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## Management of acute malnutrition in infants aged under 6 months (MAMI): Current issues and future directions in policy and research

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### Abstract

**Background**—Globally, some 4.7 million infants aged under 6 months are moderately wasted and 3.8 million are severely wasted. Traditionally, they have been overlooked by clinicians, nutritionists, and policy makers.

**Objective**—To present evidence and arguments for why treating acute malnutrition in infants under 6 months of age is important and outline some of the key debates and research questions needed to advance their care.

**Methods**—Narrative review.

**Results and conclusions**—Treating malnourished infants under 6 months of age is important to avoid malnutrition-associated mortality in the short term and adverse health and development outcomes in the long term. Physiological and pathological differences demand a different approach from that in older children; key among these is a focus on exclusive breastfeeding wherever possible. New World Health Organization guidelines for the management of severe acute malnutrition (SAM) include this age group for the first time and are also applicable to

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management of moderate acute malnutrition (MAM). Community-based breastfeeding support is the core, but not the sole, treatment. The mother–infant dyad is at the heart of approaches, but wider family and community relationships are also important. An urgent priority is to develop better case definitions; criteria based on mid-upper-arm circumference (MUAC) are promising but need further research. To effectively move forward, clinical trials of assessment and treatment are needed to bolster the currently sparse evidence base. In the meantime, nutrition surveys and screening at health facilities should routinely include infants under 6 months of age in order to better define the burden and outcomes of acute malnutrition in this age group.

## Keywords

Breastfeeding; community health; guidelines; infant; infant feeding; malnutrition

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## Background

Improving the management of acute malnutrition in infants aged under 6 months (MAMI) represents major opportunities but also major challenges. Estimates suggest that 4.7 million infants under 6 months of age worldwide are moderately wasted and 3.8 million are severely wasted [1]. Yet, despite a seemingly clear case for action in terms of the numbers affected, the group has traditionally been overlooked by clinicians, nutritionists, and policy makers [2]. In this narrative review, we present evidence to argue that preventing and managing malnutrition in infants under 6 months of age is important and outline some key debates and research questions needed to advance their care.

## Why infants under 6 months of age matter

There are numerous reasons why acutely malnourished infants under 6 months of age warrant special attention. Physiologically, this period represents the transition from neonatal life and the beginnings of independence from mother's milk as the only source of nutrition. In terms of health policy, they fall between guidelines for neonatal care and those for the management of malnutrition (focused on infants over 6 months). This is a key gap, given that they also lie within the first 1,000 days of life special window of opportunity underpinning the Scaling Up Nutrition (SUN) Movement [3]. As well as reducing malnutrition-associated mortality in the short term [4], improved care has the potential to influence long-term health and development [5, 6]. Tempering these opportunities is the fact that treating infants under 6 months of age can be much more difficult than treating older children. Maternal factors are central, and treating the mother–infant dyad rather than the infant alone is critical. Another challenge is that the exclusive breastfeeding aim [7] excludes infants under 6 months of age from treatment with ready-to-use therapeutic foods (RUTFs), which has underpinned the success of Community-Based Management of Acute Malnutrition (CMAM) in older children [8]. Establishing or reestablishing effective exclusive breastfeeding, which is often the first line of management, can be time-consuming and requires skilled support [9] that is often unavailable in the resource-poor settings where malnutrition is common, and may not be a viable option where an infant is not breastfed. Other challenges include a wide range of possible problems and pathologies underlying acute malnutrition in infants under 6 months of age. Though breastfeeding is key, there are

numerous other causes, ranging from underlying infant disease (e.g., neurological, HIV, tuberculosis, cardiac, metabolic) to poor maternal physical or mental health [10] to social factors, such as the need for the mother to return to employment that does not cater for accompanying infants. The contribution of these factors remains to be documented and will be important in developing screening and management protocols. Lastly, rapid physical and physiological maturation means that a 1-month-old is, for example, very different from a 4-month-old. The benefits of precisely age-tailored treatments need to be balanced against the added complexities that they impose on programs; more complex guidelines are less likely to be effectively implemented in everyday practice.

### The MAMI-1 report

The 2010 MAMI-1 report was one of the first to explore acute malnutrition in infants under 6 months of age in detail [2]. Despite a dearth of evidence overall, it succeeded in describing basic epidemiology and documented higher mortality among infants under 6 months of age than among children aged from 6 to 59 months within the same nutrition programs. A major barrier to progress was that guidelines at the time described only inpatient treatment options. Since such facilities were often unavailable, many programs and practitioners were reluctant to actively seek out malnourished infants; knowing that little can be offered makes it ethically questionable to identify a problem. Indeed, merely “labeling” an infant as malnourished without taking full account of his or her clinical and nutritional status may lead to adverse consequences [11].

### World Health Organization SAM Guidelines 2013: Translating limited evidence into policy

Despite the limited evidence identified, MAMI-1 contributed to increased international interest in infants under 6 months of age and ultimately led to a dedicated chapter in the new 2013 World Health Organization (WHO) Guideline on the Management of Severe Acute Malnutrition in Infants and Children [12]. The key recommendation for infants under 6 months of age was that uncomplicated severe acute malnutrition (SAM) should be recognized and that practical, clinically plausible *outpatient* treatments (e.g., simple feeding support and follow-up) should be offered as first-line treatment. Having these low-risk interventions as an alternative to either high-risk inpatient admission (e.g. risk of nosocomial infection, opportunity costs of long hospital stay) or malnutrition “labeling” alone makes it possible to be proactive about identifying affected infants. Outpatient options also make the guidelines as applicable to infants under 6 months of age with moderate acute malnutrition (MAM) as to infants under 6 months of age with uncomplicated SAM.

### Challenges in assessing malnutrition in infants under 6 months of age

Effectively treating a problem requires that it first be defined. There is no single gold standard measure of acute malnutrition in infants under 6 months of age, but anthropometry is universally used in older children and has proven value [13]. There are many discussions around the advantages and disadvantages of the two main current measures of wasting: weight-for-length z-score (WFLz) and mid-upper-arm circumference (MUAC) [14, 15].

These only partly overlap, identifying different groups of wasted individuals [16]. For infants under 6 months of age, WFLz-based definitions are the same as for older children ( $< -3$  WFLz for SAM,  $-3$  to  $< -2$  WFLz for MAM). There are, however, no currently accepted MUAC criteria for acute malnutrition in infants under 6 months of age. If WFLz were a perfect measure of wasting, this would not necessarily be a problem. In this section, we argue that current reliance on WFLz alone *is* a problem. Diagnosing an infant as malnourished causes concern in parents and healthcare workers and may, if not handled carefully, undermine rather than support exclusive breastfeeding [11, 17]. Reviewing the current case definition:

In a cross-sectional study exploring the *reliability of WFLz* among infants under 6 months of age, community health workers were able to reproduce absolute measures of weight and length, but this did not translate to reliable z-score indicators. The effect was more pronounced for WFLz [18] than for weight-for-age z-score (WFAz) or MUAC (MUAC): WFLz was very sensitive to small variations in length measurement. A review reporting reliability scores for WFLz observed a similar result [19]. Reliable initial measures did not translate to high reliability of the combined index in very young children.

The *validity of WFLz* to correctly identify infants under 6 months of age with acute malnutrition has not been studied. Inferring from research in older children, weight-for-height z-score (WFHz) poorly identifies undernourished children with visible severe wasting, kwashiorkor [16, 20], or dehydration [21]. These problems would also likely apply to infants under 6 months of age.

The *accuracy of WFLz* has also hardly been studied [19]. In one paper, the accuracy of WFLz taken by community health workers among infants under 6 months of age was assessed against a trainer's "gold standard" [22]. The difference in variance was statistically significant for WFLz (but not for MUAC assessed in the same project). Equipment-related bias is another source of inaccuracy [23]. Measurements requiring more complicated equipment and procedures such as length measurement are more likely to be inaccurate than those requiring simpler equipment and procedures. In the WHO multicenter growth reference study, trained observers underestimated length by  $-0.21$  to  $-0.37$  cm compared with measurements obtained by the expert anthropometrist [24].

Finally, using anthropometry to predict short- and long-term future outcomes, including morbidity and mortality, has been studied. In a retrospective cohort analysis involving infants recruited at the time of vaccination between 6 and 14 weeks of age and followed up to 12 months of age, a WFLz cutoff of  $< -2$  identified only 3 of 40 infants who subsequently died and was not associated with mortality (hazard ratio, 1.9; 95% CI, 0.6 to 6.8) [22]. Within the same cohort, a MUAC cutoff of  $< 115$  mm identified 18 of 40 infants who died and was associated with the risk of death (hazard ratio, 4.5; 95% CI, 1.4, to 15.0). The area under the receiver characteristic (ROC) curve for predicting subsequent death was 0.55 (95% CI, 0.46 to 0.64) for WFLz. This suggests that WFLz performs poorly at identifying infants at high risk of death. These findings corroborated the results of a study that analyzed data from infants in Ghana, India, and Peru. These infants had also been recruited at their first immunization visit between 6 and 10 weeks of age and followed up until the age of 6

months. A cutoff of WFLz < -3 identified few of those who died: 0 of 30 deaths in Ghana, 0 of 13 deaths in Peru, and 23 of 45 deaths in India [25]. Kwashiorkor (edematous malnutrition) appears to be less common in infants under 6 months of age than in older children, but this finding, and the reliability of assessment of pretibial edema in this age group, remains to be accurately quantified.

In summary, what little evidence there is highlights some serious problems with WFLz-based definitions of acute malnutrition among infants under 6 months of age. MUAC shows greater promise, but more evidence is needed before it can be widely recommended, especially regarding what cutoffs should be used and at what age infant MUAC would be applicable (around the time of the first immunization seems appropriate). A MUAC-based case definition for infants under 6 months of age would harmonize treatment of infants under 6 months of age with that of older children and could play a key role in more proactive community-based case finding [15].

### **Challenges in community-based treatment of infants under 6 months of age**

Despite the wide range of possible problems and pathologies underlying acute malnutrition among infants under 6 months of age, the cornerstone of treatment will almost always be feeding support. One of the biggest challenges is how to support infants who have no option to be breastfed (such as orphans with no wet-nurse available or in contexts where exclusive formula feeding is common). Even when breastfeeding is possible, ensuring that it is effective is not always straightforward. For example, infrequent feedings due to the mother having to work during the day will eventually decrease milk production. Merely “educating” the mother on what she should be doing is far from empowering her to actually do it. Wider family and social factors must sometimes be addressed. Effective programs promoting exclusive breastfeeding in the community have been well described [26–28]. However, additional efforts are required to successfully support feeding of infants who may not be thriving or who seem to be malnourished. The same model is applicable: peer counselors are trained and conduct a number of visits during pregnancy, soon after delivery, and regularly thereafter. A core aim is to establish effective exclusive breastfeeding, but also to help identify and solve other problems that may be underlying or contributing to the malnutrition. Preliminary data from a program in Bangladesh showed low birthweight to be a common factor in infants under 6 months of age with WFAz-defined MAM. This highlights the need for careful assessment and low-risk community-based treatments, as many of these infants might have catch-up growth even without specific intervention. Cases of acute malnutrition in infants under 6 months of age often emerge in crisis contexts, situations that both contribute to and spotlight caseload and complicate care. Further challenges emerge where formula feeding is common; for example, in a non-governmental organization program managing acute malnutrition in northern Syria, of 119 cases of acute malnutrition, 45% were infants under 6 months of age. Community-based support was limited for breastfed infants and absent for nonbreastfed infants [29].

## Conclusions

Treating malnourished infants under 6 months of age is important to avoid malnutrition-associated mortality in the short term and to impact health and development in the long term. By recognizing the group for the first time, new WHO guidelines offer exciting ways forward. The mother–infant dyad is at the heart of approaches, but wider relationships are also recognized. Community-based breastfeeding support is the core, but not the sole, treatment. Uncomplicated SAM and MAM can be treated in the same way. Non-breastfed infants need special attention. An urgent priority is to develop better case definitions; MUAC-based criteria are promising but need further research. To effectively move forward, clinical trials of assessment and treatment are needed to establish a firm evidence base. In the meantime, now that management guidelines are included in WHO recommendations, nutrition surveys and screening at health facilities should routinely include infants under 6 months of age in order to better define the burden and outcomes of acute malnutrition in this age group.

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