also spent significantly more time en route to their various work activities, including more time spent daily traveling to household visits (62.0 minutes, SD=30.7 versus 53.1, SD=25.4). CCM CHWs had more children in their catchment area on average, and therefore spent more time at the monthly GMP sessions and held more sessions each month.

3.1.3 Preventive care at a routine household visit

Table 5.3 summarizes results for quality of care on routine preventive tasks performed by CHWs at household visits. A non-parametric test showed CCM SAM+ CHWs' scores to be significantly higher than CCM CHWs' scores (Wilcoxon Mann-Whitney: z=2.49, p=0.013). Scores for CCM SAM+ CHWs were clustered towards the high end of the distribution, with 63% achieving a perfect score. Scores for CCM CHWs exhibited a broader range with nearly half (48%) scoring 100%. The few CHWs scoring below 75% (n=17) did not differ notably from the rest of the sample.

3.1.4 Adherence to CCM guidelines

Adherence scores for the curative case scenario analysis were high on average, with CCM SAM+ CHWs scoring significantly higher for treatment of severe disease and diarrhea. Table 5.4 presents a summary of findings.

CCM SAM+ CHWs scored significantly higher (Wilcoxon Mann-Whitney: z=2.81, p=0.005) on the severe disease case scenario than CCM CHWs (39% achieving perfect scores and 14% scoring below 60, versus 26% scoring perfectly and 23% scoring below 60 respectively). Nearly all CHWs recalled actions for referral and follow-up. CCM CHWs were more likely to remember to write a referral note. A large proportion of CHWs in both groups forgot to advise the caretaker to return for further treatment. In only two cases each did CCM SAM+ CHWs prescribe incorrect treatment, recommending home treatment rather than a referral, and incorrectly prescribing co-trimoxazole for severe disease (data not shown).

Adherence to guidelines for managing a pneumonia case was high (median=85.7%) and did not differ significantly between groups (Wilcoxon Mann-Whitney: z=-0.28, p=0.778). CCM SAM+

CHWs were significantly more likely to recommend the correct co-trimoxazole dosage. More CCM CHWs remembered to advise to give the child fluids and continue feeding. In both groups, only 3% of CHWs incorrectly referred the case to a facility (data not shown). Only one CHW in each group incorrectly prescribed ORS for treatment.

CCM SAM+ CHWs achieved a significantly higher score (median=100%) on adherence to guidelines for managing a diarrhea case, compared to CCM CHWs (median=87.5%) (Wilcoxon Mann-Whitney: z=2.11, p=0.035). CCM SAM+ CHWs were more likely to advise the correct ORS dosage and to remember to help the caretaker give ORS to the child. As was observed in the pneumonia case scenario, CCM CHWs were better able to recall the nuanced aspects of case management such as giving fluids and continuing to feed the child. Only 3% of CHWs in both groups incorrectly referred the case to a facility (data not shown). No CHWs incorrectly prescribed co-trimoxazole for treatment of diarrhea.

3.2 Qualitative results

3.2.1 CHWs' ranked work challenges

Table 5.5 and Table 5.6 report ranked challenges for both CHW groups. Both groups ranked a lack of training to treat more diseases in their communities and inadequate medicines and supplies to treat more diseases as major challenges. CCM CHWs ranked the irregular supply of medicine, primarily of ORS for diarrhea, as their top constraint. CCM SAM+ CHWs ranked this challenge second most important. CCM CHWs cited the inability to adequately treat severely malnourished children in their community as their second most important challenge, stating that they needed extra materials to support these children. CCM SAM+ CHWs ranked inadequate honorarium higher on their list of challenges, and explicitly associated this with pressure from

their families about their low remuneration. Both groups expressed a desire for more formal integration with the medical community, which they felt would help to secure a regular supply of medicines (ORS and co-trimoxazole) from the hospital, to get better treatment for children they referred, and to get more support from trained medical professionals. In terms of challenges specific to managing SAM, CCM SAM+ CHWs cited that the MUAC screening criteria did not identify all children who they perceived to be severely malnourished. Due to this factor and the increased number of counseling messages involved in managing SAM in the community, they felt challenged to sensitize their communities about the management of SAM.

3.2.2 Discussion about CHWs' perceived work challenges

Several themes emerged during FGDs around CHWs' perceived work challenges. Both groups responded to their increased workload by stretching their schedule to accommodate new tasks. They managed their schedules by waking up earlier, cooking all daily meals in the morning, eating lunch later, spending less time on other income-generating activities (i.e. tailoring and poultry rearing), spending less time with their husbands and children, and visiting their relatives less. As a result, both groups cited increased pressure from their families, both in terms of workload and low pay. "*My husband says 'You cannot do so much work in exchange for a small amount of money. It is good to give time to my child.'*" Both groups felt their salary was inadequate for their workload, with some expressing personal shame as a result. "*I feel proud to tell my job to community members, but feel embarrassed to tell my pay*." "*Sometimes those who are educated they tell us 'you are working day long and receive a funny honorarium!'*"

A comparative analysis of discussions with both groups revealed several differences. Constraints to domestic time were evident in all discussions, but emerged as a greater perceived constraint

for CCM SAM+ CHWs. These CHWs reported being unable to spend adequate time with their children five days of the week, and were rarely able to visit relatives or take leave due to work requirements. Further, CCM CHWs reported that they were only able to work for extra income on the weekends, while CCM SAM+ CHWs could no longer spare the time to do this income-generating work at all.

CCM SAM+ CHWs also demonstrated strong feelings of self-efficacy, reporting more often than CCM CHWs that they were able to manage their expanded work hours and increased workload. "*Sometimes [patients] come unexpectedly but it does not hamper our work.*" "*Actually now we do not face any problems because we do [domestic tasks] during gaps in our work.*" This was due in part to the sporadic nature of the increased workload attributable to treatment of SAM cases: "*We rarely get SAM children*." Both CHW groups mentioned that the addition of CCM resulted in a significant increase in their workload. Several CCM SAM+ CHWs also stated that the addition of CCM to their preventive workload in 2007 resulted in a greater impact on their schedules than the addition of SAM to their curative workload in 2009.

CCM SAM+ CHWs' heightened feelings of competence could also have an alternative explanation. CCM CHWs, who had not been exposed to the CCM of SAM methodology and with whom the study team did not discuss management of SAM, reported that they faced many severely malnourished children in their communities who did not respond to counseling alone, and that their inability to adequately treat these children was one of their most pressing challenges (Table 5.5). CCM SAM+ CHWs were given the tools to effectively treat this problem of which they had always been aware: "*We feel good. There was no such treatment earlier… No doctor can do so much good within a week.*"

4. Discussion

Adding treatment of SAM to a CHW workload that included preventive and curative tasks resulted in added demands on CHWs' time. CCM SAM+ CHWs worked three additional hours per week compared to CCM CHWs, and one and a half additional hours at monthly GMP sessions. In spite of this additional workload, quality of care on curative and preventive tasks was maintained.

These findings suggest, as other studies do, that CHWs stretch their work hours to accommodate demand for their services (Berman et al., 1987). CHWs' additional responsibilities appear to have increased their utilization (Curtale et al., 1995), making them more confident, mobile and active in their communities. However, CCM SAM+ CHWs reported having little extra leisure time to spend with family or engage in income-generating work. Care should be taken to ensure that this increased tension between domestic and work responsibilities does not become detrimental to quality of care over time (Mumtaz et al., 2003). In this context, further increases in workload may not be feasible without additional incentives, and at some point quality of care may begin to suffer regardless of the incentives offered.

4.1 Quality of care

CCM SAM+ CHWs achieved higher quality performance on routine preventive tasks, including counseling and negotiating with caretakers, compared to CCM CHWs. Findings compare favorably with a study examining quality of counseling delivered by CHWs in Pakistan after training in the IMCI counseling module. In that study, for example, only 33% of trained CHWs (and 4% of untrained CHWs) made recommendations for improved feeding practices (Zaman et al., 2008), compared to 93% and 95% of CCM and CCM SAM+ CHWs respectively. The

relatively high scores on preventive care tasks achieved by CCM SAM+ CHWs challenges the perception that a CHW's quality of preventive care would decrease as more curative tasks are added to her workload. Instead, these results suggest that the extra responsibilities—with the associated additional training and practice—may improve the quality of a properly supervised CHW's work, within the context of a program in which curative and preventive activities are given equal importance.

Adherence to CCM guidelines was high in both groups; with CCM SAM+ CHWs achieving significantly higher performance compared to CCM CHWs in the management of severe disease and diarrhea, and equal performance in management of pneumonia. CHWs in both groups scored above 85% in recommending needed life-saving treatments, including referrals and medicines. This compares favorably with a study in Kenya where 58% of children were not prescribed all appropriate treatments (Rowe et al., 2007a). In this study, incorrect treatment was rare in both groups (<4% for all diseases), compared to a study in Zambia that documented incorrect treatment of malaria and pneumonia at 9.3% (Yeboah-Antwi et al., 2010). For pneumonia guidelines, CHWs achieved rates of adherence (85.7%) that were similar to other studies with CHWs in Bangladesh (89%) (Hadi, 2003) and Pakistan (81%) (Mehnaz et al., 1997), and outperformed CHWs in Zambia where only 68% of children received appropriate treatment for non-severe pneumonia (Yeboah-Antwi et al., 2010). CCM SAM+ CHWs were significantly more likely to recommend the correct antibiotic and ORS dosages. This could be due to their familiarity with co-trimoxazole due to its use in managing SAM, further suggesting a possible reinforcing effect of the SAM component. Findings also show a possible divergence in adherence to nuanced aspects of guidelines with increasing curative responsibilities. These gaps could grow wider over time without additional support to reinforce skills learned. This suggests

that when increasing CHWs' workload, careful attention should be paid to the frequency of supervisory visits and refresher trainings, to ensure that CHWs maintain consistent knowledge and competency on diverse tasks over time (Gilson et al., 1989).

4.2 CHWs' perceptions of challenges related to workload

CCM SAM+ CHWs reported high motivation despite the increase in workload. Without this additional motivation and respect from the community, it is likely that the time allocation required for the addition of SAM to the CCM workload would have been too much to sustain with current incentives.

Themes emerging in discussions with CHWs regarding perceived work challenges were consistent with previous studies (Bhattacharyya et al., 2001, Lehmann and Sanders, 2007, UNICEF, 2004). The challenges ranked most important to CHWs in this study were similar to findings from other CHW studies in South Asia, including irregular medicine supply and inadequate salary (Haq et al., 2008), provision of poor quality care at hospitals for referred patients, and conflicting domestic and work responsibilities (Mumtaz et al., 2003). Work challenges were the same for both CHW groups, and therefore are unlikely to explain the differences in quality of care between them. In addition to time constraints, other issues were raised which may have impacted the potential quality and impact of CHWs' work. These factors included community poverty constraining uptake of recommended practices, along with irregular medicine supply from the health facility and poor quality of care for their referrals sent there.

CCM SAM+ CHWs expressed more confidence than CCM CHWs in their ability to manage their increased workload in spite of increased family pressure. These feelings of enhanced self-efficacy, found to be a key determinant of motivation (Franco et al., 2002, Franco et al., 2004),

may be due in part to the visible changes in a recovered case of SAM (Collins et al., 2006b) promoting a sense of professional achievement (Bhattacharyya et al., 2001). Other studies have shown that CHWs provide high quality of care when addressing high-priority illnesses in their communities (Kelly et al., 2001). Another potential explanation for CCM SAM+ CHWs' ability to manage their increased workload may be the small number of SAM cases seen at any one time, with only a handful of children per year needing intensive treatment.

In all discussions, CHWs mentioned that their pay was inadequate for their workload. This impression did not differ significantly between groups, with 40% of all CHWs feeling that they did not receive fair pay compared to other employed women. They ranked this as a less important challenge than others, stating that they did this work to help their communities rather than for personal gain. However, it is reasonable to assume that this altruistic attitude would have limits dictated by their own personal and familial responsibilities.

There is little consensus on the issue of remuneration for large cadres of community-based workers. Some evidence suggests that communities valuing volunteerism may lose respect for paid CHWs (Glenton et al., 2010); however, several studies recommend some form of incentive in order to maintain motivation and job satisfaction (Bhattacharyya et al., 2001, Bhutta et al., 2010, Kironde and Klaasen, 2002). This study demonstrates that good quality care from CHWs comes with personal and financial consequences for these workers. This indicates a need to reevaluate the common hesitancy to provide some kind of compensation to this workforce (Gilson et al., 1989, UNICEF, 2004, Bhattacharyya et al., 2001). Compensation may be difficult to sustain in a large-scale program over time; however, considering the unparalleled reach of these workers and the service quality that they are able to achieve, payment may be one of

several necessary mechanisms to ensure their continued commitment to extending health services for underserved communities.

4.3 Generalizability

Several factors contributed to the good quality of care achieved by CHWs in this study. This sample of CHWs was well-supervised and trained, which likely influenced their motivation and promoted delivery of quality services. This level of support, particularly the monthly refresher trainings, may be difficult to maintain in a program implemented at scale. However, supervisory ratios were below optimal levels, at 1:25-40 compared to 1:10-20 (Mason et al., 2006), indicating that the high quality exhibited in this program could be within the means of other ongoing programs to achieve.

Due to lack of variation in quality of care outcomes, it was not possible to examine determinants of quality via multivariate regression analysis. One such study in Kenya found that factors such as patient characteristics had significant associations with quality of care, while intervention-related factors (e.g. supervision, training and adequacy of medicine supplies) did not (Rowe et al., 2007a). Other studies providing adequate support and training to CHWs achieved lower performance quality than was seen in this study (Yeboah-Antwi et al., 2010, Rowe et al., 2007a). While it is plausible that other factors contributed to successful results in this program, the strong management and supervision, and regular refresher training provided are believed to be as much of a key factor promoting the program's success as has been found with other programs delivered by CHWs (Fagbule et al., 1994, Berman et al., 1987, Hadi, 2003, Rowe et al., 2005, Haines et al., 2007, Zaman et al., 2008, Bhutta et al., 2010).

A related analysis of effectiveness of the CCM of SAM program showed that rates of comorbidity of SAM with pneumonia and diarrhea were low at 5% (Sadler et al., 2011). It is possible that quality of care would have suffered if workers were dealing with higher levels of illness, although high caseload can help to maintain skills and competence (Halm et al., 2002). Further, malaria, a major complicating factor in Africa and other parts of Asia, was nonexistent in this region. Other differences between the African and Asian context, including population density and women's education, may also limit global generalizability of findings.

5. Limitations

It is possible that the presence of researchers during FGDs may have introduced some observer bias into the qualitative data collection process (Babbie, 2006). However, discussions were designed to promote participants' comfort in expressing their honest opinions. Similarly, administration of case scenarios and household visit observation by supervisors may have influenced CHWs' quality of preventive care and made them more careful than they would be otherwise (Rowe et al., 2006, Rowe et al., 2002). However, in this program CHWs were accustomed to supervisor observation at household visits during routine monitoring. Further, the high quality shown in this analysis is supported by findings from a related study, demonstrating high recovery and coverage rates in this program (Sadler et al., 2011). Lastly, it was not possible to conduct multivariate analysis for the determinants of quality due to low variation in the dependent variable; therefore it is difficult to ascertain the determinants of high quality of care achieved in this program.

6. Conclusions and future directions

Among a well-supervised and trained cadre of CHWs in southern Bangladesh, adding community case management (CCM) of SAM to a workload including CCM of pneumonia, diarrhea and routine preventive care increased work time by three hours per week, but did not negatively impact on quality of preventive or curative care delivered. This suggests that adding additional curative tasks to a CHWs' workload does not necessarily affect the quality of more traditional services delivered by a CHW workforce such as growth monitoring and promotion.

Further, additional trainings and increased curative practice appear to reinforce CHWs' basic curative knowledge and skills. The addition of SAM to the CCM package may positively influence motivation by giving CHWs a tool to effectively treat a common and visible illness in their communities. Further research is needed to determine optimum frequency of supervision and trainings, and threshold levels for CHW workload, in order to maintain these levels of quality.

Finally, renewed focus should be given to determining adequate remuneration for CHWs in different contexts. This could help to ensure the continued commitment of these workers who hold the potential to deliver high quality basic health services to vulnerable communities as yet underserved by the formal health system.

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8. Tables and Figures

Table 5.1: CHW characteristics and perceived work support

Characteristic	Overall N=338 100%	CHW Group CCM *n*=141 41.7%	CHW Group CCM SAM+ *n*=197 58.3%
Background			
Age – mean ± SD	28.7 ± 5.6	29.0 ± 5.0	28.5 ± 6.0
Marital status:			
Married	95%	92.9%	96.4%
Widowed	3.3%	4.3%	2.5%
Divorced	1.2%	2.1%	0.5%
Separated	0.6%	0.7%	0.5%
Highest completed education:			
Primary (0-5)	0.3%	--	0.5%
Lower Secondary (6-8)	56.8%	60.3%	54.3%
Secondary (8-10)	32.5%	27.7%	36.0%
High Secondary (11, 12)	8.6%	9.9%	7.6%
Graduate (Bachelors)	1.8%	2.1%	1.5%
Education system:			
General	74%	78%	71.1%
Madrasa	26%	22%	28.9%
Household size – mean ± SD	5.4 ± 2.5	5.6 ± 2.6	5.4 ± 2.4
No. of children – mean ± SD	2.0 ± 0.9	2.0 ± 0.9	2.0 ± 0.9
No. of children below school age – mean ± SD	0.5 ± 0.9	0.6 ± 0.6	0.5 ± 0.6
No. of male children – mean ± SD	1.0 ± 0.8	1.0 ± 0.9	1.0 ± 0.8
Socioeconomic Status			
CHW does other work for pay:	(*N*=330)	(*n*=135)	(*n*=195)
No other paying work	83.1%	87.4%	83.6%
Skilled/semi-skilled work	13.0%	12.6%	13.3%
Professional work	1.8%	--	3.1%
Husband's occupation level:	(*N*=240)	(*n*=96)	(*n*=144)
Does not work for money	8.8%	13.5%	5.6%
Unskilled work	10.4%	10.4%	10.4%
Semi-skilled/Skilled work	67.1%	64.6%	68.8%
Professional/technical work	13.8%	11.5%	15.3%
Homestead has electricity	51.6%	56.7%	48.0%
Homestead has rudimentary roof (tin)	99.1%	98.6%	99.5%

Characteristic	Overall N=338 100%	CHW Group	
		CCM *n*=141 41.7%	CCM SAM+ *n*=197 58.3%
Work support			
Years worked as CHW for SCUS – mean ± SD	4.1 ± 0.8	4.2 ± 0.6	4.1 ± 0.9
No. trainings in past year (excl. refreshers) – mean ± SD	1.3 ± 1.0	0.5 ± 0.8	1.8 ± 0.8***
Days since last supervisory visit – mean ± SD	13.7 ± 11.6	10.8 ± 8.0	15.8 ± 13.3***
Family thinks work is socially acceptable:			
Yes, very much	94.7%	97.2%	92.9%
Somewhat	5.0%	2.8%	6.6%
Not much	0.3%	--	0.5%
CHW feels her work is appreciated in her community:			
Yes, very much	97.9%	100%	96.4%*
Somewhat	2.1%	--	3.6%
CHW feels her work is valuable:			
Very valuable	99.1%	99.3%	99.0%
Somewhat valuable	0.9%	0.7%	1.0%
CHW feels she is paid fairly compared to other employed women:			
Strongly agree	15.7%	5.0%	23.4%
Agree	35.5%	45.4%	28.4%
Neither agree nor disagree	7.7%	7.1%	8.1%
Disagree	21.9%	25.5%	19.3%
Strongly disagree	19.2%	17.0%	20.8%
CHW has necessary work documents (out of 6) with her at time of interview – mean + SD	5.6 ± 0.7	5.7 ± 0.6	5.5 ± 0.7***
Registers (GMP, ANC & CCM)	99.7%	100%	99.5%
CCM manual	98.5%	97.2%	99.5%
Promise Sheets	97.3%	96.5%	98.0%
Flipchart	95.6%	94.3%	96.5%
Pushti Card	90.8%	92.2%	89.8%
Referral slips	76.0%	92.9%	64.0%***

* $p < .05$, ** $p < .01$, *** $p < .001$; for significance of difference between CHW groups (Wilcoxon Mann-Whitney test, Pearson's Chi Square, Fisher's exact test or t-test for independent samples as appropriate).

Table 5.2: Workload and time allocation

Characteristic	Overall *N*=338 100%	CHW Group	
		CCM *n*=141 41.7%	**CCM SAM+** *n*=197 58.3%
Workload	Mean ± SD		
Children under 2 in catchment area (# children)	42.6 ± 18.1	41.2 ± 18.9	43.6 ± 17.4
Children 2-5 in catchment area (# children)	129.8 ± 71.6	146.4 ± 83.2	117.6 ± 59.4***
GMP sessions per month (# sessions)	1.6 ± 0.6	1.8 ± 0.6	1.5 ± 0.5***
Time allocation			
Time spent at GMP last month (hours)	6.7 ± 2.8	7.2 ± 3.0	6.4 ± 2.6*
Time to travel to GMP (hours)	0.30 ± 0.2	0.25 ± 0.2	0.33 ± 0.2**
Days of household visits last week (# days)	3.8 ± 0.9	3.7 ± 0.8	3.9 ± 0.9*
Minutes per day travelled for household visits	58.3 ± 28.9	53.1 ± 25.4	62.0 ± 30.7**
Total hours spent on household visits last week	11.5 ± 4.6	9.7 ± 3.2	12.8 ± 5.0***
Minimum household visits/week	11.7 ± 4.5	10.0 ± 4.2	12.9 ± 4.2***
Maximum household visits/week	12.8 ± 4.9	10.9 ± 4.4	14.2 ± 4.8***
Total hours worked last week as CHW	15.3 ± 6.3	13.3 ± 4.6	16.7 ± 6.9***
Hours spent last week treating pneumonia & diarrhea‡ median ± IQR (range)	*N*=285 2.0 ± 2.4 (0.2, 25.0)	*n*=133 2.8 ± 2.4 (0.5, 13.0)	*n*=152 1.5 ± 2.0 (0.2, 25.0)***
Time allocated to CCM of SAM			
Hours spent last week for SAM follow-up sessions‡			*n*=58 2.4 ± 2.3
Time spent at GMP before treating SAM children			*n*=195 4.9 ± 1.8

* $p < .05$, ** $p < .01$, *** $p < .001$; for significance of difference between CHW groups (Wilcoxon Mann-Whitney test, Pearson's Chi Square, Fisher's exact test or t-test for independent samples as appropriate).

‡ Results for this variable include only non-zero values.

Table 5.3: Quality of care on routine preventive tasks during household visits

Checklist item	Overall	CHW Group % correct (N)	
		CCM	CCM SAM+
Overall % error-free case management: Median; range (N)	100; 15.4-100 (336)	93.3; 53.8-100 (141)	100; 15.4-100* (195)
1. Announce objective of visit	95.8 (333)	95.0 (140)	96.4 (193)
2. Try to involve key family members, if appropriate	80.2 (253)	69.5 (105)	87.8 (148)***
3. Discuss with the caretaker about commitments made on the "Promise Sheet"	98.2 (335)	97.1 (140)	99.0 (195)
4. Enquire about what the caretaker is already doing at home for this child	94.3 (335)	92.2 (141)	95.9 (194)
5. Listen to the caretaker in order to understand her situation and concerns regarding caring for her child	95.8 (333)	97.9 (141)	94.3 (192)
6. Use encouraging non-verbal communication and simple language	96.4 (334)	95.0 (140)	97.4 (194)
7. Recognize and praise what she is doing correctly before suggesting changes	88.8 (331)	87.1 (140)	90.1 (191)
8. Provide clear, focused counseling and feeding information	98.7 (317)	97.9 (140)	99.4 (177)
9. Make recommendations by which the caretaker can improve the care and feeding of her child	94.7 (319)	93.0 (129)	95.8 (190)
10. Clear up doubts when a caretaker says that the recommendation is complicated	94.6 (148)	92.7 (55)	95.7 (93)
11. Answer any questions about the advice.	89.9 (159)	89.3 (75)	90.5 (84)
12. Troubleshoot any problems (or potential problems) with complying with the advice	93.0 (158)	94.4 (72)	91.9 (86)
13. Negotiate what is feasible for the caretaker in terms of the advice given	95.5 (291)	94.9 (138)	96.1 (153)
14. Confirm commitments made on the "Promise Sheet" and encourage caretaker to put recommendations into practice	97.0 (333)	97.1 (139)	96.9 (194)
15. Inform caretaker of next GMP, EPI, Courtyard session or household visit as appropriate	84.3 (325)	84.4 (141)	84.2 (184)

* $p < .05$, ** $p < .01$, *** $p < .001$; for significance of difference between CHW groups (Wilcoxon Mann-Whitney test, Pearson's Chi Square or Fisher's exact test as appropriate).

Table 5.4: Adherence to CCM guidelines

Case treatment scenarios (% error-free case management)	Overall	CHW Group	
		CCM	CCM SAM+
	N=338	*n*=141	*n*=197
	100%	41.7%	58.3%
1. ***Severe disease***: mean ± SD, median ± IQR	82.7% ± 15.3	80.6% ± 13.9	84.3% ± 16.1
	80% ± 20	80% ± 20	80% ± 20‡**
a) Advise to refer to health facility	99.4	100	99.0
b) Write a referral note	91.7	97.9	87.3***
c) Arrange transportation to health facility	79.0	73.8	82.7*
d) Advise when to return to CHW or facility	44.7	31.2	54.3***
e) Follow up after return from hospital	98.8	100	98.0
2. ***Pneumonia:*** mean ± SD, median ± IQR	87.3% ± 11.9	87.6% ± 11.4	87.1% ± 12.3
	85.7% ± 14.3	85.7% ± 14.3	85.7% ± 28.6
a) Give Cotrimoxazole for 5 days	94.4	92.9	95.4
b) Advise to give fluids and continue feeding	63.3	74.5	55.3***
c) Advise when to return to CHW or facility	70.7	75.9	67.0
d) Follow up after completing 4 Cotrim doses	98.2	98.6	98.0
e) Advise correct Cotrim dosage	85.8	71.6	95.9***
f) Advise correct Cotrim frequency	98.8	100	98.0
g) Advise correct Cotrim duration	100	100	100
3. ***Diarrhea***: mean ± SD, median ± IQR	90.9% ± 10.5	89.4% ± 11.3	91.9% ± 9.8
	87.5% ± 12.5	87.5% ± 12.5	100% ± 12.5*
a) Help caregiver to give child ORS solution	92.0	85.1	97.0***
b) Give caretaker ORS solution to take home	96.5	93.6	98.5*
c) Tell to begin ORS solution immediately	93.8	92.9	94.4
d) Advise to give fluids and continue feeding	73.4	80.9	68.0**
e) Follow up child in 3 days	93.5	95.0	92.4
f) Advise correct ORS dosage	87.6	80.1	92.9***
g) Advise correct ORS frequency	99.7	100	99.5
h) Advise correct ORS duration	90.5	87.2	92.9

* $p < .05$, ** $p < .01$, *** $p < .001$; for significance of difference between CHW groups (Wilcoxon Mann-Whitney test, Pearson's Chi Square, Fisher's exact test or t-test for independent samples as appropriate).

‡ Medians do not reflect significant difference due to heaping and limited range of scores.

Table 5.5: CCM CHW work challenges ranking matrix

Work challenges of CCM CHWs	Median rank (range)	# FGDs reporting
Irregular medicine supply.	1 (1-9)	3
Unable to properly care for and treat severe malnutrition.	2 (1-3)	2
Inadequate training to treat more diseases.	2.5 (2-4)	4
Inadequate medicines and supplies to treat more diseases.	3.5 (1-5)	4
Want better relations with medical community.	4 (4-7)	3
Community cannot afford to go to the hospital.	7 (3-8)	4
Need more food for poor children in the community.	7 (5-9)	2
Low honorarium.	8.5 (4-11)	4
Workload is too high.	11.5 (8-13)	4
Low community motivation after stopping food ration.	12 (5-12)	3

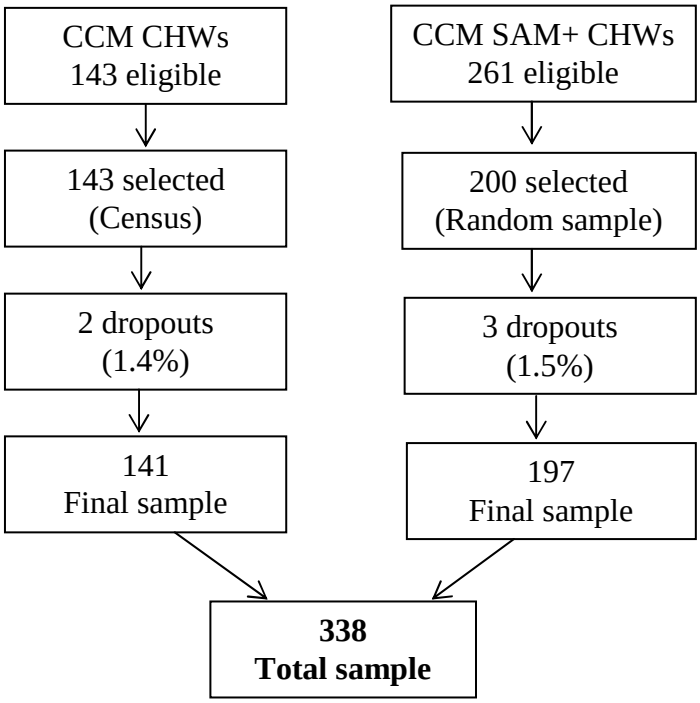
Number of FGDs=4
Each group listed 9-13 indicators for ranking.

Table 5.6: CCM SAM+ CHW work challenges ranking matrix

Work challenges of CCM SAM+ CHWs	Median rank (range)	# FGDs reporting
Inadequate training to treat more diseases.	1.5 (1-5)	6
Irregular medicine supply.	3 (1-6)	6
Inadequate medicines and supplies to treat more diseases.	3 (1-4)	4
Low honorarium and related family pressure.	3.5 (2-7)	6
MUAC does not identify all children who appear malnourished.	5 (1-5)	3
Hospitals provide poor quality care, need more formal integration with CHWs.	5 (2-7)	4
Some children relapse into SAM after stopping treatment.	5.5 (4-7)	2
Need more work support, incentives and reimbursements.	7 (3-8)	4
Low community motivation after stopping food ration.	7 (6-8)	2
Community cannot afford to go to the hospital.	8.5 (8-9)	2
MUAC tape is of poor quality and breaks easily.	9 (7-9)	3
Workload is too high with SAM duties.	9 (7-11)	2
Difficult to properly explain to community about SAM program.	10 (6-11)	4
Don’t have enough time for my children and family.	11 (8-12)	4

Number of FGDs=6
Each group listed 10-14 indicators for ranking.

Figure 5.1: Selection of participants



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6 Chapter 6: Article #3: Cost-effectiveness of the community-based management of severe acute malnutrition by community health workers in southern Bangladesh

By Chloe Puett, Kate Sadler, Harold Alderman, Jennifer Coates, John L Fiedler, and Mark Myatt

Abstract: This study assessed the cost-effectiveness of adding the community-based management of severe acute malnutrition (CMAM) to a community-based health and nutrition program delivered by community health workers (CHWs) in southern Bangladesh. The cost-effectiveness of this model of treatment for severe acute malnutrition (SAM) was compared with the cost effectiveness of the "standard of care" for SAM (i.e. inpatient treatment) in a neighboring area.

An activity-based cost model was used, and a societal perspective taken, to include all costs incurred in the program by providers and participants for the management of SAM in both areas. Cost data was coupled with program effectiveness data. CMAM delivered by CHWs outperformed inpatient treatment, costing $26 per DALY averted, and resulting in considerably lower costs for participant households. These results suggest that this model of treatment for SAM is highly cost-effective by common standards and that CHWs, given adequate supervision and training, can be used effectively to expand access to treatment for SAM in Bangladesh.

Key words: cost-effectiveness, activity-based costing, community health workers, severe acute malnutrition, community case management, community-based management of acute malnutrition, nutrition, Bangladesh, South Asia

1. Introduction

Severe acute malnutrition (SAM) carries a high risk of death, and requires therapeutic treatment for recovery (WHO, 1999). Community-based management of acute malnutrition (CMAM) combines outpatient treatment of cases of SAM with no medical complications, including the absence of severe edema and serious infection, with inpatient treatment to stabilize those cases that present with complications (Valid International, 2006). This approach benefits households by reducing opportunity costs for caretakers (Ashworth, 2006, Collins et al., 2006a, Collins et al., 2006b), and holds potential for introducing cost savings to health systems by reducing the number of cases of SAM needing intensive rehabilitation in an inpatient setting (Ashworth, 2006, Collins et al., 2006a). There is concern in the international nutrition community however, that the cost of a critical ingredient of CMAM programs, ready to use therapeutic food (RUTF), is "too" costly (Golden, 2007, Prasad, 2009, Sachdev et al., 2010, Gupta et al., 2006) when compared to inputs for other child survival programs (Horton et al., 2010, Ashworth, 2006). This has sparked ongoing debate about the affordability and cost-effectiveness of this treatment strategy (Horton et al., 2010). Despite the importance of these questions, relatively few studies have been conducted to ascertain CMAM's cost-effectiveness or to better understand how this varies with program structure and setting.

1.1. Cost-effectiveness of CMAM

The few reported cost analyses of CMAM suggest that it is cost-effective compared to alternative treatments for SAM. An Ethiopian study found CMAM to be more than twice as cost-effective as an inpatient therapeutic feeding center (TFC), with costs per recovered case of US$145 versus US$320, respectively (Tekeste, 2007). In Bangladesh, domiciliary treatment of SAM was found

to be five times more cost-effective than inpatient treatment, at US$29 per child recovered compared to US$156 for inpatient care. Costs to beneficiary households were highest for domiciliary care in this study, as no food was provided; however, parents preferred this option because it allowed them the convenience of staying at home (Ashworth and Khanum, 1997).

In Zambia, CMAM was found to cost an average of US$203 per child, US$1,760 per life saved, and US$53 per DALY averted compared to no treatment (Bachmann, 2009). In Malawi, the incremental cost-effectiveness of adding CMAM to existing health services was US$42 per DALY averted, and US$1,365 per life saved (Wilford et al., 2011). These results suggest that CMAM is highly cost-effective (Commission on Macroeconomics and Health, 2001, Jha et al., 1998).

A recent World Bank report on addressing malnutrition at scale included treatment of SAM with RUTF as one of a number of proven interventions (Horton et al., 2010). Notwithstanding its effectiveness at saving the lives of children at high risk of death (Collins et al., 2006a), CMAM was found to be the most expensive relative to other existing nutrition strategies at US$200 per child treated, underscoring concerns about its costs. Further, weak delivery capacities were cited as a barrier to scale-up of this approach in the under-resourced countries where SAM predominates (Horton et al., 2010).

1.2 Justification for the study

Given the persistent concern about the costs of CMAM, there is a need for a better understanding of these costs, particularly those of the newer CMAM delivery models. This analysis took a societal perspective, as is recommended by the Panel on Cost-Effectiveness in Health and Medicine of the US Public Health Service (Russell et al., 1996), and used activity-based costing

with an ingredients approach (Tan-Torres Edejer et al., 2003) to analyze the cost-effectiveness of an innovative CMAM model, with treatment delivered by community health workers (CHWs) in southern Bangladesh. This study aimed to contribute evidence to claims that opportunity costs are lower for caretakers participating in CMAM than in inpatient treatment of SAM (Collins et al., 2006b, Collins et al., 2006a, Ashworth, 2006). Further, this is the first study that has examined the cost-effectiveness of delivering CMAM protocols primarily by CHWs. Most CMAM programs to date have been delivered by workers at primary and secondary level health care facilities. Currently in Bangladesh, the treatment of SAM remains based in inpatient care (IPHN et al., 2008). Cost effectiveness data for complementary interventions such as CMAM, that hold potential for improving coverage and outcomes associated with this treatment, is needed to help the Government of Bangladesh make decisions about national strategies for addressing this common condition.

The first objective of this analysis was to compare the cost-effectiveness of CMAM delivered by CHWs relative to inpatient treatment of SAM. The second objective was to provide a disaggregated cost analysis of the integration of SAM treatment into an existing community-based health and nutrition program in Bangladesh.

2. Methods

2.1 Description of the intervention

This study was conducted within a Save the Children (US) (SCUS) health and nutrition program that employed a cadre of CHWs to deliver preventive and curative care to children in underserved areas of southern Bangladesh. Each worker was paid a monthly stipend of 800 Taka (US$11.80). CHWs counseled on health, nutrition and sanitation, and used treatment algorithms

to deliver community case management (CCM) of basic childhood illness including diarrhea and pneumonia. Additionally, all CHWs in a selected upazila (the second lowest tier of regional administration) of Bhola district, Barisal division, received training, with monthly refreshers, and ongoing supervisory support to implement the CCM of SAM (called "community treatment" throughout this analysis and based on the CMAM model of care), for children 6-36 months of age. Children were screened at monthly Growth Monitoring and Promotion (GMP) sessions and household visits. Cases of SAM with medical complications were referred to the Upazila Health Complex (UHC), the equivalent of a general hospital, for a few days of stabilization care before returning home for community treatment (Valid International, 2006). Cases of SAM without medical complications received weekly follow-up visits at home by the CHW. CHWs delivered RUTF and counseling, and monitored with mid-upper arm circumference (MUAC) measurements until the child recovered (as defined by a MUAC over 110 mm and/or loss of edema).

In an adjacent upazila, CHWs were trained to identify children with SAM and refer them to the UHC while continuing to provide counseling, and treatment for pneumonia and diarrhea. Facility-based inpatient treatment of SAM at the UHC is the existing standard of care in Bangladesh (called "inpatient treatment"), and its effectiveness was compared with that of community treatment for this study (Table 6.2). The UHC was provided with inputs including training according to WHO Guidelines (Ashworth et al., 2003), supervisory and staffing support, and the materials and supplies necessary for delivery of inpatient treatment. SCUS program staff monitored UHC service delivery over the course of the study. After being referred to the UHC, caretakers of children with SAM either chose to stay in treatment until their children recovered, or left the facility and returned home before completing treatment (referred to as "defaulting").

Other caretakers either refused referral to the UHC and stayed in the community or were referred but not admitted, due to limited beds and staffing. These latter groups, whose children did not receive inpatient treatment, accessed outpatient care from other sources such as village doctors and pharmacists. Additionally, CHWs continued to provide routine counseling and treatment of pneumonia and diarrhea, with additional household monitoring visits and subsequent referrals where necessary. All this support is referred to as "other outpatient care" in this analysis.

Ethical approval was obtained for this study from the Institutional Review Board of Tufts University, USA and from the Bangladesh Medical Research Council (BMRC). Approval was also obtained from the Director General for Health Services (DGHS) in Dhaka, Bangladesh.

2.2 Analytical strategy

An activity-based cost analysis was used, with the sum of the estimates for all component activities assumed to equal total program costs. Costs included were intended to reflect the full range of resources required by households and care providers to initiate and sustain community and inpatient treatment of SAM during the first "start-up" year. Further, this analysis focuses on the total incremental costs of adding the management of SAM to the existing program, considering only those activities or proportions of activities specifically relevant to this objective. All costs were expressed in local amounts where possible, and converted from Bangladesh Taka to US Dollars using the April 2010 exchange rate (1 US$= 67.941 BDT) (OANDA, 2010).

Results were analyzed as cost-effectiveness ratios in terms of costs (in 2010 US$) per child treated and recovered, and per disability-adjusted life year (DALY). A sampling-based sensitivity analysis determined the relative effect of different inputs on the calculated number of

DALYs averted in community and inpatient treatment, and produced credible intervals for cost-effectiveness outcomes. An improved scenario was modeled for inpatient treatment outcomes to determine potential for improved cost-effectiveness. Costs centers were analyzed as percentage of overall costs for each area.

To estimate program costs, a micro-costing approach was applied wherein all activities were broken down into their component "ingredients", with costs estimated for each ingredient (Tan-Torres Edejer et al., 2003). The societal perspective was taken, with data collected on household costs incurred for participation in both community and inpatient treatment. This approach captured all resources used to treat SAM, regardless of who incurred them (Weinstein et al., 1996, Russell et al., 1999). Program staff were consulted to create a list of cost centers to which all program costs were allocated. Supervisory costs were aggregated rather than allocated to activities to facilitate their analysis as a proportion of overall costs (Cooper, 1988a). Cost centers were comprehensive and mutually exclusive, providing a total cost for activities related to community and inpatient treatment of SAM without double counting any of the resources used to implement the program. Table 6.1 describes cost centers and their data sources.

Cost data were coupled with outcome (effectiveness) data collected during program monitoring and shown in Table 6.2 (Sadler et al., 2011).

Disability-adjusted life years (DALYs) are a standard metric for disease outcomes combining the years of life lost (YLL) due to premature mortality and the years lived with disability (YLD) (Murray, 1994). Averting DALYs represents an intervention's ability to avoid or prevent negative health outcomes such as death and lasting disability. Calculating cost per DALY averted facilitates comparison between health interventions. DALYs attributable to death and

disability due to SAM were calculated using the standard formulas (Murray and Lopez, 1996, Fox-Rushby and Hanson, 2001) and differing assumptions for calculation of YLL and YLD as described in Table 6.3.

Since treating SAM averts mortality, this DALY calculation accounts for the probable number of lives that would have been lost in one year without treatment. To do this it includes previously reported estimates of mortality of untreated SAM at different levels of MUAC. A value appropriate for the mean admission MUAC (106.7 mm) was calculated using linear interpolation and published data with cohorts of patients the same age as those in this program, and located in countries with limited access to health services, including Bangladesh (Briend and Zimicki, 1986, Briend et al., 1987), Malawi (Pelletier et al., 1994) and Uganda (Vella et al., 1994). Taking into account a baseline mortality risk of 1 / 10,000 / day, the expected mortality rate was estimated as 207 deaths per 1,000 cases per year. That is, 20.7% of the cohort of SAM cases would be expected to have died within a mean of six months of admission, or onset of SAM episode.

The expected mortality rate was multiplied by the number of cases treated successfully, or recovered from SAM, to get the total deaths averted, and used to weight the YLL and YLD components of the DALY estimate. YLD was calculated for all treated children. YLL and YLD were summed to get the final DALY estimate.

2.3 Data collection

Cost data was collected in March and April 2010. Provider costs were collected via semi-structured key informant interviews with field staff, program officials and administrative staff at SCUS, clinical and accounting staff at the UHC, and review of key program, administrative and

financial documents (Table 6.1). Time allocation interviews were conducted with program and clinical staff to estimate the personnel resources devoted to implementing, monitoring and overseeing treatment of children with SAM. Estimates from time allocation interviews were triangulated with supervisory staff where possible. For those staff with whom an interview was not possible or practical, time allocation estimates were taken from grant budgeting staff. All relevant key informants were identified both at SCUS and the UHC, with a total of 31 interviews conducted.

Participant costs were collected using semi-structured guides for focus group discussions (FGDs). Three guides were designed, one each for caretakers in three groups: community treatment, inpatient treatment, and other outpatient care. The research team piloted these guides and made any necessary changes. Caretakers were selected from a range of unions (the lowest tier of regional administration) within the study area, with 28 participants in community treatment (4 FGDs), 21 in inpatient treatment (4 FGDs), and 25 in other outpatient care (3 FGDs). Point estimates for direct costs represent the median value for each cost item from each group. Point estimates for indirect costs represent the median time allocated for various activities multiplied by the hourly shadow wage (see below). Medians were used so that extreme values would not distort the point estimate from what might be considered typical. Participants were assumed to have a demographic profile similar to the average woman in Bhola district, characterized by low income and education levels.

Costs included those incurred from diagnosis through recovery from SAM, covering slightly different time periods for each group. Community treatment discussions covered the costs incurred during the CHWs' treatment of SAM. Inpatient treatment discussions covered the time spent from CHW's diagnosis of SAM until the end of the treatment episode (i.e. discharge as

recovered, defaulted, non-response, or death), including time spent at the UHC in addition to any extra food, medicine and time costs incurred after default. Other outpatient care discussions included costs incurred since diagnosis on extra food and medicines for the child, transportation while seeking care for child, and time spent feeding child, meeting with CHW, or seeking treatment for child.

2.4 Costing assumptions

A shadow wage for CHWs and caretakers was valued at the wage rate for women in public works: 100 Taka (US$1.47) for a five hour workday, or 20 Taka (US$0.29) per hour. Rental rates for buildings and equipment were used to estimate capital costs (Drummond et al., 1987). Capital depreciation was estimated for cars and computers. Costs were not discounted as they covered less than a year.

2.5 Data analysis and sensitivity analyses

Cost data were entered and cleaned using Microsoft Excel software (Microsoft, 2010a). Errors were modeled for each cost center using the authors' estimations of uncertainty around the data sources as shown in Table 6.4, assuming normal errors to calculate a 95% credible interval on the baseline estimates for each cost center total in Table 6.5.

Purpose-written scripts for the R Language for Data Analysis and Graphics were used to calculate DALYs and cost-effectiveness ratios, and to conduct sensitivity analyses (Ihaka and Gentleman, 1996). Uncertainty in the data was modeled with a sampling-based sensitivity analysis, using probability distributions of the model parameters (see Table 6.3) generated with Monte Carlo simulations using one million replicates per analysis and assuming all errors to be uncorrelated (Efron and Gong, 1983, Briggs et al., 1997). A one-way sensitivity analysis was

conducted using an alternative mortality rate, in order to gauge the sensitivity of cost-effectiveness outcomes to this model parameter.

Cost-effectiveness ratios for several outcomes of interest were calculated by dividing total program costs by outcome measures. DALY estimates are presented separately for community and inpatient treatment compared to a no treatment alternative, assuming costs to be zero, with the same expected mortality rate (see Table 6.3) for all cases of untreated SAM within six months of start of episode.

An "improved" scenario was modeled for inpatient treatment outcomes by applying a modest improvement of 20% to the coverage, recovery and default rates observed at facility level in the comparison upazila.

3. Results

3.1 Cost centers

Table 6.5 presents an overview of total costs for each cost center.

3.2 Cost-effectiveness outcomes

Table 6.6 summarizes cost-effectiveness outcomes for community and inpatient treatment, including an "improved" scenario for inpatient treatment.

Examination of two-way input-output scatter plots revealed that the DALY estimate was only marginally sensitive to all input variables apart from the projected number of deaths in the patient cohort to which it was highly sensitive. This variable accounted for almost all variation in the DALY estimates. A one-way sensitivity analysis was used to examine the variation in

outcomes when using different mortality estimates (analysis not shown). Substituting one-half the expected mortality rate from the literature (10%) resulted in a cost per DALY averted of US$53 (US$41-70) and a cost per death averted of US$1,803 (US$1,414-2,378).

3.3 Cost center comparison

Figure 6.1 presents the proportion of costs attributed to each cost center for both community and inpatient treatment.

Two costs predominated in community treatment: management costs (combining the monitoring and supervision cost centers) and curative care. RUTF and related storage and transport represent nearly all “curative care” costs in community treatment (Table 6.5), at 24% of total costs. Management costs, including salaries and overhead, comprised over half of total program costs at 53%. These activities were conducted by SCUS staff in both areas, resulting in similar costs for inpatient treatment (39% of total). Curative care for inpatient treatment, including therapeutic milks, hospital overhead and clinical personnel time was a significantly smaller proportion of total costs (3%) than for community treatment (25%). This is primarily because few children were treated at the UHC. Costs representing actual service provision by CHWs (combining cost centers for household visits and GMP sessions) made up only 5-6% of total costs in both areas.

In the comparison area, costs incurred by households for treating cases of SAM comprised the largest proportion of total costs, at 40% compared to 5% for community treatment, supporting claims (Collins et al., 2006a, Collins et al., 2006b) that opportunity costs are lower for caretakers participating in CMAM. Household cost estimates, collected in community discussions, are further detailed in Table 6.7. This qualitative data, while not intended to be representative of all participating households, enables a basic comparison of the difference in costs among groups.

Costs for beneficiaries in community treatment were lower compared to inpatient treatment or outpatient care for medicines (median=0.44 versus 8.32 and 4.42) and food (median=0 versus 1.47 and 1.77 per week), as well as transportation and opportunity costs of time. The main resource expenditure for households receiving community treatment was the time required for program participation, including interaction with the CHW and following her advice on responsive feeding.

4. Discussion

4.1 Cost-effectiveness

Community treatment of SAM by CHWs in Bhola cost US$26 (US$21-31) per DALY averted compared to no treatment, and US$869 (US$723-1,059) per death averted. Bangladesh's 2009 per capita GDP was US$551 (World Bank, 2011), suggesting this intervention to be highly cost-effective according to the WHO's GDP per capita threshold for cost per DALY (Commission on Macroeconomics and Health, 2001). These results (Table 6.8) are within the same range as the two other published costs per DALY for community treatment of SAM: US$42 in Malawi (Wilford et al., 2011) and US$53 in Zambia (Bachmann, 2009). Further, these results suggest community treatment of SAM to have cost-effectiveness outcomes comparable with other basic health interventions in developing countries, such as childhood immunization (US$8 per DALY averted), insecticide-treated bed nets (US$19-85 per DALY averted), and treatment for infectious tuberculosis (US$5-10 per DALY gained) (Jamison et al., 2006), and commensurate with the most cost-effective health interventions identified by a World Bank study (US$50 or less per life year saved) (Jha et al., 1998).

Results from this study echo the findings of other analyses showing community treatment of SAM to be more cost-effective than inpatient treatment. Previous studies found inpatient treatment to be from two to five times as costly as community treatment to recover a child from SAM (Ashworth and Khanum, 1997, Tekeste, 2007). Costs per child recovered in Bhola were similar to those in Ethiopia (US$180 and US$145 respectively) (Tekeste, 2007). Further, costs per child treated by CHWs at US$165 were similar to the costs of a program based out of primary health care facilities in Zambia at US$203 (Bachmann, 2009), suggesting that costs may not differ strongly between African and South Asian settings or among various CMAM delivery models. In Bangladesh, Ashworth and Khanum (1997) found domiciliary care of SAM to cost US$29 per recovered child. However, this study differs from the present analysis in several important ways. First, the sickest children were excluded from the analysis. The nature of the intervention in Ashworth and Khanum's study also differs from CMAM programs, with no RUTF used, and one week of quality inpatient day care provided before community treatment, a resource which would not be possible to implement at scale across Bangladesh. Further, the present analysis includes additional costs, such as training, supervision, RUTF and its storage and distribution. Table 6.8 presents a summary of findings from CMAM costing studies.

Results from this study should be interpreted within the context of the overarching program, with CHWs providing preventive and curative care for young children. This environment supported high recovery and coverage rates, and a low mortality rate, and is likely to have reduced the risk of cases of SAM presenting with medical complications (Sadler et al., 2011). Costs included in this analysis represent marginal costs required to add treatment of SAM to this program, while effectiveness results represent this "virtuous cycle" of program factors.

Differing methodologies can make direct comparisons of cost-effectiveness outcomes a challenge. Nevertheless, if these differences are taken at face value, the lower costs per outcome for treatment of SAM in this study may be due in part to the aforementioned programmatic context, and particularly to the decentralized delivery model enabled by CHWs. Previous research supports this argument, finding that CHW programs can achieve lower costs than comparable clinic-based services (Berman et al., 1987), with similar outcomes (Islam et al., 2002). Due to their proximity to communities and the low cost of their time compared to clinical staff, community workers can expand the coverage and equity of health services at low overall cost, removing barriers to access such as distance, travel, and opportunity costs for poor and remote households. In Indonesia, CHWs were consulted for simple curative care more than any other source of treatment. Further, they showed no bias against low-income patients in contrast to clinic-based services (Berman 1985 as cited in Berman et al., 1987). These factors contribute to increased program utilization, coverage and effectiveness.

The sensitivity of the DALY calculation to the number of deaths anticipated without treatment is consistent with findings from other studies (Bachmann, 2009, Wilford et al., 2011), and is plausible for a condition affecting children associated with high mortality but little or no lasting disability among survivors. As with these other analyses, this calculation used the most appropriate mortality estimates available, from historical cohort studies. Even assuming a halved mortality estimate, the cost per DALY averted by community treatment of SAM (US$53) would remain highly cost-effective according to common standards (Bobadilla et al., 1994, Commission on Macroeconomics and Health, 2001).

4.2 Cost analysis

RUTF is a high-cost input and typically comprises 30 to 40% of costs for CMAM programs (Bachmann, 2009, Tekeste, 2007, Wilford et al., 2011, Horton et al., 2010). In Bhola, RUTF-related costs comprised only 24% of total costs. This difference is due in part to the high proportion of management costs in this intervention, including salaries and overhead (53%, combining monitoring and supervision cost centers). This compares with findings from Zambia estimating technical support at 34% of total costs (Bachmann, 2009), and Malawi where administration, personnel and overhead comprised 51% of total costs (Wilford et al., 2011). This suggests that the CCM of SAM was relatively management-heavy. However, these costs represent the intensive start-up costs needed in the first year of a program to establish new systems. This cost structure would likely change over time due to economies of scale, as SAM treatment is integrated into ongoing NGO or government programs. Actual service provision by CHWs at household visits and GMP sessions made up only 5% of total costs suggesting that the ongoing service delivery resources required to add CCM of SAM to an existing program were relatively low.

Proper supervision is important for CHWs (Berman et al., 1987), with effective community programs paying careful attention to their training and support (Mason et al., 2006). Further, motivated CHWs, receiving adequate training and supervision, are necessary to ensure quality community treatment of SAM (Ashworth and Khanum, 1997). These lessons are of particular importance when integrating preventive and curative care (Mason et al., 2006), and suggest that strong supervision can help to ensure that both components receive equal attention. As seen in this study, costs allocated to training, supervision and support should continue to make up a

considerable proportion of the overall cost of similar programs in order to maintain good outcomes.

The UHC in the comparison upazila was supported with training, staff, money, therapeutic milk and drugs and can be said to have been “improved”. However, its poor effectiveness and cost-effectiveness were due in part to low utilization by the community. There are well-documented reasons for caretakers of children suffering from SAM to refuse inpatient care. These include perceptions of hospital quality, perceptions of the costs of treatment and transport, loss of earnings and other responsibilities at home (Ashworth, 2006, Sadler et al., 2011). There is also evidence that inpatient treatment of SAM can be improved by implementing WHO guidelines and providing adequate personnel, supervision and beds (Ahmed et al., 1999, Ashworth et al., 2004). To this end, an improved scenario was modeled for cost-effectiveness outcomes for inpatient treatment (Table 6.6). These results show that even if it were possible, given all the constraints, to improve quality of care for SAM at the UHC, the community treatment of SAM remains over eight times more cost-effective than inpatient treatment. Limited capacity and resource constraints at facility level point to a need to consider viable alternatives. This study adds to the growing evidence that the community treatment of SAM can be more effective than inpatient treatment for most cases of SAM (Collins et al., 2006a, Collins et al., 2006b, WHO et al., 2007).

Household costs made up a large proportion (40%) of costs involved in inpatient treatment. Household costs to recover a child from SAM in inpatient treatment were six times those for community treatment (US$49.72 and US$8.50 respectively, data not shown). Costs were even higher for the majority of cases who defaulted from the UHC and hence bore costs for both inpatient treatment and other outpatient care. The finding that household costs are higher for

inpatient treatment is consistent with other studies. In Ethiopia, direct household costs for inpatient cases were over twice those of outpatient cases. Opportunity costs to caretakers enrolled in CMAM, including wage loss and transportation, were approximately one-fourth the amount of those receiving inpatient treatment (Tekeste, 2007). In Bangladesh, household costs for outpatient care were three times higher than inpatient care since caretakers paid for additional food. Notwithstanding these higher costs, caregivers preferred this option because it allowed them the convenience of staying at home (Ashworth and Khanum, 1997).

The lower resource burden on households was a big part of the appeal of community treatment to caretakers in Bhola. During FGDs, they expressed appreciation for the CHWs delivering services to their doorstep, especially in more conservative Muslim communities where women were not permitted to leave their homes. It is likely that these women would not have accessed treatment for a case of SAM without this decentralization, unless their children were severely ill.

4.3 Future research

This study analyzed costs from the societal perspective for an innovative delivery strategy for CMAM in Bangladesh. Given the disparity in effectiveness between community and inpatient treatment, comparative measures of incremental costs and health effects were not included. Future comparative studies are needed to explore the relative cost-effectiveness of different CMAM models, such as different coverage levels, different service delivery mechanisms, or treatment of SAM alone versus the addition of treatment of moderate acute malnutrition.

5. Conclusion

The CCM of SAM at community level by CHWs was a cost-effective strategy compared to inpatient treatment and compares well with the cost-effectiveness of other common child

survival interventions. Households accessing SAM treatment through CHWs incurred considerably lower expenses than those accessing care from the UHC or elsewhere.

UHC performance was poor. Even assuming improved coverage, recovery and default rates, cost-effectiveness outcomes were still not comparable to those achieved via community treatment.

The CCM of SAM should be considered by policy-makers as a feasible mechanism for treating large numbers of children with SAM in countries like Bangladesh. It also appears suitable for integration into common packages of preventive and curative care delivered at community level. Providing a dedicated corps of community health workers with good training and supervision should be prioritized as a viable way to expand access to treatment for SAM.

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7. Tables and Figures

Table 6.1: Description of cost centers and data sources

Cost Center	Description	Data Sources
1. Monitoring	Personnel and transportation costs incurred while monitoring and supervising CHWs during community case management of SAM.	Time allocation interviews with program and supervisory staff. Review of key program, administrative and budget documents.
2. Trainings	Technical instruction in SAM management for community and inpatient staff, both initial and refresher trainings. Includes salary, per diems, transport and supplies.	Key informant interviews with administrative and program staff at SCUS. Review of training plans and budgets.
3. Supervision	Personnel and overhead costs for program supervision at all levels of the program. Proportion of time at monthly coordination meetings.	Key informant interviews with administrative and accounting staff at SCUS. Time allocation interviews with program and supervisory staff. Review of key program, administrative and financial documents.
4. GMP sessions	Shadow costs for CHW wage and site rental for additional time at GMP session attributable to identifying and treating cases of SAM.	Key informant interviews with administrative and program staff at SCUS. Time allocation interviews and surveys with CHWs.
5. Household visits	CHW time spent visiting households of children with SAM, and all printed materials and supplies used in case management of SAM.	Key informant interviews with administrative and program staff at SCUS. Time allocation interviews and surveys with CHWs.
6. Curative care	All curative care for SAM, including medicines and therapeutic foods (and its transportation and storage) for community management, and equipment, medicines, food, bed and personnel costs at inpatient facility.	Key informant interviews with program, administrative and accounting staff at SCUS and the UHC. Time allocation interviews with clinical staff. Review of key program, administrative and financial documents. Online drug price indicator (Management Sciences for Health, n.d.).
7. Household costs	Value of caretaker's resources spent and extra time caring for child with SAM or accessing care for SAM from CHW, UHC or elsewhere, including treatment-seeking, medicines, and additional food purchased for child.	Focus group discussions with caretakers of children with SAM. Program monitoring database.

Table 6.2: Effectiveness data from community and inpatient SAM treatment

Outcome	Community treatment N=724 % (n)	Inpatient treatment N=633 % (n)
Recovered	91.9 (665)	1.4 (9)
Defaulted	7.5 (54)	7.9 (50)
Non-responder	0.6 (4)	0.3 (2)
Refused Referral	--	52.9 (335)
Non-admitted	--	37.4 (237)
Died	0.1 (1)	0*

* The eventual number of deaths in children not under treatment is unknown.

Table 6.3: DALY model input parameter values and distributions

Parameter	Units	Baseline estimate	Distribution*	Parameter source and notes
Proportion of cases female	NA	0.623	Binomial (n = NT‡, p = BE†)	Source: Program data
Proportion recovered (community treatment)	NA	0.919		
Proportion recovered (inpatient treatment)	NA	0.014		
Number treated (community treatment)	cases	724	Fixed	
Number treated (inpatient treatment)	cases	633		
Degree of disability for death (YLL)	NA	1	Fixed	Source: (WHO, 2004)
Degree of disability for wasting (YLD)	NA	0.053		
Life-expectancy (males) (YLL)	years	66.0		Source: (WHO, 2009), Bangladesh estimates for age group 1-4 years
Life expectancy (females) (YLL)	years	67.2		
Age at start of episode (YLD)	months	19.4	Gamma (k = BE†, θ = 1)	Mean: age at admission
Age at death (YLL)	months	25.4		Mean: 6 months after admission
Duration of SAM episode (YLD)	months	6		Untreated cases
Age-weighting modulation factor	NA	1	Fixed	Source: (Fox-Rushby and Hanson, 2001)
Age weight	NA	0.04		
Constant	NA	0.1658		
Discount rate	NA	0.03		
Expected deaths within one year	deaths	207 / 1000 / year	Poisson (λ = 0.207 × PR¥ × NT‡)	Sources: (Briend and Zimicki, 1986, Briend et al., 1987, Pelletier et al., 1994, Vella et al., 1994)

*Probability distribution functions used to produce credible intervals around certain model parameters.
†BE = Baseline estimate. Source is listed in notes column.
‡NT = Number treated
¥PR = Proportion recovered

Table 6.4: Cost data error estimates by cost center (USD)

Cost center	Baseline estimate	Distribution	Error estimates
Community treatment		$Normal\ \mu = BE, \sigma = \frac{error}{1.96} \times BE$	
Monitoring	$16,075		20%
Training	$14,423		5%
Supervision	$47,721		20%
GMP sessions	$3,043		10%
Household visits	$1,981		10%
Curative care	$30,109		5%
Household costs	$6,345		40%
Inpatient treatment			
Monitoring	$7,685		20%
Training	$9,929		5%
Supervision	$24,046		20%
GMP sessions	$1,803		10%
Household visits	$3,522		10%
Curative care	$2,505		5%
Household costs	$32,834		40%

All costs are in USD; BE = Baseline Estimate. More detail on costs in Table 6.5.

Table 6.5: Comparison of total costs per cost center by study group (USD)

Cost center	Community treatment	Inpatient treatment
Monitoring (*% total costs*):	***13%***	***10%***
Monitoring of CHWs	16,075	7,685
TOTAL	**16,075**	**7,685**
Trainings (*% total costs*):	***12%***	***12%***
For SCUS staff & CHWs	13,900	9,370
For UHC Staff	523	559
TOTAL	**14,423**	**9,929**
Supervision (*% total costs*):	***40%***	***29%***
SCUS coordination meetings	413	413
Field supervisor time	22,436	10,218
Higher-level & support staff time	12,742	6,370
Overhead, institutional costs, capital depreciation	12,131	7,044
TOTAL	**47,721**	**24,046**
GMP sessions (*% total costs*):	***3%***	***2%***
CHW time (shadow wage)	1,383	721
Rental of GMP site (shadow cost)	1,660	1,082
TOTAL	**3,043**	**1,803**
Household visits (*% total costs*):	***2%***	***4%***
CHW time in visits (by case result)		
– Recovered	990	5
– Default	80	265
– Non-response	18	11
– Non-admitted	--	1,256
– Refused referral	--	1,578
– Death	2	--
CHW supplies & printing	892	408
TOTAL	**1,981**	**3,522**
Curative care (*% total costs*):	***25%***	***3%***
Community treatment:		
RUTF	26,336	
Shipment & storage of RUTF	2,521	
SAM medicines from CHW	471	
Inpatient treatment: [1]		
UHC setup equipment	689	689
Medicines	8	92
Food for mothers[2]	13	270
Bed costs	17	361
Therapeutic milk ingredients	7	148
Salary: Clinical staff, Facility Health Worker		
– Admission	8	100
– Daily care	40	846
TOTAL	**30,109**	**2,505**
Household costs for SAM care and treatment	***5%***	***40%***

Cost center	Community treatment	Inpatient treatment
(*% total costs*):		
Community treatment:		
Transportation	--	
Time[3]	6,226	
Medicine and doctor's fees	--	
Food	--	
Inpatient treatment: [1]		
Transportation[4]	24	1,404
Time[5]	48	1,379
Medicine and doctor's fees[6]		--
Food[2, 7]	20	838
Visitors[8]	26	518
Other outpatient care: [9]		
Transportation		551
Time[10]		7,103
Medicine and doctor's fees		4,768
Food		16,273
TOTAL	**6,345**	**32,834**
Total cost	***$119,697***	***$82,324***

[1] Inpatient costs in the community treatment group are for stabilization care at UHC for complicated cases of SAM, which was used by only 5 children in the study.
[2] Costs for caretakers' meals during UHC stay were split between UHC and caretaker, based on evidence from FGDs.
[3] Includes time spent meeting with CHW and feeding child RUTF according to CHW's advice.
[4] Costs incurred when traveling to UHC for admission.
[5] Includes time traveling to UHC, meeting with CHW, waiting for admission, and staying at UHC.
[6] Costs were zero on average, although some bribes or outpatient medicine costs were reported.
[7] Includes food purchased for caretaker and accompaniment during travel to UHC, and food purchased by caretaker for self and child during UHC stay.
[8] Includes direct costs for visitors assisting with child care (food and transportation).
[9] Costs incurred for other outpatient care for defaults, non-response, non-treated, and refused referral cases. This includes follow-up at home by the CHW and costs of CCM of common childhood illness.
[10] Includes value of caretakers' time treatment seeking, meeting weekly with CHW, and extra time feeding child according to CHW's advice.
Totals may not match added figures due to rounding.

Table 6.6: Comparative cost-effectiveness outcomes, including an improved scenario for inpatient treatment (USD)

	Community treatment	**Inpatient treatment *Observed***	**Inpatient Treatment *Improved****
Total cost	$119,697	$82,324	$90,973
Number of children treated	724	61	175
Number of children recovered from SAM	665	9	61
Deaths averted	138	2	12
	(115-161)	(0, 5)	(6, 21)
Total DALYs averted	4,683	67	418
	(3,913, 5,501)	(0, 172)	(203, 713)
Cost per child treated	**$165**	**$1,344**	**$520**
	(151, 180)	(1,119, 1,580)	(434, 604)
Cost per child recovered	**$180**	**$9,149**	**$1,491**
	(164, 196)	(7,582, 10,712)	(1,249, 1,733)
Cost per death averted	**$869**	**$45,688**	**$7,276**
	(723, 1,059)	(15,134, ∞)	(4,209, 15,917)
Cost per DALY averted	**$26**	**$1,344**	**$214**
	(21, 31)	(445, 3,788,726)	(124, 467)

Figures in parentheses are 95% CI for modeled estimates.

*These results are based on a modeled scenario, not actual program outcomes. See discussion for explanation.

Table 6.7: Household costs in accessing SAM treatment, reported in focus group discussions (USD) [1]

Cost	**Community treatment** N[2]=28, 4 FGDs median (range)	**Inpatient treatment** N=21, 4 FGDs median (range)	**Other outpatient care** N=25, 3 FGDs median (range)
Direct costs:			
One-time costs:			
Transportation to UHC (round trip)		2.35 (0.24-7.36) n[3]=21	
Food purchased while traveling to UHC		1.47 (0.37-7.36) n=21	
Food purchased for self during UHC stay		0.74 (0-4.78) n=19	
Food purchased for child during UHC stay		0.74 (0-11.04) n=21	
Total bribes paid at UHC[4]		0.66 (0.44-1.91) n=7‡	
Transportation to seek treatment for illness	--	--	0.88 (0-2.94) n=24
Total medicines purchased (post-treatment)	0.44 (0-2.50) n=6‡	8.32 (0-39.74) n=21	4.42 (0.52-36.80) n=24
Total doctors' fees paid (post-treatment)	0 n=6‡	0.74 (0-2.94) n=19	0 (0-2.21) n=23
Weekly costs:			
Extra food purchased for child	0 n=28	1.47 (0.59-5.89) n=21	1.77 (0-7.36) n=22
Indirect costs: Caretaker's time			
Travel one-way to UHC (hours)		2 (0.5-3) n=21	
Waiting at UHC for admission (hours)		2 (0-6) n=21	
Staying at UHC during treatment (days)		7 (4-15) n=21	
Time per CHW household visit (min.)	45 (20-90) n=26		75 (30-120) n=20
Traveling to seek treatment for child (min.)	2.5 (0-60) n=6‡		60 (0-360) n=24
Extra time per day feeding SAM child (min.)	45 (30-160) n=22		39 (0-150) n=14

[1] These estimates are from focus group discussions and the sample may not be representative of all caretakers in the program area. These provide a summary of the median value and ranges for key costs incurred by caretakers.

[2] *N* (uppercase) represents total caretakers responding in all focus group discussions for each of the three groups.

[3] *n* (lowercase) represents caretakers providing a response to each cost item.

[4]Bribes were paid for hospital bed, food, admission, mosquito net, therapeutic milks.

‡ These values were only reported for those caretakers for whom this question was applicable (eg those whose child had been ill, those who paid bribes).

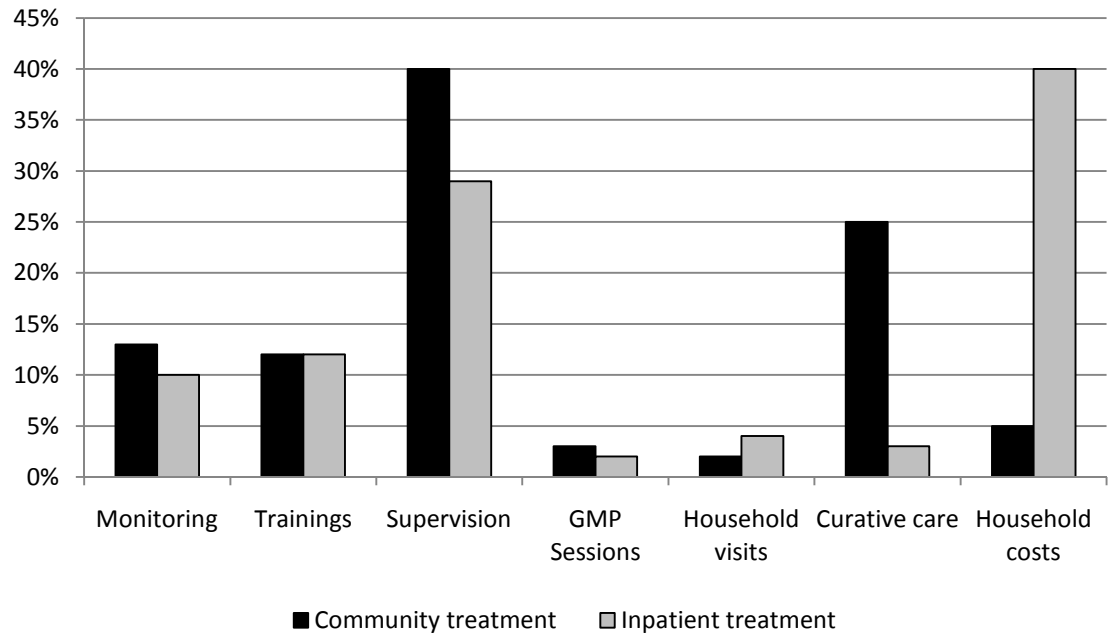
Table 6.8: Comparison of cost-effectiveness results for CMAM (USD)

Cost outcome	Bhola	Bangladesh	Ethiopia	Malawi	Zambia
Per recovery	$180	$29*	$145		
Per treated case	$165				$203
Per DALY	$26			$42	$53

* Results from this study are not exactly comparable due to different program models and included costs. See discussion.

Data cited are from the following sources: (Ashworth and Khanum, 1997, Tekeste, 2007, Wilford et al., 2011, Bachmann, 2009)

Figure 6.1: Cost centers as a percentage of total program cost in both areas



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7 Chapter 7: Summary and Discussion

This dissertation sought to address key debates and operational concerns related to the integration of treatment of SAM into community-based health and nutrition programs by researching one such integrated program in southern Bangladesh. The objectives of this research were to examine the quality of care achieved by CHWs when managing cases of SAM, to examine how adding treatment of SAM to a CHW workload affects the quality of care they provide for other tasks, and to examine the cost-effectiveness of the CCM of SAM compared to inpatient treatment of SAM, including costs incurred by both care providers and participating households. This Chapter summarizes the key findings of this dissertation, discusses implications and recommendations for policy and practice, and suggests areas for future research.

7.1 Key findings

7.1.1 Quality of care

CHWs' ability to provide high quality treatment for SAM

Findings from this dissertation attest to CHWs' ability to deliver good quality care for SAM, with 89% of CHWs (95% CI: 77.8 – 95.9%) achieving 90% error-free case management or higher. This indicates that in areas where CHW cadres are available, it is feasible to further decentralize delivery of treatment for SAM from current CMAM models delivering care from primary and secondary health centers.

Impact of SAM management on quality of care for other tasks

Adding treatment of SAM to a CHW workload that included preventive and curative tasks resulted in increased work hours (16.7 ± 6.9 hours per week for CCM SAM+ CHWs compared to 13.3 ± 4.6 hours per week for CCM CHWs) but did not negatively affect quality of care. In fact, CCM SAM+ CHWs scored significantly higher than CCM CHWs on a checklist of preventive tasks to be performed at a routine household visit (median checklist scores: 100% versus 93.3% respectively), and on two out of three curative case scenarios. The additional training and practice afforded by the treatment of SAM with other curative tasks appeared to reinforce CHWs' basic curative knowledge and skills. This may be due in part to the ongoing SAM case load being low, with a small number of SAM cases seen at any one time. Further, during focus group discussions, CCM SAM+ CHWs demonstrated strong feelings of self-efficacy regarding their ability to provide effective treatment for SAM, a common and visible illness in their communities.

Acceptability to caretakers of SAM treatment by CHWs

The doorstep service provided by CHWs in this remote area of rural Bangladesh was a highly effective mechanism for increasing coverage and promoting early presentation of cases of SAM. Caretakers' trusting relationship with CHWs was highlighted often during community discussions, and further promoted the acceptance and utilization of CHW services and bolstered the effectiveness of the program.

Methods for measuring the quality of CHW service delivery

Performance checklists provided useful and detailed information on CHW quality of care. This information is both relevant to quality of care research, and assists program managers in identifying specific aspects of service delivery that are in need of strengthening. Further,

discussions with CHWs and caretakers provided useful information regarding factors promoting and inhibiting quality of care and program effectiveness.

7.1.2 Cost effectiveness

Cost-effectiveness of the CCM of SAM

CMAM delivered by CHWs costed $26 per DALY averted, $165 per child treated, and $180 per child recovered. These results suggest that this program was not only cost-effective compared to inpatient treatment, but that it also compared well with other child survival interventions when using standardized health outcome measures such as DALYs. This research provided the first assessment of CMAM cost-effectiveness in an Asian setting.

Costs to households for accessing treatment for SAM

Household costs to recover a child from SAM—including medicines, doctor's fees and the opportunity costs of their time—were six times lower for community than for inpatient treatment of SAM. This finding provides evidence for claims that opportunity costs are low for caretakers participating in CMAM. These results also supply additional context for high community acceptance of this program and the service delivery mechanism.

Estimating uncertainty in DALY calculations

This study contributed to the limited evidence base around DALYs attributable to SAM. Further, the DALY estimate calculated for this dissertation was the first in the CMAM literature to use probabilistic uncertainty analysis to estimate variability around parameters with unknown distributions, as is recommended by the WHO and World Bank (Tan-Torres Edejer et al., 2003, Jamison et al., 2006). This practice was particularly important given the qualitative methods used

in collecting cost data, as it derived confidence intervals thereby providing information about the precision of these estimates.

7.2 Implications

Findings from this dissertation have several implications for policy and programs. First, this research indicated that the community-based treatment of SAM by CHWs is a feasible, cost-effective service delivery mechanism that can promote the effective treatment of large numbers of children who are underserved by formal health systems in countries like Bangladesh. This finding is particularly relevant considering the interest of the WHO in incorporating treatment of SAM into IMCI protocols (Dr. André Briend, personal communication).

Second, this research demonstrated that having CHWs deliver treatment for SAM at community level was an effective strategy in a non-emergency context in South Asia, characterized by a high population density. This research contributes evidence regarding the feasibility of adapting CMAM programs—originally developed in emergency settings—into ongoing development contexts, particularly in countries with a high burden of SAM. This is an area of ongoing discussion in CMAM policy and practice (Deconinck et al., 2008, Gatchell et al., 2006).

Additionally, while CHWs were motivated by their new responsibilities in this pilot program, their increased work schedules put significant domestic and financial pressures on these workers. It is unlikely that the quality of care seen in this study could have been maintained over time without additional incentives. While this dissertation examined the relationship between two different CHW workloads and quality of care, it did not quantify an optimal CHW workload or determine an optimal combination of work-related tasks for CHWs in this setting. Future research should contribute evidence to fill the existing gaps in the literature regarding these

important operational concerns. There is also a need for advocacy to governments and donor agencies about the potential contribution of CHWs to the health workforce, and the institutional support required to enable their provision of quality care with high coverage.

To measure quality of care, this study used a performance checklist based on a CMAM classification algorithm to provide more detailed information regarding the service delivery process than studies examining outcome effectiveness alone. While such tools are commonly used in program monitoring and evaluation, nuanced analyses of CHW technical procedure are uncommon in the published literature on quality of care. This is due in part to the challenges involved in developing common standards for measuring performance on diverse CHW tasks. Increasing the use of these assessment techniques in research settings would generate an evidence base with which to compare future studies, and would contribute towards standardizing measurement of various CHW tasks. Basing these checklists on accepted treatment algorithms where possible would contribute further to their standardization.

Further, this dissertation made significant contributions to the ongoing debate around the cost-effectiveness of CMAM. A growing body of evidence has shown that, notwithstanding the high cost of RUTF, the effectiveness of CMAM programs in saving lives makes it a highly cost-effective intervention. This is illustrated through the use of disability-adjusted life years (DALYs), a standard outcome measurement endorsed by the WHO (Tan-Torres Edejer et al., 2003). This dissertation provided the first evidence of CMAM's cost-effectiveness in an Asian setting, demonstrating that outcomes are within the same range as studies carried out in Africa (Bachmann, 2009, Wilford et al., 2011). Further, this research undertook one of the first cost-effectiveness assessments of CMAM from a societal perspective, and determined that costs incurred by participating households were six times lower in CMAM compared to inpatient

treatment of SAM. This finding carries important implications for community utilization and acceptance, and resulting coverage and effectiveness of these programs. There is a need for increased advocacy around the cost-effectiveness of CMAM in order to promote recognition of these factors.

Finally, this project was initiated in response to the current policy environment in Bangladesh. Local policy-making institutions had created guidelines for inpatient management of SAM. This study aimed to provide evidence to policy-makers about the effectiveness and feasibility of community management of SAM when delivered by CHWs, a mainstay of Bangladeshi community-based programming for decades. This research initiative provided evidence for the National CMAM working group in Bangladesh to develop national guidelines for community-based management of SAM. This work is ongoing. Nonetheless, there is a recent policy shift within the country to deliver community-based health programs through community clinics rather than CHWs. This approach would significantly reduce the coverage achieved via CHWs in this field trial since one community clinic covers a much larger area than a CHWs' catchment area. Further, the Health Assistant working at these clinics would be a multipurpose worker, whose work responsibilities would not provide the time needed for active SAM case-finding as CHWs did. Integration of SAM management into existing infrastructure is an important step towards sustaining this life-saving treatment. By attaching CHWs to community clinics, and integrating them into the health system, government policy would ensure that there is a continuous mechanism at community level for identifying those children most in need of treatment.

7.3 Future research

Findings from this research raise several questions. This study determined that CHWs can provide high quality care for severe acute malnutrition. However, the vast majority of child morbidity and mortality related to malnutrition occurs in moderately malnourished children due to its higher prevalence (Pelletier et al., 1995), and many CMAM programs include management of severe and moderate acute malnutrition concurrently. Considering that caseloads and consequent workloads entailed in such programs would be higher than those seen in this study, research should be conducted to determine whether CHWs could provide high quality care when managing severe and moderate acute malnutrition together.

This research indicated that the time allocation required for the addition of SAM to the CCM workload came with significant domestic and financial consequences for CHWs. There is very little consensus in the literature around the optimal level of support needed by CHWs to provide good quality of care in different settings. Answering this question would require a concentrated research initiative, spanning different geographic areas, in order to determine the potential range of each input listed below required by CHWs to deliver quality services in different cultural and geographic contexts.

- Optimum workload (in terms of work time and number of tasks)
- Optimum combination of different types of tasks (e.g. curative and preventive)
- Optimum ratio of population or households per CHW catchment area
- Optimum frequency of supervision and trainings

- Threshold level, in terms of number of tasks or number of hours worked (i.e. per week, day or month), which CHWs can achieve and still maintain quality
- Optimum remuneration to prevent attrition and maintain motivation

The ideal research agenda would provide: (a) evidence towards these questions, and assess whether results vary by geographic and cultural settings, along with (b) a consideration of the costs required to achieve quality care, and at what point diminishing returns would be encountered.

While this research determined the effectiveness of CHWs in managing cases of SAM at community level in Bangladesh, recent policy changes in this country have promoted delivery of SAM treatment through community clinics, a mechanism around which there is a limited evidence base. Further research should be conducted specifically within the formal health care system in Bangladesh, to compare delivery of treatment of SAM through community clinics and CHWs, and to assess strategies for integrating CHWs into the health workforce to extend services from these clinics. This research would provide local policy-makers with evidence regarding the relative effectiveness, coverage and cost-effectiveness of these various delivery mechanisms for the integrated management of SAM.

This analysis provided the first evidence around cost-effectiveness of delivering CMAM through CHWs in a South Asian setting. Further research is needed to determine whether factors such as population density in other settings might impact the cost-effectiveness of delivering treatment for SAM through CHWs.

Although a thorough analysis of effects and household costs post-discharge was beyond the scope of this research, there was anecdotal evidence that many children participating in the CCM

of SAM experienced fewer illnesses after discharge from the program. Further research should be conducted to elucidate whether, after discharge from CMAM programs, children revert to their pre-diagnosis health state or experience less frequent and intense episodes of illness, carrying implications for cost-effectiveness.

Lastly, this dissertation contributed important evidence regarding costs incurred by households when accessing treatment for SAM. Future research should be undertaken to examine household costs in different cultural and programmatic contexts. This research should employ methods such as household surveys to achieve precision in these cost estimates.

7.4 Recommendations

The following recommendations are made on the basis of the findings and implications of this research. First, CHWs should be entrusted to deliver treatment for SAM, promoting the further decentralization of CMAM. Supported by adequate training and supervision, they could provide effective treatment to large numbers of children in countries like Bangladesh where prevalence of SAM is high but access to health facilities is low for poor families. CHWs hold strong potential to extend treatment of SAM from community clinics as a formal part of the Bangladesh health workforce. Effectiveness data from CHW programs like the one examined in this dissertation should be used at country level to advocate for appropriate financing and support for a decentralized network of community health agents.

Community case management (CCM) of SAM should be incorporated into the CCM package of services, including treatment of pneumonia and diarrhea. This dissertation demonstrated that the CCM of SAM was an effective service delivery mechanism for integrating treatment of SAM into a community-based health and nutrition program in southern Bangladesh. It is reasonable to

infer that the low prevalence of SAM with complications in this program was due in part to delivery of SAM treatment alongside services addressing the underlying illnesses that typically contribute to malnutrition. Average caseloads appeared to be manageable for CHWs, who were motivated by witnessing the rapid recovery of children suffering from this common and visible illness. If CHWs are well-supported, this expanded curative workload need not come at the expense of quality for more traditional services delivered by a CHW workforce such as growth monitoring and promotion. Considering CHWs' demonstrated ability to manage cases of SAM in their communities, policy change should be promoted to include management of SAM with pneumonia and other recommended community-level treatments (WHO and UNICEF, 2004).

CHWs should be paid at a level commensurate with their workload, and supported with adequate training and supervision. This is especially important for programs asking CHWs to manage multiple illnesses in their communities, an undertaking which requires a significant time investment. Securing designated funding for CHW programs is a long-standing challenge. A coherent policy framework should be developed to promote to governments and donors the importance of CHWs as community agents having the potential to extend coverage of essential health services. To support this effort, there is an emerging consensus in the international nutrition community that sustained resources are needed for proven health and nutrition interventions in order to manifest their potential impact (Bezanson and Isenman, 2010, Horton et al., 2010).

7.5 Conclusions

This research was conducted to investigate a set of priority operational concerns related to expanding the use of CMAM programs through integration into existing community-based health and nutrition infrastructure. Findings from the analyses conducted in Chapters 4, 5 and 6

all suggest that integration of the treatment of SAM into the CCM package of services is feasible and effective.

Findings from this research indicate that CHWs can be entrusted to deliver good quality of care for SAM. The CCM of SAM is a cost-effective alternative to inpatient treatment, comparing well with the cost-effectiveness of other priority child survival interventions. Further, it is effective when integrated with other health and nutrition interventions delivered at community level. Considering the effectiveness and cost-effectiveness of this service delivery mechanism, policy change should be promoted to include management of SAM with other recommended community-level treatments, and sustained resources should be devoted to support CHWs in delivering effective treatment for large numbers of children suffering from SAM in South Asia and beyond.

7.6 References

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8 Appendices

Appendix 1. CHW Survey

#	QUESTIONS	CODED RESPONSES
01	Does CHW practice CCM of SAM or ARI & Diarrhea only?	CCM of SAM..... 1 CCM of ARI & diarrhea only..... 2
02	CHW ID No. and Name	
03	Date of interview	☐☐ -- ☐☐ -- ☐☐ DD--MM--YY
04	FO ID No.	☐☐☐☐
05	EPI Site No.	
	Background Questions	
06	How old are you?	Age (in completed years) ..... ☐☐
07	What is your marital status?	Married..... 1 Widowed..... 2 Divorced..... 3 Separated..... 4 Deserted..... 5
08	What was the highest grade you completed in school? ("0" if no education) TICK HIGHEST LEVEL ACHIEVED.	Primary (0-5) ..... 1 Lower secondary (6-8) ..... 2 Secondary (8-10)..... 3 High secondary (11, 12)..... 4 Graduate (bachelors) ..... 5 Masters..... 6 Other (specify)..... 7
09	Education system?	General..... 1 Madrasa..... 2
10	How many trainings have you attended in the past one year? (Not including monthly refresher trainings)	Number of trainings ☐☐
11	What was the date of your last supervisory visit with FO?	☐☐ -- ☐☐ -- ☐☐ DD--MM--YY
12	How long have you been employed as a CHW with SCUS?	(# years, months) YY ☐☐ MM ☐☐
13	How many people usually live in your household? (A household is a person or group of persons that usually lives and eat together, including spouse, children, son/daughter in law, grandparents, grandchildren,	Number ☐☐

#	QUESTIONS	CODED RESPONSES
	brother/sister, foster children, step children, and other relatives or friends)	
14	How many children do you have?	Number ☐☐
15	How many of your children are below school age? (below 6 yrs)	Number ☐☐
16	How many of your children are male?	Number ☐☐
17	Aside from doing your work as a CHW and doing regular household work in your own home (including tending to children, poultry, etc), do you do any other work on a regular basis for which you are paid in cash or in kind or both? → **IF "NO" SKIP TO QUESTION 20.**	Yes ..... 1 No 2
18	Are you doing this work now?	Yes ..... 1 No 2
19	What do you do for your earning?	Handicrafts/Handloom ..... 1 Agricultural/Farming ..... 2 Rice pounding ..... 3 Work in other household ..... 4 Services ..... 5 Business ..... 6 Poultry ..... 7 Daily wage earner ..... 8 Private tutor ..... 9 Other (Specify) 10
20	What is your husband's major occupation at this time?	Deceased/not present in HH ..... 1 Does not work ..... 2 Household work ..... 3 Daily labor ..... 4 Non-farm business ..... 5 Agriculture/ Farming ..... 6 Poultry ..... 7 Fishing/fish-rearing ..... 8 Cattle rearing ..... 9 Teacher ..... 10 Private Tutor ..... 11 Transport (Rickshaw/Van/Boat man/Driver) ..... 12 Carpenter ..... 13 Weaver ..... 14 Tailor ..... 15 Other (Specify) 16
21	What did your household spend on the following items in the past 30 days?	House rent ..... ☐☐☐☐☐ (Tk.) Food purchasing.... ☐☐☐☐☐ (Tk.) Utilities (electricity, gas, water, telephone) ..... ☐☐☐☐☐ (Tk.)

#	QUESTIONS	CODED RESPONSES
		Education ..... ☐☐☐☐☐ (Tk.) Transport ..... ☐☐☐☐☐ (Tk.) Medical ..... ☐☐☐☐☐ (Tk.) Loan repayment..... ☐☐☐☐☐ (Tk.) Others..... ☐☐☐☐☐ (Tk.) Total..... ☐☐☐☐☐ (Tk.)
22	Does your household have electricity?	Yes ..... 1 No 2
23	Main material of the roof of their house. Record observation	Natural Roof: Jute/Bamboo/Mud (Katcha) 1 Rudimentary Roof: Tin ..... 2 Finished Roof: Cement/concrete ..... 3 Other (specify) 4
	Support Questions	
24	Does your family (husband, mother in law) think it is socially acceptable for you to do this work?	Yes, very much ..... 1 Somewhat ..... 2 Not much ..... 3 No, not at all 4
25	Do you feel like your work is appreciated in your community?	Yes, very much ..... 1 Somewhat ..... 2 Not much ..... 3 No, not at all 4
26	How valuable do you feel your work is as a CHW with SCUS?	Very valuable..... 1 Somewhat valuable ..... 2 Not very valuable ..... 3 Not valuable at all 4
27	Do you feel that you are paid fairly compared to other employed women?	Strongly agree ..... 1 Agree ..... 2 Neither agree nor disagree ..... 3 Disagree ..... 4 Strongly disagree 5
28	CHW possesses appropriate guideline documents. PHYSICALLY CHECK TO SEE THAT SHE IS CARRYING THEM, AND GIVE A TICK FOR EACH DOCUMENT TO THE RIGHT.	☐ (1) Registers for GMP, ANC and CCM ☐ (2) CCM Manual ☐ (3) Promise Sheets ☐ (4) Flipchart ☐ (5) Pusti Card ☐ (6) Referral Slips

#	QUESTIONS	CODED RESPONSES
	Workload Questions	
29	How many children are currently located within your catchment area?	a) Under 2 ☐☐☐ b) 2-5 years ☐☐☐
30	How many GMP sessions do you hold each month?	Number of sessions ☐
31	This past month, how long did you spend at the GMP session?	☐☐ Hours ☐☐ Minutes
32	For each GMP session, how long does it take you to travel to the GMP session from your house?	☐☐ Hours ☐☐ Minutes
33	Currently, how many household visits do you make per week? (GIVE A RANGE)	From ☐☐ to ☐☐ visits/week
34	Approximately how much time do you spend traveling to, from and between household visits each day?	Own home to 1st visit: ☐☐ Hr ☐☐ Min 1st to 2nd visit: ☐☐ Hr ☐☐ Min 2nd to 3rd visit: ☐☐ Hr ☐☐ Min 3rd visit to own home: ☐☐ Hr ☐☐ Min
35	Last week, on how many days did you make household visits?	Number of days ☐
36	On each of these days, how much time did you spend (including travel time) completing the visit(s)?	Day 1: ☐☐ Hours ☐☐ Minutes Day 2: ☐☐ Hours ☐☐ Minutes Day 3: ☐☐ Hours ☐☐ Minutes Day 4: ☐☐ Hours ☐☐ Minutes
37	Last week, how much time did you spend managing cases of ARI and diarrhea for sick children in household visits?	☐☐ Hours ☐☐ Minutes
38	Last week, how many hours did you work as a CHW for SCUS?	☐☐ Hours ☐☐ Minutes
	NOTE—#s 39-43 ONLY FOR SAM CHWs	
39	Last week, how long did you spend at the weekly follow-up session with SAM children and their caretakers?	☐☐ Hours ☐☐ Minutes
40	Now that you treat SAM, do your GMP sessions take more time than they did before you treated SAM?	Yes ..... 1 No 2
41	On average, how much time did GMP sessions take before you treated SAM?	☐☐ Hours ☐☐ Minutes
42	Last week, how much extra time did you spend dealing with all SAM children in household visits?	☐☐ Hours ☐☐ Minutes

#	QUESTIONS	CODED RESPONSES
43	Last week, how much time did you spend with each SAM child in your community?	☐☐ Hours ☐☐ Minutes
	CCM ASSESSMENT	
44	**Assessing knowledge of general danger signs** Please list the danger signs in a sick child. DO NOT PROMPT. GIVE A TICK FOR ALL CORRECT RESPONSES TO THE RIGHT.	☐ (1) Convulsions ☐ (2) Not able to eat or drink anything ☐ (3) Vomits everything ☐ (4) Very sleepy or unconscious
45	**Assessing knowledge of conditions for immediate referral** Please list the four conditions of children needing referral. DO NOT PROMPT. GIVE A TICK FOR ALL CORRECT RESPONSES TO THE RIGHT.	☐ (1) Convulsions ☐ (2) Not able to eat or drink anything ☐ (3) Vomits everything ☐ (4) Very sleepy or unconscious ☐ (5) Cough for more than 21 days ☐ (6) Diarrhea for 14 days or more ☐ (7) Blood in Stool ☐ (8) Chest indrawing
46 47 48	(Read each of the following 3 case scenarios through each case with each CHW, and tick responses on scenario sheets.)	(SEE FOLLOWING PAGES)

To be filled out at end of interview with CCM and CCM of SAM CHWs. There are 3 cases to read through with each CHW.

Case Scenario #1: (Question #46)

Read the following case scenario to the CHW.

Case scenario 1

A 2 year old little girl is seen By a CHW. She has been passing watery stools, has been eating poorly, and is vomiting. When asked, the mother states she has had diarrhoea for ten days. There is no blood in the stool. She also began vomiting yesterday and has not eaten anything since. The CHW examines the child and finds the little girl to be very weak. The CHW helps the mother to feed her child some khichuri at the household visit, and the girl vomits everything. The CHW tries to give her ORS but she will not take it. No other problems are found.

After reading the case scenario with the CHW, ask him/her to tell you all actions and/or prescriptions he/she would take to provide this child with the most appropriate treatment, assuming that all needed drugs are in stock in his/her drug box and that there is a referral facility available 20 minutes away.
DO NOT PROMPT.

Circle "yes" for each of the following actions mentioned by the health worker.

Help caregiver to give child ORS solution in front of CHW	(1) Yes (2) No
Give caretaker ORS solution to take home	(1) Yes (2) No
Begin giving ORS solution immediately	(1) Yes (2) No
Give paracetamol for 3 days	(1) Yes (2) No
Give cotrimoxazole for 5 days	(1) Yes (2) No
Give first dose of cotrimoxazole	(1) Yes (2) No
Advise to refer to health facility	(1) Yes (2) No
Advise to give fluids and continue feeding	(1) Yes (2) No
Advise to keep child warm if not hot with fever	(1) Yes (2) No
Write a referral note	(1) Yes (2) No
Arrange transportation to health facility	(1) Yes (2) No
Advise caregiver on when to return to CHW or to a health facility	(1) Yes (2) No
Follow up child immediately after returning from hospital.	(1) Yes (2) No

Case Scenario #2: (Question #47)

Read the following case scenario to the CHW.

Case scenario 2

A 15 month old girl is seen by a CHW. Her mother has brought her child to the GMP session, and the CHW notices that this little girl is coughing. The CHW inquires to the mother how long she has been coughing for and finds out she has had a cough for about 10 days. She does not believe there has been fever, vomiting or diarrhoea. The CHW examines the child and finds that she is breathing about 55 times per minute. There is no chest indrawing.

After reading the case scenario with the CHW, ask him/her to tell you all actions and/or prescriptions he/she would take to provide this child with the most appropriate treatment, assuming that all needed drugs are in stock in his/her drug box and that there is a referral facility available 20 minutes away.
DO NOT PROMPT.

Circle "yes" for each of the following actions mentioned by the health worker.

Help caregiver to give child ORS solution in front of CHW	(1) Yes (2) No
Give caretaker ORS solution to take home	(1) Yes (2) No
Begin giving ORS solution immediately	(1) Yes (2) No
Give paracetamol for 3 days	(1) Yes (2) No
Give cotrimoxazole for 5 days	(1) Yes (2) No
Give first dose of cotrimoxazole	(1) Yes (2) No
Advise to refer to health facility	(1) Yes (2) No
Advise to give fluids and continue feeding	(1) Yes (2) No
Advise to keep child warm if not hot with fever	(1) Yes (2) No
Write a referral note	(1) Yes (2) No
Arrange transportation to health facility	(1) Yes (2) No
Advise caregiver on when to return to CHW or to a health facility	(1) Yes (2) No
Follow up child after completion of 4 doses of Cotrim	(1) Yes (2) No
If given Cotrim, ask and fill the following	(1) Yes (2) No

Amount each time:
- Age less than 12 months:
- Age more than 12 months:

Frequency:
Total days:

Case Scenario #3: (Question #48)

Read the following case scenario to the CHW.

Case scenario 3

A three year old girl is brought to the CHW because of diarrhoea. She had been playing with some other children last week who also had diarrhoea and her mother thinks she may have gotten it from them. When asked, the mother states the diarrhoea has been present for about one week. There is no blood in the stool. The girl is eating and drinking well but has frequent loose stools, approximately 6 per day. The CHW checks for dehydration but finds no sign of dehydration (Sunken Eyes, Thirsty, Restless or skin pinch go slowly). There are no other problems.

After reading the case scenario with the CHW, ask him/her to tell you all actions and/or prescriptions he/she would take to provide this child with the most appropriate treatment, assuming that all needed drugs are in stock in his/her drug box and that there is a referral facility available 20 minutes away.
DO NOT PROMPT.

Circle "yes" for each of the following actions mentioned by the health worker.

Help caregiver to give child ORS solution in front of CHW	(1) Yes (2) No
Give caretaker ORS solution to take home	(1) Yes (2) No
Begin giving ORS solution immediately	(1) Yes (2) No
Give paracetamol for 3 days	(1) Yes (2) No
Give cotrimoxazole	(1) Yes (2) No
Give first dose of cotrimoxazole	(1) Yes (2) No
Advise to refer to health facility	(1) Yes (2) No
Advise to give fluids and continue feeding	(1) Yes (2) No
Advise to keep child warm if not hot with fever	(1) Yes (2) No
Write a referral note	(1) Yes (2) No
Arrange transportation to health facility	(1) Yes (2) No
Advise caregiver on when to return to CHW or to a health facility	(1) Yes (2) No
Follow up child in 3 days	(1) Yes (2) No
If given ORS, ask and fill the following:	(1) Yes (2) No

Amount each time:
Frequency:
Total days:

Appendix 2. Routine household visit checklist

Union Name: _____
FO ID No.: _____
CHW Name and ID No.: _____
Date of assessment: _____

To be completed at a routine household visit (ie not for a CCM child.)
(If a step is not applicable to a particular case, write "N/A" under "Item completed", otherwise "Y" or "N".)

#	**Item completed? (Y/N)**	**Action**
1	_____	Announce objective of visit.
2	_____	Try to involve key family members, if appropriate.
3	_____	Discuss with the caretaker about her commitments made on the "promise sheet", or if she did not make any commitments, give her advice now based on her child's situation and make recommendations by which she can improve the care and feeding of her child.
4	_____	Enquire about what the caretaker is already doing at home for this child.
5	_____	Listen to the caretaker in order to understand her situation and concerns regarding caring for her child.
6	_____	Use encouraging non-verbal communication (facial expression, eye contact, body language) and simple language.
7	_____	Recognize and praise what she is doing correctly before suggesting changes.
8	_____	Provide clear, focused counseling and feeding information.
9	_____	Make recommendations by which the caretaker can improve the care and feeding of her child. Only give amount of information or advice that can be remembered and followed.
10	_____	Clear up doubts when a caretaker says that the recommendation is complicated.
11	_____	Answer any questions about the advice.
12	_____	Troubleshoot any problems (or potential problems) with complying with the advice.
13	_____	Negotiate what is feasible for the caretaker in terms of the advice given (if it was unrealistic or she can't comply due to time or resource constraints).
14	_____	Confirm commitments made on the "promise sheet" and encourage caretaker to put recommendations into practice. Tell her it is important to follow the advice in order to improve the child's health.
15	_____	Inform caretaker of next GMP, EPI, Courtyard session or household visit as appropriate and set up a time to follow up with her if necessary.

Appendix 3. CMAM quality of care checklist

Union Name: _____
FO ID No.: _____
CHW Name and ID No.: _____
Date of assessment: _____

To be completed for assessment of malnourished child at GMP session.
(If a step is not applicable to a particular case, write "N/A" under "Item Completed", otherwise "Y" or "N".)

#	**Item completed? (Y/N)**	**Action**
1		☐ New SAM case ☐ Follow-up of existing SAM case
2	_____ _____ _____ _____ _____ _____	Measure MUAC: a) Keep work at eye level. b) Remove clothing covering arm. c) Find approximate midpoint of child's arm. d) Make sure arm is relaxed at child's side and wrap tape around arm, putting the end through the smaller hole. e) Make sure tape is flat and not too tight or loose. f) Read measurement number on MUAC strip.
3	_____ _____	Check for Edema in sick children only: a) Press firmly on top of child's feet for 3 seconds. b) Release, and feel pressed spot for indentation
4	_____ _____ _____ _____ _____ _____ _____ _____	Diagnose as SAM with or without complications: c) MUAC <110. d) Presence of Edema (criteria explained above). e) Check for SAM with or without complications according to algorithm. 1. Check for danger signs. 2. Check for chest indrawing. 3. Count respiratory rate according to protocol. 4. Take temperature. 5. Examine for dehydration.
5	_____ _____	Check appetite: a) Give packet of RUTF to child. b) If child refuses to eat after 15 minutes, classify as SAM with complications.
6	_____	According to algorithm, is SAM diagnosed correctly?
7 8 9	_____ _____ _____	If SAM without complications identified: • Is antibiotic given according to protocol? • Is folic acid given according to protocol? • Is RUTF given and amount calculated according to protocol?
10	_____ _____	Deliver education messages: i) RUTF fulfills all dietary requirements and should replace the regular diet for that child (except for breast milk if the child is still breast feeding) j) RUTF is like medicine and therefore, should not be shared with

#	Item completed? (Y/N)	Action
	_____ _____ _____ _____ _____ _____	siblings or other children. k) Children with SAM need to be encouraged to eat. Give frequent feeding with small amount of RUTF (up to eight times a day) l) Any child 6-12 months who is breastfed should receive breast milk first then RUTF. After 1 week they can receive additional complementary foods if they are hungry after eating RUTF. m) Give adequate amounts of safe water with RUTF since the child will be thirstier than usual. n) Do not mix water in the RUTF packet. o) Medicine is important for the recovery of your child. Give the medicine provided by your CHW 2 x per day for 5 days. p) Seek immediate advice from the CHW if your child experiences any of the following after consumption of RUTF: • Severe cough or difficulty breathing • Redness or swelling around the mouth or face • Nausea, vomiting or diarrhea
11	_____ _____ _____	**Referrals** given for**:** a) Children <6 months with SAM b) Non-responders c) Any SAM cases with complications d) Referral form is filled appropriately, with addition of weight, MUAC and diagnoses of SAM with complications.

Appendix 4. Cost center allocation

The following Appendix describes the calculation of costs for each center, and any assumptions made. The presentation of cost results follows the outline and description of the cost centers in Table 6.1. Costs estimates are presented for each cost center in Table 6.5.

1. Monitoring

Community case management of SAM in the intervention area

This center comprises costs incurred by the twelve field officers (FOs) in the intervention upazila while monitoring CHWs' community case management (CCM) of SAM. These costs generally include salary and transportation. Table 8.2 provides an overview of additional personnel time required in this program to add SAM management to the existing health and nutrition program.

Salary

Of the twelve FOs, seven were from SCUS and five were from Partner NGOs. Estimates for time allocation were 30% for SCUS FOs and 25% for Partner FOs.

Transportation

Transportation costs included rental fees, and average fuel and maintenance costs for the motorbikes that FOs used to travel to the field.

Assumptions

Partner FOs came from several organizations therefore some unifying assumptions were made about their salary and travel costs. One common salary estimate was used for all Partner FOs. Since they used public transportation to travel to the field, their monthly travel costs were estimated using current bus and rickshaw fares. Because Partner FOs were not working for SCUS their involvement in CHW monitoring was estimated to be slightly lower than for SCUS staff. Based on interviews with both Partner and SCUS FOs and SCUS management staff, it was estimated that their weekly time allocation on SAM management activities would be on average five percentage points less than SCUS FOs.

Standard of care in the comparison area

Costs included are similar to those for the intervention area. Since CHWs in this area were implementing a limited range of SAM identification and referral activities, the overall time allocation for managing SAM-related activities was estimated to be less, at 15% for SCUS FOs and 10% for Partner FOs.

2. Trainings

Community case management of SAM in the intervention area

Costs included in this center are for training activities for the community and facility-based management of SAM.

Training for CCM of SAM

SCUS facilitators and CHWs in the intervention upazila each received a 3-day training on the community case management of SAM. The purpose of the facilitator's training was to give a technical background to field staff, including Program Officers and Field Officers (FO) who would then facilitate the CCM of SAM training for CHWs in their own unions. CHWs were trained in eleven batches. FOs' training session was facilitated by the Deputy Program Manager-Nutrition and an expatriate with expertise in CMAM protocols. These trainings were held at a large rented venue. Costs estimates include personnel costs for trainers and trainees, per diems, transport (rented vans and a daily rate for motorbikes of program staff), materials and supplies, equipment, support staff and refreshments.

Refresher trainings

FOs conducted monthly refresher trainings and bimonthly intensive refresher trainings with the CHWs in their unions, a proportion of which (25%) were dedicated to reviewing SAM management techniques. The purpose of these trainings was to review concepts and answer questions.

UHC training for inpatient management of SAM according to WHO Guidelines

Doctors and Nurses at the intervention UHC received a 2-day training from senior SCUS staff on inpatient protocols for stabilizing complicated SAM cases according to WHO Guidelines.

Standard of care in the comparison area

Trainings in this upazila were similar to those delivered in the intervention upazila.

Training for case finding and referral of children with SAM

SCUS facilitators and CHWs in the comparison upazila each received a 2-day training that covered identification of cases of SAM with a MUAC strip and the process for referral to the UHC. Costs for this training are similar to those described for the intervention upazila. FOs then trained CHWs in their own unions. These CHW trainings occurred in nine batches.

Refresher trainings

These were as described in the intervention upazila.

UHC training for inpatient management of SAM according to National Guidelines

Doctors and Nurses at the comparison UHC received 2-day training from senior SCUS staff that covered inpatient protocols for SAM treatment according to National Guidelines.

3. Supervision

Table 8.2 below provides an overview of additional personnel time required in this program to add SAM management to the existing health and nutrition program.

Coordination meetings

During monthly coordination meetings held at the District Office, program staff from both intervention and comparison upazilas gave updates on SAM management activities and received feedback on any challenges experienced. Around 5% of the full-day meeting was allocated to discussing activities related to SAM management. Similarly, program activities were discussed, for around 10% of the day, at the monthly sub-district coordination meetings in each upazila.

Management and administration

Management, supervisory and administrative staff supported the program in different ways and at different regional levels.

At Bhola District level time allocation for the four project officers (POs) hired to support SAM activities was estimated to be 100%. Two of the three POs worked exclusively on SAM management activities in the intervention upazila and one in the comparison upazila. The lead PO allocated two-thirds of his time to activities in the intervention upazila and one-third to the comparison upazila. Costs of motorbikes used for transportation were only included for those staff persons whose time was fully dedicated to oversight of SAM management activities. Since community case management of SAM was integrated into the health and nutrition program, existing supervisory staff in Bhola also dedicated time to oversight and supervision of the SAM component of the program. Time allocation for the Senior POs in Bhola District Office and the PO in the intervention upazila was estimated to be 17.5%. Time allocation was estimated at 12% for the PO in the comparison upazila. Support staff at the District Office helped field activities run smoothly. The Administrative Officer and Assistant Information Technology Officer in Bhola each allocated approximately 12.5% of their time to the program over the course of the year, while the Finance Officer allocated on average 7% of her time.

At Barisal Division level support and coordination for SAM management activities provided by administrative staff was estimated at 5% time for one deputy finance manager and one administrative manager.

At Dhaka central level the Deputy Program Manager allocated 100% of his time during program startup and for the first five months of implementation. After that he allocated 50% of his time to

the coordination of the program. Both salary during program planning and implementation, and field travel costs are included in cost estimates. The Deputy Country Director for Health programs provided support at 1.5% time allocation during the months of program planning and setup.

Overhead and institutional costs

Rent and utilities

Table 8.1 summarizes the allocation of overhead costs to the intervention and comparison upazilas. These include rent and utilities at the upazila-level SCUS office, and a percentage of these costs for the Bhola, and Barisal and Dhaka offices. Costs for the UHC in the intervention upazila were negligible due to the low number of children referred to the facility here, and were therefore not included. Costs for the UHC in the comparison upazila were included.

Table 8.1: Allocation of overhead costs to intervention and comparison area

Office	**% costs allotted**	**Area allotted**
Borhanuddin Office	30%	Intervention
Lalmohan Office	15%	Comparison
Lalmohan UHC	4%	Comparison
Bhola Office	10%	2/3 Intervention, 1/3 Comparison
Barisal Office	5%	2/3 Intervention, 1/3 Comparison
Dhaka Office	5%	2/3 Intervention, 1/3 Comparison

Capital depreciation

Capital depreciation was estimated for any items whose value was not estimated in some other way. This included cars and computers used by SCUS for program purposes. Ambulance costs at the UHC were not included as ambulances were never used to transport cases of SAM. Depreciation value of cars was allocated at 50% each to the intervention and comparison upazila. Value of computers was allocated to each area based on the job responsibilities of the staff person using them. Computer costs were only included for supervisory field staff devoting 100% time to the program, and for the Deputy Program Manager for Nutrition.

Assumptions

Management and administration costs were gathered for the entire program, which includes both community case management activities and setup and oversight of facility management in the comparison area. Division of overhead and management costs between the intervention and comparison area was based on allocation of field supervisors for the program, with two-thirds allocated to the intervention in the intervention upazila, and one-third to oversight of facility management in the comparison upazila. Aside from the time used for SAM activities in these

coordination meetings, no other time from upper level field management was allocated to SAM activities for the purposes of this cost analysis.

During the program planning phase, there was turnover in the management staff directly responsible for its oversight. Supervision costs included here for the Deputy Program Manager for Nutrition are based on composite time allocation estimates in key informant interviews with all management staff involved in program startup. The resulting supervisory costs are for an estimated normal scenario for time allocated by one central-level manager for the duration of the program.

For overhead and institutional costs, it was assumed that staff time allocation percentages gathered during key informant interviews were a good proxy for the overall institutional time dedicated to program activities in that particular office. Where possible, these estimates were triangulated with administrative staff in charge of grant budgeting.

4. GMP sessions

This cost center includes values for the additional time CHWs spent at GMP sessions to measure MUAC and counsel mothers of SAM children. Additionally, a shadow cost was estimated for rental of the GMP site, with the cost for renting the site for the additional time due to SAM activities allocated here. Table 8.2 provides an overview of additional personnel time required in this program to add the management of SAM to the existing health and nutrition program.

On average, CHWs in the intervention area spent an additional 1.5 hours at the GMP session managing children with SAM, including measuring MUAC, counseling mothers about SAM, and scheduling follow-up visits to provide RUTF.

In the comparison area, CHWs spent an additional hour at the GMP session measuring MUAC and counseling caretakers of SAM children.

5. Household visits

This includes costs for CHW time spent visiting the households of children with SAM in their communities, as well as the materials and supplies provided to CHWs to use for the management of SAM during household visits.

Community case management of SAM in the intervention area

CHW time

The average value of time spent by a CHW on a household visit with SAM children and related travel was estimated for children in each outcome category (i.e. recovered, died, defaulted etc). For each outcome category the total amount of time spent by CHWs on household visits was summed.

CHW supplies

For each CHW, the cost of a MUAC tape, thermometer and scissors (to cut the RUTF packets) was included.

CHW printed materials

Total printing costs included those for admission cards for the CCM of SAM program, treatment algorithms, verbal consent forms, admission and discharge criteria, monthly reports, RUTF dosage calculation sheets, treatment instructions sheets, education messages, discharged weight sheets and referral slips for SAM with complications.

Assumptions

It was assumed that CHWs paid one visit to each child with SAM per week.

Standard of care in the comparison area

CHW time

This was estimated in the same way as that for the intervention upazila.

CHW supplies

This included the cost of one MUAC tape per CHW.

CHW printed materials

This included total costs of printing verbal consent forms, monthly monitoring reports and referral slips to the UHC.

Assumptions

Each SAM case referred to the UHC was assumed to have received a household visit before and after their stay at the UHC. Children who were not cured at the UHC received additional (weekly) household visits from CHWs for provision of CCM of illness and other support provided by the broader health and nutrition program. It was assumed that children who recovered at the UHC did not receive additional visits from the CHW.

Table 8.2: Summary of additional personnel time allocated for management of SAM

Category	Overall	
	Community program	**Facility program**
SCUS staff		
Community health volunteers (CHWs):		
Extra time for GMP session/month	1.5 hours	
Extra household visits/week/SAM child	1-3 @ 45 min	1-3 @ 75 min
District Staff (Bhola):		
Monthly District Coordination meetings	+ 15 min.	
1 Senior Program Officer-SAM	100%	
	66%	33%
3 Program Officers-SAM	100% x 2	100% x 1
15 MCHN FOs: CHW SAM activities	30% x 7	15% x 8
8 Partner FOs: CHW SAM activities	25% x 5	10% x 3
1 Administrative & 1 IT Officer	12.5%	
1 Finance Officer	7%	
Division Staff (Barisal)		
1 Finance & 1 Administrative Officer	5%	
Country Office Staff (Dhaka)		
1 HR Officer	25%	
1 IT Officer	10%	
1 Driver	100%	
DPM-Nutrition	50% @ 19 mos (avg)	
DCD-Health & Nutrition Programs	1.5% @ 7 mos	
Health Facility staff—time per child		
Medical Assistants:		
Admission		15 min
Daily care		--
Nurses:		
Admission		30 min
Daily care		18 min
Doctors:		
Admission		10 min
Daily care		10 min
Facility Health Worker		
Admission		--
Daily care		3 hours

The times stated here reflect the *additional* time, on top of existing workload, required for the management of SAM.

6. Curative care

Community case management of SAM in the intervention area

This cost center includes treatment provided by CHWs for SAM children in the intervention upazila in the form of RUTF and medicines, as well as setup equipment provided to the UHC for treating cases with complications.

RUTF, shipping and storage

International transportation included all costs incurred in shipping RUTF (Plumpynut©) from France to Chittagong port. Local shipping costs included trucks from Chittagong port to Barisal and Barisal to the intervention upazila, in addition to fuel and ferry fees. Local vans were rented each month for transporting RUTF from the SCUS office to the CHWs' respective unions. RUTF was stored primarily in Barisal, with a buffer stock kept in the intervention upazila. Total costs for RUTF and international and local transportation were summed and divided by the number of kilograms purchased to get separate costs per kilogram for both RUTF and shipping and storage. The total kilograms of RUTF consumed during the program were estimated by multiplying the average kilograms consumed per child by the total number of children enrolled.

Medicines

CHWs administered one dose of Cotrimoxazole and folic acid per admitted child. According to an online drug price indicator, Cotrim costs $0.40 per dose and folic acid costs $0.25 per one-time large oral dose (Management Sciences for Health, n.d.). The total cost for admission drugs was estimated at $0.65 per child.

UHC setup equipment

To implement WHO SAM management protocols, SCUS provided the UHC with equipment and supplies including a height board, Salter scale, digital weight machine, glasses and spoons, storage equipment (almirah, steel trunk and lock), and a blender and refrigerator for preparation of therapeutic milks.

Assumptions

Recurrent costs at the UHC were negligible since few complicated cases were identified and referred to the UHC. Given limited use of these services, it was difficult to get an average ongoing time and resource allocation for personnel and overhead costs. Therefore recurrent costs at the UHC in terms of SAM treatment were excluded from this cost component. One half of actual costs for refrigerator and installation at UHC were included in these cost estimates as the refrigerator was used for the dual purpose of refrigerating other medicines.

Standard of care in the comparison area

This cost center includes all costs related to facility-based treatment of SAM cases at UHC in the comparison upazila.

UHC setup equipment

The UHC in the comparison upazila was provided with the same setup materials for the treatment of SAM as detailed above for the UHC in the intervention upazila.

Medicines

According to discussions with clinical staff, and a review of prescription records, all admitted SAM children were given folic acid, vitamin A and a broad spectrum antibiotic. According to a drug price indicator, a dose of these basic medicines costs approximately $1.50 (Management Sciences for Health, n.d.).

UHC food for caretakers

Caretakers were estimated to contribute half the daily cost of their own food, based on evidence from focus group discussions and described in the assumptions section below. The daily cost of food provided by the UHC was multiplied by the total days spent at the UHC by children with SAM.

UHC bed costs

The daily cost per bed provided by the UHC was multiplied by the total days spent in inpatient care by children with SAM.

Therapeutic milk ingredients

Total costs for the ingredients provided to the UHC (milk powder, oil, sugar and multivitamin mix) were collected from SCUS financial records. An average cost per child per day was then estimated.

UHC staff salary and the Facility Health Worker

The average time spent by all clinical staff with children with SAM at admission and per day was calculated and multiplied by an average hourly wage for each type of staff (doctors, nurses and medical assistants as well as Facility Health Worker). Estimates for daily costs were multiplied by number of admitted children and number of days spent at the UHC by children with SAM, and added to admission costs. Table 8.2 provides an overview of additional personnel time required in this program to add SAM management to the existing health and nutrition program.

Assumptions

According to hospital staff, mothers were provided meals each day by the UHC. However, during focus group discussions, many caretakers mentioned that they did not receive meals and had to purchase their own food during their hospital stay. The estimate used in this analysis comprises one half of the daily value of caretaker's meals provided by the UHC, and one half the median value of food purchased daily as reported by caretakers.

It was assumed that the Facility Health Worker spent three hours a day per child at the UHC since she worked six hours a day and at any given time there would have been no more than two children with SAM admitted.

It was assumed that in order to achieve adequate weight for discharge, cured cases spent two weeks at the UHC. Average length of stay for default cases was assumed to be the median value from focus group discussions with caretakers of children with SAM who had attended the UHC.

No costs for drugs supplied by CHWs (for community case management of pneumonia or diarrhea) were included in this analysis.

One half of actual costs for refrigerator and installation were included in these cost estimates as the refrigerator was used for the dual purpose of refrigerating other medicines at the UHC.

7. Participant household costs

This cost center includes the total estimated value of the time spent by caretakers to care for their child/ren with SAM. Table 8.3 details the average household costs per child treated in the community program and the UHC. These estimates are from qualitative data, with median and range presented.

Community case management of SAM in the intervention area

Cost estimates include the caretaker's time meeting with the CHW at her own household each week, and the extra daily time she spent feeding the child RUTF. Median values were used in calculations. These estimates were multiplied by the length of stay for each child by category.

Assumptions

Other household costs incurred by caretakers receiving the CCM of SAM intervention, including medicines, doctor's fees and other foods purchased for their child, were estimated to be negligible on average and were therefore not included.

Standard of care in the comparison area

This cost center includes costs incurred by caretakers of SAM children both during inpatient treatment at UHC and while accessing outpatient care from the CHW and other sources.

Costs incurred at UHC

Household costs are separated by category of child since different categories incurred different costs. For example, some SAM cases traveled to the UHC but did not stay there.

The cost for CHW follow-up represents the value of the caretaker's time spent with CHW during the household visit before and after going to the UHC.

Travel to the UHC includes the round trip bus or rickshaw fare to the UHC for caretakers plus any accompaniment (usually husband or grandfather), value of caretaker's time spent traveling to UHC, and any food purchased by caretaker or accompaniment while traveling.

The cost for UHC admission includes the value of mother's time spent waiting for admission to the UHC after arriving.

The cost for UHC stay includes half the value of any food purchased by the caretaker for herself or her child, or brought by family and friends (the other half of the daily food cost is estimated to come from the UHC), the daily time valuation for the caretaker during UHC stay and a valuation of time spent by visitors. Visitor time was calculated using one-half of the caretaker's reported total visitor days in order to approximate visits for the purpose of assisting with child care (as opposed to social visits from friends), including transportation and travel food costs for these visitors.

Costs incurred in outpatient care

This cost center includes those costs incurred by caretakers while seeking treatment for SAM outside of the UHC. This includes a one-time cost for mother's transportation and time spent traveling to seek treatment for her child, either from a doctor or other care provider not within walking distance of her home. Additionally, cost estimates for weekly expenditures were summed and multiplied by the length of stay in outpatient care of different categories of children. These weekly cost estimates included the value of caretaker's time in a household visit with the CHW each week, daily time spent in responsive feeding with the child as advised by the CHW (beyond normal feeding times before the child was diagnosed with SAM), cost for any medicines purchased or doctor's fees incurred, and cost per week of additional foods purchased specially for the malnourished child as advised by the CHW.

Assumptions

Cases that recovered from SAM at the UHC were assumed to spend no time accessing outpatient care from CHWs or otherwise. Default and refused referral cases were assumed to spend 16 weeks receiving outpatient care from CHWs, based on the median value from focus group discussions.

It is assumed that caretakers of all non-recovered SAM cases in the comparison upazila only traveled once to seek treatment outside their villages during their time in outpatient care. This is supported by results from focus group discussions, where time and travel costs in seeking treatment were not areas of high expenditure. However, caretakers did demonstrate a tendency to purchase medicines or incur fees at local village doctors and pharmacists on a more regular basis and these costs are included.

Two different cost estimates are used for weekly medicines and doctor's fees and extra weekly food specially purchased for children with SAM, for default and refused referral cases respectively. Focus group discussions were held with two groups of caretakers: those who had attended UHC (many of whom had defaulted), and those who were receiving outpatient care from CHWs (many of whom had refused referral). Values obtained from these two separate groups were slightly different and were thought to reflect a possible underlying difference among these two categories of children. For example, it is possible that mothers of less-sick children were less likely to perceive referral to UHC as necessary, while mothers of sicker children had a greater propensity to attend the UHC for at least a few days.

Table 8.3: Household cost per child for SAM care and treatment, comparison by area

Cost by outcome	USD	USD	USD	USD
Community case management of SAM	**Recovered N = 665**	**Default N = 54**	**Non-response N = 4**	**Death N = 1**
Total costs for *(n)* weeks average stay:	*(4.8)*	*(4.8)*	*(14.6)*	*(7.0)*
Time in weekly follow-up meeting with CHW*	1.06	1.06	3.21	1.54
Extra time per day to feed child RUTF*	7.44	7.44	22.63	10.85
Total household costs per child in Borhanuddin	**$8.50**	**$8.50**	**$25.84**	**$12.39**
Facility-based management of SAM				
UHC referral and stay	**Recovered N = 9**	**Default N = 50**	**No inpatient care N = 237**	
One-time costs: [1]				
Time in CHW household visit pre- & post- UHC*	0.44	0.44	0.44	
Caretaker transportation to UHC	2.35	2.35	2.35	
Caretaker travel time*	1.18	1.18	1.18	
Caretaker travel food	1.47	1.47	1.47	
Accompaniment food	0.74	0.74	0.74	
Accompaniment travel	2.35	2.35	2.35	
UHC Admission wait time*	0.59	0.59	0.59	
Total daily costs for *(n)* days average stay:	*(14)*	*(7)*	*(0)*	
Food purchased by caretaker	5.18	2.59	--	
Total caretaker wage loss*	20.58	10.29	--	
Total costs for visitors assisting with child care	14.84	7.42	--	
Total inpatient costs	$49.72	$29.42	$9.12	
Outpatient care		**Default**	**No inpatient care**	**Refused referral N = 335**
One-time treatment seeking costs:				
Transportation to doctor		0.88	0.88	0.88
Caretaker's travel time*		0.29	0.29	0.29
Total weekly costs for *(n)* weeks average stay:		*(16)*	*(16)*	*(16)*
Total extra time feeding SAM child*		7.52	7.52	7.52
Total time in weekly CHW follow-up meetings*		3.52	3.52	3.52
Total costs for medicines and doctor's fees		11.04	11.04	4.64
Total extra food purchased for child		23.52	23.52	28.32
Total outpatient costs		$46.77	$46.77	$45.17
Total household costs per child in Lalmohan	**$49.72**	**$76.19**	**$55.89**	**$45.17**

* Costs for caretaker's time are calculated using median reported time allocation multiplied by the shadow wage rate: 20 Tk ($0.29) per hour or 100 Tk ($1.47) per day.

[1] In two out of four focus groups, caretakers also reported paying bribes to UHC staff for items such as meals, mosquito nets, admission, beds, and therapeutic milks used for treatment. Median values for these bribes ranged from 10 to 60 Tk, with median total bribes equaling 45 Tk.

Appendix 5. DALY estimation

The calculation of DALY estimates described in this Appendix benefited from collaboration with Mark Myatt, Consultant Epidemiologist with Brixton Health, who worked together with the Researcher on this component of the research. First the DALY equation is presented along with the input parameters used in DALY estimations for this analysis. Then each parameter is described in more detail.

DALY equation and input parameters

DALYs attributable to death and disability due to SAM were calculated using the standard formulas (Equation 8.1) (Murray and Lopez, 1996, Fox-Rushby and Hanson, 2001) and differing assumptions for calculation of YLL and YLD as described below.

Equation 8.1: DALY formula

$$f\ (r,K,B) = D\frac{KCe^{ra}}{(r+B)^2}\{e^{(-r+B)(L+a)}[-(r+B)(L+a)-1] - e^{-(r+B)a}[-(r+B)a-1]\} + \frac{1-K}{r}(1-e^{-rL})$$

Where: D = disability weight; K = age-weight modulation factor (1); C = constant (0.1658); r = discount rate (0.03); a = age at death; β = age-weight (0.04); and L = life-expectancy at age a (local life-table used).

Where (YLL): K = age weighting modulation factor; C = constant; r = discount rate; a = age of death; β = parameter from the age weighting function; L = standard expectation of life at age a; D = disability weight.

Where (YLD): K = age weighting modulation factor; C = constant; r = discount rate; a = age of onset of disability; β = parameter from the age weighting function; L = duration of disability; D = disability weight.

The formula above was used to calculate both YLL and YLD, the results of which were then added to generate the DALY estimate. For both YLL and YLD calculations, some component variables assumed different values.

- *D = Disability weight*
  - For YLL, death = 1 (WHO, 2004)
  - For YLD, wasting = 0.053 (WHO, 2004)
- *a = Age*

- In YLL, *a* represents age of death, it was assumed that most deaths would occur within one year of admission, or six months after date of program admission.
- In YLD, *a* represents age of onset of disability, assumed to be the age at admission.

- *L = Duration*
  - In YLL, *L* represents life expectancy. The calculations in this analysis are based on local life-tables separated by gender for age group 1-4 years (WHO, 2009).
  - In YLD, *L* represents duration of disability, assumed to be 6 months on average.

Assumptions

Age of death

This is a "counter-factual" used to estimate the age at death for cases of SAM that were not treated and eventually died. The assumption made is that the majority of death would have occurred within one year of admission, or, on average, six months after the date of program admission. The age at admission from the program monitoring data is approximately normally distributed with mean = 19.4 months and sd = 1.2 months.

We have, therefore, a distribution for age of death (a) in years as:

a = NORMAL(mean = ((19.4 + 0.5) / 12, sd = 1.2 / 12)

We generate one million replicates drawn randomly from this distribution.

Life expectancy at age of death

This is based on local life-tables (Fox-Rushby and Hanson, 2001), using the WHO Global Health Observatory figures for Bangladesh in 2008 (WHO, 2009):

Expectation of life at age x

Where *x* is the age-group:

1-4 years

See: http://apps.who.int/ghodata/?vid=60120

This is:

Males = 66 years

Females = 67.2 years

The exact values are not critical as the age-weighting and discounting means that the life of an elderly person 60 or more years in the future means very little in terms of DALYs.

Program data shows that 62.3% of the 724 admissions were female; females live longer than males. We need a weighted average life-expectancy for a program population. This weighted average should also account for some random variation in the sex-ratio of cases. To do this, we generate one million replicates from:

WEIGHT_FEMALES = BINOMIAL(size = 724, probability of success = 0.623) / 724

And also have the inverse:

WEIGHT_MALES = 1 - FEMALES

The expectation at age of death (L) is:

L = WEIGHT_MALE * 66 + WEIGHT_FEMALE * 67.2

Note that L also has 1 million replicates.

Age of onset

The onset of wasting is assumed to be the age at admission. This is a simplifying assumption. As long as time of onset to time of admission is short (and it probably was in our program) then this makes little difference to final calculations.

We have a distribution for age onset (a) in years as:

a = NORMAL(mean = (19.4 / 12, sd = 1.2 / 12)

We generate one million replicates drawn randomly from this distribution.

Duration of disability

This is assumed to have a left truncated normal distribution with mean = 6 months and sd = 3 months. Left-truncation is used to impose a minimum duration of 1 month. This is a "counter-factual" excess duration in untreated cases (i.e above the 1.1 months in program for treated cases). Again, one million replicates are used.

This distribution is used to calculate YLDs for both survivors and deaths.

Sources for the simulated data

NOTE: The simulated data is generated from :

Observation:

Age distribution of cases

Sex-ratio of cases

Cure rate

Number of case admitted and treated

Published data:

Life expectancy at age of death

Mortality if untreated (see below)

Assumptions:

Duration of illness to death when untreated

Duration of illness to recovery when untreated

Baseline mortality = 1 / 10.000 / day (see below)

This allows us to estimate averted YLLs and averted YLDs (i.e. we can calculate an average and a 95% credible interval on that average).

We calculate YLLs and YLDs using standard formulae and the standard assumptions below.

Standard assumptions

Discount rate:

$r = 0.03$

Age weight:

B = 0.04

These are considered to be standard values for these input parameters (Fox-Rushby and Hanson, 2001).

Disability weight:

For death we have:

D = 1

For cured we have:

D = 0.053

This is from the GBD 1990 (also used for GBD 2004) see: (WHO, 2004)

http://www.who.int/healthinfo/global_burden_disease/GBD2004_DisabilityWeights.pdf

Mortality in the absence of treatment

For our YLD and YLL estimates to be useful we need to estimate the numbers of deaths and survivals that would have occurred in the absence of treatment. To do this we use previously reported estimates of mortality of untreated malnutrition at different levels of MUAC from cohorts of children similar to those seen in our program (see reference list at end). We calculate a value appropriate for our mean admission MUAC (106.7 mm) using linear interpolation and published data:

From Briend & Zimicki (1986)

Mortality @ 100 mm := 304

Mortality @ 110 mm := 178

Slope := (178 - 304) / 10 = -12.6

Mortality @ 106.7 mm := 304 + (-12.6 * 6.7) = 220

From Briend (1987)

Mortality @ 100 mm := 593

Mortality @ 110 mm := 199

Slope := (199 - 593) / 10 = -39.4

Mortality @ 106.7 mm := 593 + (-39.4 * 6.7) = 329

From Vella (1994)

Mortality @ 105 mm := 366

Mortality @ 115 mm := 55

Slope := (55 - 366) / 10 = -31.1

Mortality @ 106.7 mm := 366 + (-31.1 * 1.7) = 313

From Pelletier (1993)

Mortality @ 100 mm := 340

Mortality @ 110 mm := 105

Slope := (105 - 340) / 10 = -23.5

Mortality @ 106.7 mm := 340 + (-23.5 * 6.7) = 183

All figures are in deaths / 1000 / year.

We use this data to estimate the number of deaths we would expect in cohorts of patients similar to that of our program that would have occurred in one year without treatment. Taking into account a baseline mortality risk of 1 / 10,000 / day (36.525 / 1000/ day), the harmonic mean of these rates is:

4 / (1 / (220 - 36.525) + 1 / (329 - 36.525) + 1 / (313 - 36.525) + 1 / (183 - 36.525))

=207.1091 / 1000 / year

=0.2071091 (as a proportion of the cohort)

We model deaths (M) using the Poisson distribution with

lambda = 0.2071091 * Proportion Cured * Number Treated

and survivors (S) as:

Proportion Cured * Number Treated - M

We simulate a million "programs" in this way taking into account variation in mortality and survival.

Probability distributions of model parameters

The model parameters described above are point estimates; in order to conduct a probabilistic sensitivity analysis, the probability distributions of several variables must be defined (Tan-Torres Edejer et al., 2003).

Recovery rate

The program under analysis achieved a 91.9% recovery rate. To model uncertainty about the true recovery rate, a binomial proportion was used. The binomial model is appropriate for variables that have a binary outcome (i.e. cured / not cured). Because coverage in the program was very high (Sadler et al., 2011), we know that all or nearly all malnourished children residing in the program communities were participating in the program. This means that the hypergeometric model would be most appropriate but at the sample size we have (n = 724) the binomial and hypergeometric are almost identical.

We treat the observed cure rate as an estimate of the true cure rate or expectation of the future cure rate. We create a distribution of probable cure rates that is consistent with what we saw.

R script:

```
pCured <- rbinom(n = 10000, size = 724, prob = 0.919) / 724
```

Disability duration

The duration of disability (time spent suffering from SAM) was assumed to be six months on average. To model uncertainty about the true disability duration, a gamma distribution was selected for several reasons.

1. Gamma distributions are commonly used to model phenomena such as waiting times. In this case the duration of disability is modeled as a waiting time with start = falling ill and end = completely recovered.
2. The gamma distribution consists of only positive numbers. This is an important benefit of the gamma distribution over the normal distribution, as it does not allow a waiting time to take on a negative value.
3. The gamma distribution is not constrained to be symmetrical, as the normal distribution is. This enables the modeling of a wait time with long tails (i.e. most children recovery quickly but some stay sick for a long time).

R script:

```
disabilityDuration <- rgamma(n = 10000, shape = 6) / 12
```

(The numbers are in fractions of years.)

Age

The age data for each child was only available in summary form, with a mean of 19.4 months. Therefore a distribution of ages of SAM cases was created, using a MUAC case definition for SAM, which is similar to the distribution seen in a database of 560 nutritional anthropometry surveys (data not shown). A gamma distribution was chosen for age for reasons 2 and 3 above.

R script:

```
ageStart <- rgamma(n = 10000, shape = 19.4) / 12
```

Expected mortality

As mentioned above, the number of deaths and survivals that would have occurred in the absence of treatment is unknown. To model the uncertainty in the expected number of deaths occurring without treatment, the Poisson distribution was used. This is the appropriate distribution for modeling the number of events occurring in a fixed period, and is constrained to zero or positive integers. “M” is the number of deaths we would expect to see in the successfully treated cohort if they had not been treated; survival (“S”) is modeled as the “mirror” of deaths.

R scripts:

```
M <- rpois(n = 10000, lambda = 0.2071091 * 0.919 * 724)
```

S <- 0.919 * 724 - M

Outcome estimates: YLL, YLD, DALY

Using the estimates described above, YLLs and YLDs are calculated:

Total YLL = M * YLL

Total YLD = M * YLD + S * YLD

Yielding:

YLLs :

2.5%	50%	97.5%
3917.969	4682.020	5484.629

YLDs :

2.5%	50%	97.5%
0.755774	5.012199	11.085215

DALYs :

2.5%	50%	97.5%
3923.429	4687.015	5490.184

These are estimates (50%) with 95% credible intervals. YLDs will always be very low since the disability weight for wasting is low and duration is low. These methods for DALY estimation yield the following per child estimates for YLL, YLD and DALYs (Table 8.4).

Table 8.4: DALY estimation per child, by age and sex

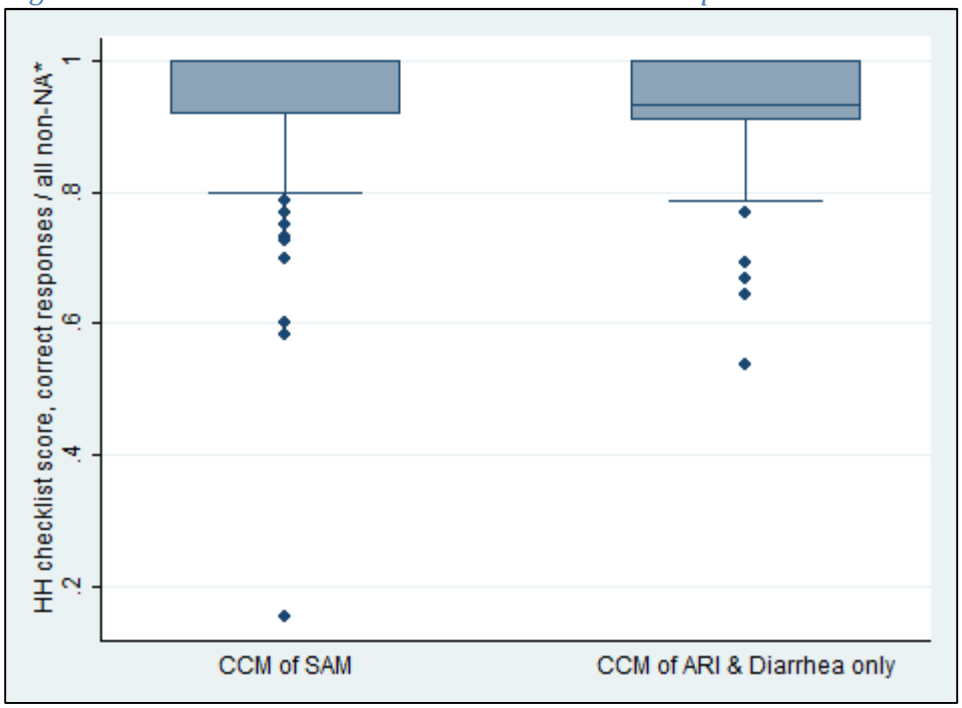
	Age (months)	Sex	Life Expectancy	YLL	YLD	DALY
1	6	male	66.0	36.21203	0.01672197	36.22875
2	12	male	66.0	37.19254	0.02207000	37.21461
3	18	male	66.0	36.10598	0.01877936	36.12476
4	24	male	66.0	33.78981	0.05004732	33.83986
5	36	male	66.0	27.57639	0.03185761	27.60824
6	6	female	67.2	36.31939	0.01731757	36.33671
7	12	female	67.2	37.28398	0.04216986	37.32615
8	18	female	67.2	36.18340	0.02491714	36.20831
9	24	female	67.2	33.85503	0.05339815	33.90843
10	36	female	67.2	27.62209	0.02699015	27.64908

Appendix 6. Household visit checklist score

The boxplot below depicts the distribution of scores achieved by both CHW groups on the routine household visit checklist. Scores for quality of routine preventive tasks by CHWs implementing CCM of SAM are clustered towards the high end of the distribution, with 63% achieving a perfect score. Scores for CHWs implementing CCM of Pneumonia & Diarrhea exhibit a broader range with nearly half (48%) scoring 100%. A non-parametric test shows the distribution of scores for these two groups of CHWs to be significantly different (Wilcoxon Mann-Whitney: z=2.49, p=0.013), with SAM CHWs achieving higher scores overall.

Figure 1: Household visit checklist score boxplot

Figure 8.1: Household visit checklist score boxplot



* HH: Household; Non-NA: all answers that are *not* ticked as "not-applicable" by the surveyor

Appendix 7. Details of CMAM cost-effectiveness analyses

Authors	Description	Costs included	Effectiveness	Limitations	Findings
Ashworth & Khanum, 1997	•Dhaka, Bangladesh •Compared inpatient, day care and domiciliary treatment •No RUTF •Excluded children with severe illness, >12 months, living far from hospital •All patients received hour-long home visits weekly for month, then biweekly until recovery, including feeding counseling •societal perspective	•Hospital institutional costs: capital, administrative, recurrent •HH costs via survey, incl transport, wage loss for working moms (not unemployed moms), payment for child care, child food costs NOT included: •training •caretaker opp costs beyond inpatient stay (seeking care, buying medicines) •monitoring/supervision of home visitors	cost per child recovered, defined by achieving 80% weight for height	•Not comparable with CMAM programs •One week day care not available at scale	•Inpatient salaries largest component of institutional and overall costs •Domiciliary care was 5x more C-E than inpatient care ($29 vs $156) •Wage loss was largest component of HH costs •Parental costs higher for domiciliary care as no food was provided, but parents preferred this for convenience of staying at home
Tekeste 2007	•Compared CMAM with inpatient TFC in rural Ethiopia •Unpublished study •societal perspective	•Accounting record review •Economic costs gathered separately •Program costs: supplies, overhead •HH costs: opportunity costs for all caretakers, transport, travel food, lodging, medicines, porters during travel	cost per child recovered, defined by achieving 85% weight for height	•No sensitivity analyses. •Not peer-reviewed	•TFC overhead was 3x that of CMAM program •TFC: largest cost was salaries (47%) •CMAM: largest costs were RUTF (42%), salaries (29%) •Opportunity costs in CMAM were ¼ those of TFC •Higher HH costs in all categories for TFC •Transportation costs 10x, lodging 20x •CMAM 2x C-E as TFC ($145 vs $320 per recovery)
Bachmann 2009	•Compared CMAM with no-treatment alternative •urban Zambia •health services perspective	•MoH budgets, Valid Intl expenditure accounts: administration, training, research, travel, consulting fees •WHO estimates for	cost per child treated, cost per DALY averted compared to no treatment	•no HH costs •no comparison with inpatient care	•CMAM cost $203 per child treated, $53 per DALY averted •largest cost components: RUTF (36%), technical support (34%) •results sensitive to expected mortality

		hospital stay and drug costs			assumptions w/o treatment •high tech support at startup, would decrease over time
Wilford, Golden and Walker, 2011	•Compared CMAM with existing health services incl TFC •rural Malawi	•MoH budgets, Concern expenditure accounts: capital and recurrent costs	cost per DALY averted compared to existing health services	•no HH costs	•incremental C-E: $42 per DALY averted •largest cost components: RUTF (32%), Concern admin (21%), international staff (12%) •results sensitive to expected mortality assumptions w/o treatment

Appendix 8. SCUS Promise Sheet

Jibon O Jibika
the new way of hope and prosperity

Mothers promise for development of child health and nutrition

Mother _____

Baby _____

Save the Children USA

USAID From the American People

For the benefit health and nutrition of my baby, I do hereby promise to :

2

7-9 Month | 7 | 8 | 9

I shall give complementary food to baby after giving breast milk.		☐	☐	☐
I shall breast feed the baby at least 5 times at day time and 3 times at night.		☐	☐	☐
I shall give minimum 3 times complementary meals to baby on her/his own plate everyday		☐	☐	☐
I shall give 5 spoon full foods to the baby in each meal		☐	☐	☐
I shall prepare soft khichuri with one spoon full oil, or, shall mix one spoon full oil with normal house hold foods for the baby		☐	☐	☐
I shall mix smashed vegetable, meat, fish, egg or pulse with baby's food		☐	☐	☐
I shall feed the baby with affection, patience and time.		☐	☐	☐
I shall wash my hand before cooking and giving food to the baby.		☐	☐	☐

Jibon O Jibika

the new way of hope and prosperity

Mothers promise for development of child health and nutrition

Mother _____

Baby _____

Save the Children USA

USAID From the American People

For the benefit health and nutrition of my baby, I do hereby promise to :

3

10-12 Month | **10** | **11** | **12**

I shall give complementary food to baby after giving breast milk.				
I shall give minimum 4 times complementary meals to baby on her/his own plate everyday				
I shall give 10 spoon full foods to the baby in each meal				
I shall prepare soft khichuri with one spoon full oil, or, shall mix one spoon full oil with normal house hold foods for the baby				
I shall mix smashed vegetable, meat, fish, egg or pulse with baby's food				
I shall feed the baby with affection, patience and time.				
I shall wash the baby's hand before and after the meal				
I shall make practicing the baby feeding on her/his own				

For the benefit health and nutrition of my baby, I do hereby promise to ;

4

13-24 Month

13	14	15	16	17	18	19	20	21	22	23	24

I shall give minimum 5 times complementary meals to baby on her/his own plate everyday

I shall give 14 spoon full foods to the baby in each meal

I shall prepare soft khichuri with one spoon full oil, or, shall mix one spoon full oil with normal house hold foods for the baby

I shall mix smashed vegetable, meat, fish, egg or pulse with baby's food

I shall feed the baby with affection, patience and time.

Besides complementary feeding I shall continue breast feeding till two years

I shall make practicing the baby feeding on her/his own

I shall wash the baby's hand before and after the meal

Appendix 9. Standardizing assessment of routine household visits

This Appendix presents results from a discussion conducted during the surveyor standardization training, regarding standardizing assessment of quality using the routine household visit checklist. Many of the checklist items presented below were linked with aspects of the "Promise Sheet" (Appendix Eight), a behavior change communication tool used by CHWs in the SCUS program to aid nutrition counseling and negotiation of improved feeding and caring practices. Anchoring definitions of "quality care" with items on the Promise Sheets facilitated FOs' measurement of CHW practice in a standardized manner. These standardization points were discussed during training and circulated among FOs for their reference during data collection.

Checklist standardization suggestions using Promise Sheet recommendations

CHW service delivery study February – March 2010

Below are listed only those checklist items that may require clarification:

1. Announce objective of visit.
   - ***CHW should make the objective of her visit clear in some way, either by the information she covers with the mother, and/or by announcing at the beginning.***

2. Try to involve key family members, if appropriate.
   - ***Only necessary if the message depends upon family members' permission or input, and if family members are available.***

3. Discuss with the caretaker about her commitments made on the "promise sheet", or if she did not make any commitments, give her advice now based on her child's situation and make recommendations by which she can improve the care and feeding of her child.
   - ***Follow up on promises already made. For new child, give new recommendation/advice.***

6. Use encouraging non-verbal communication (facial expression, eye contact, body language) and simple language.
   - ***CHW acts appropriately to bring a positive response from the mother.***

7. Recognize and praise what she is doing correctly before suggesting changes.
   - ***"Praise what mother is doing correctly", according to the recommended practices in the Promise Sheet.***

8. Provide clear, focused counseling and feeding information.

- ***CHW should counsel according to the recommendations on the Promise Sheet.***

9. Make recommendations by which the caretaker can improve the care and feeding of her child. Only give amount of information or advice that can be remembered and followed.

- ***CHW should make recommendations connected to Promise Sheet advice, like age-appropriate # of spoonsful of food to give per day; not to use bottles for feeding; not to give any water, etc.***

13. Negotiate what is feasible for the caretaker in terms of the advice given (if it was unrealistic or she can't comply due to time or resource constraints).

- ***Through discussion, agree what is feasible for caretaker based on Promise Sheet recommendations.***
- ***CHW works with caretaker's specific situation, does not offer a blanket solution to beneficiary health practices regardless of their socioeconomic status.***
- ***Negotiates according to information recommended on Promise Sheet (for example # of feeds per night, if mom says she is tired then ask her to at least do "—" feeds).***

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