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Factors Affecting Availability of Essential Medicines among Community Health Workers in Ethiopia, Malawi, and Rwanda: Solving the Last Mile Puzzle

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Abstract. To understand how supply chain factors affect product availability at the community level, the Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood Project developed a theory of change (TOC) framework for gathering, organizing, and interpreting evidence about supply constraints to community case management (CCM). Baseline assessments in Ethiopia, Malawi, and Rwanda conducted in 2010 provided information on the strengths and weaknesses of existing CCM supply chains for five main products: antibiotics for pneumonia, oral rehydration solution, ready to use therapeutic food, zinc, and artemether/lumefantrine. The assessments tested the strength and validity of causal pathways identified in the TOC that were believed to influence availability of CCM products among community health workers (CHWs) for treating common childhood illnesses. Results of the assessments showed product availability to be weak in each country, with more than half of CHWs stocked out of at least one tracer product on the day of the assessment. This report will focus on the findings related to three key preconditions of the TOC and how these were used to inform the design of the CCM supply chain improvement strategy in each country. The three key preconditions include product availability at CHW resupply points, supply chain knowledge and capacity among CHWs and their supervisors, and availability of appropriate transportation.

INTRODUCTION

To treat common diseases of childhood, national programs must ensure that supply chains effectively reach community health workers with affordable, quality medicines for treating pneumonia, malaria, diarrhea and malnutrition. Yet there is little understanding of the factors that enhance or constrain product availability at the community level, the last mile of community case management (CCM) supply chains. Understanding and identifying solutions to address these supply constraints to CCM provision may yield substantial improvements in programs' effectiveness, scale, and impact in reducing child mortality.[1,2]

Although there is limited evidence defining the supply constraints on CCM approaches, some studies have shown that child health programs often suffer shortages of key products, which suggests that supply chain factors may be adversely affecting outcomes of those programs. Robertson and others studied the availability of essential medicines for child health in the private and public sectors in 14 countries in central Africa.[3] Their findings from a sub-analysis of ten medicines, which included medicines used in CCM for child health, showed poor availability across different levels of the health system and across both the public and private sectors. Not surprisingly, they found that at lower levels of the system, such as in primary health clinics, there were fewer medicines available than in either teaching or district hospitals. Using a drug availability index, the study of Pagnoni and others on community-based treatment of presumptive malaria in children showed a decrease in severe malaria in areas with good drug availability at health center level.[4] More researchers and program managers are developing an increased awareness of and appreciation for the importance of effective logistics in their programs. For example, Bhandari and others, who looked at zinc supplementation in India, concluded that "Diarrhea is more effectively treated when caregivers receive education on zinc supplementation and have ready access to supplies of ORS and zinc."[5] These findings accentuate the need for CCM programs to ensure that their supply management systems are effective at ensuring availability of essential child health products.[6]

The Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood Project (SC4CCM) was created to identify supply chain factors that affect product availability in sub-Saharan Africa, develop strategies to address these factors, and demonstrate that product availability can be substantially improved at the lowest levels of the supply chain. The ultimate goal is to address the gap in evidence about how supply chains work at the community level so that implementers are better able to improve child health outcomes. As a learning project, SC4CCM is implemented in three countries (Ethiopia, Malawi, and Rwanda) in three stages: 1) conceptualization of the theory of change (TOC), baseline assessment of CCM supply chains, and use of results to design strategies; 2) implementation and monitoring of performance improvement strategies; and 3) evaluation of strategies to identify simple, affordable, sustainable solutions and advocacy to catalyze their adoption and scale-up. This paper reports the findings of the first stage of the project and how they relate to and validate the TOC of the project.

MATERIALS AND METHODS

Theory of change. The primary unit of interest of the SC4CCM is community health workers (CHWs) and their health product supply chain. Country specific names for community health workers include health extension workers in Ethiopia, health surveillance assistants in Malawi, and community health workers (CHWs) in Rwanda. All are referred to as CHWs in this report. To map out all factors that could affect availability of essential health commodities for CCM of childhood illness at this level and hypothesize the causal pathways to improve it, the first step the project took was to design a TOC.[7] The TOC, which was used to guide technical activity planning and evaluation, was created through iterative rounds

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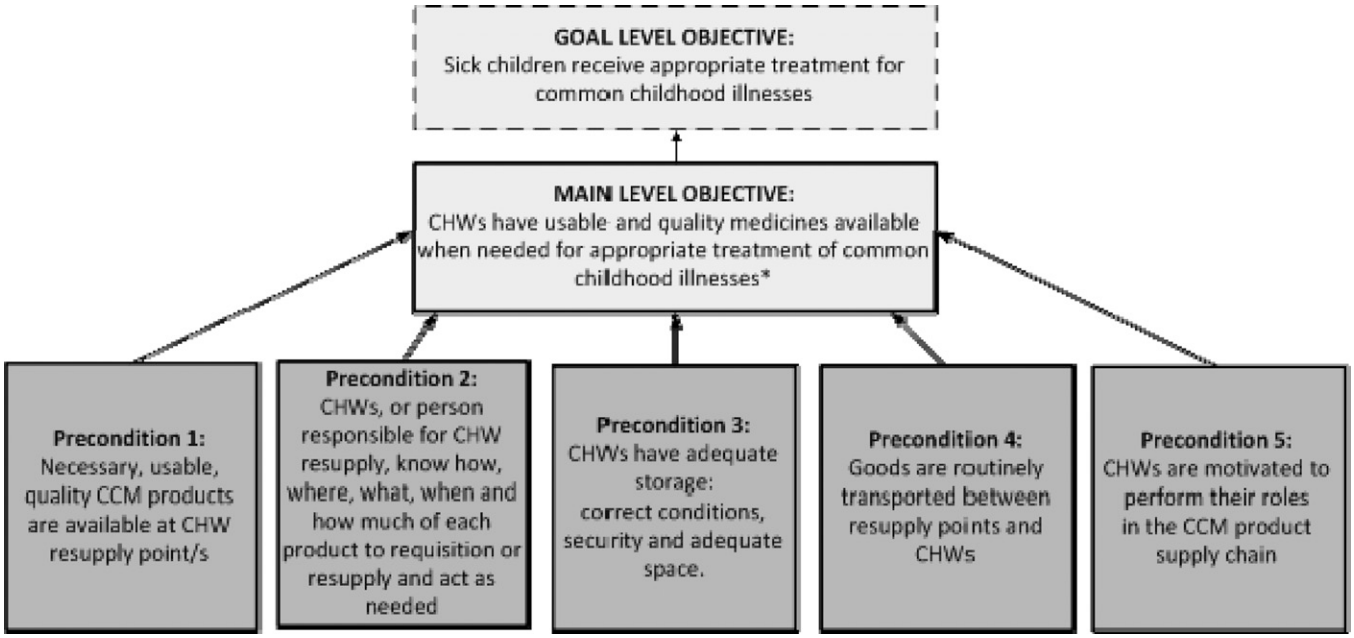

FIGURE 1. The five preconditions of product availability in the Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood Project. CCM = community case management; CHW = community health worker.

of discussion with internal experts and field staff, and informed by a review of literature and other conceptual frameworks on the subject.[8] The TOC was then validated by an external group of international supply chain and evaluation experts and used as a foundation for country-specific, results-based TOCs. Given the varying country contexts, country-specific TOCs were needed to identify specific causal pathways for each unique CCM supply chain, and were created with aid from baseline data. The TOC includes five key preconditions that affect CCM product availability among CHWs, the proximal (main-level) objective of SC4CCM (Figure 1). This objective feeds the more distal goal-level objective of increased appropriate treatment of sick children. The hypothesized causal pathways to each of these key preconditions can be found at http://sc4ccm.jsi.com/work.htm#toc.

Baseline surveys. The project baseline surveys used complementary quantitative and qualitative tools that were field-tested and adapted for each country to assess supply chain challenges at the community level.[9] Permissions for the surveys were obtained from Ministries of Health in all countries and the National Ethics Committee of Rwanda. Samples were not intended to be nationally representative, but rather chosen to diagnose major CCM supply chain strengths and weaknesses in a cross-section of districts served by key CCM partners, and to follow the supply chain from the central level to the community level. Purposeful selection at higher administrative levels (i.e., region and zone) was conducted on the basis of existence of a functioning CCM program, geographic spread, and balance of CCM partner support. Probability proportional to size sampling was used to randomly select health centers and CHWs at lower levels of the supply chain. Qualitative data were gathered using focus groups and key informant interviews. In Malawi, the survey covered 10 of 28 districts; in Ethiopia 12 of approximately 68 zones, and in Rwanda 10 of 30 districts. The CHWs were the unit of analysis in all cases. The sample of CHWs included 245 in Ethiopia, 321 in Rwanda and 248 in Malawi. This information is shown in Table 1. However, in Malawi the full sample of CHWs was reduced from 248 to 139 cases for most analyses because the national CCM program was not fully implemented at the time of survey, and a large portion of CHWs sampled had not yet begun managing health products.

Local evaluation partners were selected through a competitive process in each country to lead data collection activities. Enumerators were trained to interview CHWs and other staff managing supplies of medicines, conduct product inventories,

TABLE 1
Sample size by country and system level, Ethiopia, Malawi, and Rwanda*

Ethiopia		Malawi		Rwanda	
System level	Achieved	System level	Achieved	System level	Achieved
Regional medical stores	6				
Zonal medical stores	9	Regional medical stores	3	Central warehouse (CAMERWA, now MPDD)	1
Woreda (district) medical stores	26	District health office and pharmacy	10	District pharmacies	10
Health centers	74	Health centers	81	Health centers	100
Health extension workers	245	Health surveillance assistants	248	Community health workers	321

* Country-specific names for community health workers include health extension workers in Ethiopia, health surveillance assistants in Malawi, and community health workers in Rwanda. All are referred to as community health workers in the report. CAMERWA = Rwanda Drug, Consumables and Equipment Central Procurement Agency; MPDD = Medical Procurement and Distribution Division.

TABLE 2
Key indicators, Ethiopia, Malawi, and Rwanda*

Key indicator*	Definition	Measurement method	Comment
Country-specific key product availability	Numerator: no. CHWs with all tracer products (primary CCM medicines defined for each country) in stock, unexpired and in good condition. Denominator: no. CHWs who reported that they managed all those tracer products, on day of inspection visit.	Quantitative survey, direct observation of stocks	Includes different products in each country, based on each country's CCM program
Standardized key product availability	Numerator: no. CHWs with ORS and AL (both doses), unexpired and in good condition. Denominator: no. of CHWs who reported that they managed ORS and AL, on day of inspection visit.	Quantitative survey, direct observation of stocks	Includes only ORS and AL (both doses), as those were the only drugs in common managed by CHWs in all three countries
% Of CHWs trained in supply chain management	Numerator: no. CHWs who reported they had been trained in supply chain topics. Denominator: no. CHWs interviewed.	Quantitative survey, CHW interview	
% Of CHWs with standard operating procedures	Numerator: no. CHWs with standard operating procedures available. Denominator: no. CHWs who managed CCM products.	Quantitative survey, CHW interview and observation to confirm	
Main method of transport	% CHWs using each mode of transport (CHWs answered from a list of transport options)	Quantitative survey, CHW interview	
Distance to CHW from resupply point	Mean amount of time it took to travel by car from the CHW resupply point to each CHW visited (as timed by data collectors)	Quantitative survey, interviewer reported	
Key obstacles reported by CHWs to obtaining CCM supplies	% CHWs reporting each type of obstacle (coded from open-ended and multiple responses)	Quantitative survey, CHW interview	

* CHWs = community health workers; CCM = community case management; ORS = oral rehydration salts; AL = artemether/lumefantrine. The Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood Project collects other key indicators, such as training on reporting and storage that are not highlighted in this report.

and rate storage conditions.[10] Data collectors used Nokia (Espoo, Finland) e71 and e63 smart phones loaded with the EpiSurveyor application (DataDyne, Chicago, IL), which enabled streamlined data entry and immediate review of data after uploading records to a web-based system.

Survey instruments. Quantitative and qualitative tools were adapted from tools originally developed by the USAID | DELIVER Project,[11,12] including questionnaires, inventory assessment forms, storage assessment forms, and key informant interview guides. Tools were tailored to each level of the supply chain from central medical stores down to the community level, to capture processes, behaviors and product availability along each step in the chain. Questions were designed to capture information related to the hypothesized change pathways of the TOC. Responses to these questions were customized by country. The project's key indicator of product availability was only measurable at one point in time (on the day of visit) because of limited or non-existent logistics records from which data on duration and frequency of stock outs could be derived. Although many indicators were measured, this report focuses on some key indicators, which are shown in Table 2 and discussed in the Results.

Analysis of survey results. Frequencies, cross-tabulations and bivariate tests of significance were carried out by using SPSS version 18 (SPSS Inc., Chicago, IL) and STATA version 11 (StataCorp LP, College Station, TX), and qualitative results were synthesized from workshop notes. After assembling preliminary results, the project presented baseline findings to in-country stakeholders and representatives of all levels of the supply chain in a series of participatory data validation workshops. Factors affecting product availability were identified and verified for each TOC precondition and supply chain strengths and weaknesses were discussed. Strategies were designed to address supply chain bottlenecks, areas correlated with low product availability, and areas with greatest potential for improvement and scale up, all tailored to each country's context.

RESULTS

On the basis of qualitative work and quantitative surveys in each country, preconditions 1, 2, and 4 had the strongest empirical evidence supporting their TOC pathways. Precondition 3 played an important role in ensuring product quality, but there was little evidence that it contributed to availability. Precondition 5, CHW motivation, is a complex concept to measure because most metrics tend to be subjective and/or qualitative.[13] Because of this complexity and space limitations, it is beyond the scope of this report to include this analysis. Therefore, this report will focus on preconditions 1, 2, and 4. Baseline results are presented by the key preconditions needed to achieve the main project outcome (CCM product availability with CHWs), and stratified by country.

Main level objective: overall CCM product availability. Product availability measures in the three SC4CCM focus countries are shown in Table 3. The key indicators are shown in the bottom two rows. For country-specific and standardized measures (see Table 2 for definitions), product availability was found to be weak in each country, with more than half of CHWs stocked out of at least one tracer product on the day of the assessment.

The CCM product availability at the CHW level was generally highest in Rwanda and lowest in Ethiopia. The figures largely reflect the progress and maturity of the CCM program at the time of each survey in 2010; Rwanda began implementing CCM nationwide in 2008, Malawi in 2009, and Ethiopia added treatment of pneumonia to the health extension program in 2011 (Table 4). It should be noted that these countries are contextually different, and the Ethiopia context is more complicated than those of Rwanda and Malawi because of

TABLE 3
Percentage of CHWs with essential CCM medicines in stock on day of visit, Ethiopia, Malawi, and Rwanda*

Products	Ethiopia (n = 240),† % CHWs	Malawi (n = 139),† % CHWs	Rwanda (n = 321),† % CHWs
Antibiotics for pneumonia‡	NA	87 (n = 133)	88 (n = 238)
Oral rehydration salts	67 (n = 204)	64 (n = 129)	83 (n = 238)
Zinc	NA	NA	85 (n = 240)
AL 1 × 6	18 (n = 138)	54 (n = 119)	76 (n = 305)
AL 2 × 6	31 (n = 141)	43 (n = 114)	79 (n = 302)
AL 1 × 6 and 2 × 6§	10 (n = 130)	39 (n = 111)	66 (n = 294)
Ready-to-use therapeutic food	61 (n = 144)	NA	NA
Mean no. tracer products in stock at CHW level¶	1.9 of 4	2.4 of 4	4 of 5
Country-specific key product availability#	6 (n = 69)	28 (n = 109)	49 (n = 208)
Standardized key product availability**	7 (n = 122)	29 (n = 110)	61 (n = 215)

* CHWs = community health workers; CCM = community case management; NA = product will vary by number of CHWs managing that particular product; AL = artemether/lumefantrine.
† Total number of CHWs who reported that they manage any of the tracer products.
‡ Cotrimoxazole in Malawi and amoxicillin in Rwanda.
§ Constitutes the two dosages of AL that are provided to children depending on their age and weight. Both dosages are important from a quality of care perspective.
¶ Tracer products in Ethiopia included oral rehydration salts, AL (both doses), and ready-to-use therapeutic food; Malawi included cotrimoxazole, oral rehydration salts, and AL (both doses); Rwanda included amoxicillin, oral rehydration salts, zinc, and AL (both doses).
# Percentage of CHWs with all country-specific tracer products available.
** Percentage of CHWs with oral rehydration salts and AL (both 1 × 6 and 2 × 6) available.

geography, population size, and diversity, and more specifically due to an additional supply chain management level and greater number of products managed by CHWs (Table 4). Differences in product availability will also be influenced by these factors. Also, none of the CHWs in the three countries managed all CCM products of interest. Overall, availability was high for most individual products except artemether/lumefantrine. More than 60% of CHWs who managed antibiotics, oral rehydration salts, zinc, and ready-to-use therapeutic food had those products in stock in all three countries, but most CHWs reported stockouts of at least one product on the day of the assessment. Artemether/lumefantrine was the CCM product most likely to be out of stock.

Precondition 1: Product availability at CHW resupply points. Individual product availability at resupply points (typically nearby health centers) for the two products that were standard (oral rehydration salts and artemether/lumefantrine) across countries paired with the same measures for their associated CHWs is shown in Figure 2. There was a statistically significant correlation between product availability at resupply points and CHWs in Malawi, but not for Ethiopia and Rwanda. For all products shown, the percentage of resupply points with the item in stock was higher than for CHWs, especially in the case of artemether/lumefantrine in Ethiopia. In the three countries, as was the case among CHWs, artemether/lumefantrine was typically the product most often out of stock at resupply points.

Precondition 2: Supply chain knowledge and capacity among CHWs and their supervisors. Results varied substantially across and within countries. For example, more than 95% of CHWs who manage health products in Malawi and Rwanda had received training in supply chain topics, but only 10% of CHWs in Ethiopia reported being trained. In all three countries, even those CHWs trained in supply chain topics were often unaware of standard operating procedures or did not have them available for reference. In Malawi, 47% of CHWs had standard operating procedures available compared with 4% of CHWs in Ethiopia and Rwanda. The percent of CHWs with standardized stock keeping records such as bin cards or stock cards was low, and reporting forms used by CHWs were often incomplete. There were no significant correlations between each of the CHW capacity measures and standardized CHW product availability. Findings related to this area are shown in Table 5.

Having data available for decision making is also an intermediary precondition (or a precondition to the precondition) to preconditions 1 and 2. In all three countries, data availability was inadequate. In Malawi, only 14% of CHW logistics data are reportedly sent to higher levels of the system. In Ethiopia, Logistics System Assessment Tool respondents reported that not all essential logistics data are sent to higher levels, and the quality is questionable. In Rwanda, participants in data validation workshops confirmed that logistics data are not always available at the right place to inform resupply decisions.

TABLE 4
Country profiles for Ethiopia, Malawi, and Rwanda*

Indicator	Ethiopia	Malawi	Rwanda
Population (2009) (thousands)†	82,825	15,263	9,998
Population, % rural	83	81	81
Health worker density/1,000 person†	0.26	0.3	0.47
CHW density/1,000 persons†	0.3	0.73	1.48
Community health policy with full CCM package‡§	2010 (pneumonia added)	2006	2008
CCM implementation commenced¶	2011	2009	2008
No. CHWs nationwide who manage CCM products	≥ 30,000	≥ 3,000	≥ 30,000
No. products managed per CHW (2010)	~≥ 50	~19	~5–8
Push or pull CCM product supply mechanism to CHW level#	Push	Push	Push

* CHW = community health worker; CCM = community case management.
† World Health Organization Global Health Observatory worker densities from 2007, 2008, and 2004–2005, respectively.
‡ U.S. Agency for International Development/Malawi Community Case Management Evaluation, May 2011.
§ Full CCM package is defined as CHWs providing treatment of uncomplicated pneumonia, diarrhea, and malaria in children less than five years of age.
¶ Rwanda National Community Health Policy, 2008.
# In a pull system, CHWs calculate their own resupply quantities and order from their resupply point. In a push system, resupply quantities are calculated by personnel at a higher level, ideally using reported logistics data or a standard calculation, but in some cases issuing standard quantities.

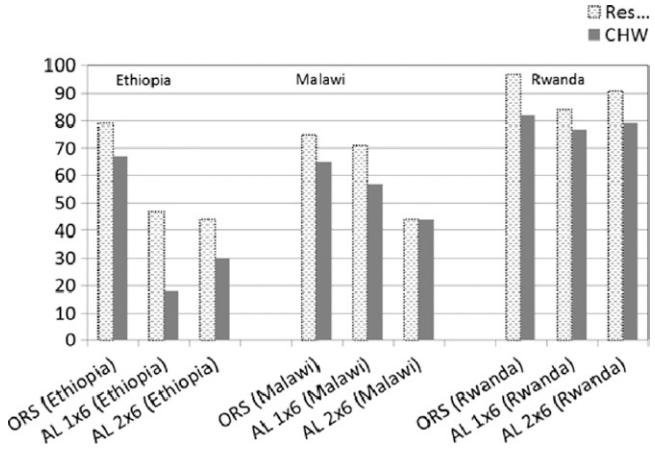

FIGURE 2. Availability of oral hydration solution (ORS) and Coartem (artemether/lumefantrine) (AL) at resupply points (Res) and community health worker (CHW) service points in Ethiopia, Malawi, and Rwanda.

Precondition 4: Availability of appropriate transportation. In almost all cases, CHWs are responsible for collecting supplies themselves, usually on foot or by bicycle. Mode of transport used by CHWs by country is shown in Table 6. In Malawi, almost 80% of CHWs depended on bicycles, whereas in Ethiopia and Rwanda, most CHWs traveled by foot. In addition in Ethiopia, 23% of CHWs used public transport. In Rwanda, although distances were shorter, the terrain was often hilly. However, during data validation workshops, CHWs in Rwanda reported that the primary challenge with transportation were the lack of incentives to pick up products because of lack of travel reimbursement, rather than the terrain. Overall, CHWs cited the lack of adequate or reliable transport as a major obstacle to obtaining products, although the mode of transport was only found to have a statistically significant effect on standardized product availability in Ethiopia, where CHWs who travel by foot were significantly less likely to have key products in stock compared with those using public transport.

Approximately half of the CHWs surveyed in Ethiopia and Malawi (66% and 46% respectively), were one hour or greater by car away from their resupply point (based on interviewer driving time from the resupply point), while in Rwanda, 11% of CHWs were an hour or more away. Actual CHW travel time was not measured but can be assumed to be longer because most CHWs traveled by foot or bike and not car. When CHWs were asked how long their trips were to resupply points, 45–90% reported trips of an hour or longer, depending on the country and whether it was dry or rainy season. In all three countries, CHWs primarily used dirt (or partial dirt) roads. Distance was only a statistically significant factor in Ethiopia and Rwanda, where CHWs located farther away from their resupply points had significantly lower standardized product availability.

TABLE 5
Community health worker capacity in selected aspects of supply chain management, Ethiopia, Malawi, and Rwanda*

Indicator	Ethiopia (n = 239)	Malawi (n = 139)	Rwanda (n = 321)
% Of CHWs trained in key aspects of supply chain (ordering, receiving, or reporting)	9	95	99
% Of CHWs with SOPs available	4	47	4
% Of CHWs who keep any stock records (stock card, bin card, tally sheet)	13	90	72
% Of CHW reports that included stock on hand and quantities dispensed (based on visual inspection)	43	63	89

* CHW = community health worker; SOPs = standard operating procedures.

TABLE 6
Percentage of community health workers using various transport means to collect supplies, Ethiopia, Malawi, and Rwanda

Mode of transport	Ethiopia* (n = 235)	Malawi (n = 139)	Rwanda (n = 320)
By foot	54	11	88
Bicycle	< 1	79	10
Public transport	23	9	< 1
Other†	22	1	1

* Respondents were able to choose more than one response in Ethiopia and only one response in Malawi and Rwanda.
† In Ethiopia, this response includes multiple responses.

The biggest obstacles CHWs said they faced in maintaining CCM product availability are shown in Table 7. The CHWs in every country named various transport related challenges as the top obstacles, (no transport available, transport always broken down, resupply point too far away, rainy season). These were aggregated into one response relating to transport. In Ethiopia, nearly two-thirds of CHWs mentioned this topic. In Rwanda, where CHWs are unpaid, the most common specific response was remuneration, and most responses referred to remuneration to pay for transport to reach resupply points.

DISCUSSION

Across all the countries, the use of the TOC framework and corresponding indicators enabled a comprehensive approach to identifying and designing SC improvement strategies while accommodating country contexts. By developing country specific TOCs to define hypothetical pathways to improved product availability, we were able to use the baseline data to identify and validate the most critical pathways in the three focus countries.

The baseline data support that product availability at resupply points (precondition 1) has an important effect on CHW CCM product availability (significant correlation in Malawi). The correlation is logical; if supplies are not available at resupply points, they are not likely to reach CHWs. Although data do

TABLE 7
Main obstacles reported by CHWs to obtaining CCM supplies, Ethiopia, Malawi, and Rwanda*

Percentage of CHWs reporting the following main obstacles	Ethiopia (n = 240)†	Malawi (n = 139)†	Rwanda (n = 320)†
Products not available at resupply point/higher levels	15	17	3
Transport-related obstacles	32	15	27
Lack of remuneration (especially for public transport)	0	0	33
Long time between sending report and receiving supplies	> 1	17	0
Other‡	1	7	37

* CHWs = community heath workers; CCM = community case management.
† In Rwanda, CHWs, regardless of whether they reported having problems related to supplies, were asked to name the main obstacle they had experienced in obtaining CCM supplies. However the method was changed for Ethiopia and Malawi where only CHWs who answered yes when asked if they had any problems related to supplies were asked to list the main obstacle.
‡ In Rwanda, Other included the response no problem.

not show significant correlations in Ethiopia and Rwanda for precondition 1, CHWs in both countries reported in data validation workshops that this was a major obstacle to increasing product availability. The lack of significance in Rwanda and Ethiopia is likely related to small subsamples: namely, CHWs who do not have products in stock, and at least for artemether/lumefantrine in Ethiopia, CHWs who work in malarial areas. Further investigation will be conducted as monitoring data and subsequent surveys are collected.

Precondition 1 underlines the vulnerability of CHWs at the last mile of the supply chain. If CCM supplies fail to reach CHW resupply points, or if those resupply points use CCM supplies to meet the needs of their facility-based patients, CHWs will continue to experience chronic shortages of CCM supplies for treating children in their communities. Supply chain strategies to improve CCM product availability at the community level must take place in concert with strengthening the entire supply chain and improving product availability at the national level, or first mile, of the CCM supply chain pipeline and at all intermediary levels.

The hypothesized relationship between CHW capacity measures (precondition 2) and product availability was not found to be statistically significant in the baseline perhaps because of the multi-faceted components of supply chain capacity, which interact in complex ways, and were not all measured in the surveys. Simply having been trained was not significantly correlated with CHW product availability in any one of the countries. These relationships will need to be explored further once more data have been collected to see if this holds true once confounders like length of time as a CHW and other related factors can be included. In general, capacity variables were substantially higher in Malawi and Rwanda than in Ethiopia, potentially because Ethiopia was still developing a logistics system for the community level at the time. There was still room for improvement in all countries.

Although not significantly correlated with product availability in our assessment, training is clearly necessary to create foundational supply chain knowledge, practices, and skills before strategies addressing other factors in the supply chain can be implemented. The CHWs in all three countries were generally operating in an environment characterized by a lack of standardized processes and reporting forms and this fragmentation affected CHW capacity and performance. Another consequence of the system fragmentation was the lack of visibility into CHW-level logistics data at higher levels of the supply chain. Because poor data hamper effective decision making, CHWs are unlikely to obtain the correct quantity of supplies, and national level procurement occurs without sufficient data to define the actual community level need. Therefore, data visibility plays an important role in ensuring that the product requirements for the last mile are accounted for in the supply chain.

Precondition 4 showed the strongest relationship to product availability in Ethiopia, which stands to reason because the CHWs sampled in Ethiopia had the longest travel times and were by far more likely to travel by foot, the slowest form of transport with the least capacity to carry bulky and/or heavy items. The CHWs in Ethiopia also manage 50 products, compared with 5–8 in Rwanda. In all three countries, transporting supplies was almost exclusively the responsibility of the CHW; products were rarely if ever delivered to them. Although geographic barriers and distance were the primary obstacles in Ethiopia, in Rwanda, transportation as an obstacle related more to a lack of motivation to travel, given that CHWs are volunteers and are not compensated for their travel time or costs. The main implication for addressing transport barriers is that each country will likely require a unique solution that is based on existing infrastructure and accommodates the specific aspects of transportation that pose key challenges to resupply at community level.

The cumulative effect of obstacles within these preconditions all contribute to lower CCM product availability at the community level. Slow rollout of CCM programs in terms of products and trainings in Ethiopia, Malawi, and Rwanda, and country-level policies defining limited CCM packages meant that no single community health worker in the three focus countries managed all products needed to treat all conditions generally considered as part of CCM: pneumonia, malaria, diarrhea, and malnutrition. Availability of the combined package of country-specific key CCM products that CHWs did manage in each country was also low, ranging from 6% to 49%, which poses a serious constraint to effective treatment of childhood disease at the community level. The poor concurrent availability of both strengths of artemether/lumefantrine had a strong downward effect on the country-specific and standardized product availability. Both strengths of artemether/lumefantrine are important because children require different dosages on the basis of age and weight, and substitution of doses introduces questions related to quality of care. Further analysis not included here showed that availability by product and by district varied substantially, with some products and districts greatly outperforming others, implying that inconsistency in the supply chain is also a challenge.

Evidence from the baseline surveys informed country-specific TOCs and identified areas where supply chain performance was strong or weak, and variables significantly correlated with standardized product availability. Together, this helped develop and tailor different sets of strategies to the needs of the three countries. For example, low product availability at the resupply point was a challenge in Malawi and Ethiopia, but addressing this issue was only a priority in Malawi. In Ethiopia, the immediate priority was the supply chain in transition, which to address requires training large numbers of CHWs and resupply point staff in supply chain essentials so that procedures directing the flow of products and information can be well executed.

There are some limitations of our data that should be noted. Small sample sizes indicated that we likely did not capture all variables significantly correlated with CCM product availability at CHWs. Nevertheless, a number of correlations were found to be significant, and others were identified through key informant interviews and other qualitative methods. Given that the baseline surveys were tailored to capture the varied CCM and supply chain contexts in each country, not all indicators for all preconditions are precisely comparable across countries. Day of visit results may present a more optimistic picture than actually exists because they do not show if products have been in stock continuously, nor whether supply levels are too low or too high to avoid future stockouts or expirations.

In conclusion, product availability is a challenge for all CCM programs and finding affordable, simple, and sustainable supply chain solutions must be guided by evidence, country context and program structure. Although it is important to note again that the surveys were small and not nationally

representative, in general, the baselines confirmed that preconditions 1, 2, and 4 from the TOC must be in place for products to consistently reach the last mile of the supply chain. Although not all preconditions are equally influential as enabling or constraining factors to product availability at community levels, these preconditions provide a framework for a program to assess, identify and address the factors affecting the availability of products at the community level. Improving availability of essential medicines among community health workers is vital if CCM is going to be successful at treating childhood illness, and ultimately, reducing child mortality.

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