

## Principles of Nutrition Assessment

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## Clinical Manifestations

- Impaired cellular immunity
- Impaired wound healing
- End organ dysfunction



## Significance of nutritional assessment

*“Nutritional assessment is the first step in the treatment of malnutrition. An optimal scheme of nutritional assessment enables the clinician to quickly detect the presence of malnutrition and provides guidelines for nutritional therapy. Although advanced cases of malnutrition are often obvious to inspection, nutritional assessment provides an objective characterization for the detection of premorbid states.”*  
(Blackburn, 1977)

- Goal of nutrition support
  - Promote positive clinical outcomes due to an illness and/or improve a patient's quality of life

Blackburn GL, et al. JPEN 1977; 1: 17

## Nutrition Deficiency States

- Acute
  - Kwashiorkor
    - I. Rapidly developing, catabolic state typically secondary to stress
    - II. Adequate caloric intake with a relative protein deficiency
    - III. Depletion of visceral proteins and preservation of adipose tissue
- Chronic
  - Marasmus
    - I. Chronic condition
    - II. Deficiency in intake and/or utilization of nutrients
    - III. Wasting of somatic proteins and adipose tissue
  - Mixed Kwashiorkor-Marasmus
    - I. Chronically ill, acutely stressed
    - II. Wasting of somatic proteins, adipose tissue, and decreased synthesis of visceral proteins

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## Malnutrition

- Significance
  - Morbidity and mortality (M & M)
    - I. Changes in weight reflecting significant loss of body mass have been shown to correlate with an increased risk in M & M
- Risk factors
  - I. Underlying disease states
  - II. Altered dietary intake
  - III. Altered nutrient metabolism/absorption
  - IV. Socioeconomic factors

## Kwashiorkor

- Edema
- Impaired immune system
- Often patients appear normal



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## Marasmus

- Severe weight loss
- Impaired immune system
- Musculoskeletal dysfunction
- Thin and cachectic appearance



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## Anthropometrics

- Height
  - Typically affected by chronic states
    - Growth hormone deficiency
    - Chronic malnutrition
- Weight
  - Reflective of body fat, skeletal, and lean body mass
  - Representative of both acute and chronic in overall health and nutritional status

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## Mixed kwashiorkor-marasmus

- Thin and edematous
- Musculoskeletal wasting
- Impaired immune system
- Poor wound healing



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## Practice calculation

CW is a 55 yo man admitted last week after sustaining multiple injuries in a motor vehicle accident. His weight on admission was 100 kg and his height was recorded as 6' 1". He had intestinal injury which required surgical resection of small bowel and ileostomy. There has been no drainage from the ileostomy as yet, and his current management includes a nasogastric tube for gastric/bowel decompression and parenteral nutrition. His medication list includes ranitidine, cefotetan, and morphine.

- Evaluate CW's weight.
 
$$\begin{aligned} \text{IBW} &= 50 + 2.3 (\# \text{ of inches above } 5 \text{ ft}) \\ &= 50 + 2.3 (13) \\ &= 79.9 \text{ or } 80\text{kg} \end{aligned}$$
- ABW is >120% of IBW → use  $\text{IBW}_{\text{adj}}$ 

$$\begin{aligned} \text{IBW}_{\text{adj}} &= [(\text{ABW} - \text{IBW}) \times 0.3] + \text{IBW} \\ &= 86\text{kg} \end{aligned}$$

## Nutritional Assessment

- History
  - Social → income, activity level, living situation
  - Surgical/Medical → surgical procedures, chronic diseases, dietary supplements
  - Dietary → food/drug interactions, food intolerance, drug/alcohol abuse
- Physical exam
  - General → edema, ascites, obesity, alopecia
  - Skin/mucus membranes → decubitus ulcers, poor skin turgor, dermatitis
  - Musculoskeletal → muscle atrophy, retarded growth
  - Neurologic → ataxia, night blindness, encephalopathy
  - Hepatic → jaundice, hepatomegaly

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## Anthropometrics

- Body mass index
  - Method used to categorize obesity in adults
  - Inaccurate in geriatric patients as BMI increases with age
- Mid-arm skinfold thickness / mid-arm muscle circumference
  - Methods used to assess subcutaneous fat by comparing measurements to population standards
  - Standards do not account for differences in bone structure, obesity, and muscle mass
  - Technique used in assessment may cause up to 30% variation in measurements

## Laboratory and Biochemical Assessment

- Visceral proteins
  - Albumin
    - I. Function → transport molecule, plasma oncotic pressure
    - II. Large body pool size, large extravascular distribution, and long half-life
    - III. Advantages
      - a. Low levels correlate with chronic malnutrition
      - b. Provides a baseline marker of nutritional status
      - c. Commonly used laboratory test
    - IV. Disadvantages
      - a. Long half-life
      - b. Affected by comorbid diseases

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## Laboratory and Biochemical Assessment

- Immunologic markers
  - Total lymphocyte count (TLC)
    - I. Reflective of total number of circulating lymphocytes
    - II. Affected by immunosuppressive agents and critical illness
  - Delayed cutaneous hypersensitivity (skin test)
    - I. Evaluates cellular immunity
    - II. Antigen injected under skin → No response may indicate malnutrition
    - III. No longer used as an assessment of nutritional status due high incidence of scarring at the injection site

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## Laboratory and Biochemical Assessment

- Visceral proteins
  - Transferrin
    - I. Function → Binds and transports ferric iron to the liver for storage
    - II. Smaller body pool size (100 mg/kg) vs. albumin and shorter half-life
    - III. Advantages
      - a. Reflective of acute protein deficiency
      - b. Commonly used laboratory test
      - c. Can be calculated using Total Iron Binding Capacity (TIBC)
    - IV. Disadvantages
      - a. Affected by comorbid states → critical illness, hydration status, and iron stores

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## Laboratory and Biochemical Assessment

- Nitrogen balance
  - Measurement of amino acid metabolism
    - I. Advantages
      - a. Allows for baseline assessment of patient's metabolic state
      - b. Provides means for acute assessment of nutritional supplementation
    - II. Disadvantages
      - a. Potential for unmeasured losses
      - b. Requires 24 hour urine collection
      - c. Unclear relationship to caloric intake
      - d. Requires adjustment for changing BUN

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## Laboratory and Biochemical Assessment

- Visceral proteins
  - Prealbumin (transferrin)
    - I. Function → Transports thyroxine and retinol-binding protein
    - II. Small total body pool size vs. albumin / transferrin, short half-life
    - III. Advantages
      - a. Most useful parameter for detecting short-term effects of nutritional changes
      - b. Reflective of nutritional changes within 3 days of altered nutrient intake
    - IV. Disadvantages
      - a. Rapidly declines in response to acute stress or illness

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## Practice calculation

The same 55 year old trauma patient has now been hospitalized for one week. The physician asks you what laboratory data you would like to have drawn in order to evaluate this patient's nutritional status.

1. Laboratory data → albumin, prealbumin, transferrin, +/- WBC w/ differential, 24 hour urine collection

The physician agrees to draw an albumin, prealbumin, and transferrin

Alb 3.0 g/dL      prealbumin 15mg/dL      transferrin 125mg/dL

2. What is your interpretation of the laboratory data?

Patient is moderately under nourished → reassess and adjust nutrition supplementation

## Assessment of Nutritional Requirements

- Nutritional requirements
  - Factors affecting nutritional requirements
    - Age, size, gender, physical activity, disease state, and clinical condition
  - Recommended daily allowances (RDAs)
    - Nutrient requirements adequate to meet the needs of all healthy persons
    - Values are overestimations so that 2/3 of the recommended value would be sufficient

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## Assessment of Nutritional Requirements

- Daily energy requirements calculations
  - Weight-based methods
    - I. Simplest method, based on population estimations
    - II. Do not account for differences in energy expenditure due to age and gender
  - Harrison-Benedict equation (HBE)
    - I. Considered to be a more accurate assessment vs. weight-based methods
    - II. Incorporates height, age, gender, and clinical condition of patient
    - III. Calculates basal energy expenditure (BEE)
    - IV. BEE is modified (multiplied) by factor representative of a patient's clinical condition (stress factor)
  - Patients < 60 years old
    - BEE (male) =  $66 + 13.7 (\text{wt}) + 5 (\text{ht}) - 6.8 (\text{age})$
    - BEE (female) =  $655 + 9.6 (\text{wt}) + 1.8 (\text{ht}) - 4.7 (\text{age})$

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## Assessment of Nutritional Requirements

- Energy and protein requirements
  - Energy allowances
    - I. Men: 2300 – 2900 kcal/day
    - II. Women: 1900 – 2200 kcal/day
  - Factors influencing energy requirements and expenditure
    - I. Physical activity
    - II. Stress / illness
    - III. Basal metabolic expenditure
    - IV. Environment
    - V. Maintenance vs. anabolism vs. catabolism

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## Practice calculation

Due to the poor nutritional status of the 55 year old trauma patient the physician has requested that you take over provision of nutritional therapy for this patient. Using the Harrison-Benedict equation determine what this patient's energy requirements.

1. BEE (male) =  $66 + 13.7 (\text{wt}) + 5 (\text{ht}) - 6.8 (\text{age})$   
=  $66 + 13.7 (86 \text{ kg}) + 5 (185.4 \text{ cm}) - 6.8 (55)$   
1797.2 kcal (calories) or 1800 calories
2. Stress factor → 1.3 – 1.6 = a range of 2340 to 2880 kcal

## Assessment of Nutritional Requirements

- Terminology of energy requirements
  - Basal metabolic rate (BMR)
    - At complete rest
  - Basal energy expenditure (BEE)
    - Physiologic functions only; varies with age, body size, and sex
  - Resting energy expenditure (REE)
    - At rest with minimal activity; approx. 10% greater than BMR
  - Total energy expenditure (TEE)
    - Total daily energy requirements; includes BMR and increases in demands due to clinical state

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## Assessment of Energy Expenditure

- Indirect calorimetry
  - Most accurate method for estimating energy requirements
  - Measures actual REE and provides information on substrate utilization
  - Represents expenditure at the point in time the test is performed
  - Results are extrapolated to represent a 24 hour period
  - Uses the measurement of oxygen ( $\text{VO}_2$ ) and carbon dioxide ( $\text{VCO}_2$ ) content in expired air

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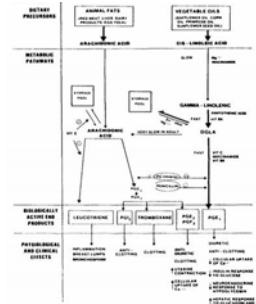
## Assessment of Energy Expenditure

- Respiratory quotient (substrate utilization)
  - RQ allows nutrient administration to be tailored to meet patient needs
- On a Kcal per Kcal basis carbohydrates (CHO) produce 21% more CO<sub>2</sub> than fat
- RQ values and interpretation
  - I. < 0.85 = fat and/or protein oxidation → provide more CHO
  - II. 0.85 – 1.0 = ideal metabolic use of nutrient supplementation
  - III. > 1.0 = CHO oxidation → provide more lipids

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## Assessment of Energy Expenditure

- Fat requirements
  - Fats (lipids) are required to provide essential fatty acids (EFA)
- EFA → cell membranes, prostaglandins, immune mediators
  - I. Omega-6 fatty acids (Linoleic acid)
  - II. Omega-3 fatty acids (Linolenic acid)



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## Assessment of Energy Expenditure

- Protein utilization
  - Protein requirements are based on nutritional status and clinical condition
    - I. Unlike energy requirements protein requirements do not decrease with age
    - II. Metabolism and elimination of protein is dependent upon kidney and liver function
    - III. Critical ill patients have elevated protein requirements
- Protein requirements
  - Healthy, maintenance → 0.8 – 1.0 g/kg/d
  - Mild – moderate stress → 1.0 – 1.5 g/kg/d
  - Moderate – severe stress → 1.5 – 2.0 g/kg/d

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## Fluid and electrolyte requirements

- Fluids
  - Holliday-Segar method  
= 1500 mL + 20 mL/kg/d (each kg > 20) OR 30 – 35 mL/kg/d
  - Patients with increased sensible losses require increased supplementation
- Electrolytes
  - Supplementation is dependent upon route of administration
  - Renal dysfunction or failure may limit supplementation
  - Refeeding syndrome requires increased electrolyte supplementation
  - Excessive fluid and electrolyte losses may influence supplementation

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## Assessment of Energy Expenditure

- Optimizing protein utilization
  - Protein should be used for maintenance of physiologic structure and function – **NOT FOR ENERGY**
    - I. Tissues require glucose for metabolic function
    - II. Sufficient non-protein calories (NPC) must be provided to minimize the conversion of protein into glucose
    - III. Minimum amount of glucose required to prevent gluconeogenesis
      - Brain → 120 g/d
      - Blood → 30 – 40 g/d
      - Wound tissue → 20 – 60 g/d
  - Minimum of 200g glucose required per day to prevent protein degradation

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## Vitamins and trace elements

- Vitamins
  - Most people who eat a well balanced diet do not need vitamin supplementation
    - I. Inadequate intake → alcoholics, elderly, severe calorie-restricted diets
    - II. Increased requirements → severe injury, surgery, severe infection, trauma
    - III. Poor absorption → chronic diarrhea, GI malignancy, short bowel syndrome,
    - IV. Iatrogenic losses → INH, laxatives, bile acid sequestrates
  - Supplements that supply 100% of RDA are sufficient in most cases.
    - I. Supplements containing > 150% of RDA are prescription only
  - Vitamin classification
    - I. Fat soluble → A, D, E, and K
    - II. Water soluble → all others
  - Trace elements
    - I. Serve as co-enzymes in hormonal metabolism, function, and in erythropoiesis

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## Questions

