Biochemical parameters

Urea
The liver produces urea if amino acids break down. Urea production is bigger after a protein rich meal and when endogenous catabolism is increased (infections, internal bleedings, intoxication, fever and after tissue damage). Healthy kidneys will excrete a big quantity of urea without elevation of the plasma concentration of urea.
The urea clearance is depending on hydration and diurese. In dehydration an increased urea level is found.

Causes of an increased urea concentration:

A. Also an elevated kreatinine concentration: Kidney function is disturbed, post-renal obstruction and decreased renal circulation.
B. Also a normal kreatinine concentration:
    1. Increased tissue break down
    2. Sodium deficiency (by diuretics)

Causes of a decreased urea concentration:

a. Low protein nutrition
b. Cachexia
c. Extreme liver-insufficiency

Reference value: 3.0 – 7.0 mmol/ l

Transferrin
Transferrin is produced in the liver. It is a transport-protein for iron and zinc. It can also be used as a marker for iron status in the body. In iron-deficiency the serum transferrin increases. In illness transferrin is low because the liver produces less transferrin. Anaemia and nephrosis also influence transferrin. Transferrin is a marker of visceral protein and a useful marker of early malnutrition.

Reference value
The academic hospital of Maastricht (Maastricht UMC+) uses 1.65 – 3.10 g/ l. Spiekerman uses a reference value of 225-400 mg/ dl. According to Spiekerman a value of 150-200 mg/ dl indicates mild malnutrition, 100-150 mg/dl is mediate malnutrition and <100 mg/ dl points at severe malnutrition.

Interaction
Iron stores affect serum transferrin, this marker is also affected by the presence of inflammation. False low values are found in patients who use antibiotics. Transferrin decreases in metabolic stress situations. Shenkin writes that transferrin-concentration is only influenced by protein-intake, not by energy-intake. In patients with a low protein and energy-intake the serum transferrin decreases after 24 days.
The half-life is 9 days.

Literature

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Prealbumin

It is a sensitive indicator for protein-deficiency. Prealbumin increases with nutritional therapy, even when the disease is not getting better. It decreases fast in case of a low energy-intake, even if protein-intake is adequate. It decreases however also in case of inflammation and is depending on hydration. Careful interpretation of prealbumin values in the clinical setting is advised. Prealbumin (transthyretine or thyroxinebinding pre-albumin) in serum. This assay is more expensive than the assay of albumin. In MUMC+ this parameter not often used.

- Reference values 15-40 mg/ dl
- 10-15 mg/ dl is mild malnutrition
- 5-10 mg/ dl indicates moderate malnutrition
- < 5 mg/ dl is severe malnutrition
- It is a negative acute phase protein
- It is synthesised in the liver and broken down in the kidney
- This protein carries thyroxin (protein hormone, produced in the thyroid gland)
- It is a carrier protein for RBP (retinol binding protein -> transport of vitamin A)
- the half-life is two days
- the body pool is small: 10 mg/ kg body weight

Literature

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Pointdeficienties
Screening on point-deficiencies using medical- and food questionnaires. Only in severe deficiencies this is shown in the blood.

Reference-values
- Iron:
  Men 14- 27umol/l
  Women 11-25 umol/l
- Sodium:
  132 – 145 mmol/l
  1 mmol = 23 mg
- Potassium:
  3.60-5.00 mmol/l
  1 mmol = 39 mg
- Vitamin B12: 150 – 630 pmol/l
- Vitamin B1: 85-155 nmol/l
- Vitamin A: 1,1 – 3,0 umol/l
- Vitamin E:15,6 – 43,8 umol/l
- Magnesium:0,75 – 1 mmol/l
- Selenium: 0,91 –1,52 umol/l
- Zinc:10-19 umol/l

Lymfocytes (white bloodcells)
The total lymphocytes-count is not a sensitive index for malnutrition, because it reacts very slowly to recovery from malnutrition. The total amount of lymphocytes can be increased in case of inflammation, radio- and chemotherapy.
- Reference values 2000-3500 cells/ mm3.
- During malnutrition there is a dysmaturity of lymphocytes, so the total lymphocytes-count can be less than1500/ mm3.

Total count
The most used parameter for immunity is the total lymphocytes-count, which is diminished in malnutrition. This parameter is determined by multiplying the percentage lymphocytes and the amount of white blood cells (leukocytes). A value between 900-1500 mm³ points at moderate malnutrition, a value beneath 900 mm³ is severe malnutrition. This is a routine-measurement, it is cheap and easy to determine, but it is not useful in infectious diseases, in plasmapheresis or in oedema or dehydration.

Hemoglobin (Hb)
This parameter can be used to determine the response to illness. In illness Hb deceases very fast.

Reference values

- Reference values: for men 8,6-10,9 mmol/ l and for women 7,4-9,6 mmol/ l.
- In illness Hb decreases fast.

An acute decrease in Hb is caused by dilution: vasodilatation, Increase of fluid in the in the blood. If Hb decreases it is caused by anaemia, by inadequate production of red blood cells.

CRP (C-Reactive Protein)
An increased CRP is a result of inflammation. It can increase up to a thousand times as a reaction to inflammation, sepsis or infection. CRP can be used to monitor stressresponse during the acute fase.

- Normal value for CRP is < 1 mg/ dl.
- Increased CRP points at inflammation.
- It is a positive acute phase protein.
- Half-life is 4-6 hour.
- It can rise to thousand as a reaction to inflammation, sepsis or infection.
- CRP can be used to monitor the stress-response during the acute phase.
- As CRP decreases, the visceral proteins can be used to monitor the nutritional state.

Literature

- Ferard G., Gaudias J., Bourguignat A., Ingenbleek Y.C-reactive protein to transthyretin ratio for the early diagnosis and follow-up of postoperative infection. Clin Chem Lab Med 2002;40 (12): 1334-1338.

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Creatinine
Creatinine can be used in certain cases to get an impression of the quantity of muscle mass. When the kidney works well a decreased creatinine can be a measure of decreased muscle mass. Creatinine arises by the conversion of creatin to creatinine in the muscle mass.

Causes of an increased creatinine-concentration

a. Decreased glomerular filtration rate
b. Post-renal obstruction
c. Strong pre-renal factors like lowered blood-pressure or shock
d. Strong catabolism

Causes of a decreased creatinine-concentration
A small amount of muscle mass

Reference values in bloodserum
For men: 71 – 110 umol/ l
For women: 53 – 97 umol/ l
Reference values in urine

- for men: 5.8 - 16.4 mmol/ 24 hours or 1288- 1891mg
- for women: 4.5 - 13.3 mmol/ 24 hours or 830 - 1240mg

These values are dependent on height

Creatinine-clearance
As a measure for renal function. The creatinine-clearence can be calculated. There are two methods:

creatinineclearance =
creat. in *u*mol in 24-hour-urine/ creat. in *u*mol in bloodserum) * 0.7

or (this method is less reliable)

creatinineclearance =
weight * (140 - age) / 0.81 * bloodserum creat in men
0.85 * bloodserum creat in women

Reference value for creatinineclearance is 125 - 135 ml/ minute

Creatinine- Length- index
The 24-hour excretion of urinary creatinine is used to assess the degree of muscle mass depletion. Creatinine is derived from the catabolism of creatine phosphate, a metabolite present in skeletal muscle. In the presence of normal renal function, urinary creatinine excretion can be used as an index of skeletal muscle.

Creatinine height index (CHI)=

measured 24-hour urinary creat x 100%/ ideal 24-hour urinary creat.
Percent deficit = 100% - CHI

Literature
Blackburn, G.L. Bristian B.R. et al. Nutritional and metabolic assessment of the hospitalized patient. JPEN 1: 11, 1977.

Albumin
As a measure in nutritional assessment albumin is useful because a fast diminishing albumin- concentration is a sign for an inflammatory reaction. Increasing albumin can be interpreted as an improvement. The patient becomes anabolic. The albumin level only increases when the inflammation decreases. Nutrition has no influence on that.
Albumin:

- Is a negative acute phase protein.
- Has a reference value of 35 - 45 g/ l.
- Is responsible for 80% of the colloid osmotic pressure and is 50-60% of the total amount of plasma-proteins.
- Is a transport protein for fatty acids, bilirubin and some hormones.
- Is synthesised in the liver, about 200 mg / kg/ day, that is less than 5% of the total body protein pool. The synthesis capacity of the liver can improve 2-3 times. The body albumin pool is about 3.5-5.0 g/ kg body weight and 35-40% is intravascular.
- Has a half-life of 20 days.
- An albumin of 34 g / l or less can be the result of an inflammatory response in the body (often together with a fast elevated CRP).

Albumin as a measure for malnutrition is not useful
The albumin level in the blood is not useful as a measure for acute malnutrition, because it is influence by a lot of factors, for example illness. In a sick patient the distribution volume changes: albumin leaks to the extra-cellular compartment. The body also has a big albumin pool. In healthy people a loss of 25 % of the bodyweight leads to 10 % diminished albumin (Hoffer, 1994). In chronically malnourished patients, albumin tends to shift out of the intravascular compartment.

Albumin as a measure for inflammatory reaction is useful
Interpretation of changes in albumin:

Increase	**Decrease**
Dehydration	Inflammatory reaction
	Nephrosis
	Losses: IBS, burns
	Severe liver failure
	Overhydration
	Pregnancy

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