Assessment or nutritional status – what are we measuring?

Blood tests in the assessment of nutritional status - an overview

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Blood tests in the assessment of nutritional status - an overview

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Development of malnutrition

Intake lower than required

Decreasing deposits

Biochemical changes

Anatomical and functional changes
The slope of malnutrition

Malnutrition

↓ Cell mass

↓ Visceral protein synthesis

Organ dysfunction

↓ Immun defense

Infections

MODS

MORS

+ Inflammation
Malnutrition & disease

Anorexia ➔ Low dietary intake

Disease ➔ Inflammation

Catabolism ➔ Protein synthesis ➔ Protein degradation

Waste of fat ➔ muscles

Waste of tissue

Waste of both fat and muscles
Nutritional status

Screening
- Weight & BMI
- Weight curve
- Appetite

Nutritional assessment
- Dietary intake
- Body composition
- Function
- Biochemical indices
  - Protein/energy intake
  - Specific deficiencies
  - Comorbidity
Factors affecting the interpretation of blood tests

**Medical**
- Disease
- Inflammation/trauma/malignancy
- Weight loss

**Constitutional**
- Age, sex, genetics

**Behavioral**
- Physical activity
- Dietary intake

**Pharmacological**
- Drugs

**Physiological**
- Homeostatic regulation
- Circadian variation
- Endocrine variation
- Interaction between nutrients

**Technical**
- Contamination
- Sampling errors
- Accuracy & precision
- Sensitivity & specificity

Easier to get than to interpret!
Serum values in relation to physiology

- Overhydration
  \[ x = \text{amount} \text{ volume} \]
- Dehydration
- Redistribution
- Synthesis
- Elimination
Serum samples in relation to total body water

%  

0 100  

[Albumin] 40g/l ≈ 140g in PV

[Albumin] 15 g/l ≈ 180g in PV
ESR Erythrocyte sedimentation rate

ESR = mm sedimentation of erythrocytes in 1 hr

↑ Fibrinogen
↑ Immunoglobulins
↓ Albumin
↓ Erythrocyte count

General index of inflammation
Biochemical indices decreasing with low protein/energy intake or malnutrition

<table>
<thead>
<tr>
<th>Index</th>
<th>half life</th>
<th>relative cost</th>
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</thead>
<tbody>
<tr>
<td>S-albumin</td>
<td>([t^{1/2}=20 \text{ d}])</td>
<td>1</td>
</tr>
<tr>
<td>S-transferrin /TIBC</td>
<td>([t^{1/2}=8 \text{ d}])</td>
<td>1</td>
</tr>
<tr>
<td>S-Orosmucoid</td>
<td>([t^{1/2}=5 \text{ d}])</td>
<td>2</td>
</tr>
<tr>
<td>S-Prealbumin/transthyretin</td>
<td>([t^{1/2}=1-2\text{d}])</td>
<td>3</td>
</tr>
<tr>
<td>S-IGF-1 insulin like growth factor</td>
<td>([t^{1/2}=1 \text{ d}])</td>
<td>7</td>
</tr>
<tr>
<td>S-RBP retinol binding protein</td>
<td>([t^{1/2}=0.5 \text{ d}])</td>
<td>2</td>
</tr>
<tr>
<td>Lymphocyte count</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>S-Creatinine, K, Mg, PO4, (glucose) (Na) (Ca(_2^+))</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Biochemical indices for nutrition assessment/PEM

**S-albumin**

\[ \approx 35-50 \text{g/l} \quad \text{normal range} \]
\[ > 50 \text{g/l} \quad \text{dehydration?} \]
\[ < 35 \text{g/l} \quad \text{malnutrition, overhydration, inflammation} \]
\[ < 25 \text{g/l} \quad \text{leakage (GI/renal/burns), cirrhosis, malignancy} \]

Hypoalbuminemic edema rare > 20g/l

Albumin **transports** Ca, Mg, Zn, Se, as well as bilirubin, lipids, FFA, drugs...

whose **serum levels will decrease** during inflammation, in parallel with albumin

More prognostic than nutritional index!
Biochemical indices to assess nutritional status/PEM

S-transferrin/TIBC

≈45-70μmol/l normal range (≈2-4g/l)

Low TIBC: protein malnutrition, alcoholism, inflammation

High TIBC: Iron deficiency, estrogen, 17-α-AAS

S-orosomucoid

≈0.55-1.05g/l normal range

Low: protein losses, malnutrition

High: inflammation
Biochemical indices to assess nutritional status/PEM

S-transthyretin/prealbumin

≈0.3g/l normal range
High TT/PA uraemia, dehydration, alcoholism
Low TT/PA Fasting, malnutrition/malabsorption, inflammation, pregnancy, cirrhosis, overhydration

Quick response to nutrition support, but insensitive to adapted starvation.
Biochemical indices to assess nutritional status/PEM

**S-RBP** retinol binding protein

- ≈60mg/l normal range
- High RBP uraemia, alcoholism
- Low RBP malnutrition/malabsorption, Vit A deficiency, cirrhosis,

Quick response to nutrition support/ recent dietary intake, but insensitive to adapted starvation.
Biochemical indices to assess specific nutritional status

Vitamins:
- Fat soluble: S-A, D, E (K as INR)
- Water soluble: S-B12, S/B- folate (S/WBC-C, B1, B6...)

Electrolytes
- (t)U-Na, U-K, U-Cl (t)U-Na<10 mmol/l = Na-depletion

Protein
- tU-N: Low: Starvation / chronic inadequate intake
- High: Excess dietary protein, catabolism/inflammation
  tU-urea (≈80% of U-N), tU-creatinine (≈2kg muscle/mmol)

Minerals
- tU-Mg, (tU-Ca), tU-I2, S-Zn, S-Se, S-Ferritin/ Fe+TIBC
  Low urine excretion values indicate depletion
Biochemical indices as acute phase reactants (APR)

Positive APR:
- CRP \( [t^{1/2} \ 0.8d] \)
- Orosmucoid
- Fibrinogen
- Ferritin

Negative APR:
- Albumin
- Prealbumin/
  transthyretin
- RBP
- Transferrin / TIBC
- \( Fe \)
- IGF1

Abnormal indices could be driven by inflammation rather than malnutrition – always check CRP!
Serum levels of IGF-1 in SBS patients during 4 days of nutrition therapy on a metabolic ward

Serum levels of IGF-1 and CRP in major abdominal surgery

Plank, Ellegård & Hill unpublished
## Effects of inflammation on serum levels of vitamins and minerals

<table>
<thead>
<tr>
<th>Blood test</th>
<th>Reference</th>
<th>CRP&lt;15</th>
<th>CRP&gt; 100 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>18-30umol/l</td>
<td>-40%</td>
<td>-60-90%</td>
</tr>
<tr>
<td>Zn (Ca, Mg)</td>
<td>11-17umol/l</td>
<td>-10%</td>
<td>-40-60%</td>
</tr>
<tr>
<td>Se</td>
<td>0,8-2 umol/l</td>
<td>-10%</td>
<td>-40-60%</td>
</tr>
<tr>
<td>Cu</td>
<td>10-24 umol/l</td>
<td>+10%</td>
<td>+ 30%</td>
</tr>
<tr>
<td>Vit A</td>
<td>1-2,8 umol/l</td>
<td>-40%</td>
<td>-40%</td>
</tr>
<tr>
<td>Vit E</td>
<td>15-40 umol/l</td>
<td>=</td>
<td>-30%</td>
</tr>
<tr>
<td>Vit B12</td>
<td>110-600pmol/l</td>
<td>=</td>
<td>= (no change)</td>
</tr>
<tr>
<td>Folate</td>
<td>5-30nmol/l</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>β-carotene</td>
<td>90-300ug/l</td>
<td>-50%</td>
<td>-90%</td>
</tr>
</tbody>
</table>

Effect of the inflammatory response on trace element and vitamin status
Summary

- Malnutrition could be detected by several biochemical indices
- Most of these (serum) indices are severely affected by acute or chronic inflammatory responses
- Biochemical indices of malnutrition must be related to the extent of APR, e.g., by CRP
- If APR is present, malnutrition might better be diagnosed by anthropometry/body composition methods