

ORIGINAL RESEARCH

Treating Childhood Malnutrition in Rural Haiti: Program Outcomes and Obstacles



C. Nicholas Cuneo, MD, Emily Dansereau, MPH, Anand R. Habib, MPhil, Mary Davies, BA, Samuel Ware, BA, Kenneth Kornetsky, MD

Boston, Massachusetts; Seattle, Washington; New York, New York; Thomassique, Haiti; and Manassas, Virginia

Abstract

BACKGROUND Haiti has the worst malnutrition rate in the Western hemisphere. In October 2010, a cholera epidemic erupted and spread rapidly throughout the country, straining Haiti's already fragile health infrastructure across all levels of care. This study reviews data from an outpatient therapeutic feeding program (OTP) for acute childhood malnutrition at a clinic in rural Haiti with a focus on the effect of the 2010 cholera epidemic on program operations.

METHODS A retrospective chart review was conducted for the complete set of patients who were enrolled in the OTP from its inception in March 2009 through January 2014.

FINDINGS A total of 187 charts were retrieved representing 176 unique patients, of whom 5 were currently enrolled in care. At admission, 96 (51.3%) met criteria for severe acute malnutrition, 88 (47.1%) met criteria for moderate acute malnutrition, and 3 (1.6%) did not meet criteria for acute malnutrition. Of the 182 completed charts, 119 (65.4%) reached their target weight (≥ -1 weight-for-height z-score) by discharge (ie, were "cured"), 43 (23.6%) defaulted, 11 (6.0%) were discharged prematurely, 8 (4.4%) died, and 1 (0.5%) was hospitalized. A total of 11 patients (6.3%) who were initially admitted relapsed after discharge and were later readmitted. Data from 170 complete records (93.4%) were included in a multivariate logistic regression. Severe (vs moderate) acute malnutrition was negatively associated with likelihood of being cured when controlling for other patient- and care-related factors (OR = 0.261, $P = .002$). Average cholera burden was negatively correlated with likelihood of OTP treatment cure when controlling for patient- and care-related variables (OR = 0.859, $P = .002$) but was insignificant when controlling for year.

CONCLUSIONS Results from the study have been used to inform a restructuring of the clinic's acute malnutrition program toward a more community-centered model of management, the context and implications of which are discussed in relation to the existing literature.

KEY WORDS Haiti, malnutrition, outpatient, treatment, RUTF, cholera, outcomes, rural

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From the Department of Global Health and Social Medicine, Brigham and Women's Hospital, Boston, MA (CNC); Department of Medicine, Boston Children's Hospital, Boston, MA (CNC); Harvard Medical School, Boston, MA (CNC, ARH); Institute for Health Metrics and Evaluation, The University of Washington, Seattle, WA (ED); Columbia University College of Physicians and Surgeons, New York, NY (MD); St. Joseph's Clinic, Thomassique, Haiti (MD, SW, KK); Medical Missionaries, Manassas, VA (KK). Address correspondence to C.N.C. (cncuneo@bwh.harvard.edu).

INTRODUCTION

Childhood malnutrition is understood “as a state in which physical function of a child from birth to 5 years old is impaired due to either over- or under-nutrition, the latter of which is the result of poor or insufficient nourishment, poor absorption, or poor biological use of nutrients consumed.”¹ The World Health Organization (WHO) defines childhood acute malnutrition, also referred to as wasting, in terms of its severity—severe acute malnutrition (SAM) being a weight-for-height *z*-score (WHZ, calculated in comparison to the WHO’s 2006 growth standards) ≤ -3 and moderate acute malnutrition (MAM) being a WHZ between -2 and -3 standard deviations (SD).² The more recent definition of global acute malnutrition (GAM) combines WHZ with mid-upper arm circumference (MUAC) (SAM: <115 mm; MAM: 115 – 125 mm) and presence of bilateral edema.^{1,3}

Globally, SAM and MAM affect approximately 19 million and 33 million children, respectively.³ The WHO estimates that 35% of the 7.6 million deaths among children younger than 5 years old are nutrition related, with 4.4% specifically caused by SAM.² Children with SAM exhibit mortality rates 10 times higher than well-nourished children.³ This difference in part results from the increased susceptibility of children with acute malnutrition to infectious disease.^{4–7} Malnutrition in 6–18 month olds has particularly far-reaching implications, correlating with lower performance on intelligence tests, poorer educational attainment, and lower future income.^{8,9}

Proper delivery of therapies addressing SAM could alone save 435,000 lives annually.¹⁰ For much of the 20th century, faulty case management, outmoded treatment practices, and ambiguous treatment guidelines contributed to SAM case fatality rates (CFR) of 20%–30%.¹¹ Current SAM treatment guidelines call for inpatient treatment of complicated cases and community-based treatment of uncomplicated SAM, comprising an estimated 80% of cases.^{2,3,10,12} Such protocols can attain CFRs as low as 5%.¹²

This reduction in CFRs and move from inpatient to outpatient treatment for uncomplicated SAM cases was enabled by the formulation of ready-to-use therapeutic foods (RUTF). RUTFs have key advantages, including decreased expense,^{1,13} increased patient adherence,^{3,14,15} and increased ease of preparation and shelf life.^{12,14} Although expert consensus affirms the efficacy of community-based RUTF use to treat

SAM, pooled analyses reveal mixed results.^{3,10} There is some evidence, however, that community-based therapy leads to greater recovery and weight gain compared with standard care.^{3,14} There is neither a formally accepted protocol for treatment of MAM nor a strong evidence base for MAM treatment with RUTFs.^{1,3}

Haiti is a Caribbean nation occupying the western third of the island of Hispaniola with the lowest human development index in the Western Hemisphere. As of 2010, mortality for children younger than 5 was 165 per 1000 live births, with diarrheal disease, perinatal infections, and malnutrition as the leading causes of death.^{16,17} Although improved compared with data from 2005–2006, Haiti’s 2012 Demographic and Health Survey revealed persistently high levels of malnutrition, with stunting, underweight, and wasting prevalences among children younger than 5 of 21.9%, 11.4%, and 5.1%, respectively.¹⁸ In October 2010, Haiti’s first cholera patients were hospitalized in Haiti’s Central Plateau; within a month, cases were reported across the country.^{19,20} The early outbreak was defined by a high CFR (7.0%) as a result of many factors, including poor preparedness, inadequate supplies, and deficient communication.²¹ By the end of 2013, cholera had claimed more than 8531 lives, including 676 children younger than 5.²² The unexpected nature of the epidemic coupled with the previously listed issues strained already resource-strapped primary health care centers and threatened to divert resources from other areas like acute malnutrition treatment.

Outpatient Therapeutic Feeding Program, 2009–2013. The outpatient therapy feeding program (OTP) described in this paper was implemented at a resource-constrained primary care health clinic in Thomassique, a rural community on Haiti’s Central Plateau. The clinic, funded by a US-based nonprofit organization and staffed by Haitian employees, offers ambulatory, obstetric, emergency, and low-acuity inpatient care. The OTP began in March 2009, when a local auxiliary nurse was hired and trained as the program coordinator (PC). Clinical supervision was provided by a clinic physician, but most program activities were performed independently by the PC, including entry and discharge examinations for many cases. The program employs RUTF (Plumpy’Nut/Medika Mamba produced locally in Cap-Haïtien by Meds and Food for Kids–Nutrisset) for acute malnutrition in children aged 6–59 months. At the time of the program’s inception it was operating in accordance with international standards for the

treatment of SAM in children²³ and used guidelines provided by Meds and Food for Kids,²⁴ electing to treat MAM with RUTF in the absence of international consensus on the topic. In the fall of 2012, the clinic OTP partnered with the Haitian Ministry of Health (*Ministère de la Santé Publique et de la Population* [MSPP]) and United Nations Children's Fund and began to shift toward greater compliance with the Haitian MSPP national protocol for the management of GAM,¹⁵ focusing on severely malnourished children while making exceptions for certain MAM cases deemed high risk in the absence of suitable referral options.

Clinicians evaluated children presenting at the health center or mobile clinics for signs of GAM and prescribed an outpatient treatment regimen consisting of RUTF dispensed according to the child's weight. WHZ was considered the primary criterion for admission, though children could also qualify for admission based on MUAC (≤ 125 mm) or the presence of bilateral pitting edema.²⁵ The child and accompanying caregiver would return weekly or biweekly for evaluation of progress and to receive more RUTF until the child recorded a WHZ that was ≥ 1 for 2 consecutive weeks along with absence of edema. In February 2010, the clinic launched a community health worker (CHW) program designed to improve access to basic first aid and health education in 5 outlying villages within the clinic's catchment area. CHWs began conducting home visits for patients in the villages, including those enrolled in the OTP. Between September 2012 and January 2013, the clinic had a supplementary food program in effect operated in partnership with the World Food Programme, which offered enrollment for children aged 6–59 months meeting criteria for MAM. However, apart from the brief duration of that program there were no alternative options available to moderately malnourished children presenting to the clinic outside of the OTP. In August 2013, CHWs were trained to screen children for the program in an effort to expand the program's reach in preparation for a transition to community-based management.

Community-Based Management of Acute Malnutrition. Community-based management of acute malnutrition (CMAM), formerly known as community-based therapeutic care, is distinct from outreach and extension services in its use of lay health workers to more effectively engage communities in order to improve coverage among vulnerable and hard-to-reach populations, to actively identify malnourished children earlier, and to

improve uptake of interventions and subsequent regimen compliance.¹⁵ CMAM is increasingly being seen as an integral part of improving equity and sustainability in global health care delivery and is aligned with the WHO's task-shifting recommendations for settings in which there exists a shortage of trained health care professionals.^{10,15}

Study Purpose. This study aimed to evaluate 5 years of data from an OTP at a primary care clinic in rural Haiti to support and inform implementation as the program transitioned to a community-based model of delivery. Specifically, we aimed to (1) identify barriers to program effectiveness and sustainability to inform program reconfiguration and expansion; (2) define challenges in supervision, staffing, and resource allocation in the setting of an emergent epidemic that can be applied elsewhere; (3) investigate the effect of the cholera epidemic on the program and its ability to provide care within a resource-constrained setting; and (4) propose a data-informed plan to transition the program from a primarily hospital-based (OTP) to a primarily community-based (CMAM) model of delivery.

MATERIALS AND METHODS

This study consisted primarily of a retrospective chart review of existing patient records for the OTP. Ethical approval was obtained from the Ethics Committee of St. Joseph Clinic, Thomassique, Haiti, which was established in 2009 and operates in accordance with US Title 45 Code of Federal Regulations 46.

Data Collection. A retrospective chart review was conducted for all patients admitted to the OTP since its inception. Data were extracted using a standardized Excel (Microsoft Corp., Redmond, WA) template. Each chart included a clinical abstraction form with basic demographic data, including date of birth and distance from the clinic. Data from the patient's entry visit into the program were extracted, including entry weight, height, MUAC, presence of edema (categorized by severity), and diarrhea. Patient names or other unique identifiers were excluded. Throughout extraction, any ambiguities in the records were resolved with the PC, who was responsible for maintaining the records. The patient's exit date was taken as the last date during which an evaluation visit was recorded and clinical data from that visit were similarly extracted. The total number of visits including entry and exit was calculated and

noted, along with the reported reason for exit and whether or not the patient was readmitted.

Each record was categorized based on the reported reason for exit, using the following designations: cured, defaulted, died, prematurely discharged, hospitalized due to malnutrition, and hospitalized for another reason. We further assessed whether “cured” patients had been appropriately discharged by comparing their final weight to a goal weight based on final height, as established by program protocols. Some patients who had been reported as “cured” had not met their goal weight at the time of discharge; we reclassified them as “prematurely discharged.” In some cases, the reason for exit was not reported. For these patients, we assessed whether the patient had met his or her goal weight at the last recorded visit. Those who met the goal weight were classified as cured, and those who had not as defaulted. Few patients were readmitted: Of the 176 distinct patients who have entered in the program, 11 were readmitted.

A minority of completed charts (19.7%) contained a home visit record. Starting in June 2010, the PC attempted to conduct home visits for at-risk patients enrolled in the program. The objective of each home visit was to evaluate the general living conditions, nutrition, and health of patients’ families. Each form contained information on family composition, number of household rooms and inhabitants, water source, and access to latrines. Basic nutrition information included the average number of meals per day, type of cooking fuel, and whether any of the patient’s siblings showed signs of malnutrition (prompting referral to the program if appropriate). Finally, general health information was recorded, including vaccination coverage, family planning access, mosquito net usage, and the general health of family members.

Additional Sources. The number of hospitalized cholera patients in Thomassique by month was obtained from the MSPP epidemiologist on staff at the clinic. Data on monthly cholera cases in the 3 nearest surrounding clinics were obtained directly from staff at those clinics. Catchment population sizes were obtained from public MSPP records.²⁶ To better contextualize our quantitative results, qualitative follow-up with the PC was performed using semistructured interviews. Informed consent was obtained to record, transcribe, translate, and publish material from these interviews, and the PC was present at the ethics review committee case presentation for the study as a nonvoting member.

Data Preparation. Clinical characteristics at entry were compared against international standards to ascertain if patients suffered from MAM or SAM. For the purpose of regression analysis, a binary variable was created classifying patients as SAM (by weight for height, MUAC or edema) or not. Weight for height (WFH) was compared against international reference values in use by the program²⁵; patients >3 SD below median WFH were categorized as having SAM. Patients with a MUAC <115 mm or indications of bilateral edema were also categorized as having SAM. For the purpose of regression analysis, outcomes were classified as “cured” and “not cured.” “Cured” included patients who had been discharged and who had met their goal weight at discharge according to program protocol. “Not cured” included patients who died, defaulted, were hospitalized, or were discharged but had not met the appropriate criteria for discharge.

To better understand the effect of the cholera epidemic on the success of the program, additional analysis was performed in relation to cholera rates. Cholera was assumed to be 0 before November 2010 for the greater Thomassique region. Cholera rates were missing for certain months after November 2010 in Thomassique; missing months were imputed using the average hospitalized cholera rate from the 3 surrounding clinics, for which there was a complete set of data. For months for which there were existing data for Thomassique, the correlation rate between the imputed average and actual values was 0.90.

Data Analysis. Results are presented descriptively over time. A logistic regression was used to test for statistically significant predictors of a patient being cured. Independent variables were selected based on potential theoretical relationships. We first examined the associations between demographic characteristics and outcomes and then between facility factors and outcomes, before including both groups of covariates in our final model. Although the sample size was relatively small, we noted that the magnitude and significance of the coefficients in the model including all covariates were similar to those found in the models with only demographic or facility covariates. Patients currently in the program were excluded from analysis, along with 12 (6.6%) completed charts missing data, mostly age at entry. Household distance was missing for a substantial number of completed charts (21, 11.5%), so “missing distance” was included as its own category in the regression. A sensitivity analysis excluding these cases found similar results. The final regression was run on

patient characteristics alone, care components alone, and with all combined. A variable was created to capture the average cholera burden during the patient's intended treatment period by averaging the hospitalized cholera rate for the month the patient entered care and the 2 months after. A binary indicator for each year was additionally included in a final model. All data management and analysis were conducted in Stata Version 13 (Statacorp LP, College Station, TX).

RESULTS

Patient Characteristics. There were 187 total admissions to the OTP between 2009 and 2013 (Table 1). The median age was 22.6 months, and 53.5% were female. The median time from the patient's household to the clinic was 67.5 minutes.

Considering MUAC, WHZ, and edema together, 47.1% of children suffered from MAM and 51.3% from SAM at program entry. The proportion of patients who were severely malnourished decreased from 59.4% in 2009 to 26.5% in 2011 but rose again to 80.0% in 2013. The median MUAC at entry was 120 mm. Overall, 33.0% of children weighed ≤ 3 SD below median WFH, and an additional 56.6% weighed 2–3 SD below median WFH. A summary of characteristics for the subset of patients who received home visits is included in Table 2.

Patient Outcomes. Excluding 5 children currently enrolled in the program, 119 (65.4%) were cured, 43 (23.6%) defaulted, 11 (6.0%) were discharged prematurely, 8 (4.4%) died, and 1 (0.5%) was hospitalized (Figure 1). Outcomes differed by malnutrition status at entry to the program: Among the 88 entrants with MAM with outcomes, 65 (73.9%) of

Table 1. Characteristics of Patients Enrolled in the OTP Program by Year of Entry

	2009	2010	2011	2012	2013	All
Total Admissions	64	31	34	38	20	187
Female	30 (46.9%)	19 (61.3%)	17 (50.0%)	23 (60.5%)	11 (55.0%)	100 (53.5%)
Median age (mo)	22.8	23.9	33.3	19.5	9.9	22.6
Median HH distance (min)	82.5	70.0	120.0	50.0	60.0	67.5
Readmissions	3 (4.7%)	1 (3.2%)	0 (0.0%)	3 (7.9%)	4 (20.0%)	11 (5.9%)
Physician at intake	54 (84.4%)	10 (32.3%)	0 (0.0%)	3 (7.9%)	1 (5.0%)	68 (36.4%)
Edema at entry	14 (21.9%)	8 (25.8%)	2 (5.9%)	29 (76.3%)	11 (55.0%)	64 (34.2%)
Diarrhea at entry	10 (15.6%)	8 (25.8%)	1 (2.9%)	5 (13.2%)	3 (15.0%)	27 (14.4%)
Median no. of visits	7	9	6.5	5	4	7
Overall malnutrition status at entry (based on MUAC, WFH, and edema)						
SAM	38 (59.4%)	17 (54.8%)	9 (26.5%)	16 (42.1%)	16 (80.0%)	96 (51.3%)
MAM	23 (35.9%)	14 (45.2%)	25 (73.5%)	22 (57.9%)	4 (20.0%)	88 (47.1%)
Neither	3 (4.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (1.6%)
WFH at entry (SD)						
<−4 (SAM)	17 (27.9%)	0 (0.0%)	1 (2.9%)	1 (2.6%)	1 (5.3%)	20 (11.0%)
−4 to −3 (MAM)	12 (19.7%)	8 (26.7%)	7 (20.6%)	8 (21.1%)	5 (26.3%)	40 (22.0%)
−3 to −2 (MAM)	26 (42.6%)	21 (70.0%)	24 (70.6%)	25 (65.8%)	7 (36.8%)	103 (56.6%)
>−2	6 (9.8%)	1 (3.3%)	2 (5.9%)	4 (10.5%)	6 (31.6%)	19 (10.4%)
Median entry MUAC (cm)						
<115 (SAM)	5 (7.9%)	7 (22.6%)	1 (2.9%)	8 (25.8%)	11 (61.1%)	32 (18.1%)
115–125 (MAM)	24 (38.1%)	21 (67.7%)	33 (97.1%)	23 (74.2%)	5 (27.8%)	106 (59.9%)
>125	34 (54.0%)	3 (9.7%)	0 (0.0%)	0 (0.0%)	2 (11.1%)	39 (22.0%)
Outcome (N = 187)						
Cured	41 (64.1%)	24 (77.4%)	12 (35.3%)	32 (84.2%)	10 (50.0%)	119 (63.6%)
Defaulted	11 (17.2%)	5 (16.1%)	22 (64.7%)	3 (7.9%)	2 (10.0%)	43 (23.0%)
Died	2 (3.1%)	2 (6.5%)	0 (0.0%)	1 (2.6%)	3 (15.0%)	8 (4.3%)
Hospitalized	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.6%)	0 (0.0%)	1 (0.5%)
Still in program	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (25.0%)	5 (2.7%)
Discharged prematurely	10 (15.6%)	0 (0.0%)	0 (0.0%)	1 (2.6%)	0 (0.0%)	11 (5.9%)

HH, household; MAM, moderate acute malnutrition; MUAC, mid-upper arm circumference; OTP, outpatient therapeutic feeding program; SAM, severe acute malnutrition; WFH, weight for height.

Table 2. Characteristics of OTP Patients Receiving Home Visits (N = 36)

	Median
Entry age (mo)	21.74
HH distance (mins)	67.5
People in HH	5
Siblings	1.5
HH rooms	2
Meals per day	2
Count (%)	
Female (N = 36)	20 (55.5)
Diarrhea at entry (N = 32)	6 (18.8)
Mosquito net (N = 36)	13 (36.1)
Vaccine card (N = 35)	33 (94.3)
Family planning (N = 34)	8 (23.5)
Latrine (N = 36)	21 (58.3)
Entry year (N = 36)	
2009	1 (2.8)
2010	5 (13.9)
2011	8 (22.2)
2012	16 (44.4)
2013	6 (16.7)
Water source (N = 36)	
None	30 (83.3)
River	3 (8.3)
Yes, unspecified	3 (8.3)
Family composition (N = 33)	
Orphan	3 (9.1)
1 parent	4 (12.1)
2 parents	26 (78.8)

HH, household; OTP, outpatient therapeutic feeding program.

children were cured, 21 (23.9%) defaulted, 1 (1.1%) died, and 1 (1.1%) was discharged prematurely. Among the 91 entrants with SAM, 51 (56.0%) were cured, 22 (24.2%) defaulted, 7 died (7.7%), 10 were prematurely discharged (11.0%), and 1 (1.1%) was hospitalized. For all years except 2011, patients who were admitted with MAM were observed to have a higher cure rate than those admitted with SAM. In 2011, only 2 outcomes occurred—cured and defaulted—and they occurred with similar frequency regardless of the patient’s initial severity. Of the 11 improper discharges, 10 occurred in 2009. Of the 8 patients who died after enrolling in the program (Table 3), 6 (75.0%) were female, 7 (87.5%) had SAM, 5 (62.5%) had at least 1 episode of recorded diarrhea in their charts, and 2 (25.0%) presented with edema on entry. Median age of entry was 14.8 months for this group, with a mean of 3.1 total visits while in the program.

Effect of the Cholera Epidemic. Figure 2 shows the rate of hospitalized cholera cases per 10,000

population and trends in patient outcomes, grouped into 6-month periods. Cholera entered the region in November 2010. The rate of cholera hospitalizations peaked at 2.6 per 10,000 in July 2011 (an average of approximately 1 per 10,000 including the surrounding 6-month period). The rate of defaulting patients also peaked in 2011 and nearly reached 100% for one 6-month period; the peak in defaults occurred one 6-month period after the peak in cholera.

Logistic Regression Model. Being severely malnourished at entry was significantly associated with a lower odds of leaving the program cured (odds ratio [OR] = 0.26, *P* = .002) after controlling for other patient- and care-related factors (Table 4). Older age was also statistically significantly associated with a worse outcome (OR = 0.76, *P* = .03). Being treated during a time with a higher cholera burden was a significant predictor of program failure in the models that did not additionally control for calendar year (OR = 0.86, *P* = .002). Living more than an hour from the clinic, sex, and having home visits were not significant predictors of being cured.

DISCUSSION

This study contributes valuable data on the effectiveness of RUTF as administered through a hospital-based OTP in the treatment of GAM within rural Haiti, for which there is scant available published data. Although this study presents data from a relatively small program, there is value to be found in the analysis as we focused on the complete set of patients enrolled in treatment over the program’s entire 5-year history. Although a number of studies have provided data for outcomes of RUTF as a treatment for acute malnutrition, they have been geographically biased toward sub-Saharan Africa and South Asia and remain limited, particularly with respect to the use of RUTF in treating MAM.^{3,10,15} The study further offers an important case study on the effect of an emergent epidemic on patient outcomes for an existing outpatient program at a resource-constrained rural primary health clinic.

Over the first 5 years of the program’s operation, its 65.4% overall cure rate (56.0% for SAM), 4.4% CFR (7.7% for SAM), and 23.6% default rate (24.2% for SAM) place it within range of the published literature but with room for improvement. According to the Haitian national guidelines, the program’s outcomes are all surpassing failing levels for treatment of SAM with RUTF (defined as <50% cure rate, >15% CFR, and >25% default rate), below target performance for cure rate

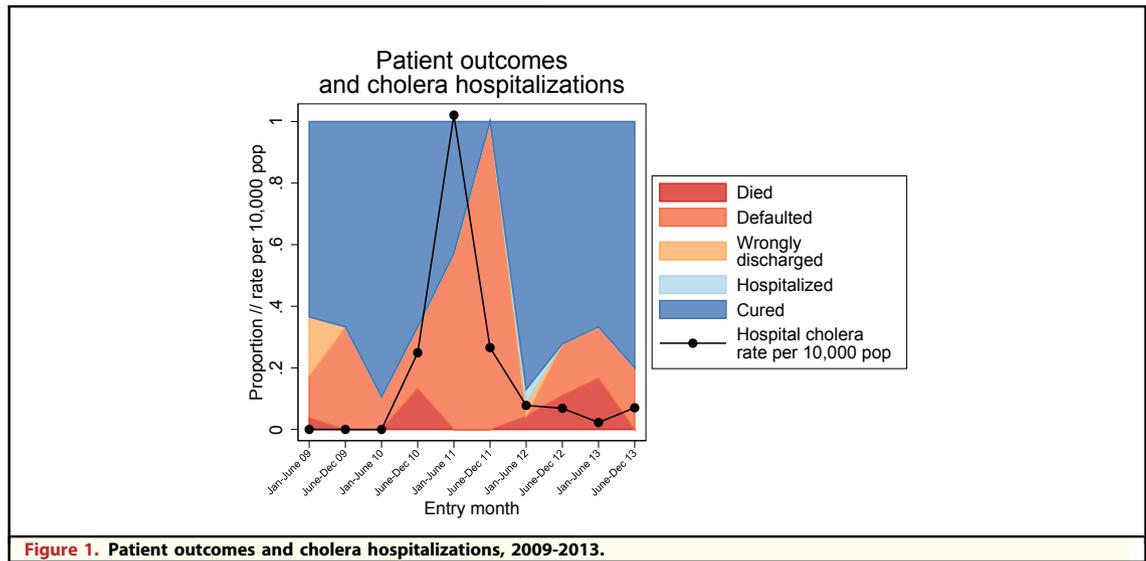


Figure 1. Patient outcomes and cholera hospitalizations, 2009-2013.

(>75%) and default rate (<15%), and within target range for CFR (<10%).²⁷ In a systemic review and meta-analysis of 3 published studies on the use of RUTF in the treatment of childhood (aged 6–59 months) SAM in Malawi, pooled data revealed a cure rate of 78.8% (range: 69.3%–89.6%) and a CFR of 5.3% (range: 2.5%–11.1%).²⁸ However, “cure” was defined differently across the included studies, none of which matches the definition used by our program, making such comparisons problematic. In Ethiopia, published cure rates from 3 SAM programs have ranged from 33.2%–61.8%.^{28,29}

Composition and volume of patients enrolled in the OTP changed over time. In the first year of operation (2009), the program enrolled nearly 3 times as many patients as were enrolled in 2013, including a large number of severe cases. This early surge could have resulted from the absence of

adequate community coverage for GAM before the program’s inception and a consequent backlog of cases as well as greater acceptance of MAM cases. In 2013, SAM cases constituted 80% of the overall caseload, reflecting a transition toward greater compliance with the MSPP, which does not advocate for the treatment of MAM with RUTF even in the absence of a supplementary food program.²⁷ More striking are the age differences across the years, with a significantly younger set of patients enrolling in 2013 than in prior years. It is possible that this is due to improved active case finding on the part of clinic staff and CHWs or earlier presentation of children at the clinic by their parents as a result of improved awareness of the problem in Thomassique.

That our logistic regression revealed an increased risk of treatment failure and mortality associated with severity of initial presentation is not surprising

Table 3. Characteristics of Deceased OTP Patients

Year	Cause of Death	Sex	Entry Age (mo)	Overall Severity	Entry MUAC	Entry Height	Entry Weight	Entry Edema	Recorded Diarrhea	No. of Clinic Visits	Home Visit
2009	Unknown	F	14	SAM	121	71	5.3	No	Yes	8	No
2009	Febrile Illness	F	22	SAM	130	79	6.9	No	Yes	3	No
2010	Unknown	F	29	SAM	127	71	6.2	Yes	Yes	2	No
2010	Unknown	F	16	SAM	115	68	6.3	No	No	1	No
2012	Unknown	M	38	MAM	120	84	9.6	No	No	6	No
2013	Unknown	F*	8	SAM	<100	56	3.1	Yes	Yes	1	No
2013	Unknown	F*	8	SAM	<100	54	3.9	No	No	1	No
2013	Unknown	M	6	SAM	100	61	5.6	No	Yes	3	Yes

F, female; M, male; MAM, moderate acute malnutrition; MUAC, mid-upper arm circumference; SAM, severe acute malnutrition.
* Twins.

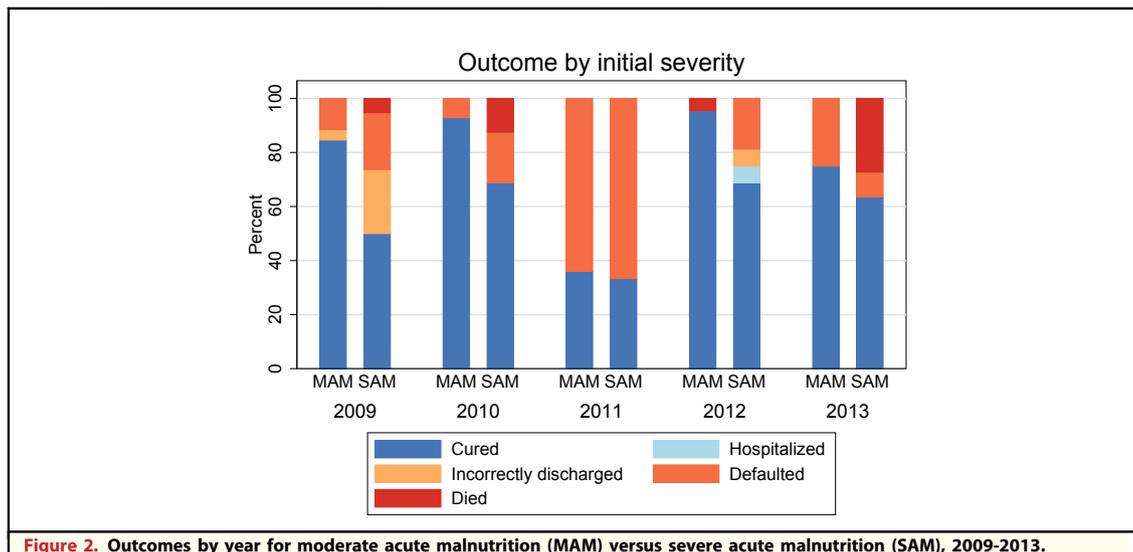


Figure 2. Outcomes by year for moderate acute malnutrition (MAM) versus severe acute malnutrition (SAM), 2009-2013.

(Table 3). The association between severity of malnutrition as assessed by anthropometric measures and mortality risk is well established in the literature,³⁰⁻³² and the longer duration of treatment required for children with severe malnutrition increases the risk of default. Our finding that older age was associated with less favorable outcomes even when controlling for year of entry, however, is less

supported by the literature. In a study with a similar OTP population from Ethiopia, age was found to have no effect on recovery.³³ The most likely explanation for such an effect would be if there is an age-linked variable not measured or included in our logit model; for example, immunologic and nutritional benefits that younger children could be deriving from continuing to breastfeed during

Table 4. Results From Logistic Regression Model for the Outcome of Being Cured, Reported as Odds Ratios (P Value)

	Patient Factors	Care Factors	Patient + Care Factors	Patient + Care + Time Factors
Odds ratio (P value)				
N	170	170	170	170
SAM at entry	0.467 (.027)*		0.361 (.006)†	0.261 (.002)†
Female	0.590 (.131)		0.616 (.184)	0.523 (.098)
Age at entry (y)	0.728 (.010)†		0.742 (.017)*	0.760 (.032)*
Distance from clinic				
Reference: <1 h				
≥1 h	0.518 (.098)		0.569 (.177)	0.661 (.352)
Distance not recorded	0.455 (.195)		0.413 (.153)	0.359 (.130)
Patient had home visit		1.986 (.137)	1.372 (.523)	1.143 (.817)
Hospital cholera burden‡		0.881 (.005)†	0.859 (.002)†	1.001 (.987)
Year of entry				
Reference: 2009				
2010				2.117 (.194)
2011				0.158 (.017)*
2012				2.121 (.269)
2013				1.067 (.933)

SAM, severe acute malnutrition.
 * P < .05.
 † P < .01.
 ‡ Average hospital cases per 1000 population for the month of entry and 2 months after.

treatment (not a measured variable) or increased risk of acquiring helminthic infections during the treatment period among older children.

One issue that likely influenced program effectiveness was variable involvement of the program's acting supervising physician. Although the PC, trained as an auxiliary nurse, has remained in her position since the commencement of the program, clinical oversight for the OTP was assigned on a yearly basis to a rotating social service physician reporting to the medical director of the clinic. Social service physicians in Haiti are recent medical school graduates who are given compulsory clinical posts for 1 year at an underserved health center; as such, they come with a diverse range of motivations, training backgrounds, and public health experience. As noted in one study of management of SAM at hospitals in rural South Africa, young doctors may not encounter much malnutrition in tertiary hospitals and may lack experience in case management.³⁴ Thus, despite the high involvement of the supervising physician in the first year of the program (who was present at 84.4% of intakes), there were 3 inappropriate admissions and 10 of 11 of the program's premature discharges occurred that year. Semistructured interviews with the PC highlighted the importance of an involved physician partner on all levels, from recruitment and enrollment to program development. In addition to turnover in direct clinical oversight of the program, changes in leadership likely had additional impact, with 3 different physicians serving as medical director since the program's inception. Turnover among medical directors could have affected preparation of social service physicians to take on their responsibilities supervising the program. In rural Angola, in-service physician supervision of a therapeutic feeding center for children with SAM led to an increase in successful outcomes (from 73.2% to 82.6%) and decrease in fatality rates (from 15.6% to 8.7%).³⁵

The effect of staffing shortages on quality of care and patient mortality is well established in the literature, with multiple high-quality studies documenting decreased morbidity and mortality among patients presenting to services with better nurse staffing.^{36,37} The tradeoff between staffing and patient outcomes is especially apparent within the developing world, however, where there are critical shortages of trained health care workers, particularly in rural areas. Haiti is no exception to this, with a density of 0.4 doctors, nurses, and midwives per 1000 population—well below the WHO-defined critical threshold of 2.3 and within the bottom tercile of the WHO's 49 priority countries.³⁸ Staffing, particularly at the nursing

level, is a major issue at the clinic at which the OTP is based, which relies heavily on rotating auxiliary and social service nurses to meet patient demand. As a trained auxiliary nurse, the PC was often called on to perform shifts on services such as the emergency room or patient triage, which limited the time she was able to devote to the program.

Problems of supervision, staffing, and resources were exacerbated by the cholera epidemic that arrived at the clinic in November 2010. The first wave of the epidemic was characterized by very high case burden and CFR, as Haiti's strained health system struggled to accommodate the rapid influx of patients needing hospitalization.³⁹ Nursing demands for these patients were high. Our logit model revealed higher probability of malnutrition treatment failure associated with higher burden of hospitalized cholera patients. Follow-up interviews with the PC supported a connection between the cholera outbreak, staff diversion, and compromised outcomes for existing programs like the OTP: "When they came I didn't have time to see them. I'd say, 'wait for me, wait for me, I'll come find you'—...and they'd see that it was taking too long, they'd go, and when I'd finish seeing the others, they'd have left and wouldn't come back....At that time it was cholera...that took priority, you understand. There were many children who had it. All those people were afraid....It was those patients we saw more....We did everything we could so that people with cholera wouldn't die. Despite that there were many who died...The parents of the children would tell them not to enter the clinic because if they entered the children would get cholera too. The children would never return again."

As a retrospective chart review, a major limitation was missing or incomplete data and difficulties in interpreting certain records, with 6.6% of charts ultimately excluded from the logit model. Missing data were also an issue with the cholera records; although we were able to interpolate hospitalization rates using data from surrounding clinics with a high degree of correlation, relying exclusively on primary data would have been preferable. Any conclusions to be drawn from the home visit data, furthermore, were limited by its small sample size: Although the sample of households was representative of the larger set of patients in terms of age, household distance, and sex, as a convenience sample the conclusions to be drawn from it are necessarily limited. Unfortunately, we were not able to include potentially important variables collected during the home visits in our logistic regression

because of the small sample. Finally, one notable limitation with respect to interpreting the data was that our qualitative follow-up was limited to 1 active employee and therefore a potentially biased account. One future opportunity for research would include population sampling to understand the impact of the program on the community level.

CONCLUSIONS

From Evidence to Action: Moving Toward the CMAM Model. Our findings of diminished caseload and increased mortality in 2013 emphasized the need to improve community referrals and outreach and to provide the PC with significantly more dedicated time to be able to spend on programmatic activities. Our finding that the cholera epidemic served as a deterrent to patient follow-up when consultations were based at the hospital, furthermore, led to a decision to decentralize the program and allow for consultations to take place at the clinic's 5 community health centers, which are physically removed from all cholera treatment-related activities. Together, we believe these changes have advanced the program toward a more community-based model of care that will increase its overall effectiveness and resilience in dealing with future shocks, such as cholera.

Since August 2013, CHWs have been able to make referrals after receiving training and equipment for measuring MUAC, weight, and height. Enabling CHWs to refer patients living in the villages has allowed for earlier detection and entry

into the program. CHWs identify some patients through active case finding but also conduct education sessions each month on malnutrition to increase program awareness and encourage community members to present to the health center for screening. Per MSPP guidelines, CHWs are not currently qualified to enroll children in the program, and all enrollments continue to be overseen by the PC. For patients living centrally, both enrollment and follow-up visits occur in the clinic. For patients in outlying villages, the PC travels to mobile clinics for enrollment. In potentially complicated cases, patients are referred to the clinic for physician consultation. Following WHO guidelines, all uncomplicated cases are treated at local community health centers within each village: the PC travels to villages for biweekly appointments for any patient enrolled in the program and sees patients along with the CHW. All community health centers are equipped to measure weight, height, and MUAC.

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