WEST AFRICAN JOURNAL OF MEDICINE

*REVIEW ARTICLE*

# Assessment and Management of Severe Malnutrition in Children

## *Evaluation Et Gestion De La Malnutrition Chez Les Enfants*

**S. Antwi**

**ABSTRACT**

BACKGROUND: **Severe malnutrition is a common cause of morbidity and mortality among children less than five years of age. The World Health Organisation (WHO) has developed two manuals for the in-patient treatment of severe malnutrition. However, these manuals are not widely distributed with the result that most health practitioners caring for severely malnourished children unknowingly use practices that, though may be suitable for sick well nourished children, may be highly dangerous for the severely malnourished child.**

OBJECTIVE: **This review article, based on the two WHO manuals for in-patient treatment of severe malnutrition and other relevant literature, seeks to offer the medical fraternity the opportunity to abreast themselves with the assessment and case management of children with severe malnutrition.**

CONCLUSION: **Health practitioners caring for children with severe malnutrition should abreast themselves with the recommended guidelines for assessment and management of this common disorder. WAJM 2011; 30(1): 11–18.**

Keywords: **Severe malnutrition, assessment, management, reductive adaptation, case fatality.**

***RÉSUMÉ***

***CONTEXTE:*** *La malnutrition sévère est une cause fréquente de mortalité et de morbidité chez les enfants de moins de cinq ans. L'organisation mondiale de la santé (OMS) a développé deux ouvrages portant sur la prise en charge des enfants hospitalisés pour malnutrition sévère. Cependant ces ouvrages ne sont pas largement distribués. Ceci explique que la plupart des praticiens prenant en charge les enfants présentant une malnutrition sévère peuvent dans l'ignorance avoir des pratiques appropriées pour les enfants malades bien nourris, et peut être dangereuses à l'endroit des enfants avec une malnutrition sévère.*

***OBJECTIF :*** *Cette revue, basée d'une part sur les deux ouvrages de l'OMS portant sur le traitement des enfants hospitalisés pour une malnutrition et d'autre part sur des données pertinentes de la littérature, a pour but d'offrir aux praticiens l'opportunité de se mettre à jour sur l'évaluation et la prise en charge des enfants ayant une malnutrition sévère.*

***CONCLUSION :*** *Les praticiens prenant en charge la malnutrition sévère devront se mettre à jour avec les recommandations sur l'évaluation et la prise en charge des enfants présentant cette affection fréquente.* ***WAJM 2011; 30(1): 11–18.***

***Mot-Cles:*** *Malnutrition Severe – Evaluation- Prise En Charge-Adaptation Reductive-Mortalite.*

**Department of Child Health, School of Medical Sciences, Kwame Nkrumah University of Science and Technology/Komfo Anokye Teaching Hospital, Kumasi, Ghana.**

***Corespondence:*** **Dr. Sampson Antwi,** P. O. Box Ks 12400, Kumasi-Ghana. E-Mail: antwisampson@yahoo.com Cell: +233-277406519 Fax: +233-5134400

**Abbreviations: PEM,** Protein Energy Malnutrition; **RESOMAL,** Rehydration Solution for the Malnourished; **SD-Score,** Standard Deviation Score; **WHO,** World Health Organisation.

## INTRODUCTION

Optimal nutrition is needed for growth, development, and health. Nutritional deficiencies, referred to as malnutrition in this review article, are common problems in developing countries among children less than five years of age and result from variety of factors that are often prevalent in Africa. These include poverty, infectious diseases such as HIV/AIDS and tuberculosis, lack of clean water and poor levels of hygiene leading to diarrhoeal diseases, nutritional customs, cultural habits, illiteracy, and ignorance especially in relationship to weaning diets.[1–3]

Malnutrition may involve protein and energy (macronutrients) or vitamins and/or minerals (micronutrients). Protein energy malnutrition (PEM) is a well recognised macronutrient disorder whereby the body fails to access adequate energy and protein needed for optimal growth and function. Micronutrient malnutrition, on the other hand, refers to failure of the body to access and absorb adequate amounts of specific vitamins and minerals in order to stay healthy. Though specific micronutrient deficient disorders like iodine deficiency disorder are recognised, children with PEM suffer from micronutrient deficiencies as well, and these often contribute to both the clinical manifestation of the disorder and mortality.[4]

Case fatality rates of severe malnutrition have been reported at 20-50%.[5] The high case fatality associated with malnutrition is accounted for in part by under-diagnosis, and the poor management practices that are often instituted by health practitioners.

In this article, the assessment and in-patient management of PEM among children < 5 years of age based on World Health Organisation (WHO) guidelines and other relevant literature are reviewed. Community-based therapeutic care, based on ready to use therapeutic food (RUTF), is not reviewed here.

Protein Energy Malnutrition is used in this article to mean severe malnutrition, and the two terms will be used interchangeably.

## Assessement of Protein Energy Malnutrition

Nutritional assessment can be approached through four basic procedures/methods: history, clinical examination, anthropometric measurements, and laboratory tests[1,3]

### History

Malnutrition should be suspected in any child whose dietary history reveals deficiency in the quantity or quality of food intake. Children at risk of malnutrition may have a history of one or more of the following: premature birth or low birth weight; lack of breastfeeding in poor social circumstances; twin birth; prolonged or recurrent diarrhoea, pneumonia, tuberculosis or other infectious diseases; affectation or infection by HIV; cancer or chronic disease; has loss of a parent by death or desertion; has a mother in poor social circumstances with many children; lives in a home without piped water supply or other source of clean water.[6]

### Clinical Signs of Malnutrition

Clues to malnutrition can be deduced from clinical signs, which alone or in combination with other factors, could confirm malnutrition.

The following clinical signs are often recognized:

***Hair changes*** includes silkiness, curliness or straightness; lightly coloured to shades of brown/red; lack of luster; sparsely distributed to alopecia; thin and easily pluckable.[1,3,6]

***Dermatosis:*** This is commoner in the oedematous PEM and manifest as hypo- or hyperpigmentation, rough patches (hyperkeratosis), shedding of the skin in scales and sheets, cracks and fissures that may ooze plasma.[4] Extensive skin desquamation may present appearances like second degree burns.[1,6] Areas commonly involved are nappy areas, legs and forearm, face, behind the ears, armpits.

***Dermatosis*** may be rated as (a) mild or (1+) (few rough patches or areas of dyspigmentation, (b) moderate or (2+), with large areas or multiple patches of dyspigmentation, and (c) severe or (3+) with flaking or raw skin, cracks, fissures.

***Stomatitis:*** This typically manifests as angular stomatitis and glossitis with loss of papillais.[1,3,6] It may be related to deficiency of micronutrients like iron or vitamin B2,[3,7] and are often complicated by infection (Candida or anaerobic bacterial).[7] In severe cases, anaerobic infection of the oral mucosa and gums by fusiform bacilli and spirochaetes can lead to gangrenous stomatitis called *cancrum oris.*

***Visible Signs of Wasting:*** Wasting is most visible in the following areas: chest as prominent ribs, arms and thighs as loose skin and flabby muscle, the back as prominent scapula and spine, and the buttocks as loss of fat and muscles with the overlying skin hanging loose in a typical "baggy pants" fashion.[4]

***Peripheral Oedema:*** The presence of bilateral pedal oedema in a child should alert health practitioners on the possible diagnosis of oedematous malnutrition, particularly in the presence of other physical signs of malnutrition. Oedema in malnutrition is rated as follows:[4]

Mild, involves only the feet; moderate, feet and legs and/or the upper limbs and severe, generalized oedema (moderate + facial).

Oedematous malnutrition may mimic nephrotic syndrome and may sometimes be difficult to differentiate, especially in the presence of abnormal urinalysis from urinary tract infection. Points of discrimination between the two conditions include the development of oedema from the feet in malnutrition as opposed to the face in nephrotic syndrome, and non-association of oedema from nutritional origin with significant ascites.[1]

***Other clinical features of Malnutrition***

These include pallor (from anaemia related to deficiency of protein, iron and folate), moon face with drooping cheeks, abdominal distension (related to fatty liver, gaseous distention, worm infestations), apathy and irritability (from mental and neurological dysfunction).[1,3,6]

## Anthropometric Indicators of Malnutrition

Anthropometry is the determination of nutritional status by physical measure-

ments and comparing them to relevant reference charts such as the WHO weight-for-height reference chart.[8] (Table 1). Anthropometry may not accurately diagnose oedematous malnutrition due to the added weight of the oedema fluid.[4,8] Another pitfall of anthropometry is that the reference chart used can only be generalized to the population that yielded the data.[3] Anthropometric measurements that have been used include height-for-age, weight-for-age, weight-for-height, head circumference, mid-upper arm circumference, and skinfold thickness.[9]

*Height-for-age* is used to assess linear growth. Deficit indicates long-term, cumulative nutritional inadequacies.[9] Children whose height-for-age indices fall below 90% of the median value (< –2 SD) of the WHO reference value are classified as *stunted* with those below 85% (<–3SD) being severe.[4] Because deficit in height results from a long-term process, stunting denotes chronic malnutrition. Length is measured for children less than of age 2 years whilst standing height is done for others, Figure 1. Length is usually greater than standing height by 0.5cm but this difference is accounted for in most reference charts.[10]

*Weight-for-age* index has traditionally been used in defining malnutrition with children whose measurements fall below 80% of the median value (< – 2 SD) being classified as malnourished.[9] Because low weight-for-age may be due to low height-for-age (stunting), low weight-for-height (wasting), or both (global malnutrition), weight-for-age is not currently a recommended measurement to define acute malnutrition.[4,9]

*Weight-for-height* is the most objective way of assessing for recent nutritional inadequacies. Its use carries the advantage of requiring no knowledge of age which is often difficult to obtain in most developing countries. Children whose measurements fall below 80% of the median value (< – 2 SD) of the WHO reference value are classified as wasted with those below 70% (< –3SD) being severe.[4] Weight-for-height is the current recommended measurement for defining acute malnutrition.[4]

*Mid-upper arm* circumference (MUAC) has been used as alternative index for assessing the nutritional status of children especially where the collection of height and weight measurements may be difficult as, for example, in emergency situations like refugee crises and famines.[9] In these situations, a low MUAC, based on a fixed cut-off point of 12.5cm has been used as a proxy for low weight-for-height or wasting for children less than five years of age.[9] The use of a fixed cut-off value is based on the observation that the MUAC increases relatively little by about 1 cm between onr and five years of age.[9] The relative constancy of the MUAC has been utilized in the construction of a tape (Shakir tape) for simple nutritional screening in pre-school children. Markers on the tape distinguish children who are nutritionally normal (MUAC > 14cm), mild-moderately wasted (12.5 – 14cm), and those who are severely wasted (<12.5cm).[1]

*Head circumference,* measured as the longest measurement around the head in the occipito-frontal plane, may be used to assess for the rapid brain growth that occurs in the first 2 years of life. Nutritional deficiencies during this period may reflect in faltering head circumference. Thereafter, it reflects nutritional state poorly.[1]

*Skinfold thickness,* measured with skinfold calipers, assesses the thickness of the skin and subcutaneous fat and may thus indicate nutritional stores. Classical sites of measurements are over the triceps, biceps, sub scapula, and abdomen.[5] Values are judged by reference to centile charts. Used alone, they are of limited value for assessing the degree of wasting because they fail to take into account changes in muscle mass.[9] Skinfold thickness are widely used for assessing obesity among adults.

## Laboratory Indices of Malnutrition

Several biochemical derangements occur in malnutrition although blood values do not always reflect body reserves accurately. The assessment of tissue content and stores by analysis of hair, bone marrow, or liver biopsy may be more accurate but less practical.[1] Recognizable biochemical abnormalities that occur in malnutrition include low serum prealbumin (transthyretin) and albumin, depressed blood urea nitrogen, profoundly low serum cholesterol, and reduced levels of transferrin.[3,6,11] They may also serve as useful markers in monitoring response to treatment.

Table 2 summarises the four procedures for assessment of malnutrition.

## Classification of Protein Energy Malnutrition

Various methods of classifying malnutrition have been used in the past. In 1956, Gomez *et al*[12] classified malnutrition in Mexican children according to weight-for-age with those whose measurements fell between 90%–75% of the standard value (standard is the 50th percentile of the Harvard value) being classified as mild (Grade I) malnutrition, 75%–60% as moderate (Grade II) and < 60% as severe (Grade III) malnutrition. Waterlow *et al*[13] classified PEM (excluding kwashiorkor) based on height-for-age and weight-for-height with height-for-age < 90% of the standard value being classified as stunted and weight-for-height <80% of standard value as wasted. Children with both height-for-age < 90% and weight-for-height <80% of standard values were classified as wasted and stunted. The Wellcome classification utilizes weight-for-age and the presence or absence of oedema.[3,6] In the Wellcome classification, children whose weight-for-age falls between 60-80% of the standard value are classified as underweight (if no peripheral oedema) or kwashiorkor (if there is peripheral oedema) whilst those whose measurements fall below 60% of the standard value are classified as marasmus (if no oedema) or marasmic-kwashiorkor (if there is peripheral oedema).[6]

### *Speaking One Language –The New WHO Classification of Malnutrition*

In an attempt to bring some order into the classification of PEM, WHO has developed criteria for the classification of malnutrition based on the degree of wasting (weight-for-height) or stunting (height-for-age) and the presence of oedema. This new classification has a special value of determining whether the nutritional deficiency is of recent onset and thus demands urgent institutional-based care, or is of long-term inadequacies that can be managed satisfactorily in the community.

Under this new classification, three types of severe malnutrition are recognized; severely wasted, oedematous malnutrition, and severely stunted. Severe wasting and oedematous malnutrition represent acute, severe malnutrition and all such children should be preferably admitted to hospital where they can be observed, treated and fed day and night.[4] Since stunting denotes chronic form of malnutrition, such children may be satisfactorily managed in the community, rather than in hospital.[4] Table 3 summaries both the new and old classifications of malnutrition.

**Table 1: WHO Weight for Length/Height Reference Chart**

| Boys' Weight (Kg) | | | | | Length | Girls' Weight (Kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| –4SD | –3 SD | –2 SD | –1 SD | Median | (cm) | Median | –1 SD | –2 SD | –3 SD | –4 SD |
| 1.7 | 1.9 | 2.0 | 2.2 | 2.4 | 45 | 2.5 | 2.3 | 2.1 | 1.9 | 1.7 |
| 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 46 | 2.6 | 2.4 | 2.2 | 2.0 | 1.9 |
| 2.0 | 2.1 | 2.3 | 2.5 | 2.8 | 47 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 |
| 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 48 | 3.0 | 2.7 | 2.5 | 2.3 | 2.1 |
| 2.2 | 2.4 | 2.6 | 2.9 | 3.1 | 49 | 3.2 | 2.9 | 2.6 | 2.4 | 2.2 |
| 2.4 | 2.6 | 2.8 | 3.0 | 3.3 | 50 | 3.4 | 3.1 | 2.8 | 2.6 | 2.4 |
| 2.5 | 2.7 | 3.0 | 3.2 | 3.5 | 51 | 3.6 | 3.3 | 3.0 | 2.6 | 2.5 |
| 2.7 | 2.9 | 3.2 | 3.5 | 3.8 | 52 | 3.8 | 3.5 | 3.2 | 2.9 | 2.7 |
| 2.9 | 3.1 | 3.4 | 3.7 | 4.0 | 53 | 4.0 | 3.7 | 3.4 | 3.1 | 2.8 |
| 3.1 | 3.3 | 3.6 | 3.9 | 4.3 | 54 | 4.3 | 3.9 | 3.6 | 3.3 | 3.0 |
| 3.3 | 3.6 | 3.8 | 4.2 | 4.5 | 55 | 4.5 | 4.2 | 3.8 | 3.5 | 3.2 |
| 3.5 | 3.8 | 4.1 | 4.4 | 4.8 | 56 | 4.8 | 4.4 | 4.0 | 3.7 | 3.4 |
| 3.7 | 4.0 | 4.3 | 4.7 | 5.1 | 57 | 5.1 | 4.6 | 4.3 | 3.9 | 3.6 |
| 3.9 | 4.3 | 4.6 | 5.0 | 5.4 | 58 | 5.4 | 4.9 | 4.5 | 4.1 | 3.8 |
| 4.1 | 4.5 | 4.8 | 5.3 | 5.7 | 59 | 5.6 | 5.1 | 4.7 | 4.3 | 3.9 |
| 4.3 | 4.7 | 5.1 | 5.5 | 6.0 | 60 | 5.9 | 5.4 | 4.9 | 4.5 | 4.1 |
| 4.5 | 4.9 | 5.3 | 5.8 | 6.3 | 61 | 6.1 | 5.6 | 5.1 | 4.7 | 4.3 |
| 4.7 | 5.1 | 5.6 | 6.0 | 6.5 | 62 | 6.4 | 5.8 | 5.3 | 4.9 | 4.5 |
| 4.9 | 5.3 | 5.8 | 6.2 | 6.8 | 63 | 6.6 | 6.0 | 5.5 | 5.1 | 4.7 |
| 5.1 | 5.5 | 6.0 | 6.5 | 7.0 | 64 | 6.9 | 6.3 | 5.7 | 5.3 | 4.8 |
| 5.3 | 5.7 | 6.2 | 6.7 | 7.3 | 65 | 7.1 | 6.5 | 5.9 | 5.5 | 5.0 |
| 5.5 | 5.9 | 6.4 | 6.9 | 7.5 | 66 | 7.3 | 6.7 | 6.1 | 5.6 | 5.1 |
| 5.6 | 6.1 | 6.6 | 7.1 | 7.7 | 67 | 7.5 | 6.9 | 6.3 | 5.8 | 5.3 |
| 5.8 | 6.3 | 6.8 | 7.3 | 8.0 | 68 | 7.7 | 7.1 | 6.5 | 6.0 | 5.5 |
| 6.0 | 6.5 | 7.0 | 7.6 | 8.2 | 69 | 8.0 | 7.3 | 6.7 | 6.1 | 5.6 |
| 6.1 | 6.6 | 7.2 | 7.8 | 8.4 | 70 | 8.2 | 7.5 | 6.9 | 6.3 | 5.8 |
| 6.3 | 6.8 | 7.4 | 8.0 | 8.6 | 71 | 8.4 | 7.7 | 7.0 | 6.5 | 5.9 |
| 6.4 | 7.0 | 7.6 | 8.2 | 8.9 | 72 | 8.6 | 7.8 | 7.2 | 6.6 | 6.0 |
| 6.6 | 7.2 | 7.7 | 8.4 | 9.1 | 73 | 8.8 | 8.0 | 7.4 | 6.8 | 6.2 |
| 6.7 | 7.3 | 7.9 | 8.6 | 9.3 | 74 | 9.0 | 8.2 | 7.5 | 6.9 | 6.3 |
| 6.9 | 7.5 | 8.1 | 8.8 | 9.5 | 75 | 9.1 | 8.4 | 7.7 | 7.1 | 6.5 |
| 7.0 | 7.6 | 8.3 | 8.9 | 9.7 | 76 | 9.3 | 8.5 | 7.8 | 7.2 | 6.6 |
| 7.2 | 7.8 | 8.4 | 9.1 | 9.9 | 77 | 9.5 | 8.7 | 8.0 | 7.4 | 6.7 |
| 7.3 | 7.9 | 8.6 | 9.3 | 10.1 | 78 | 9.7 | 8.9 | 8.2 | 7.5 | 6.9 |
| 7.4 | 8.1 | 8.7 | 9.5 | 10.3 | 79 | 9.9 | 9.1 | 8.3 | 7.7 | 7.0 |
| 7.6 | 8.2 | 8.9 | 9.6 | 10.4 | 80 | 10.1 | 9.2 | 8.5 | 7.8 | 7.1 |
| 7.7 | 8.4 | 9.1 | 9.8 | 10.6 | 81 | 10.3 | 9.4 | 8.7 | 8.0 | 7.3 |
| 7.9 | 8.5 | 9.2 | 10.0 | 10.8 | 82 | 10.5 | 9.6 | 8.8 | 8.1 | 7.5 |
| 8.0 | 8.7 | 9.4 | 10.2 | 11.0 | 83 | 10.7 | 9.8 | 9.0 | 8.3 | 7.6 |
| 8.2 | 8.9 | 9.6 | 10.4 | 11.3 | 84 | 11.0 | 10.1 | 9.2 | 8.5 | 7.8 |
| 8.4 | 9.1 | 9.8 | 10.6 | 11.5 | 85 | 11.2 | 10.3 | 9.4 | 8.7 | 8.0 |
| 8.6 | 9.3 | 10.0 | 10.8 | 11.7 | 86 | 11.5 | 10.5 | 9.7 | 8.9 | 8.1 |
| | | | | | | Height | | | | |
| 8.9 | 9.6 | 10.4 | 11.2 | 12.2 | 87 | 11.9 | 10.9 | 10.0 | 9.2 | 8.4 |
| 9.1 | 9.8 | 10.6 | 11.5 | 12.4 | 88 | 12.1 | 11.1 | 10.2 | 9.4 | 8.6 |
| 9.3 | 10.0 | 10.8 | 11.7 | 12.6 | 89 | 12.4 | 11.4 | 10.4 | 9.6 | 8.8 |
| 9.4 | 10.2 | 11.0 | 11.9 | 12.9 | 90 | 12.6 | 11.6 | 10.6 | 9.8 | 9.0 |
| 9.6 | 10.4 | 11.2 | 12.1 | 13.1 | 91 | 12.9 | 11.8 | 10.9 | 10.0 | 9.1 |
| 9.8 | 10.6 | 11.4 | 12.3 | 13.4 | 92 | 13.1 | 12.0 | 11.1 | 10.2 | 9.3 |
| 9.9 | 10.8 | 11.6 | 12.6 | 13.6 | 93 | 13.4 | 12.3 | 11.3 | 10.4 | 9.5 |
| 10.1 | 11.0 | 11.8 | 12.8 | 13.8 | 94 | 13.6 | 12.5 | 11.5 | 10.6 | 9.7 |
| 10.3 | 11.1 | 12.0 | 13.0 | 14.1 | 95 | 13.9 | 12.7 | 11.7 | 10.8 | 9.8 |
| 10.4 | 11.3 | 12.2 | 13.2 | 14.3 | 96 | 14.1 | 12.9 | 11.9 | 10.9 | 10.0 |
| 10.6 | 11.5 | 12.4 | 13.4 | 14.6 | 97 | 14.4 | 13.2 | 12.1 | 11.1 | 10.2 |
| 10.8 | 11.7 | 12.6 | 13.7 | 14.8 | 98 | 14.7 | 13.4 | 12.3 | 11.3 | 10.4 |
| 11.0 | 11.9 | 12.9 | 13.9 | 15.1 | 99 | 14.9 | 13.7 | 12.5 | 11.5 | 10.5 |
| 11.2 | 12.1 | 13.1 | 14.2 | 15.4 | 100 | 15.2 | 13.9 | 12.8 | 11.7 | 10.7 |
| 11.3 | 12.3 | 13.3 | 14.4 | 15.6 | 101 | 15.5 | 14.2 | 13.0 | 12.0 | 10.9 |
| 11.5 | 12.5 | 13.6 | 14.7 | 15.9 | 102 | 15.8 | 14.5 | 13.3 | 12.2 | 11.1 |
| 11.7 | 12.8 | 13.8 | 14.9 | 16.2 | 103 | 16.1 | 14.7 | 13.5 | 12.4 | 11.3 |
| 11.9 | 13.0 | 14.0 | 15.2 | 16.5 | 104 | 16.4 | 15.0 | 13.8 | 12.6 | 11.5 |
| 12.1 | 13.2 | 14.3 | 15.5 | 16.8 | 105 | 16.8 | 15.3 | 14.0 | 12.9 | 11.8 |
| 12.3 | 13.4 | 14.5 | 15.8 | 17.2 | 106 | 17.1 | 15.6 | 14.3 | 13.1 | 12.0 |
| 12.5 | 13.7 | 14.8 | 16.1 | 17.5 | 107 | 17.5 | 15.9 | 14.6 | 13.4 | 12.2 |
| 12.7 | 13.9 | 15.1 | 16.4 | 17.8 | 108 | 17.8 | 16.3 | 14.9 | 13.7 | 12.4 |
| 12.9 | 14.1 | 15.3 | 16.7 | 18.2 | 109 | 18.2 | 16.6 | 15.2 | 13.9 | 12.7 |
| 13.2 | 14.4 | 15.6 | 17.0 | 18.5 | 110 | 18.6 | 17.0 | 15.5 | 14.2 | 12.9 |
| 13.4 | 14.6 | 15.9 | 17.3 | 18.9 | 111 | 19.0 | 17.3 | 15.8 | 14.5 | 13.2 |
| 13.6 | 14.9 | 16.2 | 17.6 | 19.2 | 112 | 19.4 | 17.7 | 16.2 | 14.8 | 13.5 |
| 13.8 | 15.2 | 16.5 | 18.0 | 19.6 | 113 | 19.8 | 18.0 | 16.5 | 15.1 | 13.7 |
| 14.1 | 15.4 | 16.8 | 18.3 | 20.0 | 114 | 20.2 | 18.4 | 16.8 | 15.4 | 14.0 |
| 14.3 | 15.7 | 17.1 | 18.6 | 20.4 | 115 | 20.7 | 18.8 | 17.2 | 15.7 | 14.3 |
| 14.6 | 16.0 | 17.4 | 19.0 | 20.8 | 116 | 21.1 | 19.2 | 17.5 | 16.0 | 14.5 |
| 14.8 | 16.2 | 17.7 | 19.3 | 21.2 | 117 | 21.5 | 19.6 | 17.8 | 16.3 | 14.8 |
| 15.0 | 16.5 | 18.0 | 19.7 | 21.6 | 118 | 22.0 | 19.9 | 18.2 | 16.6 | 15.1 |
| 15.3 | 16.8 | 18.3 | 20.0 | 22.0 | 119 | 22.4 | 20.3 | 18.5 | 16.9 | 15.4 |
| 15.5 | 17.1 | 18.6 | 20.4 | 22.4 | 120 | 22.8 | 20.7 | 18.9 | 17.3 | 15.6 |

Adapted from reference 8.

**Abnormal Physiology in Malnutrition**

The malnourished child has abnormal physiology that has implications for case management. With severe malnutrition, the physiological systems slow down or 'shut down' and do less to allow for survival on limited nutrients. This slowing down of the systems is called reductive adaptation.[4] With treatment and re-feeding, the systems gradually 'learn' to function again. Rapid changes in the system with respect to feeding and fluid administration would overwhelm the systems so feeding must be slowly started and cautiously increased. Case management practices suitable for sick well nourished children could thus be highly dangerous for the malnourished child.

Almost all the physiological systems function abnormally in the severely malnourished child. Table 4 summarises selected organ systems with abnormal physiology.

**Management of Protein Energy Malnutrition**

Management of the severely malnourished child is broadly divided into two phases; the acute stabilsation phase and the rehabilitation phase.

***Acute Stabilization Phase***

During this phase of initial treatment, life-threatening complications are identified and treated, and specific deficiencies (electrolytes and micronutrients) are corrected.

The severely malnourished child is typically brought to medical attention on account of one or several complications

**Table 2: Assessment of Malnutrition**

| Parameter | Findings |
|---|---|
| History | Inadequate quantity or quality of food intake, preterm or low birth weight, lack of breastfeeding in a poor social circumstance, faulty weaning practices, chronic or recurrent infection/disease, HIV infected or affected, lost of parent by death or desertion. |
| Physical findings | Changes in hair colour and texture, apathetic look, mouth ulcers, visible ribs and scapula, over-hanging skin and flabby muscles, skin dyspigmentation and desquamation, symmetrical pedal oedema |
| Anthropometric measurements | Weight-for-height < 80% of median value (< –2SD), height-for-age < 90% of the median value, mid-upper arm circumference < 12.5cm |
| Laboratory findings | Low serum prealbumin and albumin, depressed blood urea, profoundly low serum cholesterol, and low haemoglobin and transferrin. |

**Table 3: Classification of Malnutrition***

| Old Classification (Wellcome) | | | New Classification (WHO) | | |
|---|---|---|---|---|---|
| Weight % of standard value† | Oedema | | Index | Moderate malnutrition | Severe malnutrition (type) |
| | Present | Absent | Symmetrical oedema | No | Yes (oedematous malnutrition) |
| 80 – 60 | Kwashiorkor | Symmetrical oedema | Weight-for-height | –3 ≤ SD-score < –2 wasting) | SD-score <–3 (severe |
| < 60 | Marasmic-kwashiorkor | Weight-for-height | Height-for-age | –3 ≤ SD-score < –2 | SD-score <–3 (severe stunting) |

*Adapted from References 3,4 and 6; †Standard here refers to the 50th percentile of the Harvard value

that are associated with this condition. It is the diagnosis and the appropriate management of these complications that determine the survival or demise of the child. Whilst some of these complications are always present in any child with severe malnutrition and thus must be treated straight away, others may not be present in all malnourished children and must therefore be actively looked for by the attending health practitioner if death is to be averted.

During the stabilization phase, re-feeding is started slowly and is carefully monitored. Emotional and physical stimulation are slowly introduced as may be permitted by the physical strength of the child. This phase of treatment generally lasts two- seven days.[4] Table 5 summarises treatment in the acute stabilization phase.

**Rehabilitation Phase**

During this phase of treatment, intensive feeding is instituted to recover most of the lost weight (catch-up growth), whilst correction of electrolytes and micro-nutrients continues. Emotional and physical stimulation are increased as the child regains strength. The mother or carer is trained to continue care at home in preparation for discharge. Discharge and follow-up plans are made at this stage. This phase of treatment usually commences on second week of admission and generally lasts 4–6 weeks.[4]

It generally takes it two-seven days for the child to be stabilized on F-75 and to enter the rehabilitation phase. Signs of readiness for transition into the rehabilitation phase include; return of appetite, responsive smile, resolution of oedema, and completion of all feeds in the stabilization phase.[4,5,10]

The following treatment should be instituted during the rehabilitation phase:

i) Increase feeding to recover lost weight; start F-100

High energy and protein feed is introduced at this stage to achieve rapid weight gain of > 10g/kg/day.[5] F-100 is a special milk feed designed as "catch-up" feed to meet these requirements, (Table 7). It contains 100 kcal and 2.9g protein per 100 ml.

F-100 is started when there are clear signs of readiness of transition into the rehabilitation phase.[4,10] Start F-100 every four hours (in the same amount as the last schedule of F-75) for two days. From third day onward, increase F-100 by 10 ml per feed as long as the child can tolerate.[5,10] Up to 200ml/kg/day may be consumed during this rehabilitation phase.[5] Monitor for heart failure which can occur at this stage if the child suddenly consumes huge amounts of feeds.

For children less than six months old, the regular F-100 may have to be diluted by one-third (F-100 dilute) since full strength F-100 may put stress on the young infant kidney's ability to excrete the high solute load and may therefore be at danger of hypernatraemia or hyperosmolar syndrome especially in hot dry climates.[16] But where there is rapid weight gain during this period, regular F-100 may still be used.[16] Breast milk and infant formula may be suitable alternatives to F-100 and "F-100 dilute".[16]

ii) *Give Iron Syrup:* This should be given only during this phase of treatment once the child starts to gain weight and to rebuild tissues.[45,10] Dose: 3mg/kg/day of elemental iron.

iii) *Continue correction of Electrolytes and Micronutrients Deficiencies*

**Table 4: Organ/Systems with Abnormal Physiology in the Malnourished Child**

| Organ or System Affected | Physiological Change | Consequence |
|---|---|---|
| Cardiovascular | The contractile force of the heart is reduced and thus the stroke volume and cardiac output. | Any increase in blood volume (e.g. following large volume feeds, fluid therapy intravenously or orally, or high salt diet) can easily produce acute heart failure. |
| Gastrointestinal | Production of gastric acid is is reduced. This allows bacterial evasion of the acid barrier. Intestinal motility is reduced. This is made worse by potassium and magnesium deficiencies which, in severe severe cases, can lead to ileus. | There is small bowel bacterial overgrowth and acquisition of systemic infections through the GI route. Significant bowel mucosal and villous atrophy may occur and could lead to malabsorption and lactase deficiency. Improves quickly on re-feeding. |
| Liver | Gluconeogenesis is reduced. Synthesis of all serum proteins are reduced including complements and coagulation factors. | Increased risk of hypoglycaemia during periods without feeding. There is immune dysfunction and risk of coagulopathy. |
| Immune System | All aspects of immunity are diminished; cell-mediated immunity is depressed, IgA secretions are reduced, phagocytosis is impaired, lymph glands, tonsils and thymus are atrophied. | There is immune suppression. Typical signs of infection like fever are frequently absent. Relying on the presence of fever to suspect infection could therefore be misleading. |
| Genitourinary | Glomerular filtration is reduced so is sodium excretion. Capacity of kidney to excrete excess acid or water load is greatly reduced. | High salt diet and large volume feeds or fluids can easily lead to plasma expansion that can tip the child into acute heart failure. |
| Cellular Ionic Transport | The sodium-potassium pump is severely depressed leading to intracellular sodium accumulation and loss of potassium from the body. The latter is made worse by hypomagnesenaemia that is associated with PEM. Though serum sodium level may be low, the total body sodium is high. | Following treatment, sodium is exported from within the cells into the extracellular compartment which is accompanied by expansion of blood volume. Fluid therapy (oral or intravenous) and large volume feeds or high sodium diet during this period can tip the child into heart failure. |
| Skin, Muscles, Exocrine glands | The skin and subcutaneous fat are atrophied, which leads to loose folds of skin and sunken eyes. Many exocrine glands, including the sweat, lacrimal (tear), salivary, and pancreatic glands are atrophied. | Many signs of dehydration (decreased skin turgor, dry oral mucosa, absent tears, sunken eyes) are unreliable in the severely malnourished child. |

**Table 5: Checklist for Essential Steps during Acute Stabilization Phase of Treatment**

**A) Actively look for and treat the following complications:**
- Hypoglycaemia
- Hypothermia
- Shock
- Dehydration
- Very severe anaemia
- Congestive cardiac failure
- Xerophthalmia
- Severe dermatosis
- Specific infections

**B) Routinely offer the following general aspect of therapy:**
- Start cautious feeding with F-75
- Correct electrolyte and micronutrient deficiency
- Introduce stimulative play activity.

The micronutrient supplementation that was started during the stabilization phase should continue during this phase.

iv) *Increase Emotional and Physical Stimulation*

As the child regains more strength, more physical activity should be introduced into the daily play activity started at the stabilization phase. They should interact with other children in the ward.

*v) Prepare Patient and Family for Discharge*

Children who achieve a weight-for-height of 90% of the median value (equivalent of –1 SD) can be considered to have recovered and should be prepared for discharge.[4,5] Since the child's home is the environment in which the severe malnutrition developed, recurrence may occur if the family is not adequately prepared. Where possible, the child's home should be visited by social worker or nurse to assure of adequate home environment. Mother or carer should be involved in the handling of the child during in-patient treatment and should participate in the preparation of feeds and play activity. Locally grown food that could be recommended for the child's feeding at home should be identified and where possible, preparation of sample meal should begin whilst on admission. Before discharge, immunization status should be checked and any deficiencies corrected as per national guidelines.

If early discharge is being considered before full recovery, it is desirable for the child to have completed all antibiotic treatment and preferably, two weeks of potassium, magnesium, mineral and vitamin supplements.[5] Such children should be reviewed more frequently. Alternatively, referral could be made to community-based treatment center if available.

*vi) Book patient for follow up visit*

Follow-up visits either at special clinic for malnutrition or at the malnutrition unit should be arranged before discharged. Scheduled reviews are one week, two weeks, one month, three months, and six months.[4] At each visit, weight and height measure-

**Table 6: Recipe for ReSoMal (45mmol Na/L)***

| Ingredient | Amount |
|---|---|
| **Standard WHO-ORS (90mmol Na/L)** | **One 1-Litre Sachet** |
| Water | 2 Litres |
| Sucrose (Sugar) | 50g (5 Dissert Spoons) |
| Mineral-Electrolyte Mix | 40mls (or Equivalent of CMV) |
| **New WHO-ORS (75mmol Na/L)** | **One 1-Litre Sachet** |
| Water | 1.7 Litres |
| Sucrose | 40g |
| Mineral-Electrolyte Mix | 33mls |
| **Dannex (Ghana) ORS** | **One 1-Litre Sachet** |
| Water | 1.2 litres |
| Sucrose | 30g |
| Mineral-Electrolyte Mix | 24mls |

*, Adapted and modified from reference 4 and 16

**Table7: Recipe for F-75 and F-100***

**Where Cereal Flour is used (cooking is required):**

| Type of Milk | Ingredient | Amount for F-75 |
|---|---|---|
| | Dried Skimmed Milk | 25g |
| | Sugar | 70g |
| | Cereal Flour | 35g |
| Dried Skimmed Milk | Vegetable Oil | 30g |
| | Mineral Mix | 20ml |
| | Water to make .. | 1000ml feed vol. |
| | Dried Whole Milk | |
| | Sugar | 35g |
| | Cereal Flour | 70g |
| Dried Whole Milk | Vegetable Oil | 20g |
| | Mineral Mix | 20ml |
| | Water to make .. | 10000ml feed vol. |
| | Fresh Cow's Milk or Full-Cream | |
| | Long Life Milk | 300ml |
| Fresh cow's milk, or full- | Sugar | 70g |
| cream (whole) long life milk | Cereal Flour | 35g |
| | Vegetable Oil | 20g |
| | Mineral Mix | 20ml |
| | Water to make ... | 1000ml feed vol. |

**Where no cooking facility available, or cereal flour not used: (No cooking or cereal floor required for F-100)**

| | | | |
|---|---|---|---|
| | Dried Skimmed Milk | 25g | 80g |
| | Sugar | 100g | 50g |
| Dried Skimmed Milk | Vegetable Oil | 30g | 60g |
| | Mineral Mix | 20ml | 20ml |
| | Water to Make .. | 1000ml feed vol | 1000ml |
| | Dried Whole Milk | 35g | 110g |
| | Sugar | 100g | 50g |
| Dried Whole Milk | Vegetable Oil | 20g | 30g |
| | Mineral Mix | 20ml | 20ml |
| | Water To Make .. | 1000ml feed vol | 1000ml |
| | Fresh Cow's Milk, or Full-cream (Whole) | | |
| | Long Life Milk | 300ml | 880ml |
| Fresh Cow's Milk/Full- | Sugar | 100g | 75g |
| Cream Long Life Milk | Vegetable Oil | 20g | 20g |
| | Mineral Mix | 20ml | 20ml |
| | Water To Make .. | 1000ml feed vol | 1000ml |

*, Adapted from reference 10

ments should be taken and the results computed on weight-for-height chart. Child's general wellbeing, feeding practices and play activities should be inquired. If a problem is identified, visit should be more frequent until it is resolved. After six months, visits should be twice yearly until the child is at least three years old.

***Important things NOT to do***

- Do not use IV fluids for rehydration except in cases of shock; there is danger of heart failure and death with IV fluids.
- Do not use diuretics to treat oedema; they will worsen the already existing profound hypokalaemia. The oedema is partly due to potassium and magnesium deficiencies, and free radical damage; it will resolve on re-feeding.
- Do not give iron during the initial stabilization phase of treatment; it may aggravate the existing bacterial infection and may also promote free radical formation.
- Do not give high protein diet (> 1.5g/kg/day), or high calories ( >100kcal/kg/day) during initial phase of treatment; it will overwhelm the fragile physiological state and reduced homeostatic capacity of the child.
- Do not give high sodium diet; it will lead to volume expansion and heart failure.
- Be careful with blood transfusion for severe anaemia that occurs after admission (particularly in associa-

**Table 8: Recipe for Mineral-Electrolyte Mix***

| Substance | Amount |
|---|---|
| Potassium chloride | 89.5g |
| Tripotassium citrate | 32.4g |
| Magnesium chloride ($MgCl_2.6H_2O$) | 30.5g |
| Zinc acetate | 3.3g |
| Copper sulphate | 0.56g |
| Sodium selenate† | 10mg |
| Potassium iodide† | 5mg |
| Water to make | 1000ml |

* Adapted from reference 4

† If not possible to weigh these very small amounts accurately, these may be omitted.

**Figure 1: Proper Positioning of a Child (Left) and an Infant (Right) in Length and Height Measurement.**

tion with short term weight gain); it may be due to haemodilution from plasma expansion. Transfusion at such a time may be fatal.

## Conclusion

We have reviewed the assessment and inpatient management of children with protein energy malnutrition. Use of the WHO guidelines in the management of these children improves significantly the outcome in there cares.

## REFERENCES


1. Poskitt EME. Nutrition in Childhood. In: Hendrickse GR, Barr DGD and Matthews TS. Eds. *Paediatrics in the Tropics*. Oxford: Blackwell Scientiic Publications, 1991: pp 90–118.
2. Rollins N, Willumsen J. Feeding and nutrition. In: Coovadia HM and Wittenberg DF. Eds. *Paediatrics & Child Health: A manual for health professionals in develoing countries*. Cape Town: Oxford University Press, 5th edition, 2007: pp 175–193.
3. Ebenebe J, Ulasi TO. Nutrition, nutritional assessment and nutritional disorders in childhood. In: Azubuike JC and Nkanginieme KEO. Eds. *Paediatrics and Child Health in a Tropical Region*. Owerri: African Educational Services, 2nd edition, 2007: pp 240–267.
4. World Health Organisation (1999). Management of severe malnutrition: manual for physicians and other senior health care workers. Geneva.
5. World Health Organisation (2000). Management of the child with a serious infection or severe malnutrition: guidelines for care at the first-referral level in developing countries. Geneva.
6. Wittemberg DF. Nutritional disorders. In: Coovadia HM and Wittenberg DF. Eds. *Paediatrics & Child Health: A manual for health professoinals in develoing countries*. Cape Town: Oxford University Press, 5th edition, 2007: pp 194–218.
7. Walker-Smith JA, Mittal SK, Hendrichse RG. Disorders of the digestive system. In: Hendrickse GR, Barr DGD and Matthews TS. Eds. *Paediatrics in the Tropics*. Oxford: Blackwell Scientiic Publications, 1991: pp 301–335.
8. World Health Organisation weight-for-height reference chart. [Online]. Available: http://www.who.int/childgrowth/standards/en
9. World Health Organisation (1995). Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series No. 854. Geneva: WHO.
10. World Health Organisation (2002). Training course on the management of severe malnutrition; Modules 1–7. Geneva.
11. Potter MA, Luxton G. Prealbumin measurement as a screening tool for protein calorie malnutrition in emergency hospital admissions: a pilot study. *Clin Invest Med* 1999; **22:** 44 – 52.
12. Gomez F, Ramos-Galvan R, Frenk S, Cravioto JM, Chavey R, Vasquez J. Mortality in second and third degree malnutrition. *J Trop Paeiatr*. 1956; **2:** 77–81.
13. Waterlow JC. Classification and definition of protein-calorie malnutrition. *Br Med J*. 1972; **3:** 566–569.
14. Leonard PJ, MacWilliam KM, Jones KW. The relationship between changes in plasma volume, plasma proteins and haemoglobin concentration during treatment of kwashiorkor. *Trans R Soc Trop Med Hyg*. 1965; **59:** 582–584.
15. Wharton BA, Howells GR, McCance RA. Cardiac failure in kwashiorkor. *Lancet*. 1967; **2:** 384–387.
16. World Health Organisation (2004). Severe malnutrition: Report of a consultation to review current literature. Geneva.