Laboratory assessment of nutritional status in children

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Malnutrition

CHO, proteins, lipids ,vitamins, mineral and trace elements are nutrients that are crucial for human life , growth and well being

Malnutrition : Inadequate intake or use of these nutrients
It is associated with risk of:

- impaired physiologic function
- increased morbidity and mortality

>50% of deaths among children < 5 years old have malnutrition

Causes of child mortality with malnutrition due to:

- diarrhea
- Infections : acute respiratory infection, measles etc..

Malnutrition:

Risk factors:

- Low socio-economic status
- Malabsorption
  - Chronic diarrhea
  - Chronic liver disease
  -Pancreatic diseases
  -Parasites infestation
- Post operative state (ileus with long periods without oral intake)
- Chronic disease: AIDS ,TB , chronic renal disease
- Hypermetabolic conditions:
  major burns; septicemia ;ARF ; multiple organic failure

Malnutrition

Early detection and treatment is needed to avoid morbidity and mortality :

- Increased rates of infections
- Impaired wound healing
- Extended lengths of hospital stay
- Higher mortality rates

Lab work up for malnutrition

Hematology:

- **FBC and peripheral smear :anemia from nutritional deficiency such as Iron ,folate and vit B12**

Biochemistry:

- **S-Pre-albumin and transferrin :better short term indicators of protein malnutrition**
- **S-Albumin : measure of long term malnutrition**
- **RBP**
- **S-BUN**
- **S-electrolytes and creatinine**
- **LFT**
- **Blood glucose**
- **CMP**

Microbiology/parasitology /Serology

- **Septic screening**
- **Stool and urine for parasites and bacteria**
- **HIV**

Lab work up for malnutrition

Other tests:

- Trace elements: Zn ; Iodine
- Creatinine /proline ratio
- Coeliac serology :

  -Screening test if family history or presence of other autoimmune diseases

  -IgA tissue transglutaminase Ab (IgA tTG)

  -IgA endomysial antibody (IgA EMA)

Complication of PEM:

- Hypoglycemia
- Hyponatremia
- Dehydration and shock
- Infections (bacterial ,viral and trush)
- Hypothermia

Ideal selection of serum proteins in malnutrition

- Proteins with a short biologic half-live reflecting changes in the serum
- Associated with an :
  - -Severe infection
  - -Stress injury
  - -End stage liver disease
  - -Renal disease

Ideal s-proteins:

- Albumin
- Transferrin
- Prealbumin
- Retinol binding protein (RBP)
- IGF-1
- Nitrogen balance

Albumin

- Long Biological ½ life of 20 days
- Not a good indicator of short term PEM
- Good indicator in chronic protein deficiency under conditions of adequate non-protein-calorie intake such chronic liver disease ,NS , PLE etc…
- Low S-alb : predictor of high morbidity and mortality in hospitalised patients

Classification of malnutrition from pl. albumin levels:

- Levels >35 g/l : normal
- Levels of 28 to 35 g/l : mild malnutrition
- Levels of 23 to 30 g/l : moderate malnutrition
- Levels < 25 g/l : severe albumin depletion

Transferrin

- Biologic half-life : 9 days
- Synthesized in the liver and binds and transports ferric iron
- High levels in iron deficiency(in proportion to deficiency)
- An early indicator in iron deficiency
- Last analyte to return to normal when iron deficiency is corrected
- More sensitive indicator of protein depletion than s-Alb
- Low levels can also be seen :
  -Nephrotic syndrome
  -Liver disorders
  -Neoplastic disease

Prealbumin

- Biological half-life : 2 days
- Each prealbumin subunit contains one binding site for RBP
- Major transport protein for thyroxin
- Better indicator of visceral protein status and positive nitrogen balance than albumin and transferrin
- Has a superior indicator for monitoring short term effects of nutritional therapy
- In protein-energy malnutrition, there is a greatly decrease levels of prealbumin and RBP complex ; but levels return towards normal after nutritional replenishment

RBP

- Biologic half-life : 12 hrs
- Can be used to monitor short term changes in nutritional status
- Interacts strongly with plasma prealbumin and circulates in the plasma as a 1:1 mol/l prealbumin-RBP complex

IGF-1

- Important for stimulation of growth
- Regulated by GH and nutritional intake
- Used as a nutritional marker
- Circulates in plasma bound to IGF-BP3
- IGF-BP3 modulates the biologic effect of IGF-1 in the stress response

Malnutrition

- Protein-calorie malnutrition: Kwashiorkor
- Calorie malnutrition : Marasmus
- Protein loosing enteropathy
- Stress hypermetabolism

Kwashiorkor

- **Calorie-protein malnutrition**
- **Maladaptive response to starvation where the body utilizes proteins and conserve s/c fat**
- **Significant muscle and nitrogen losses from proteolysis**

Clinical presentation :

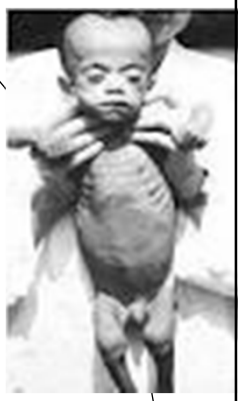
- **Edema**
- **Mental apathy**
- **Growth retardation**
- **Muscle wasting**
- **Desquamating patchy rash**
- **Hepatomegaly**
- **Dehydration (diarrhoea and vomiting)**
- **Signs of vitamin deficiencies**
- **Signs of infections**

Lab findings:

- **↓TP ; ↓ Alb; ↓ pre-alb**
- **↓BUN; ↓ Chol**
- **↓ transferrin ; ↓ ferritin**
- **↓ B12; ↓ folate ; ↓ lymphocyte count with severe anemia**

Marasmus (wasting)

- **Inadequate intake of proteins and calories**
- **An adaptive response to starvation , the body utilizes all fat stores before using muscle**
- **Seen most commonly in the 1st yr of life due to lack of breast feeding**



Clinical presentation :

- **Emaciation**
- **Severe loss of muscle tissue due to gluconeogenetic activity**
- **Severe loss of adipose tissue due to increased lipolytic activity**
- **Severe growth retardation ;child looks older than his age**
- **No edema or hair changes**
- **Alert but miserable ; child appears hungry**
- **Dehydration (diarrhoea)**
- **No protein deficiency : normal serum transport proteins levels**

Risk factors:

- **Poverty and famine**
- **Diarrhea**
- **Ignorance and poor maternal nutrition**

Protein loosing enteropathy

Loss of s-protein into the lumen of GIT due to increased permeability as a result of cell damage or death

Causes:

Any condition causing serious inflammation ,erosion, in the intestines such as :

- **Intestinal parasite or bacteria infection**
- **Coeliac sprue**
- **Necrotizing enterocolitis**
- **Measles**
- **Whipple disease**
- **TB ; sarcoidosis**
- **Lymphatic obstruction**

Symptoms :

- **depend on underlying disease**
- **Diarrhea with or without bleeding**
- **Fever**
- **Abdominal pain and /or weight loss**
- **Edema secondary to decreased pl.oncotic pressure**

Lab workup of Protein loosing enteropathy

- ↓ s-alb (exclude NS, chronic liver disease ,malnutrition)
- ↓ Igs and lymphocytes
- Abnormal presence of α-1 antitrypsin in stool (important in diagnostic) :
  - α-1AT is an endogenous protein not present in diet , not normally actively secreted , absorbed or digested ; not secreted in urine
  - α-1AT is stable in feces at 37 ° C ; detected by IMX
- ↓ fat soluble vitamins (ADEK) in fat malabsorption if lymphatic obstruction

Imaging Tests :MRI or CT of abdomen

Histologic findings: Biopsies for definitive diagnosis of underlying disease

Stress hypermetabolism

- Catabolic state associated with stress injury (trauma ,burns and sepsis)
- Driven by cytokines release (IL-1, IL-6 and TNF- α); proportionate to the amount of injury
- Linked to the release of stress hormones such as cathecolamine ,glucagon , GH,cortisol and thyroid hormones
- Cathecolamine and glucagon stimulate hepatic glycogenolysis
- Adrenal cortisol opposes the effects of insulin (insulin resistance):
  - -muscle proteolysis provides gluconeogenic precursors through alanine
  - -Muscle weakness and wasting

Stress Hypermetabolism will result in:

- Hyperglycemia
- Release of FFA and associated ketosis
- Release of IGF-I
- Increase metabolic rate
- Negative nitrogen balance from gluconeogenesis due to massive proteolysis (conversion of lean body protein to a.a)

Stress hypermetabolism

- Patients may become marasmic when the gradual loss of fat tissue is associated with starvation
- Kwashiorkor is also present in stress injury when there is visceral protein loss