Acute Malnutrition

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Acute Malnutrition

Picture from Famine in South Sudan 1998
Case Study, South Sudan 1998

• 20 month old child presents to your center with watery diarrhea. He has no history of fever nor vomiting. Parents have been displaced due to political instability and mom is living with distant relatives. Other persons in the family are thin, but no one is ill.

• On exam, the child is weak. He is irritable but consolable. Conjunctiva are pale. Weight is 8 kilograms. Arm, leg and buttocks muscles are wasted. Chest exam is normal, abdominal exam is also normal. There is no edema.

• What do you?
Picture of typical child presenting to a feeding center
Acute Malnutrition

• This child suffers from acute malnutrition – a highly preventable and highly treatable condition
  – A condition which underpins mortality/morbidity from a multitude of other diseases
  – Predisposes affected persons to chronic conditions
  – A condition which has been often overlooked because of its relation to a country’s overall economic development

• Newer modalities may create circumstances in which severe acute malnutrition may be more easily treated

• Ongoing work is needed to define appropriate technologies for countries at various stages of development
Malnutrition – Learning Objectives

• Gain knowledge about the global burden of malnutrition
• Understand the physical consequences of Malnutrition
• Understand commonly used anthropomorphic definitions of malnutrition
• Community assessment of malnutrition
• Treatment of Malnutrition
• Introduction of the use of ‘Ready to Use Therapeutic Foods’ (RTUF)
Definition of Malnutrition

Absence of sufficient calories and micronutrients
• Caloric absence - Referred to as PEM, protein-energy malnutrition
• Absence of sufficient micronutrients accompanies PEM
• NEED for both FOOD and MICRONUTRIENTS
Epidemiology and the Global Burden of Malnutrition

- Much of the world is at risk for malnutrition
- Estimated by UNICEF to be ~146 million undernourished children, defined by weight for age
  - approximately 1 in 10 in developing countries
  - ~20 million with severe acute malnutrition
- 1 in 4 children under 5 from developing countries suffer from malnutrition
- Estimated 800 million undernourished persons worldwide
Epidemiology and the Global Burden of Malnutrition

- Implicated in over 5 million deaths preventable deaths among young children
- 9 children / minute die as a result of malnutrition
- Many persons suffer from micronutrient deficiencies – the most common are Vitamin A, iron, zinc and iodine
- For example, 40-60% of children under 5 in under-resourced countries suffer from Vitamin A deficiency
Additionally, many countries experience chronic food insecurity and have “Regular Starvation” or a “hunger gap”

This refers to the time when food stores from the previous year’s harvest have been exhausted and the current year’s harvest is not ready

Exacerbated by:
- Poor harvest
- Micronutrient deficiencies – common in monotonous cereal based diets
- Civil conflict or natural disasters

Picture illustrates the period of the “hunger gap” when food stores have been exhausted and harvest is not yet ready. This has also been termed “regular starvation”.
This graph demonstrates the seasonal nature of malnutrition in a province (Guidan Roumji) of Niger – a country which regularly experiences a “hunger gap’. Cases of Severe Acute Malnutrition rapidly increase in week 22 and decrease to baseline levels around week 52.
Table 1 - Countries ranked by global share of children underweight

<table>
<thead>
<tr>
<th>Country</th>
<th>Prevalence of underweight children in country (%)</th>
<th>Share of total underweight children in the world (%)</th>
<th>Cumulative total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>47</td>
<td>39.0</td>
<td>39.0</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>48</td>
<td>5.7</td>
<td>44.7</td>
</tr>
<tr>
<td>Pakistan</td>
<td>38</td>
<td>5.5</td>
<td>50.2</td>
</tr>
<tr>
<td>China</td>
<td>8</td>
<td>4.8</td>
<td>54.9</td>
</tr>
<tr>
<td>Nigeria</td>
<td>29</td>
<td>4.4</td>
<td>59.3</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>47</td>
<td>4.2</td>
<td>63.5</td>
</tr>
<tr>
<td>Indonesia</td>
<td>28</td>
<td>4.2</td>
<td>67.7</td>
</tr>
<tr>
<td>Democratic Republic of Congo</td>
<td>31</td>
<td>2.3</td>
<td>70.0</td>
</tr>
<tr>
<td>Philippines</td>
<td>28</td>
<td>1.9</td>
<td>71.9</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>28</td>
<td>1.5</td>
<td>73.4</td>
</tr>
</tbody>
</table>


Approximately 20 countries have the lion’s share of underweight children – the top ten are listed here. These types of lists are important for targeting interventions.
Table 2 - Countries ranked by prevalence of children underweight

<table>
<thead>
<tr>
<th>Country</th>
<th>Prevalence of underweight children in country (%)</th>
<th>Share of total underweight children in the world (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>48</td>
<td>5.7</td>
</tr>
<tr>
<td>Nepal</td>
<td>48</td>
<td>1.2</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>47</td>
<td>4.2</td>
</tr>
<tr>
<td>India</td>
<td>47</td>
<td>39.0</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>46</td>
<td>0.1</td>
</tr>
<tr>
<td>Yemen</td>
<td>46</td>
<td>1.1</td>
</tr>
<tr>
<td>Burundi</td>
<td>45</td>
<td>0.4</td>
</tr>
<tr>
<td>Cambodia</td>
<td>45</td>
<td>0.6</td>
</tr>
<tr>
<td>Madagascar</td>
<td>42</td>
<td>0.9</td>
</tr>
<tr>
<td>Eritrea</td>
<td>40</td>
<td>0.2</td>
</tr>
<tr>
<td>Lao People’s Democratic Republic</td>
<td>40</td>
<td>0.2</td>
</tr>
<tr>
<td>Niger</td>
<td>40</td>
<td>0.8</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>39</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**Note:** Table 2 lists the top 13 countries with the highest prevalence of underweight children and their respective contribution to the total share of underweight children in the world. For example, in Burundi, 45% of children are underweight which represents 0.4% of the total underweight children in the world. Ranking lists such as these based on an entire country's population may obscure regions within the country with high levels of malnutrition.
Malnutrition hotspots

www.doctorswithoutborders.org
Note for the preceding slide map. The map, created by Doctors Without Borders, represents what has been termed Malnutrition Hotspots – areas in which chronic food insecurity, civil conflict and “hunger gap” regularly occur. Areas within countries and across borders are highlighted.

The map was created data on prevalence of underweight children and population density.
Who is Vulnerable to Malnutrition?

At risk

• Children under 5
• Especially Children under two – often after weaning
• Adolescents
• Lactating or pregnant women
• Elderly
• Persons surviving a recent epidemic of measles
• Those with chronic disease- particular HIV, TB
• Children who live in countries with chronic food insecurity and civil conflict.
Famine

An epidemic of acute malnutrition or a catastrophic famine is generally due to:

• Civil war, violence, population displacement, severe food shortage
• Creates massive malnutrition (including adults), disease and epidemics
• Often occurs when there is high rate of regular starvation

Why is this child malnourished?

- High risk group (child under two)
- Region with chronic food insecurity
- Country with a baseline high rate of child malnutrition
- The regular “Hunger gap” is exacerbated by inability to plant crops because of civil conflict
- Area of civil conflict with massive displacement
- Global food insecurity
- Monotonous cereal based diet leading to micronutrient deficiency
Consequences of Malnutrition – Mortality
Consequences of Malnutrition

• "When children suffer from acute malnutrition, their immune systems are so impaired that the risks of mortality are greatly increased. A banal children's disease such as a respiratory infection or gastro-enteritis can very quickly led to complications in a malnourished child and the risks of death are high."

Dr. Susan Shepherd, MSF Medical Coordinator for the nutritional program in Maradi, Niger
Consequences of Malnutrition - Mortality

- Associated with half of all deaths in children under 5
- Contributes to approximately 50% of deaths associated with infectious disease
- In severe malnutrition a high risk of death: Case Fatality Rate (CFR) of 21% (30-50%)(WHO) without effective treatment
- A severely malnourished child has 20 times the risk of death as a normal child but responds rapidly to treatment
- Highest CFR (case fatality rate = % who die from the disease) among severely malnourished, However, more deaths occur among moderately malnourished group because so many more children are moderately malnourished.

Malnutrition and Deaths Associated with Childhood diseases

This graphic illustrates that Malnutrition underpins 50% of the deaths associated with childhood disease - most of which is infectious.

http://www.who.int/nutrition/challenges/en/
Consequences of Malnutrition - Mortality

- The odds of death in a child with severe wasting is 9.4 times the odds of a child without stunting.
- The odds of mortality from all causes in a child with severe stunting is 4.1 times greater than a child without stunting.

Maternal and child undernutrition: global and regional exposures and health consequences

This slide describes mortality related to malnutrition. Wasting – refers to low weight for height and generally reflects acute malnutrition. Stunting refers to low height for age and reflects chronic malnutrition. These terms will also be defined later. Acute malnutrition is often superimposed on chronic malnutrition.
Risk of death due to common illness in wasted and stunted children

Risk of death from common illness due to wasting

Risk of death from common illness due to stunting

Graph which illustrates the increased risk of death due to wasting and stunting. It is also important to note that there is significant overlap in wasting and stunting. A Government of Niger survey found that 70% of children with moderate or severe wasting were also stunted. Field Exchange
Consequences of Malnutrition - Mortality

Severely wasted child vs. Well-nourished child

9.4x risk of mortality from common illness

Keep in mind that many wasted children are often suffering from stunting as well.

This slide reiterates the previous graphs. A wasted child is at 9.4x risk of death due to common illness than a well-nourished child, but even a stunted child who is not acutely ill is at 4.1x risk of death from common illness. Also I would again point out that a stunted child is not acutely ill.
Each dot represents 5,000 deaths *Lancet* 2003 361:2226-34

Map which represents under 5 mortality. Each dot represent 5,000 deaths. This map is very similar to the map on malnutrition hotspots and could almost be superimposed – demonstrating the need to address childhood malnutrition in addressing the issue of childhood mortality.
Consequences of Malnutrition – Infection
Consequences of Malnutrition - susceptibility to infection

- Affects both acquired (lymphocyte function) as well as innate immunity (macrophages and granulocytes)
- Reduces leptin concentrations and increases levels of stress hormones
- Higher morbidity and mortality
  - Pneumonia, diarrhea, measles, malaria, intestinal parasites
- Increases susceptibility to Opportunistic infections
  - Tuberculosis, Noma.
  - Pneumocystic Carinii Pneumonia (PCP), Leishmaniasis
- Decreased efficacy of vaccines – live attenuated BCG, encapsulated bacteria, measles
- ? altered gut mucosal immunity
- Chronic PEM prevents thymic development – long term diminished immunity- nutritionally acquired immunodeficiency syndrome
Infections contribute to malnutrition

- Certain diseases increase metabolic demand and can cause further deterioration in a patient with malnutrition leading to worsening of energy deficiency and micronutrient deficiency
  - Gastroenteritis – diarrhea aggravates malnutrition
  - Intestinal parasites can cause anemia and micronutrient deficiencies
  - Sepsis - increase catabolic state
  - Measles - perhaps through metabolic demand
  - TB/ HIV/chronic infections – cause cachexia, anemia


Consequences of Malnutrition
Vicious cycle of malnutrition

- Malnourished
- Predisposed to infection
- Energy loss
- greater severity of malnourishment
- Even greater susceptibility to disease

Schematic demonstrating interplay between malnutrition and infection - Malnutrition sets up a vicious cycle in which malnourished child have compromised immunity, which leads to higher rates of infection, which exacerbates energy loss and leads to increased malnutrition. Then the cycle starts over again.
Long term Consequences of Malnutrition in childhood

Malnutrition in childhood is associated with –

- Less schooling
- Reduced economic productivity
- Adult stunting which in women will also lead to offspring with lower birth weight (higher infant mortality) and increased maternal complications
- This propagates the vicious cycle of malnutrition

The slide illustrates the downward spiral due to malnutrition in the community. Again malnutrition in the community predisposes individuals to infection, which creates increased energy loss, this leads to decreased production, which exacerbates poverty and impairs development of infrastructure and leads to social and political instability. This of course further aggravates malnutrition levels in the community.
Many children as well have micronutrient deficiencies which have serious consequences for health. This graph demonstrates DALYs (Disability Adjusted Life Years Lost) due to micronutrient deficiency.

### Health Effects Associated with Specific Micronutrient Deficiencies

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Major Effects of Deficiency</th>
<th>DALYs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Compromised immune system, visual impairment, child mortality</td>
<td>&lt;1 million+</td>
</tr>
<tr>
<td>Iodine</td>
<td>Lower mean birth weight, developmental problems, retardation</td>
<td>1.5 million++</td>
</tr>
<tr>
<td>Iron</td>
<td>Perinatal and maternal mortality, loss of productivity, and cognitive</td>
<td>12.2 million++</td>
</tr>
<tr>
<td></td>
<td>development</td>
<td>n/a</td>
</tr>
<tr>
<td>Zinc</td>
<td>Impaired growth, abnormal fetal growth, abnormal labor, impaired immune</td>
<td></td>
</tr>
<tr>
<td></td>
<td>function, cognitive dysfunction</td>
<td></td>
</tr>
</tbody>
</table>

* Disability-Adjusted Life-Years Lost
+ 1993 estimates
++ 2001 estimates
Consequences of Malnutrition
- Chronic disease -

• Chronic immunodeficiency
• High glucose concentrations
• Harmful lipid profiles
• Higher blood pressures
• Increased susceptibility to diabetes


Malnutrition early in life increases the risk for chronic disease.
Malnutrition – key periods

In order to demonstrate reduction in chronic morbidity and mortality– need to focus on key periods

- Under 2
- During pregnancy
- Perhaps adolescence or other key times

Also – children most likely need some type of animal based protein as well as fortified grains in order to supply sufficient micronutrients in time of crisis
Assessing severity in the community
Or, how many other children are like this out there?
Picture from Famine in South Sudan Bahr El Ghazal province – 1998
Assessing severity

Based on

- Food availability
- Prevalence of malnutrition
- Aggravating factors
### Malnutrition – community severity

<table>
<thead>
<tr>
<th>Finding</th>
<th>Action Required</th>
</tr>
</thead>
</table>
| Food availability at household level <2100kcal/person/day               | Unsatisfactory situation  
  • Improve general rations until local food availability and access can be made adequate.                                           |
| Malnutrition rate* 15% or more or 10-14% with aggravating factors.**  | Serious situation:  
  • General rations (unless situation is limited to vulnerable groups);  
  • Supplementary feeding generalized for all members of vulnerable groups, especially children and pregnant and lactating women;  
  • Therapeutic feeding for severely acutely malnourished individuals.       |
| Malnutrition rate 10-14% or 5-9% with aggravating factors              | Risky situation:  
  • No general rations; but  
  • Supplementary feeding targeted to individuals identified as malnourished in vulnerable groups;  
  • Therapeutic feeding for severely acutely malnourished individuals.     |
| Malnutrition rate 5-9% with no aggravating factors.                    | Acceptable situation:  
  • No need for population interventions;  
  • Attention to malnourished individuals through regular community services.***     |

Decision Chart for the Implementation of Selective Feeding Programmes (*WHO, 2000/a*)
Aggravating Factors

For WHO aggravating factors are:

• Poor food security
• General food ration below the mean energy requirement (<2100 kcal / person / day).
• Raised mortality or the Crude Death Rate greater than 1/10,000 / day. Can be a good indicator of the severity in the community
• Disease epidemics - measles or whooping cough.
• Harvest calendar (Is the increase in malnutrition occurring right before harvest or before planting?)
• Other – security situations, displacement, natural disaster – flooding, drought etc
Assessing severity - CMR

- Crude Mortality Rate – deaths/10,000/day

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Emergency threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least developed countries (eg SSudan, Angola)</td>
<td>0.38</td>
<td>0.8</td>
</tr>
<tr>
<td>Developing countries</td>
<td>0.25</td>
<td>0.5</td>
</tr>
</tbody>
</table>


This slide is a graph which describes the baseline and emergency threshold for Crude Mortality rate in least developed and developing countries. Although one can argue that the baseline is unacceptable, this does provide some indication as to when a crisis is occurring.
Assessing severity – U5MR

- Under 5 mortality rate – deaths/10,000/day

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Emergency threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least developed countries</td>
<td>0.53</td>
<td>1.1</td>
</tr>
<tr>
<td>Developing countries</td>
<td>1.03</td>
<td>2.1</td>
</tr>
</tbody>
</table>

How do we classify malnutrition
Wasting vs Stunting

Acute vs Chronic Malnutrition

- Chronic malnutrition or “stunting” causes chronic growth retardation and is reflected in low weight or low height for age
- Acute malnutrition or “wasting” may be superimposed on chronic malnutrition and is measured in weight for height
- In countries with chronic food insecurity distinctions between acute and chronic can sometimes be difficult
Types of Acute Malnutrition

- Malnutrition occurs in all ages, but younger children are generally more affected
- Types / Protein Energy Malnutrition
  - Marasmus, also termed Wasting, Emaciated, or dry malnutrition
  - Kwashiokor, also termed Edematous, Water in the tissues, or wet malnutrition
Marasmus “wasting”

- Low weight for height
- Emaciated
- Appear weak
- Thin, dry skin
- Hair that is easily plucked
- Redundant skin folds (loss of subcutaneous fat)
- Loss of muscles “old man buttocks”, thin arms and legs
- Wasting in the face indicates severe malnutrition, Muscle wasting in the arms, legs and buttocks can be easily missed with loose fitting clothing. (Check buttocks, not just the face)
Child with severe malnutrition with relatively spared face – it is crucial to look at the musculature in assessing malnutrition
Assessing severity

Same child with “old man buttocks” demonstrating severe wasting of the musculature
Kwashiokor “wet malnutrition”

Marked muscle wasting (thin arms, legs, buttocks)

- Anasarca, or total body swelling
- Pitting edema in the lower extremities and periorbitally
- Moon facies
- Dry, atrophic, peeling skin with confluent areas of hyperkeratosis and hyperpigmentation
- Dry, dull, hypopigmented hair that falls out or is easily plucked
- Hepatomegaly (from fatty liver infiltrates)
- Distended abdomen with dilated intestinal loops.
- These children are critically ill
Kwashiokor “wet malnutrition”

- Anasarca
- Moon facies
- Dull hypo-pigmented hair
- Periorbital edema

Susan Sanders / MSF
Ethiopia 2008
Assessing severity
Anthropomorphic definitions

Methods used to measure the type and severity of malnutrition as well as to gage recovery.

Anthropomorphic methods are surrogate markers for the metabolic changes which occur with malnutrition.

- MUAC
- Z-scores
- Weight for height
- Clinical assessment
Anthropomorphic definitions - MUAC

- MUAC is a standard measurement in children aged 6 months to 5 years
- It essentially measures muscle mass in the mid-upper arm
- This is a marker of muscle loss – similar muscle loss occurs in the legs and gluteal area.
- In some countries children wear bracelets above on the upper arm or above the calf – if the bracelets fall down – children are malnourished

MUAC = Mid-upper arm circumference
Anthropomorophic definitions - MUAC

- In a child 6 months – 5 years a MUAC of less than 13 cm signifies malnutrition
- A MUAC less than 11 cm signifies severe malnutrition
- A MUAC of 21 cm or less in a lactating or pregnant woman signifies severe malnutrition
- MUAC is a quick, inexpensive tool for assessing malnutrition and can be easily used for community screening
Anthropomorphic measurements - MUAC

Quick Screen
- Red: severe <11 cm
- Green: >13.5 cm
- Stable: 6 mos. - 5 years

This is a Doctors Without Borders tool used for a MUAC – it has both centimeters and color coding.
**MUAC:** Can be done quickly and cheaply by people with limited education

Child’s MUAC measures in the red zone (<11 cm) indicating severe malnutrition

Alexandre Carle / MSF
Anthropomorphic data – height/weight

Above – child being weighed, Upper right younger child being weighed, lower right child height measured
Anthropomorphic measurements

• Other anthropomorphic measurements are based on height and weight
• Weight for age and height for age generally measure stunting or chronic malnutrition
• However, age (particularly in months) may not be known
• Weight for height measures the incidence of acute malnutrition
• Again in areas with frequent periods of malnutrition, acute and chronic malnutrition may overlap
Anthropomorphic measurements

Height and weight are than calculated either as:

• percentage height for weight
• Or compared to a standard table of Z scores
• This is different than in primary care or in growth monitoring clinics where children are generally graphed based on height and weight for age and the growth trend is followed over time
• In any child with edema, these charts cannot be used since the child will weigh more.
Anthropomorphic measures

Picture demonstrates common ways in which height and weight are measured – particularly in a low resource setting.
CDC Growth Chart

• This graph details a CDC growth chart for boys from birth to 36 months

• In the US this is used to assess growth in all children in their primary care clinic

• Generally length for age and height for age are measured – (this could measure stunting)

• 95% of children will fall between the 3rd and 97th percentile. Those outside these percentile will be >2 SD or ±2 Z scores

The next three steps detail how we monitor growth in the US using CDC/NCHCs graphs. If time is limited – these could be skipped – but I am attempting to demonstrate the connection between this type of monitoring and that used in settings of malnutrition.
Growth Chart

A child at 12 months who weighs 8 kg and is 75 cms would be less than the 3rd percentile or -2SD or -2 Z scores. Reasons for this low score would need to be investigated – other measures which assess weight for length or a BMI are helpful to determine the etiology.

Same chart – but highlighting a point on the graph
Growth charts – weight for length

- CDC growth chart for boys 3-36 months on weight for length
- again 95% of children will fall in the 3-97%
- A child at 7.6 kilos and 73.5 cm will be < the 3rd percentile and will be <2 Z scores
Anthropomorphic data - Z scores

• In nutritional literature, Z-scores are used for height for age, weight for age or weight for height
• In statistics – a z-score is a conversion of a raw score on a test to a standardized score represented in units of standard deviations. This can be used to compare scores that might not be measured on the same scale.
• In other words – your score based “on the curve” rather than your actual percentage score
• Your Z-score reflects distance from the mean
Z-scores

- In acute malnutrition – generally most helpful are the Z-scores based on weight/height
- Moderate malnutrition is -2 Z scores below mean
- Severe malnutrition is -3 Z scores below the mean
- These scores are different but approximate percentage of weight/height
- There is also some differences in growth charts and Z-scores between WHO standards and NCHC(US)
These are WHO field tables of Z-scores of weight for height.

A child who is 74 cm would be severely malnourished at 7.6 kg and moderately malnourished at 7.0 kg.

However, any child with edema is considered severely malnourished.

Z-scores are not an intuitive measure and do require some mathematical knowledge – such as decimal points etc.
Anthropomorphomic measures  
- weight for height -

Tables are also available as weight for height in percentiles of the reference mean

- Moderate malnutrition is weight/height 70-80%
- Severe malnutrition is weight/height <70%
- Percentage of the median provided by the National Center for Health Statistics NCHS and WHO
- These percentiles approximate Z scores

See WHO guidebook for these tables
Acute Malnutrition – level of severity

<table>
<thead>
<tr>
<th></th>
<th>MUAC</th>
<th>Height/weight</th>
<th>Z-scores</th>
<th>Edema</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>&lt;13 cm</td>
<td>&lt;80%</td>
<td>&lt;2-3</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>&lt;11 cm</td>
<td>&lt;70%</td>
<td>&lt; 3 SD</td>
<td>Always severe if present</td>
</tr>
</tbody>
</table>

Example of typical data collection for malnutrition project

Table 1: Prevalence of acute malnutrition expressed in W/H % of the reference median, oedema or MUAC (n = 917). Mornay, Darfur, Sudan, 2004.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
<th>IC 95 %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global acute malnutrition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 80% or oedema</td>
<td>137</td>
<td>14,9</td>
<td>[12,4-17,8]</td>
</tr>
<tr>
<td>or MUAC &lt; 110mm*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Severe acute malnutrition</strong></td>
<td>25</td>
<td>2,7</td>
<td>[1,9-3,9]</td>
</tr>
<tr>
<td>&lt; 70% or oedema</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or MUAC &lt; 110mm*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Including 2 children with oedema

This would be typical data collection for a malnutrition project utilizing weight/height percentage of the mean.
Anthropomorphic indicators

In Summary there are three anthropomorphic measures which are used to gage the severity of malnutrition and assess recovery

- MUAC
- Z-scores
- Height/weight
- As well as assessing for the presence of edema

All of these markers however are only surrogate markers for the metabolic changes which occur with acute malnutrition
Types of feeding programs
General rations

• General food distribution when there is poor food security
• Usually dry rations
• Needs to accompany other programs such as supplementary feeding or therapeutic feeding
• Concern has raised that distributing more fortified cereal blends without concern for micronutrients will not solve the problem of malnutrition*

*Food is Not Enough, Oct.10, 2007 accessed at www.doctorswithoutborders.org/publications
Blanket Feeding

MSF Tanout, Niger Vincent Maure
Supplementary Feeding Programs (SFP)

Treatment of moderately malnourished children and other vulnerable groups with supplementary food available in take home dry rations. Goals of therapy are to prevent:

- Deterioration to acute malnutrition
- Excess mortality
- Maternal under-nutrition and subsequent low birth weight offspring
- Again with current cereal-based blends, this can fail to address micronutrient deficiency
Supplementary Feeding Programs (SFP)
Supplementary Feeding Programmes

RESOURCES

Therapeutic Feeding Center (TFC)

- Hospital-type facilities reserved for severely malnourished children
- Ideal treatment for severely malnourished children with complications
- Requires intensive resources on part of providers such as a government hospital or NGO as well as the family who must accompany malnourished child
- Inpatient treatment may pose threats such as communicable disease and security
- Limiting treatment to TFC may also limit access to malnourished children
Picture of a typical TFC. The TFC is probably in a tent because a more permanent structure is not available. As in most inpatient facilities in the developing world, Mothers need to accompany children in order to ensure that they are fed, bathed, etc.
Outpatient TFC or CTC

• Newer concept, adopted by WHO, for treating severely malnourished children in a clinic
• Also referred to as a CTC – “community treatment center”
• Treatment of severely malnourished children without complications with “Ready to Use Therapeutic Food” (RTUF)
• Closer follow-up than traditional supplementary feeding programs but less intensive care than a TFC
• May also be used to treat moderately malnourished children who may be overlooked in a program concentrating on the most severely affected

Acute malnutrition – level of severity

• Recently, people have begun to classify malnutrition based on the presence or absence of complications in addition to anthropomorphic indicators

• This combines clinical indicators with anthropomorphic definitions

• A moderately malnourished child with complications is at high risk of death and should be treated appropriately
Malnutrition with complications

Malnutrition
MUAC < 13 cm
Severe or moderate

With Complications
Anorexia
Fever
Hypothermia
Hypoglycemia
Pneumonia
Respiratory distress

Without complications
Consider outpatient or community based management as in a CTC
Treatment
Case #1: How do we treat this child

- Medical Emergency
- Untreated the Case Fatality Rate is 30-50% but can be reduced to 5% with appropriate treatment
- Also, moderately malnourished children have high rates of death even though many acute malnutrition programs only target children with severe malnutrition
Treatment

QUESTIONS

• Do we start IV fluids? The child is dehydrated
• Treat for anemia? Conjunctiva are pale
• Begin high protein/high caloric food immediately? To treat for malnutrition
• Treat for infections – if the child is afebrile?
Severe Malnutrition

Profound physiological and metabolic changes take place when children become malnourished. These changes affect every cell, organ and system. The process of change is called *reductive adaptation*. Malnourished children do not respond to medical treatment in the same way as if they were well nourished.” (WHO)
What is malnutrition with complications?

• Need to know the stages of malnutrition to understand malnutrition with complications
Clinical Stages of Malnutrition

- Early -- hungry, irritable
- Lose muscle mass, develop diarrhea and easily infected by semi-opportunistic infections
- Late – no energy, anorexic, may even refuse food – critical illness
- Signs of late malnutrition signify critical disease or severe malnutrition with complications and need critical treatment
- At any time, children with moderate or severe malnutrition may develop sepsis and should be treated as having critical disease
Treatment

Treatment is based on:
• The severity of the malnutrition
• Severity is based on anthropomorphic indicators
• And clinical indicators (anorexia, hypoglycemia, and/or hypothermia, lethargy, respiratory distress) or the presence of malnutrition with complications
• And the ten steps as outlined by WHO
Malnutrition
MUAC < 13 cm
Severe or moderate

With Complications
Anorexia, Fever
Hypothermia, Hypoglycemia
Pneumonia, Resp distress

Admit to Therapeutic Feeding Center Inpatient-type facility

Without complications

Consider outpatient or community based management as in a CTC
Treatment

• How do we assess for the presence of malnutrition with complications?
  – Children with late stage malnutrition are anorexic, and may be lethargic due to hypoglycemia, hypothermia and/or sepsis
  – If a child is lethargic, they should be assumed to have complications
Treatment

- How do we assess for the presence of complications? (cont’d)
  - Anorexia as well can be clinically assessed by determining if a child can eat a certain quantity of Ready to Use Therapeutic Food (RUTF), a micronutrient dense, high protein food.
  - If child has no appetite or is too weak to eat, child has malnutrition with complications
  - Similarly if a child has malnutrition with respiratory distress, the child has malnutrition with complications.
Severe Acute Malnutrition With Complications

• Inpatient treatment
  ▪ Therapeutic Feeding Center
These are the ten steps as outlined by the WHO and are used as guides in the treatment of malnutrition with complications.
Treatment – Initial phase 1-2 days

Need Intensive and Comprehensive treatment in the initial phase – critical period. Goal of feeding is to provide water and calories sufficient for stabilization and to prevent death. Treatment is broken down into ten steps though they occur simultaneously and not consecutively. The most crucial initial concerns are hypoglycemia, hypothermia, dehydration and treatment of sepsis --- WHO.
**TEN STEPS - Hypoglycemia**

Hypoglycemia
- Very common
- May present as apnea in infants
- Often a sign of sepsis
- Prevented by small frequent feedings (8-10/24 hours) or continuous feeds if an NG is available
- May be checked with a glucometer or assumed if glucometer is not available
TEN STEPS - Hypothermia

- Very common and signifies critical illness
- Hypothermia – prevented by warm room, additional blankets even in a tropical climate, skin to skin contact or an incandescent lamp near but not touching the body
- Persistent hypothermia – particularly cold extremities should trigger concern and treatment for sepsis as well as hypoglycemia and dehydration
Malnutrition Treatment – electrolytes and dehydration

- Malnourished children are generally dehydrated
- Malnourished children usually have diarrhea which aggravates dehydration
- Before food & with food – need rehydration
- Malnourished children have excess total body stores of Sodium and total body deficiencies of potassium, magnesium and other micronutrients.
- ReSoMal is a commonly used rehydration formula used for severely malnourished children which accounts for these changes
- This can also be easily made.

ReSoMaI formula available at [http://www.searo.who.int/LinkFiles/FCH_app3.pdf](http://www.searo.who.int/LinkFiles/FCH_app3.pdf)
TEN STEPS - Rehydration

• Diarrhea generally accompanies malnutrition and aggravates malnutrition
• Children with diarrhea should receive additional fluids based on the amount of diarrhea – generally provide a cup after each liquid stool
• Sepsis can be difficult to distinguish from dehydration
• Stop rehydration if a child becomes edematous or dyspneic
• Increasing weight with increasing respiratory distress and enlarging liver can be indicators of too much fluid
• Generally, the presence of urine is a good indicator of adequate hydration.
• Often malnourished children need 70-100 ml/kg in the first 24 hours though this needs to be individualized.
Ten Steps
• Hypoglycemia
• Hypothermia
• Dehydration
• Electrolytes
• Infections
• Micronutrients
• Cautious feeding
• Catch-up growth
• Sensory stimulation
• Prepare for follow-up

TEN STEPS - Rehydration

• Start feeds and hydration via the oral route – by spoon, or syringe if the child is unable to drink
• With limited resources this amount to be given can be measured and given to the mother or assistant to give to the child over a specified time period
• Nasogastric tube (NG) feeding / fluid replacement should be safe and should be utilized if child cannot take sufficient fluid orally and may be needed in anorexic children
• IV fluid replacement is very difficult and should only be done in carefully controlled situations. It can rapidly lead to congestive heart failure
Ten Steps

- Hypoglycemia
- Hypothermia
- Dehydration
- Electrolytes

Infections
- Micronutrients

Cautious feeding
- Catch-up growth
- Sensory stimulation
- Prepare for follow-up

TEN STEPS - cautious feeding

- Severely malnourished children with complications are anorexic
- Initially the goal of feeding is stabilization NOT weight gain
- Either need small frequent feedings such as every 1-2 hours or a continuous drip feed such as may be provided by an NG
- A caregiver may need to administer feeds via a spoon or syringe
- Specific milk based formulas such as F-75 have been developed or can be made
- Generally, when the child recovers an appetite, the child’s appetite can dictate the amount of food needed
TEN STEPS - cautious feeding

- Need to begin feeding carefully to avoid “Refeeding Syndrome”
- Refeeding syndrome refers to various metabolic abnormalities that occur when a malnourished patient is exposed to a carbohydrate load
- Refeeding syndrome will cause cardiovascular collapse and patient demise
- “Refeeding syndrome” was seen in large numbers after WWII when patients from concentration camps were given large quantities of food and died
- “Refeeding syndrome” is often due to dangerously low levels of phosphorus, which are already low in severe acute malnutrition
- Careful feeding with small, frequent feeds until the appetite has been reestablished can avoid the refeeding syndrome
Frequent small feedings in a severely malnourished child by spoon feeding
Malnutrition
MUAC < 13 cm
Severe or moderate

With Complications
Anorexia, Fever
Hypothermia, Hypoglycemia
Pneumonia, Resp distress

Admit to Therapeutic Feeding Center Inpatient-type facility

Without complications

Consider outpatient or community based management as in a CTC

In review - the intensive treatment just reviewed focuses on children on the left side – children with acute malnutrition with complications. Now we focus on treatment for all children with malnutrition.
Treatment

- Malnourished children without complications are unlikely to suffer from hypoglycemia and hypothermia.
- They do however suffer from some degree of dehydration, electrolyte imbalance, silent infections, micronutrient deficiencies and sensory deprivation.
- The following slides will review treatment for all malnourished children with or without complications.
Treatment

- For severely and moderately malnourished children feeding does not need to be as cautious
- The child’s appetite can dictate the food
- Child can be treated as an outpatient with the use of RTUF (Ready to Eat Therapeutic foods)
- RTUF refers to lipid based paste - One form is Plumpy’nut a peanut butter-like paste used in famine relief. It contains lipids, sugars and protein along with micronutrients. It is:
  - Designed for rapid weight gain
  - Hard to contaminate - does not require preparation or addition of water
  - Designed for malnourished persons with small stomachs and poor appetites
  - RTUF can be made locally

Mothers feeding children RTUF (ready to use Therapeutic food)
The use of Ready to Use Therapeutic foods (RTUF) is a relatively new concept. This article which corroborates that evidence that home based therapy in severe malnutrition without complications is at least as effective as hospital based care. Most country policies previously dictated that severe acute malnourished children be treated in hospital settings. This limits treatment to only the very, very ill and does not distinguish between children with and without complications.
Malawi

- Ciliberto, Manary et al. compared use of RTUF to standard care
- In Malawi standard care was hospitalization in a TFC for children with Z scores <3 and utilized WHO guidelines
- Children who received RTUF vs standard care
  - More likely to achieve a weight for height score > -2 (79% vs 46%)
  - Less likely to relapse or die (8.8% vs 16.7% p<.001)
  - RUF children had greater rates of weight gain and lower incidence of fever, cough and diarrhea
Maradi, Niger, 2005  MSF – Experience in a malnutrition crisis

- Maradi, Niger, 2005
- 39,353 admissions for severe acute malnutrition
- 91% cure (34,257)
- 65% directly to outpatient
- 85% finished treatment as outpatients
- Outpatients received weekly checkups
- Average time to cure less than a month
- 1000 deaths, 6200 cured


This slide shows the increased impact of home based therapy for severe acute malnutrition in an emergency situation.
The Use of RTUF in Malnutrition crises

- Collins summarizes data from 23,511 children attending 21 CTC programs supported by Valid International data in Sudan, Ethiopia, Niger and Malawi which demonstrated high recovery rates of 79.4%, and low case fatality rate of 4.1% compared with a usual rate of 11.0%. Coverage rates were estimated at 72.5% whereas TFC based programs often only achieve a 10% coverage rate.

Collins S Treating severe acute malnutrition seriously. Arch Dis Child; 92:453-461. Downloaded Adc.bmj.com
Multiple factors impair cellular machinery. Tissue function cannot be restored unless machinery is repaired, which includes remedying multiple specific deficiencies. These may not be visible, and often are the consequence of multiple silent infections.

WHO guidelines
TEN STEPS - Infection

TEN STEPS - Infection

Treat for infections – any child with hypothermia and hypoglycemia (or malnutrition with complications) should receive presumptive treatment for sepsis – a malnourished person cannot mount a typical febrile response

- These children would need inpatient therapy

- Antibiotic choice should be determined by local pathogens, availability of antibiotics and drug susceptibility

- Presumptive treatment may be needed for malaria, tuberculosis, helminthes and other pathogens - again the prevalence of disease in the geographic area should guide treatment

Ten Steps
- Hypoglycemia
- Hypothermia
- Dehydration
- Electrolytes
- Infections
- Micronutrients
- Cautious feeding
- Catch-up growth
- Sensory stimulation
- Prepare for follow-up
Malnutrition treatment for all children - infectious concerns

Prevention of infections

- Vaccinate for measles (an outbreak can be deadly)
- Maintain careful attention to the possibility of potentially deadly disease outbreaks such as Shigella enteritis, which has a mortality up to 50% in malnourished populations
- Water-sanitation activities are crucial for the prevention of diarrheal or arthropod disease
Measles vaccination as part of supplemental feeding program

Kris Torgeson / MSF
Malnutrition treatment for all children – micronutrient replacement

Vitamin A should be administered unless child was recently discharged from a feeding center

- Vitamin A deficiency
  - Very common in the developing world and associated with increase in childhood mortality, preventable blindness and increased susceptibility to infections
  - Often aggravated in times of famine or in monotonous diets
  - Cases of xerophthalmia or night blindness indicate global deficiency – need to consider mass administration of Vitamin A

Ten Steps

- Hypoglycemia
- Hypothermia
- Dehydration
- Electrolytes
- Infections
- Micronutrients
- Cautious feeding
- Catch-up growth
- Sensory stimulation
- Prepare for follow-up
Malnutrition treatment for all children – micronutrient replacement

Ten Steps

• Hypoglycemia
• Hypothermia
• Dehydration
• Electrolytes

Infections

• Micronutrients
• Cautious feeding
• Catch-up growth
• Sensory stimulation
• Prepare for follow-up

- Vitamin A replacement – Vit. A orally according to age: < 6 months, 50,000 IU; 6-12 months, 100,000 IU; > 12 months, 200,000 IU.
  - If child has Bitot’s spots a higher dose of Vitamin A is needed
  - and mass Vitamin A should be considered
  - treatment could be skipped if time short
Bitot’s spots

Patches on cornea – indicating xerophthalmia – Vitamin A deficiency may lead to blindness if untreated
Malnutrition treatment for all children – micronutrient replacement

Ten Steps
- Hypoglycemia
- Hypothermia
- Dehydration
- Electrolytes
- Infections
- Micronutrients
- Cautious feeding
- Catch-up growth
- Sensory stimulation
- Prepare for follow-up

- A Multivitamin generally will treat deficiencies due to Thiamine (B1), Riboflavin (B2), Niacin (B3, Pyridoxine (B6), Biotin and Vitamin C
- Folate supplementation is needed
- Start iron AFTER the first week. Malnourished persons often have an adaptive anemia and early supplementation of iron can be dangerous.
- Need to consider other vitamin deficiencies such as E, K, B12 and D which may not be available in most multivitamin preparations (see appendix)
Treatment

Problems

• Child fails to gain weight
• Consider other problems – HIV, tuberculosis, other semi-opportunistic infections
• Ongoing evaluation requires surveillance for other problems.
Other treatment needs and considerations

- Creating a stimulating environment for children; playing with children
- Providing ongoing education in the detection and treatment of malnutrition for the community
- Developing local networks for the treatment of malnutrition
- Ongoing surveillance for malnutrition
Approximate time-scale for the 10 steps for treatment of severe malnutrition

1. Hypoglycaemia
2. Hypothermia
3. Dehydration
4. Electrolytes
5. Infection
6. Micronutrients
7. Cautious feeding
8. Catch-up growth
9. Sensory stimulation
10. Prepare for follow-up

Back to the case

- Child is severely malnourished Z score of <2
- In a setting of massive malnutrition with a very difficult logistical situation
- Child is, however, still without complications
- Child was admitted to TFC and did well on standard therapy
- However, this is the type of child who would likely benefit from RTUF at significant less cost to the family
- The NGO could have had a greater impact by distributing resources further with use of RTUF
Prevention
Prevention of Malnutrition

• MSF project in Niger
• “Guidan Roumdji”
• Area of country which regularly experiences a hunger gap
• Population distribution with RUSF (Ready To Use Supplemental food) -

- **Blanket distribution**
  RUSF (46 g/day) every month for 6 months during hunger gap for all children 6m to 3 yrs. (1.3 kg/month)

- 52 distribution sites

- 7 teams of 5 people + daily workers

- SAM treated using WHO standards (<-3z)

Susan Shepard MSF
Targeted distribution in 2007

- 62,878 children 6 months to 3 yr
- Total ration per child during hunger gap: 7.8 kg RUSF
- 7,258 severely wasted admitted to therapeutic program (WHO 2005)
  - Cure rate: 89%
  - 1,532 were severely malnourished according to NCHS
This slide demonstrates the significant reduction in children in 2006 and 2007 admitted for severe acute malnutrition with targeted population distribution of RTUF and RSUF during the “hunger gap”..
Preventing Malnutrition with RTUF

Niger 2007 © Michael Goldfarb – courtesy MSF
Maradi, Niger 2007 – distributing RTUF

Niger 2007 © Michael Goldfarb – courtesy MSF
MSF campaign to improve access and treatment of malnutrition

www.accessmed-msf.org
What is MSF calling for?

1. Scaling up of treatment of severe acute malnutrition with therapeutic RUFs. Countries must develop protocols to support community-based management of severe acute malnutrition. Countries must implement new WHO Growth Standards.

2. Funding must be provided to support Ministries of Health to integrate treatment of severe acute malnutrition into their protocols and to purchase therapeutic RUFs at a reasonable price.

3. Donors should review the quality of food aid addressed towards rapidly growing young children to ensure that distributions include foods that meet specific nutritional needs.

4. Academic and operational research must increase to drive the development of new complementary and supplementary foods and programme strategies aimed at meeting nutritional needs of young children, women of reproductive age and people with tuberculosis and HIV/AIDS.
Conclusion

• Malnutrition is a highly prevalent disease which underpins the mortality from common and opportunistic diseases and confers higher risk for chronic disease

• Malnutrition has often been overlooked in the medical world because of its inextricable link with development

• Certain regions carry high burdens of malnutrition due to multiple factors such as “regular starvation”, cereal based diets and political instability

• Proper treatment for acute malnutrition can significantly reduce the case fatality rate
Conclusion

• Newer modalities of treatment allow for a simplified treatment of malnutrition based on simpler measures such as MUAC and the presence or absence of complications
• Home based therapy with RTUF is emerging as the standard of care for both initial and long term treatment of patients with acute malnutrition without complications
• RTUF may be indicated for the prevention of acute malnutrition in areas which experience high rates of malnutrition
Some other agencies involved in treating malnutrition

- UN Millennium Villages Project
  http://www.unmillenniumproject.org/mv/index.htm
- GAIN Global Alliance for Improved Nutrition (Bill and Melinda Gates, CIDA, USAID) public and private partnerships to improve nutrition for 1 billion people through food fortification and other projects
  http://www.gainhealth.org/about-gain
- VALID.  http://www.validinternational.org
- WHO
- UNICEF
References

• Black, RE et al. "Where and why are 10 million children dying every year?" The Lancet 2003; 361:2226-2234
• Duop Am J Clin Nutr 2003;78:302-7
References

• Doctors Without Borders Food is Not Enough: Without Essential Nutrients million of children will die
• Dewey KG and Adu-Afarwuah S. Matern Child Nutr. 2008;4[1]:24-85
• Kuehn B Aid Groups Target "Silent" Malnutrition JAMA. 2008;300(17):1983-1985
WHO/UNICEF publications

Internet sites

- Valid International. Available at: www.validinternational.org/pages/
- www.doctorswithoutborders.org
Appendix
Cost Estimates

- UNICEF/WFP estimate a cost of $7.9 billion for malnutrition programming (includes nutrition and hygiene education, micronutrients, hand-washing, as well as household food security, water treatment and parasite control).
- MSF estimates ~$50/child for therapeutic feeding for severe acute malnutrition (13 kg/child).
- ~$1 billion to treat 20 million children with Severe Acute Malnutrition.
- $271 million to prevent 225,000 deaths from Vitamin A deficiency (as well as morbidity from other deficiency problems).
- To put these costs in context, the direct costs of the Iraq war, including reconstruction, are ~$340 millions per day. ([http://www.nationalpriorities.org/costofwar_home](http://www.nationalpriorities.org/costofwar_home)).
Treatment – Initial phase 2-7 days

- For a 10 kg child
  - Goal is 80-100 kcal /kg
  - 800-1000 kcal in the first few days = 1067-1333 cc of an F-75 formula/day
  - Divide this into minimum of q 2 hour feeds = 1067/12 = 89 to 111 cc / feed
  - Food can be given as a bolus or continuous drip or by multiple teaspoons (18 to 22 teaspoons)
  - Often cup can be marked so caregiver can provide required amount
How to prepare milk-based formulae

• Preparation of F-75 and F-100 diets

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amounts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-75a-d</td>
</tr>
<tr>
<td>Dried skimmed milk</td>
<td>25 g</td>
</tr>
<tr>
<td>Sugar</td>
<td>70 g</td>
</tr>
<tr>
<td>Cereal flour</td>
<td>35 g</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>27 g</td>
</tr>
<tr>
<td>Mineral mixf</td>
<td>20 mL</td>
</tr>
<tr>
<td>Vitamin mixf</td>
<td>140 mg</td>
</tr>
<tr>
<td>Water to make</td>
<td>1000 mL</td>
</tr>
</tbody>
</table>

• a. To prepare the F-75 diet, add the dried skimmed milk, sugar, cereal flour and oil to some water and mix. Boil for 5-7 minutes. Allow to cool, then add the mineral mix and vitamin mix and mix again. Make up the volume to 1000 mL with water.

b. A comparable formula can be made from 35 g of whole dried milk, 70 g of sugar, 35 g of cereal flour, 17 g of oil, 20 ml of mineral mix, 140 mg of vitamin mix and water to make 1000 mL.

c. Isotonic versions of F-75 (280 mOsmol/L), which contain maltodextrins instead of cereal flour and some of the sugar and which include all the necessary micronutrients, are available commercially.

How to prepare milk-based formulae (cont.)

• d. If cereal flour is not available or there are no cooking facilities, a comparable formula can be made from 25 g of dried skimmed milk, 100 g of sugar, 27 g of oil, 20 mL of mineral mix, 140 mg of vitamin mix and water to make 1000 mL. However, this formula has a high osmolarity (415 mOsmol/L) and may not be well tolerated by all children, especially those with diarrhea.

• e. To prepare the F-100 diet, add the dried skimmed milk, sugar and oil to some warm boiled water and mix. Add the mineral mix and vitamin mix and mix again. Make up the volume to 1000 mL with water.

• f. See "WHO Vitamin mix" and "WHO Mineral mix" tables. If only small amounts of feed are being prepared, it will not be feasible to prepare the vitamin mix because of the small amounts involved. In this case, give a proprietary multivitamin supplement. Alternatively, a combined mineral and vitamin mix for malnourished children is available commercially and can be used in the above diets.
# Milk vs RTUF

## Comparison of the nutritional composition of the 2 diets, per 100 gr

<table>
<thead>
<tr>
<th></th>
<th>F100</th>
<th>RTUF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>414</td>
<td>2281</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>2.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Lipid (g)</td>
<td>5</td>
<td>35.7</td>
</tr>
</tbody>
</table>

|                |      |      |
| **Minerals**   |      |      |
| Potassium (mg) | 212  | 1111 |
| Calcium (mg)   | 58   | 320  |
| Phosphorus (mg)| 58   | 349  |
| Magnesium (mg) | 15   | 92   |
| Zinc (mg)      | 2.1  | 14   |
| Copper (mg)    | 0.3  | 1.8  |
| Iodine (microgram) | 14 | 110  |
| Selenium (microgram) | 4 | 30   |
| Iron (mg)      | 0.4  | 11.5 |

F100: liquid, milk-based diet; RTUF: solid ready-to-use food  
## Milk vs RTUF

Comparison of the nutritional composition of the 2 diets, per 100 g

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>F100</th>
<th>RTUF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine (mg)</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Vitamin B-6 (mg)</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Vitamin B-12 (microgram)</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>9.7</td>
<td>53</td>
</tr>
<tr>
<td>Folic acid (microgram)</td>
<td>39</td>
<td>210</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>Biotin (microgram)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Pantothenic acid (mg)</td>
<td>0.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Retinol (microgram)</td>
<td>910</td>
<td></td>
</tr>
<tr>
<td>Vitamin D (microgram)</td>
<td>2.9</td>
<td>16</td>
</tr>
<tr>
<td>Vitamin K (microgram)</td>
<td>2.9</td>
<td>21</td>
</tr>
<tr>
<td>Vitamin E (mg)</td>
<td>3.9</td>
<td>20</td>
</tr>
</tbody>
</table>
**Vitamin D deficiency**

- Common in areas where there is not adequate exposure to sunlight due to higher latitudes or clothing
- can cause hypocalcemia, greenstick fractures, bowing of the legs
- Signs: Craniotabes, caused by thinning of the skull’s outer table
- Enlargement and delayed closure of the anterior fontanelle
- Frontal bossing of the skull
- Delayed eruption of the teeth and tooth enamel defects
- Beading of the ribs (rachitic rosary)
- Scoliosis, ie, spine curved side to side
- Exaggerated lordosis, ie, an inward curvature of the vertebral column, called “swayback” or “saddle back”)
- Radiographic changes include widening, concave cupping, and frayed poorly demarcated ends of long bones with metaphyseal flaring
Other vitamin deficiencies

- Iron – a common deficiency. Common cause of anemia, particularly in areas with prevalent hookworm and malaria – implicated in 60,000 deaths of women and children / year
- Folate – deficiency leads to 250,000 severe birth defects / year
- B12 - May be common factor in anemia in areas with strict vegetarian diets or no access to meat or dairy products because of drought
- Iodine -18 million babies born mentally impaired secondary to iodine deficiency
Mineral deficiencies

- Calcium
  - Tetany, Chvostek sign, Trousseau sign, and seizures and rickets
- Phosphate
  - Myopathy, rhabdomyolysis, bone pain, and osteomalacia or rickets.
- Magnesium
  - Muscle fasciculations, tremors, or spasms, personality change, and seizures
Re So Mal

Recipe for ReSoMal oral rehydration solution

**Ingredient Amount**

- Water (boiled & cooled)  
- WHO-ORS  
- Sugar  
- Electrolyte/mineral solution (see below)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (boiled &amp; cooled)</td>
<td>2 litres</td>
</tr>
<tr>
<td>WHO-ORS</td>
<td>One 1 litre-packet*</td>
</tr>
<tr>
<td>Sugar</td>
<td>50 g</td>
</tr>
<tr>
<td>Electrolyte/mineral solution</td>
<td>40 ml</td>
</tr>
</tbody>
</table>

ReSoMal contains approximately 45 mmol Na, 40 mmol K and 3 mmol Mg/litre.
Credits

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