• Occurs as a result of a relative or absolute deficiency of energy and protein.
• It may be primary, due to inadequate food intake, or secondary, as a result of other illness.
• For most developing nations.
• In children, starvation (protein-energy malnutrition, PEM) is manifest as the syndromes of kwashiorkor (malnutrition with oedema) and marasmus (malnutrition with marked muscle-wasting).
• In industrialized societies, protein-energy malnutrition is most often secondary to other diseases.

*Kwashiorkor-like secondary protein–energy malnutrition* occurs primarily in association with hypermetabolic acute illnesses such as trauma, burns, and sepsis.

*Marasmus-like secondary protein–energy malnutrition* typically results from chronic diseases such as chronic obstructive pulmonary disease (COPD), congestive heart failure, cancer, or AIDS.

**In Adults**

The predominant form of PEM is undernutrition results from a sustained negative energy balance.

**Etiology**

• Insufficient food supply
• Persistent regurgitation or vomiting
• Anorexia, Malabsorption
• Increased energy requirement e.g. thyrotoxicosis
• Increased calorie loss e.g. glucosuria in diabetes mellitus

Undernutrition often leads to vitamin deficiency esp. thiamin, folate and vit C. Diarrhea is also seen in these patients leading to loss of sodium, potassium and magnesium

**Pathophysiology**

• In the first 24 hours following low dietary intake, the body relies for energy on the breakdown of hepatic glycogen to glucose, then gluconeogenesis to maintain glucose levels.
• The majority of protein breakdown takes place in muscle releasing amino acids (used for gluconeogenesis), with eventual loss of muscle bulk.
• Lipolysis, The stored triglyceride is hydrolysed by lipase to glycerol (used for gluconeogenesis), and to non-esterified fatty acids that can be used directly as a fuel or oxidized in the liver to ketone bodies.

**Clinical features**

1. Loss of weight
2. Thirsty , weakness , feeling cold, nocturia , amenorrhea , impotence and craving for food
3. Lax , pale , dry skin , loss of turgor and occasionally pigmented patches
4. Hair thinning
5. Cold and cyanosed extremities , pressure sore
6. Muscle wasting
7. Loss of subcutaneous fat
8. Odema even in the absence of hypo albuminemia
9. Slow pulse , low blood pressure and small heart
10. Distended abdomen with diarrhea
11. Diminished tendon jerk
12. Apathy , loss of initiatives, depression introversion
13. Susceptibility to infections
The most common cause of death in famine is infections and the usual signs of infection may not appear

1. Gastroenteritis and gram negative septicemia
2. Respiratory infections esp. bronchopneumonia
3. Viral infections esp. measles and herpes simplex
4. Tuberculosis
5. Strep and staphylococcal infections
6. Helminthic infestation
   - All organs atrophy except the brain
   - Old people are more vulnerable to death

**Investigations**

In addition to calculation of BMI and measurement of arm circumference

1. Plasma free fatty acid increases
2. Ketosis and metabolic acidosis
3. Plasma glucose decreases
4. Serum albumin is normal
5. Urine has fixed specific gravity and creatinine excretion is low
6. Mild anemia, thrombocytopenia and leukopenia, Anaemia due to folate and iron deficiency, Eosinophilia suggests parasitic infestation.
7. ESR is normal unless there is infections
8. Delayed skin sensitivity tests e.g tuberculin test is false negative
9. ECG shows sinus bradycardia and small voltage

- Stools should be examined for parasitic infestations.
- Chest X-ray - tuberculosis is common and is easily missed if a chest X-ray is not performed.
Tube Feeding

Patients who are unable to swallow e.g. stroke patients, may require nutritional support

Types of nutritional support: Enteral and parenteral

Enteral route should be administered unless contraindications are present.

Enteral feeding should always be used if possible because it is cheaper than intravenous feeding and it prevents bacterial translocation from GIT and has a protective effects in multi organ failure.

Absorption through the small intestine presents most nutrients to the enterohepatic circulation.

- Reduces surges of glycemia and lipemia,
- Permits first-pass hepatic extraction of nutrients
- Stimulates physiologic endocrine responses to feeding.

Enteral nutrition

- For short term feeding, a fine nasogastric tube is used through which liquid food administered either as continuous infusion or bolus technique. In cases of gastric outlet obstruction or gastric stasis, nasojejunal tube instituted using endoscopy or radiologic techniques
- For long term feeding, a percutaneous endoscopic gastrostomy “PEG “placed which is more comfortable without irritation to the nasal mucosa and less likely for displacement or pulling out. Jejunal extension can be done through its tube for food delivery directly into the small bowel

Parenteral nutrition

- For short term support (for up to 2 weeks) liquid containing nutrient mixes can be infused via a peripheral vein. Solutions of high osmolality cause painful thrombophlebitis (e.g. dextrose solutions 5%, 10%, 50 %)
- For long term support, all in one mixture infused through a large cEnteral vein. Energy source is provided by carbohydrates usually glucose, the solution also contains amino acids, lipid emulsions electrolytes, trace elements and vitamins (amino acid “vamine”, “intralipid” …. “total parenteral nutrition TPN “

Cental parenteral nutrition: through subclavian or internal jugular veins has. These complications include

- mechanical complications of catheter insertion: pneumothorax, hemothorax, and injury to blood vessels, the brachial plexus, and the thoracic duct.
- Infectious complication: include tunnel and line sepsis, metastatic abscess, and right-sided endocarditis
- Severe hyperglycemia and fluid, acid-base, and electrolyte disturbances, as well as nutritional deficiencies, are more common with parenteral nutrition

INITIAL SUPPORTIVE CARE and REFEEDING

- Resuscitation with fluids and electrolytes may be necessary before beginning feedings.
- Mild to moderate starvation need extra food on an outpatient setting treatment , but severe starvation need hospital admission
- Initiation of feeding should be in small amounts owing to intestinal epithelial atrophy and diluted bile. Palatable combination of sugar, milk and oil is preferred with additional micronutrient like magnesium, Zink, and multivitamins
- Salt should be restricted
- Vitamin supplementation should be given routinely.
- Daily monitoring of body weight, fluid intake, urine output, and plasma glucose and electrolyte values is critical during the first few days of refeeding.
REFEEDING COMPLICATIONS:

- Refeeding can be harmful and may even cause death
- The adverse consequences caused by initiating feeding too aggressively are known as the refeeding syndrome and usually occur within the first 5 days.
- Refeeding syndrome complications include fluid overload, glucose intolerance, electrolyte imbalances, cardiac arrhythmias, and diarrhea.

**Fluid Overload**

- Severely malnourished patients are at increased risk for fluid retention and congestive heart failure after nutritional therapy because of compromised cardiac and renal function.
- Because the ability to excrete sodium is impaired, even normal amounts of dietary sodium intake can be excessive.

**Glucose Intolerance**

- Starvation and malnutrition impair insulin's ability to suppress endogenous glucose production Therefore, providing enteral or parenteral carbohydrates can cause hyperglycemia, glucosuria, dehydration, and hyperosmolar coma.
- Furthermore, because of the importance of thiamine in glucose metabolism, carbohydrate refeeding in patients who are thiamine deficient can precipitate Wernicke's encephalopathy.

**Mineral Depletion**

- Carbohydrate refeeding stimulates insulin release and intracellular uptake of phosphate, which is used for protein synthesis and glucose metabolism.
- Therefore, plasma phosphorus concentrations can sometimes fall precipitously after initiating nutritional therapy.
- Severe hypophosphatemia, associated with muscle weakness, paresthesias, seizures, coma, cardiopulmonary decompensation, and death.
- In addition, hyperinsulinemia during refeeding increases cellular uptake of potassium and can cause a rapid decline in extracellular concentrations.

**Cardiac Arrhythmias**

- Sudden death from ventricular arrhythmias can occur during the first week of refeeding in severely malnourished patients and has been reported in conjunction with severe hypophosphatemia.

**Gastrointestinal Dysfunction**

- Mild diarrhea after initiating oral-enteral feeding usually resolves and is not clinically important.
- However, in some severely malnourished patients, oral feeding is associated with severe diarrhea and death. Therefore, a search for enteric pathogens should be considered in patients with prolonged or severe diarrhea.

**Malnutrition in hospitalized population**

Once in hospital, patients may lose weight from poor appetite, concurrent illnesses, inadequate intake and keeping them "nil by mouth for investigations"

Malnutrition is still poorly recognized in hospitals, it might lead to:

- Impaired immunity and muscle wasting which in turn affects cardiac and respiratory function
- Apathy and withdrawal usually mistaken for depressive illness and poor cooperation with treatment
- Delayed wound healing after surgery and increased risk of post-operative infections