MALNUTRITION IN CHILDREN
PROTEIN-ENERGY MALNUTRITION

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MALNUTRITION

- defined as a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain natural bodily capacities such as growth, pregnancy, lactation, learning abilities, physical work and resisting and recovering from disease. The term covers a range of problems from being dangerously thin (Underweight) or too short (Stunting) for one's age to being deficient in vitamins and minerals or being too fat (obese).

ICD-10

IV. ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASE
CHRONIC DISORDERS OF NUTRITION (CDN)

- Hypotrophy (undernutrition, protein-energy malnutrition, wasting)
- Hypostature (stunting) - CDN which characterized with evenly lag in height and weight beside the satisfactory state of nourishment and turgor of tissue. It is typical for children with congenital heart diseases, CNS malformation, endocrinopathy
- Paratrophy – CDN which accompanied with disorders of metabolism and characterized with excessive or normal body weight and increased hydrolability of tissue
**Protein energy malnutrition:**

- **Wasting:** reflects a recent and severe process that has led to substantial weight loss, usually associated with starvation and/or disease. *(low weight for height)*

Wasting is calculated by comparing weight-for-height of a child with a reference population of well nourished and healthy children. Often used to assess the severity of emergencies because it is strongly related to mortality.
**Protein energy malnutrition:**

- **Underweight:** measured by comparing the weight-for-age of a child with a reference population of well nourished and healthy children. *(low weight for age ->2\(\delta\))*

It is estimated that the deaths of 3.7 million children aged less than five are associated with the underweight status of the children themselves or their mothers *(source: Comparative Quantification of Health Risks, 2004).*
**Protein energy malnutrition:**

- **Stunting:** reflects shortness-for-age; an indicator of chronic malnutrition and calculated by comparing the height-for-age of a child with a reference population of well nourished and healthy children. *(low height for age ->2δ)*

According to the UN Standing Committee on Nutrition's 5th Report on the World Nutrition Situation (2005) **almost 1/3 of all children are stunted.**
Different Types of Childhood Malnutrition

- **Normal**: Low weight for height
- **Wasted**: Low height for age
- **Stunted**: Low weight for age
- **Underweight**: Low weight for age

*Normal height for age*
- WHO - World Health Organization  www.who.int
- WFP – World Food Programme  www.wfp.org
- FAO – United Nations Food and Agriculture Organization  www.fao.org
- UNSCN - United Nations Standing Committee on Nutrition  www.unscn.org
The World Health Organization defines malnutrition as "the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions."

Malnutrition is globally the most important risk factor for illness and death, contributing to more than 1/2 of deaths in children worldwide; child malnutrition was associated with 54% of deaths in children in developing countries in 2001.
CONSEQUENCES OF MALNUTRITION

- **Acute effects** on morbidity and mortality, health and survival:
  - Severe - more than an 8-fold greater risk of mortality;
  - Moderate – 4-5-fold greater risk of mortality;
  - Mild – 2-3-fold greater risk of mortality;

- **Long-term effects** on subsequent performance, cognitive and social development, physical work capacity, productivity, economic growth
UNICEF Model of Malnutrition (Adapted from 1991 UNICEF Model)
ETIOLOGY OF PROTEIN-ENERGY MALNUTRITION

Exogenous causes of PEM

1. **Nutritional factors**, connected with feeding difficulties in infancy (poverty, hypogalacty, abnormal breast nipples)
2. Infections, especially gastrointestinal tract infections
3. Toxic factor (e.g. using formulas with expired term of realization)
4. Anorexia
ETIOLOGY OF PROTEIN-ENERGY MALNUTRITION

Endogenous causes of PEM

1. Perinatal encephalopathy of various origin
2. Bronchopulmonary dysplasia
3. Congenital Heart disease
4. Syndrome of short intestine
5. Hereditary diseases of GIT
6. Primary malabsorption
7. Hereditary defects of metabolism
8. Endocrine diseases
9. Diathesis
PATHOGENESIS
HORMONAL IMBALANCE
(CATABOLIC TRENDS)

- ↑ catecholamine, glucagon, cortisol → 
  ↑ lipolysis, protein breakdown, gluconeogenesis;
- ↑ thyroid hormones;
- ↑ ADH → hyperaldosteronism;
- ↑ STH (but low level of somatomedins, insulin-like growth factor);
- ↓ insulin
WATER AND ELECTROLYTE IMBALANCE

- ↑ hydration (extracellular);
- Redistribution of liquid (↑ interstitial, ↓ VBC);
- ↓ VBC, filtration → ↑ADH etc.;
- ↑ Na (in intercellular space);
- ↓ K up to 25-30 mmol (N– 45-50);
- ↓ Mg, P, Fe, Zn, Cu
- ↓ Vit
DISORDERS OF PROTEIN METABOLISM

- ↓ total protein;
- ↓ albumin;
- ↓ transport protein (transferrin, ceruloplasmin, retinol binding protein);
- ↓ fibrinogen, blood-coagulation factors;
- Disorders of amino acid composition («preservation» of protein metabolism—inhibition of synthesis, slowing of albumin degradation, reutilization of amino acids, using of muscular protein)
DISORDERS OF LIPID METABOLISM

- Intensification of lipolysis (gluconeogenesis) → ↓ triglycerides, cholesterol, phospholipids;

- Disturbances of lipoproteid synthesis → balloon and adipose hepatosis
GIT

- Villous atrophy, disappearance of intestine brush border;
- ↓ secretion;
- ↓ intragastric acidity;
- ↓ lysozyme and secretory IgA;
- ↓ motility – hypotonia, dilatation, antiperistalsis;
- ↓ ↓ ↓
- Maldigestion, malabsorption, ascending contamination, worsening of PEM
Vicious cycle of undernutrition

Malabsorption

Dysregulated gut permeability

Inadequate dietary intake

Altered microbiota

Impaired immune responses

Enteric infections
CVS

- Centralization of circulation;
- Sympathicotonia;
- Severe degree – failure of adaptation, decentralization of circulation
IMMUNITY

- Disturbance of maturation of neutrophils, decrease in functional activity;
- Decrease in cell mediated immunity (↓CD4, disorders of CD4/CD8 ratio);
- Low affinity and specificity of Ig
PEM

Adequate response of adrenal cortex

Muscle protein mobilized

Plasma amino acid normal

Lipoprotein synthesis normal

Optimal increase in plasma cortisol

Plasma free fatty acid normal

No fat deposits in liver

Growth hormone response inhibition

Growth retardation
ICD-10
IV. ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES

Malnutrition (E40-E46)
- **E40 Kwashiorkor** - Severe malnutrition with nutritional oedema with dyspigmentation of skin and hair.
- **E41 Nutritional marasmus** - Severe malnutrition with marasmus
- **E42 Marasmic kwashiorkor** - Severe protein-energy malnutrition [as in E43]: intermediate form, with signs of both kwashiorkor and marasmus
- **E43 Unspecified severe protein-energy malnutrition**
- **E44 Protein-energy malnutrition of moderate and mild degree**
  - E44.0 Moderate protein-energy malnutrition
  - E44.1 Mild protein-energy malnutrition
- **E45 Retarded development following protein-energy malnutrition** Nutritional: short stature; stunting
- **E46 Unspecified protein-energy malnutrition**
## CLASSIFICATION OF PEM

<table>
<thead>
<tr>
<th>Severity (degree of weight loss)</th>
<th>Period</th>
<th>Origin</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – 11-20%</td>
<td>Initial</td>
<td>Prenatal</td>
<td>Exogenous</td>
</tr>
<tr>
<td>II – 21-30%</td>
<td>Progressing</td>
<td>Postnatal</td>
<td>• Alimentary (protein-energy deficiency)</td>
</tr>
<tr>
<td>III – 31% and more</td>
<td>Stabilization</td>
<td></td>
<td>• Infections</td>
</tr>
<tr>
<td>Atrophy</td>
<td>Convalescence</td>
<td></td>
<td>• Toxic</td>
</tr>
<tr>
<td>Marasmus</td>
<td></td>
<td></td>
<td>• Unfavorable conditions of life, regimen, care and hygienic education</td>
</tr>
<tr>
<td>Kwashiorkor</td>
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</tr>
</tbody>
</table>

### Endogenous Causes

- Diathesis
- Malformations
- Chromosome diseases
- Primary (hereditary) malabsorption
- Hereditary disorders of metabolism
- Immune insufficiency
- Neuroendocrine diseases etc

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Combined causes
## CLASSIFICATION

<table>
<thead>
<tr>
<th></th>
<th>I degree</th>
<th>II degree</th>
<th>III degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Ideal Body Weight</td>
<td>80-90%</td>
<td>70-79%</td>
<td>&lt; 70%</td>
</tr>
<tr>
<td>Percent of Usual Body</td>
<td>90-95%</td>
<td>80-89%</td>
<td>&lt; 80%</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>2.8-3.4</td>
<td>2.1-2.7</td>
<td>&lt; 2.1</td>
</tr>
<tr>
<td>Transferrin (mg/dL)</td>
<td>150 - 200</td>
<td>100 - 149</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>Total Lymphocyte Count</td>
<td>1200 - 2000</td>
<td>800 - 1199</td>
<td>&lt; 800</td>
</tr>
<tr>
<td>(per µL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC, cm</td>
<td>&gt;12,5</td>
<td>12,5- 11,0</td>
<td>&lt;11,0</td>
</tr>
</tbody>
</table>
Clinical effects of Malnutrition

- Ventilation - loss of muscle & hypoxic responses
- Psychology – depression & apathy
- Immunity – Increased risk of infection
- decreased cardiac output
- Renal function - loss of ability to excrete Na & H$_2$O
- Hypothermia
- Loss of strength
- Impaired wound healing
- Liver fatty change, functional decline necrosis, fibrosis
- Impaired gut integrity and immunity
- Anorexia

Adapted from Nutrition Now Workshop
MAIN SYNDROMES OF PEM

1. SYNDROME OF TROPHIC DISORDERS

2. SYNDROME OF GASTROINTESTINAL DISORDERS

3. SYNDROME OF CNS DYSFUNCTIONS

4. SYNDROME OF HAEMOPOIESIS DISORDERS AND IMMUNE REACTIVITY DECREASE
MAIN SYNDROMES OF PEM

1. SYNDROME OF TROPHIC DISORDERS:

- subcutaneous fat layer decrease,
- trophic disorders of skin, nails, hairs, muscles, inner organs
- plane weight curve, weight deficit,
- abnormality of constitution (body building)

- features of hypovitaminosis A, B₁, B₂, B₆, D, P, PP
MAIN SYNDROMES OF PEM

1. SYNDROME OF TROPHIC DISORDERS:

- **Iron** - Fatigue, anemia, decreased cognitive function, headache, glossitis, and nail changes
- **Iodine** - Goiter, developmental delay, and mental retardation
- **Vitamin D** - Poor growth, rickets, and hypocalcemia
- **Vitamin A** - Night blindness, xerophthalmia, poor growth, and hair changes
- **Folate** - Glossitis, anemia (megaloblastic), and neural tube defects (in fetuses of women without folate supplementation)
- **Zinc** - Anemia, dwarfism, hepatosplenomegaly, hyperpigmentation and hypogonadism, acrodermatitis enteropathica, diminished immune response, poor wound healing
MAIN SYNDROMES OF PEM

2. SYNDROME OF GASTROINTESTINAL DISORDERS:

- decrease in appetite down to anorexia,
- regurgitation, vomiting
- meteorism (bloating, flatus, gaseous distention)
- unstable stool with tendency to constipation, sometimes loose stool,
- dysbacteriosis,
- decrease in food tolerance,
- signs of maldigestion
3. SYNDROME OF CNS DYSFUNCTIONS

- disorders of emotional tonus and behavior,
- decrease in activity,
- domination of negative emotion,
- sleep and thermoregulation disorders,
- psychomotor retardation, muscle hypodystonia
4. SYNDROME OF HAEMOPOIESIS DISORDERS AND IMMUNE REACTIVITY DECREASE:

- Anemia,
- secondary immune deficiency state,
- tendency to insidious, atypical course of frequent infections inflammatory diseases.
MARASMUS – E41
(MARASMUS, MARASMSOS – EMACIATION)

• Progressing weight loss
• Emaciation and atrophy of subcutaneous fat layer and muscles
• Retardation of growth, retracted abdomen
• Apathy and irritability
• Dry, pale, cold skin with patches of hyperpigmentation
• Dry, dull, thin hair
• Achlorhydria (gastric anacidity) and diarrhea

In marasmus, the child appears emaciated. **Monkey face** secondary to a **loss of buccal fat pads** is characteristic of this disorder.
KWASHIORKOR – E40
(CICELY WILLIAMS, 1935)
“RED, GOLD BOY”, “RED-HAIRED BOY” «DISPLACED»

Tetralogy of Jelifar
- Edema;
- Retardation in physical development;
- Muscles atrophy with conservation of subcutaneous fatty layer;
- Retardation of neurologic-and-behavioral development.

Depigmentation, hyperpigmentation of skin
Depigmentation of hair
Hepato- and splenomegaly
Hypothermia
Apathy, lethargy
Anorexia
<table>
<thead>
<tr>
<th>Marasmus</th>
<th>Kwashiorkor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severely wasted</td>
<td>Often not wasted</td>
</tr>
<tr>
<td>No edema</td>
<td>Edema</td>
</tr>
<tr>
<td>Wasted face (monkey face)</td>
<td>Moon face</td>
</tr>
<tr>
<td>Little subcutaneous fat</td>
<td>Subcutaneous fat present</td>
</tr>
<tr>
<td>Severe muscle wasting</td>
<td>Muscle wasting variable</td>
</tr>
<tr>
<td>Albumins are normal</td>
<td>Reduced serum albumin</td>
</tr>
<tr>
<td>Urine urea maintained</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Reduced essential and nonessential amminoacid ratio</td>
</tr>
<tr>
<td></td>
<td>Enlarged fatty liver</td>
</tr>
</tbody>
</table>
Kwashiorkor VS Marasmus
MARASMIC KWASHIORKOR – E42
(SEVERE PROTEIN AND CALORIC MALNUTRITION ASSOCIATED WITH INFECTION)

- Atrophy
- Edema
- Fatty infiltration of liver
DIAGNOSTICS

- Taking history
- Clinical symptoms, anthropometry (m, h, MUAC, Chulitskaya’s index – 3MUAC + TC + SC – H, BMI)
DIAGNOSTICS

- Laboratory tests: general protein, albumin, lymphocytes, urea of blood, creatinin level of urine, electrolytes, Ca, glucose of blood
- Specification of etiology PEM (CHD, BLD, hereditary diseases, AIDS etc.)
- Monitoring of therapy efficiency – short-lived proteins (transferrin, retinol-binding protein)
COPROGRAMME

- «milk» disorder of nutrition – alkaline pH, increase in content of calcareous and magnesium salts;

- «floury» disorder of nutrition – acidic pH, increase in content of extracellular starch, digested fiber, fatty acids, mucous, leukocytes
TREATMENT OF PEM

1. Detection and elimination of PEM causes
2. Diet therapy
3. Arrangement of rational regimen, care, hygienic education, massage, gymnastics
4. Detection and treatment of infections foci, rickets, anemia and another complication and accompanying diseases
5. Enzyme therapy, vitamins therapy, stimulating and symptomatic therapy
PRINCIPLES OF DIET THERAPY

1. Using in the initial stage of treatment only easy assimilated food (breast milk, milk-based formulas – “Nutrilon”, “NAN”, “Bona”, specialized high-calorie formula – starter F75 - 75 kcal/100 ml, then - catch-up formula F100 – 100 kcal/100 ml)

2. Higher frequency and smaller volumes of feeding (7 for I degree PEM, 8 for II degree PEM, 10 for III degree PEM)

3. Monitoring: adequate systematic control of feeding, stool, diuresis, weight, intake of fluid (daily); regular calculation of food intake (every week), coprogramme (twice a week) etc.
DIET THERAPY OF PEM

Three phases of feeding of infants with PEM
1. The period of clearing-up of the food tolerance
2. Transitional (intermediate) period
3. Period of intensive feeding
### DIET THERAPY OF PEM

<table>
<thead>
<tr>
<th>Degree of PEM</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of clearing-up of the food tolerance</td>
<td>1-3 days</td>
<td>6-7 days</td>
<td>10-14 days</td>
</tr>
<tr>
<td>Food</td>
<td>Breast milk or formula feeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily amount of food</td>
<td>Complete or 2/3 of proper amount</td>
<td>2/3 or ½ of proper amount</td>
<td>½ or 1/3 of proper amount</td>
</tr>
<tr>
<td>Number of feeding</td>
<td>6-7 every 3-3.5 hr</td>
<td>8 every 2.5 hr</td>
<td>10 every 2 hr</td>
</tr>
<tr>
<td>Permissible daily addition of food</td>
<td>Complete amount without correction</td>
<td>100-150 ml every day</td>
<td>100-150 ml every two days</td>
</tr>
<tr>
<td>Criteria of changing of feeding number</td>
<td>No changing</td>
<td>On reaching of 2/3 food amount to carry out 7 feeding every 3 hr</td>
<td>On reaching of 1/2 food amount to feed 8 times every 2.5 hr</td>
</tr>
</tbody>
</table>
TREATMENT (WHO, 2003)

GENERAL PRINCIPLES FOR ROUTINE CARE of children with severe PEM

There are ten essential steps:
1. Treat/prevent hypoglycemia
2. Treat/prevent hypothermia
3. Treat/prevent dehydration
4. Correct electrolyte imbalance
5. Treat/prevent infection
6. Correct micronutrient deficiencies
7. Start cautious feeding
8. Achieve catch-up growth
9. Provide sensory stimulation and emotional support
10. Prepare for follow-up after recovery
10 STEPS FOR ROUTINE CARE OF CHILDREN WITH SEVERE PEM

<table>
<thead>
<tr>
<th>PHASE</th>
<th>STABILISATION</th>
<th>REHABILITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP</td>
<td>Days 1-2</td>
<td>Days 3-7</td>
</tr>
<tr>
<td>1.</td>
<td>Hypoglycemia</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Hypothermia</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Dehydration</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Electrolytes</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Infection</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Micronutrients</td>
<td>no iron</td>
</tr>
<tr>
<td>7.</td>
<td>Cautious feeding</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Catch-up growth</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Sensory stimulation</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Prepare for follow-up</td>
<td></td>
</tr>
</tbody>
</table>
1. TREAT/PREVENT HYPOGLICEMIA

NOTE: IF YOU ARE UNABLE TO TEST THE BLOOD GLUCOSE LEVEL, OR TEST IT QUICKLY, ASSUME ALL SEVERELY MALNOURISHED CHILDREN ARE HYPOGLYCEMIC AND TREAT ACCORDINGLY.

If the child is conscious, the blood glucose is <3mmol/l

- 50ml bolus of 10% glucose orally or by nasogastric tube;
- Then feed every 30 min for 2 hours (giving one quarter of the 2-hourly feed each time)
- Antibiotics and keep warm
- Then 2-hourly feeds, day and night

If the child is unconscious or convulsing

- IV 10% glucose (5ml/kg);
- Then feed every 30 min for 2 hours (giving one quarter of the 2-hourly feed each time)
- Antibiotics and keep warm
- Then 2-hourly feeds, day and night
**MONITOR:**

- repeat dextrostix with finger/heel prick blood after 2h. Once treated, most children stabilise within 30min. If blood glucose falls to <3mmol/l repeat 50ml bolus of 10% glucose or sucrose solution, and continue feeding every 30 min until stable
- rectal temperature: if this falls to <35.5°C, repeat dextrostix
- level of consciousness: if this deteriorates, repeat dextrostix.

**PREVENTION OF HYPOGLICEMIA:**

- feed 2-hourly, start straightaway (step 7) or if necessary, rehydrate first
- always give feeds throughout the night.
2. TREAT/PREVENT HYPOTHERMIA

If the rectal temperature is <35.5°C (<95.9°F)
- **rewarm the child**: either, clothe the child (including head), cover with a warmed blanket and place heater or lamp nearby (do not use hot water bottle), or put child on mother's bare chest (skin to skin) and cover them
- feed straightaway
- Antibiotic

Monitor:-
- rectal temperature 2-hourly until it rises to >36.5°C (take half-hourly if heater is used)
- ensure the child is covered at all times, especially at night
- feel for warmth
- check for hypoglycemia whenever hypothermia is found.
PREVENTION OF HYPOTHERMIA:

- feed 2-hourly, start straightaway (step 7)
- always give feeds throughout the day and night
- keep covered and away from draughts
- keep the child dry, change wet nappies, clothes and bedding
- avoid exposure (e.g. bathing, prolonged medical examinations)
- let the child sleep with the mother for warmth at night.
3. TREAT/PREVENT DEHYDRATION

**NOTE:** LOW BLOOD VOLUME CAN COEXIST WITH EDEMA.
DO NOT USE THE IV ROUTE FOR REHYDRATION EXCEPT IN SHOCK AND THEN DO
SO WITH CARE, INFUSING SLOWLY TO AVOID FLOODING THE CIRCULATION AND
OVERLOADING THE HEART.

**ReSoMal (Rehydration Solution for Malnutrition)** – 45 mmol Na, 40
mmol K, 3 mmol Mg per 1 l of solution
- ReSoMal 5ml/kg every 30min for 2h, orally or by nasogastric tube,
- 5-10ml/kg/h for next 4-10h
- begin feeding every 2 h day and night

**Monitor progress of rehydration:**-
- observe half-hourly for 2h, then hourly for the next 4-10h recording:-
  - pulse rate
  - respiratory rate
  - urine frequency
  - stool/vomit frequency

**Signs of overhydration are:**
- • increasing pulse rate (increase of 25 beats/min or more) *and*
- • increasing respiratory rate (increase of 5 breaths/min or more).
4. CORRECT ELECTROLYTE IMBALANCE

Give:-
- extra potassium 3-4mmol/kg/d
- extra magnesium 0.4-0.6mmol/kg/d
- when rehydrating give low sodium rehydration fluid (e.g. ReSoMal)
- prepare food without salt

The extra potassium and magnesium can be prepared in a liquid form and added directly to feeds during preparation. 20ml of this solution to 1 litre:
- Potassium Chloride – 224 g 24 mmol
- Tripotassium Citrate – 81 g 2 mmol
- Magnesium Chloride - 76 g 3 mmol
- Zinc Acetate – 8,2 g 300 μmol
- Copper Sulphate – 1,4 g 45 μmol
- Water make up to 2500 ml

Note: if available, also add Selenium (Sodium selenate – 0,028 g) and Iodine (Potassium Iodide 0,012 g) per 2500 ml
5. TREAT/PREVENT INFECTION

In severe malnutrition the usual signs of infection, such as fever, are often absent. Therefore assume that all malnourished children have an infection.

**Give routinely** on admission:
- broad-spectrum antibiotic(s) **AND**
- measles vaccine if child is ≥ 6m and not immunized (delay if in shock)

Note: Some experts routinely give **in addition** to broad-spectrum antibiotics, metronidazole (7.5mg/kg 8-hourly for 7 days) to hasten repair of the intestinal mucosa and reduce the risk of oxidative damage and systemic infection arising from the overgrowth of anaerobic bacteria in the small intestine.

- Where **specific infections** are identified, ADD
  - specific antibiotics if appropriate
  - antimalarial treatment if the child has a positive blood film for malaria parasites.
6. CORRECT MICRONUTRIENT DEFICIENCIES

- Although anemia is common, do **NOT** give iron initially but wait until the child has a good appetite and starts gaining weight (usually week 2) as giving iron can make infections worse.

- Vit A orally on Day 1 (if aged >1 year give 200,000 iu; age 6-12m give 100,000iu; age 0-5m give 50,000iu) unless there is definite evidence that a dose has been given in the last month.

- Give daily for at least 2 weeks:
  - Multivitamin supplement
  - Folic acid 1mg/d (give 5mg on Day 1)
  - Zinc 2mg/kg/d
  - Copper 0.3mg/kg/d
  - Iron 3mg/kg/d **but only when gaining weight.**
7. START CAUTIOUS FEEDING

In the stabilization phase a cautious approach is required because of the child's fragile physiological state and reduced homeostatic capacity.

The essential features of feeding in the stabilization phase are:

- small, frequent feeds of low osmolarity and low lactose
- oral or NG feeds (never parenteral preparations)
- 100 kcal/kg/d
- 1-1.5g protein/kg/d
- 130ml/kg/d of fluid (100ml/kg/d if the child has severe edema)
- if the child is breastfed, continue to breastfeed but make sure the prescribed amounts of starter formula are given.

Monitor and note:-
- amounts offered and left over
- vomiting
- stool frequency and consistency
- daily body weight
8. ACHIEVE CATCH-UP GROWTH

Readiness to enter the rehabilitation phase is signaled by a return of appetite, and loss of most/all of the edema.

To change from starter to catch-up formula:-

• replace starter F-75 with the same amount of catch-up formula F-100 for 48h then,
• increase each successive feed by 10ml until some feed remains uneaten. The point when some remains unconsumed is likely to occur when intakes reach about 30ml/kg/feed (200ml/kg/d).

Monitor during the transition for signs of heart failure:-

• respiratory rate
• pulse rate
8. ACHIEVE CATCH-UP GROWTH

After the transition give:-
- frequent feeds (at least 4-hourly) of unlimited amounts of a catch-up formula
- 150-220kcal/kg/d
- 4-6g protein/kg/d
- if the child is breastfed, encourage to continue

If weight gain is:
- poor (<5g/kg/d), child requires full reassessment
- moderate (5-10g/kg/d), check whether intake targets are being met, or if infection has been overlooked
- good (>10g/kg/d), continue to praise staff and mothers
9. PROVIDE SENSORY STIMULATION AND EMOTIONAL SUPPORT

Provide:-
- tender loving care
- a cheerful stimulating environment
- structured play therapy 15-30 min/d
- physical activity as soon as well enough
- maternal involvement when possible (e.g. comforting, feeding, bathing, play)
- T - 24-26°C, relative humidity - 60-70%
10. PREPARE FOR FOLLOW-UP AFTER RECOVERY

- Feeding
- Good care, sensory and emotional stimulation
- Regular follow-up checks
- Immunizations
- Vit and minerals
Enzyme replacement therapy – enzymes 1000U/kg/day lipase 3 times per day during meal or with main meals

Insulin + glucose (in the period of clearing-up of food tolerance, in case of low food tolerance, in the absence of weight gain)

Drugs with anabolic effects (in the period of intensive feeding and good weight gain):

- Inozin – 10mg/kg/day twice a day in the evening orally before meal for 3-5 weeks;
- Potassium orotas – 10mg/kg/day twice a day in the evening orally before meal for 3-5 weeks;
- Levocarnitin – 20% solution 3 times per day orally 30 min before meal for 4 weeks (5 drops – premature, 10 drops – before 1 year), 14 drops (1-3 year)
- Nandrolon – 0,5 ml/kg i.m. once a month for 3-6 month (with enzyme replacement therapy in case of severe weight and growth deficiency and bone age retardation)