Severe acute malnutrition admissions, clinical characteristics, and
treatment outcomes in Malawi from 2011 to 2019

Allison I. Daniel\textsuperscript{1-3*}, Sylvester Kathumba\textsuperscript{4}, Collins Mitambo\textsuperscript{4}, Dennis Chasweka\textsuperscript{5}, Wieger Voskuil\textsuperscript{5,6}, Esther Kamanga\textsuperscript{5}, Emmie Mbale\textsuperscript{5,7}, Robert H.J. Bandsma\textsuperscript{1-3,8,9}, Isabel Potani\textsuperscript{1-3}

\textsuperscript{1} Centre for Global Child Health, Hospital for Sick Children, Toronto, Ontario, Canada
\textsuperscript{2} Translational Medicine Program, Hospital for Sick Children, Toronto, Ontario, Canada
\textsuperscript{3} Department of Nutritional Sciences, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada
\textsuperscript{4} Malawi Ministry of Health, Lilongwe, Malawi
\textsuperscript{5} Queen Elizabeth Central Hospital, Blantyre, Malawi
\textsuperscript{6} Amsterdam Centre for Global Child Health, Emma Children’s Hospital, Amsterdam University Medical Centre, University of Amsterdam, Amsterdam, The Netherlands
\textsuperscript{7} Department of Paediatrics, Kamuzu University of Health Sciences, Blantyre, Malawi
\textsuperscript{8} Department of Paediatrics, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada
\textsuperscript{9} Department of Biomedical Sciences, Kamuzu University of Health Sciences, Blantyre, Malawi

* Corresponding author

Email: allison.daniel@mail.utoronto.ca (AID)

\& RHJB and IP are Joint Senior Authors.
Abstract

Community-based Management of Acute Malnutrition (CMAM) has been successfully implemented across Malawi, yet trends in admissions, clinical characteristics, and treatment outcomes in children with severe acute malnutrition (SAM) have not been examined. The objective was therefore to investigate trends in admissions, clinical characteristics including proportion of children with HIV and oedema, and treatment outcomes across the decade following implementation of CMAM. This research involved a retrospective analysis of existing data routinely collected across Malawi by the Ministry of Health between 2011 and 2019. These data showed a rise in outpatient therapeutic feeding (OTP) admissions from 30323 children in 2011 to 37655 in 2019 (p=0.045). However, a significant decrease in nutritional rehabilitation unit (NRU) admissions was observed over the same period, from 11389 annual admissions in 2011 to 6271 in 2019 (p=0.006). In children identified with SAM, the proportion with oedema were seen to be lower in OTP by 12.6% between 2011 and 2018 (p=0.02) and by 26.2% in NRUs in this timeframe (p=0.01). There was a 9.1% decrease in the proportion of children with SAM who had HIV over time in OTP (p=0.03). HIV prevalence was 6.1% lower between 2012 and 2017 in NRUs but this difference was not significant (p=0.06). The prevalence of HIV in children with SAM was about twice as high as in children in NRUs, at 14.5% in 2017, compared to those enrolled to OTP, at 7.1% in 2017. From 2011 to 2019, death rates decreased by only 0.7% in OTP to a rate of 1.2% (p=0.02). Mortality rates also did not change in NRUs over time being 9.8% in 2019 (p=0.4). These trends indicate that while there has been a decrease in NRU admissions, these children remain at risk of mortality with NRUs having a higher absolute number of children who die compared to OTP.
Introduction

The Community-based Management of Acute Malnutrition (CMAM) approach, which was endorsed by the World Health Organization, UNICEF, and World Food Programme in 2007, drastically changed the way that acute malnutrition is managed [1]. Severe acute malnutrition (SAM) is defined by severe wasting (weight-for-height z-scores (WHZ) below -3 SD or mid-upper arm circumference (MUAC) below 115 mm) and/or oedematous malnutrition (bilateral pitting oedema). Children with SAM and acute illnesses, loss of appetite, or other clinical complications require admission to nutritional rehabilitation units (NRUs) for clinical care and nutritional support. Children with SAM in the absence of complications are treated in outpatient therapeutic feeding programs (OTP), including those discharged from NRUs. Children with moderate wasting, otherwise known as moderate acute malnutrition (MAM) (WHZ between -3 SD and -2 SD or MUAC between 115mm and 125mm), are commonly managed within supplementary feeding programs (SFP) [2].

Malawi has seen a downward trend in the prevalence of wasting from 7% in 2000 to 3% in 2015 [3]. CMAM was first established in 2002 in Malawi as a pilot program which was then implemented nationally in 2006 to manage children with acute malnutrition [4–6]. Scale-up continued until all 28 districts in the country implemented CMAM programs by 2009 [5]. There are currently 104 operational NRUs in Malawi for inpatient treatment of SAM and over 620 OTP centers [7]. In 2019, coverage for SAM treatment was 67.3% (38610 children reached out of a target 75% of 76509 caseloads).

While CMAM has been successfully implemented in Malawi, there has been little examination of trends in admissions, clinical characteristics, and treatment outcomes since its inception in the country which would aid in resource-allocation within the CMAM approach and
to characterize the population of children with SAM in different treatment settings. The main
objective of this analysis was therefore to examine trends in SAM admissions within the last
decade, from 2011 to 2019, at CMAM settings across the country based on pre-existing data
collected by the Malawi Ministry of Health. Another important aim was to understand trends in
characteristics of children with SAM based on clinical characteristics including proportion of
children with SAM who had HIV and oedema rates, as well as gender, as well as trends in
mortality.

Materials and methods

This research involved a retrospective analysis of existing CMAM data that were
routinely collected across Malawi by the Ministry of Health between 2011 and 2019 at up to 104
NRUs and 623 OTPs (S1 File). The mean and median number of NRUs and OTPs reporting each
month across the different years is summarized in Table 1. The number of units reporting was
not documented prior to 2016, apart from 2011 in which the mean number of NRUs was 98.7
and median was 100.

Table 1. Outpatient therapeutic feeding programs and nutritional rehabilitation units
reporting each month between 2016 and 2019.

| Year  | OTP Mean | OTP Median | NRU Mean | NRU Median |
|-------|----------|------------|----------|------------|
| 2016  | 595.3    | 600        | 103      | 103        |
| 2017  | 613.4    | 613        | 103.9    | 104        |
| 2018  | 619.4    | 619        | 103.9    | 104        |
| 2019  | 623      | 623        | 104      | 104        |

NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.
Based on the number of centres reported for nine of 12 months in 2016.

Data extracted included the number of SFP, NRU, and OTP admissions, clinical characteristics including proportion of children identified with SAM who had oedema (data available from 2011 to 2018), HIV prevalence in children with SAM (data available from 2012 to 2017), and gender (data available to 2011 and 2018), and treatment outcomes. In 2011, severe wasting was identified by weight-for-height below 70% and/or MUAC below 110mm; from 2012 onwards, WHZ <-3 SD and/or MUAC below 115mm were used. The NRU and OTP data up to 2018 include children up to five years of age, while children above five years are also included in the 2019 data. The 2019 data also only capture new admissions, while data from all other years reflect total admissions. Monthly admissions between the different years were examined based on data that were available from 2011 to 2018.

All data were analyzed using statistical software Stata 16 (StataCorp LP, College Station, Texas, USA) [8]. Annual trends in admissions, proportion of children with SAM who had oedema and HIV in OTP, gender, and treatment outcomes disaggregated by CMAM setting were evaluated using a linear-by-linear trend test. These annual trends, as well as SAM admissions by month, were also presented visually.

**Ethics Statement**

Ethical approval for this analysis was obtained from the Malawi National Health Sciences Research Committee (Protocol #20/01/2459) in Lilongwe, Malawi. The information used in the analysis was routinely collected programmatic data; no individual patient information nor identifying information were collected and therefore informed consent was not required.
Results

Admissions

SFP admissions for management of moderate wasting rose from 53446 to 147696 children representing a percentage point increase of 176.3% between 2011 and 2019 (p=0.01).

Total SAM admissions, which include new admissions and readmissions, went from 41712 to 49167, which was a 17.9% percentage point increase, but this trend was not significant (p=0.06) (Fig 1). New SAM admissions specifically increased by 24.0% percentage points, from 35416 to 43926 (p=0.04).

Fig 1. Severe acute malnutrition admissions between 2011 and 2019. Total and new severe acute malnutrition admissions by year at all nutritional rehabilitation units and outpatient therapeutic feeding programs across Malawi.

There was a significant positive trend in OTP admissions (p=0.045) from 30323 to 37655 children with SAM which was a 24.2% percentage point increase (Fig 2). NRU admissions dropped significantly (p=0.006) from 11389 to 6271 between 2011 and 2019, by 44.9% percentage points (Fig 3). With regards to monthly SAM admissions between 2011 and 2018 at NRUs and OTP, the highest numbers were generally seen in the first three months of the year (Fig 4).

Fig 2. Outpatient therapeutic feeding program admissions between 2011 and 2019. Severe acute malnutrition admissions by year at all outpatient therapeutic feeding programs across
Malawi. The 2019 data only include new admissions while data from all other years reflect total admissions.

Fig 3. Nutritional rehabilitation unit admissions between 2011 and 2019. Severe acute malnutrition admissions by year at all nutritional rehabilitation units across Malawi. The 2019 data only include new admissions while data from all other years reflect total admissions.

Fig 4. Severe acute malnutrition admissions by month between 2011 and 2018. Total severe acute malnutrition admissions by month at all outpatient therapeutic feeding programs and nutritional rehabilitation units across Malawi.

There were no trends over time in the proportion of children with SAM admitted to NRUs who were transferred to hospital (p=0.4) or transferred from other OTP (p=0.3) (Table 2). There was a decrease in the rates of returned defaulters in OTP (p=0.03), a decline in transfer from NRU (p=0.01) or from other OTP (p=0.01), but no significant difference in transfers from SFP to OTP (p=0.054).

Table 2. Sources of admissions to outpatient therapeutic feeding programs and nutritional rehabilitation units between 2011 and 2018.

| Year | OTP | NRU |
|------|-----|-----|
|      | Returned defaulter | Transfer from SFP | Transfer from NRU | Transfer from other OTP | Transfer to hospital | Transfer from other OTP |
| 2011 | 1.8% | 0.4% | 17.4% | 2.9% | 0.8% | 3.8% |
| 2012 | 1.5% | 1.8% | 14.4% | 2.4% | 0.7% | 2.5% |
| 2013 | 1.3% | 1.9% | 13.0% | 2.3% | 2.6% | 3.6% |
| 2014 | 1.6% | 2.6% | 9.0%  | 1.7% | 1.3% | 3.1% |
Clinical characteristics

In children identified with SAM, the proportion of those with oedema went down over time, from 46.3% to 33.7% (p=0.02) in OTP and from 62.8% to 36.6% (p=0.01) in NRUs between 2011 and 2018 (Fig 5). The HIV prevalence in children with SAM was also seen to be lower over the years, from 16.5% to 7.1% (p=0.03) in OTP; there was no significant trend in HIV prevalence in children with SAM admitted to NRUs (p=0.06) (Fig 6). There were no trends in the proportion of males and females over time in OTP or NRUs (p=0.08 and p=0.3, respectively) (Fig 7). However, there were more females than males admitted for treatment of SAM in OTP for each year.

Fig 5. Proportion of children with severe acute malnutrition who had oedema (%) oedematous) disaggregated by outpatient therapeutic feeding programs and nutritional rehabilitation units between 2011 and 2018. NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.

Fig 6. HIV prevalence (% HIV positive) in children with severe acute malnutrition disaggregated by outpatient therapeutic feeding programs and nutritional rehabilitation
units between 2012 and 2017. HIV: human immunodeficiency virus; NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.

Fig 7. Gender disaggregated by outpatient therapeutic feeding programs and nutritional rehabilitation units between 2012 and 2018. NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.

**Treatment outcomes**

There was no trend in the absolute number of SAM deaths in OTP (p=0.5), yet there was a downward trend in death rates in OTP from 1.9% in 2011 to 1.2% in 2019 (p=0.02) (Table 3, Fig 8, Fig 9). Deaths in NRUs decreased from 1167 in 2011 to 594 in 2019 (p=0.01) yet there was no change in rates of mortality in NRUs (p=0.4) (Table 4).

**Table 3. Treatment outcomes at outpatient therapeutic feeding programs between 2011 and 2019.**

| Year | Cured | Died | Defaulted | Non-response | Transfer to NRU | Transfer to other OTP |
|------|-------|------|-----------|--------------|----------------|-----------------------|
| 2011 | 82.9% | 1.8% | 5.6% | 1.3% | 3.9% | 4.5% |
| 2012 | 83.0% | 1.6% | 6.0% | 1.1% | 3.6% | 4.7% |
| 2013 | 83.8% | 1.2% | 5.7% | 1.5% | 3.2% | 5.2% |
| 2014 | 83.4% | 1.3% | 5.9% | 1.3% | 3.0% | 5.1% |
| 2015 | 83.9% | 1.3% | 5.3% | 1.3% | 2.7% | 5.5% |
| 2016 | 86.8% | 0.9% | 4.9% | 1.5% | 2.0% | 3.9% |
| 2017 | 89.4% | 0.9% | 2.5% | 1.1% | 2.0% | 4.0% |
| 2018 | 90.3% | 1.1% | 2.4% | 1.2% | 1.6% | 3.5% |
| 2019 | 92.9% | 1.2% | 3.1% | 1.8% | p=0.008 | p=0.03 |

Trends: p=0.008, p=0.03, p=0.02, p=0.3, p=0.009, p=0.1
Fig 8. Deaths disaggregated by outpatient therapeutic feeding programs and nutritional rehabilitation units between 2011 and 2019. NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.

Fig 9. Mortality rates (% died) disaggregated by outpatient therapeutic feeding programs and nutritional rehabilitation units between 2011 and 2019. NRU: nutritional rehabilitation unit; OTP: outpatient therapeutic feeding program.

Table 4. Treatment outcomes at nutritional rehabilitation units between 2011 and 2019.

| Year | Stabilized to OTP | Cured | Died | Defaulted | Medical transfer |
|------|------------------|-------|------|-----------|------------------|
| 2011 | 63.1%            | 18.7% | 10.8%| 2.7%      | 4.7%             |
| 2012 | 72.3%            | 12.3% | 9.2% | 2.7%      | 3.5%             |
| 2013 | 74.3%            | 10.5% | 8.7% | 2.4%      | 4.6%             |
| 2014 | 72.3%            | 12.2% | 9.2% | 2.7%      | 4.4%             |
| 2015 | 71.5%            | 12.4% | 9.7% | 2.2%      | 4.3%             |
| 2016 | 74.9%            | 11.0% | 7.9% | 2.6%      | 3.7%             |
| 2017 | 74.9%            | 8.8%  | 9.7% | 2.4%      | 4.1%             |
| 2018 | 69.1%            | 11.5% | 8.5% | 2.2%      | 3.5%             |
| 2019 | 80.1%            | 13.9% | 11.0%| 2.9%      |                  |

Trends: p=0.09 p=0.2 p=0.9 p=0.7 p=0.2

There was an increase in cure rates from 82.9% in 2011 to 92.9% in 2019 (p=0.008) and a decrease in default rates from 5.6% in 2011 to 3.1% in 2019 (p=0.02) in OTP, but no change in non-response (p=0.3). There was a drop in transfer to NRU from 3.9% in 2011 to 1.6% in 2018 (p=0.009) but no difference in transfer to OTP (p=0.1). There were no differences in treatment outcomes including stabilized to OTP (p=0.09), cured (p=0.2), defaulted (p=0.7), and medical transfer in NRUs (p=0.2).
Discussion

The data collected over the last decade in Malawi have shown that while there has been an increase in SFP and OTP admissions, there has been a major reduction in NRU admissions between 2011 and 2019.

In children with SAM, the proportion who had oedema compared to severe wasting declined in OTPs and NRUs across Malawi within the time examined. The primary reason for this is likely to be that Malawi introduced highly effective active case finding in the community, which could identify more children with wasting who may have previously been missed. On the other hand, the drop in the proportion of children with oedema compared to severe wasting does not necessarily represent a change in the phenotype.

The proportion of children with HIV also was lower in both CMAM settings over time, which may represent a shift in the clinical characteristics of children with SAM in Malawi. CMAM guidelines in Malawi recommended that children with HIV and MAM be admitted for treatment in OTP rather than SFP due to the higher chance of mortality [9]. HIV is also known to been associated with elevated risk of mortality in children admitted for inpatient treatment of SAM [10–13], but the data did not indicate that SAM mortality in NRUs declined. However, the data available did not link HIV and mortality, which makes it impossible to determine whether this is the case from this particular analysis.

Though a fraction of total admissions for SAM is to NRUs, the absolute number of deaths remains higher in NRUs than in OTPs, with 445 deaths recorded in OTPs and 594 in NRUs in 2019. The Sphere Handbook states that mortality rates should be below 10% for combined OTP and NRU outcomes [14]. These targets have just barely been achieved in NRUs in Malawi mortality rates of 9.8% in 2019, and in 2019 there were four months of the year in which NRUs
exceeded mortality rates of 10%. Evidently, children admitted for inpatient treatment of SAM remain exceptionally vulnerable even though there are fewer children being treated in NRUs.

Results from this analysis point towards key actions that need to be taken. The first set of actions is to further support and strengthen active case finding and early identification of wasting, augmenting treatment in community settings where a majority of children with wasting can be managed, and improving the referral system from OTP to NRUs for children with clinical complications. Additionally, the quality of care of children admitted to NRUs should be enhanced considering the stagnant mortality rates. A recent implementation evaluation showed that a 17-month quality improvement initiative beginning in April 2016 at seven hospitals in Malawi improved the assessment of clinical complications and nutritional status, prevention and treatment of dehydration, and immediate cautious feeding of children with SAM [15]. However, the case fatality rates remained over 10%, with death audits showing that mortality was often attributed to delayed presentation, clinical complications, and inability to access antibiotics. They suggested post-training support for healthcare workers at NRUs, integration with emergency care in alignment with ETAT, and pre-service training of healthcare workers which started in Malawi in 2016 [15]. With fewer children admitted to NRUs meaning that many are not at capacity [7,16] – and many sitting empty – there is strong potential for this to be done without greatly increasing resource requirements.

Importantly, there are several key limitations of this evaluation. One is that patterns observed across NRUs and OTP may not be representative of the population in Malawi. Findings were not examined by district due to unavailability of these disaggregated data. Furthermore, annual data are presented but there is potential for issues with regards to data quality and reporting that may impact the findings. There are also no data on treatment coverage which
makes it challenging to draw conclusions on admissions in particular. Future programmatic data should include details on coverage and be presented by district and specific NRU and OTP sites if possible. Additional limitations are that the data do not allow for exploration of direct relationships between admissions, clinical characteristics, and treatment outcomes in children with wasting. The data are also not disaggregated by age, including infants under six months compared to infants and children over six months. In summary, there are many ways to improve the usability of programmatic data, which should be coupled with improving quality and completeness of these data to get a deeper understanding of these trends over time.

Conclusions

While there has been an increase in OTP admissions of children with SAM since the implementation of CMAM, there has been a significant decline in NRU admissions. These trends in NRU admissions as well as decreasing proportion of children with SAM who have oedema demonstrate the positive impact of active case finding, particularly to identify wasting. However, the mortality rate for children admitted to NRUs has not changed. In summary, these findings signal the importance of reinforcing case finding to identify wasting, effective treatment of most children who have wasting in community settings, timely referral to NRUs for children with SAM and clinical complications, and improving quality of care at NRUs for those at highest risk.

Acknowledgements

We would like to sincerely thank the Malawi Ministry of Health for sharing these data to complete this analysis, including staff members involved in collecting these data at sites across Malawi over the years.
References

1. World Health Organization. Community-based management of severe acute malnutrition: A Joint Statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children’s Fund. 2007.

2. World Health Organization. WHO Child Growth Standards and the Identification of Severe Acute Malnutrition in Infants and Children. WHO Libr. Geneva; 2009.

3. National Statistical Office/Malawi ICF. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi: National Statistical Office and ICF; 2017.

4. Concern Worldwide. Scaling Up Community-Based Management of Acute Malnutrition: Implementing the CAS Program in Malawi. Lilongwe; 2013.

5. Kathumba S. Creating an enabling policy environment for effective CMAM implementation in Malawi. In: Field Exchange 43: Government experiences of CMAM scale up [Internet]. 2012 p. 73. Available: http://www.enonline.net/fex/43/creating

6. Malawi Ministry of Health. Malawi National Community-Based Management of Acute Malnutrition (CMAM) Operational Plan 2017–2021. Lilongwe, Malawi; 2016.

7. Kouam E. Evaluation of community management of acute malnutrition (CMAM) in Malawi. UNICEF Malawi Ctry Off. 2016.

8. StataCorp. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC; 2019.

9. Malawi Ministry of Health. Malawi Guidelines for Community-Based Management of Acute Malnutrition, 2nd Edition. 2016.
10. Heikens GT, Bunn J, Amadi B, Manary M, Chhagan M, Berkley JA, et al. Case management of HIV-infected severely malnourished children: challenges in the area of highest prevalence. Lancet. 2008;371: 1305–1307. doi:10.1016/S0140-6736(08)60565-6

11. Rytter MJ, Babirekere-Iriso E, Namusoke H, Christensen VB, Michaelsen KF, Ritz C, et al. Risk factors for death in children during inpatient treatment of severe acute malnutrition: A prospective cohort study. Am J Clin Nutr. 2017;105: 494–502. doi:10.3945/ajcn.116.140822

12. Trehan I, O’Hare BA, Phiri A, Heikens GT. Challenges in the Management of HIV-Infected Malnourished Children in Sub-Saharan Africa. AIDS Research and Treatment. Hindawi Limited; 2012. doi:10.1155/2012/790786

13. Bandsma RHJ, Voskuijl W, Chimwezi E, Fegan G, Briend A, Thitiri J, et al. A reduced-carbohydrate and lactose-free formulation for stabilization among hospitalized children with severe acute malnutrition: A double-blind, randomized controlled trial. PLoS Med. 2019;16: 1–19. doi:10.1371/journal.pmed.1002747

14. Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth edition. Geneva; 2018.

15. Kauchali S, Puoane T, Aguilar AM, Kathumba S, Nkoroi A, Annan R, et al. Scaling Up Improved Inpatient Treatment of Severe Malnutrition: Key Factors and Experiences From South Africa, Bolivia, Malawi, and Ghana. Glob Heal Sci Pract. 2022;10: 1–16. doi:10.9745/GHSP-D-21-00411

16. Daniel AI, Chidzalo K, Potani I, Voskuijl WP, Gladstone M, van den Heuvel M, et al. A quantitative cross-sectional survey of psychosocial stimulation and counselling interventions at nutritional rehabilitation units in Southern Malawi. Malawi Med J.
Supporting information

S1 File. CMAM data from the Malawi Ministry of Health (2011-2019).
Fig 2
Fig 5
Fig 6
Fig 9