Evaluation of Laboratory Data in Nutrition Assessment
Laboratory Data and the NCP

- Used in nutrition assessment (a clinical sign supporting nutrition diagnosis)
- Used in Monitoring and Evaluation of the patient response to nutritional intervention
Specimen Types

- Serum: the fluid from blood after blood cells and clot removed
- Plasma: fluid from blood centrifuged with anticoagulants
- Erythrocytes: red blood cells
- Leukocytes: white blood cells
- Other tissues: scrapings and biopsy samples
- Urine: random samples or timed collections
- Feces: random samples or timed collections
- Less common: saliva, nails, hair, sweat
Types of Assays

- **Static assays**: measures the actual level of the nutrient in the specimen (serum iron, white blood cell ascorbic acid)
- **Functional Assays**: measure a biochemical or physiological activity that depends on the nutrient of interest (serum ferritin, TIBC)
  - (Functional assays are not always specific to the nutrient)
Assessment of Nutrient Pool

Biologic responses

Deficiency

Death

Overt symptoms

Sub-optimal metabolism

Normal metabolism

Abnormal metabolism

Toxicity

Overt symptoms

Death

Nutrient intake or cellular concentration
## Basic Metabolic Panel Charting Shorthand

<table>
<thead>
<tr>
<th>BMP</th>
<th>Na</th>
<th>Cl</th>
<th>BUN</th>
<th>glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K+</td>
<td>CO2</td>
<td>Creatinine</td>
<td></td>
</tr>
</tbody>
</table>
Clinical Chemistry Panels: Comprehensive Metabolic Panel

Includes

- BMP except CO2
- Albumin
- Serum enzymes (alkaline phosphatase, AST [SGOT], ALT [SGPT])
- Total bilirubin
- Total calcium

Phosphorus, total cholesterol and triglycerides often ordered with the CMP
Clinical Chemistry Panels: Complete Blood Count (CBC)

- Red blood cells
- Hemoglobin concentration
- Hematocrit
- Mean cell volume (MCV)
- Mean cell hemoglobin (MCH)
- Mean cell hemoglobin concentration (MCHC)
- White blood cell count (WBC)
- Differential: indicates percentages of different kinds of WBC
RBC Indexes

- MCV = average red blood cell size
- The MCV is measured directly by a machine
- MCV: 80 - 100 femtoliter
- Increased: liver dis., megaloblastic anemia, phenytoin use
- Decreased: iron def, thalassemia
- Normal : Simultaneous iron and folate def.
• MCH = Hemoglobin amount per red blood cell  
• MCH = Hgb/RBC count  
• 27-31 picograms (pg)/cell in adult  
• Low levels: hypochromic/ microcytosis  
• High levels: macrocytosis  

• MCHC = The amount of hemoglobin relative to the size of the cell (hemoglobin concentration) per red blood cell  
• MCHC = Hgb/Hct  
• MCHC: 32-36 g/dL in adult
• A MCHC blood test could be ordered for someone who has signs of fatigue or weakness, when there is an infection, is bleeding or bruising easily or when there is noticeable inflammation.

• The MCHC test is most commonly used to evaluate for macrocytic anemia.
MCHC

- If the levels are high then there’s a chance of macrocytic anemia.
- A deficiency in folic acid and vitamin B12 could lead to this. Also, liver disease, and is sometimes responsible for this type of result.
- Burn victims also show elevated mean corpuscular hemoglobin concentration.
Assessment of Anemias

- Iron deficiency anemia

- **Hct**
  - % RBC in total blood volume
  - Affected by:
    - High WBC
    - Hydration status
    - High altitude

High levels: vomiting, burns, polycythemia, dehydration, exercise

Low levels: macrocytosis, hypothyroidism, normocytic anemia, microcytic anemia
A more direct measure of iron deficiency (quantifies total Hgb in RBC not a % of blood volume)

- High levels: hemococoncentration (dehydration, burn, vomiting), polycythemia, exercise, smoking
- Low levels: macrocytic/ normocytic/ microcytic anemia
- False high levels: high TG, high WBC
Serum Iron

- Amount of circulating iron that is bound to transferrin
- Poor index of iron status:
  - Large day to day changes
  - Diurnal variations (highest between 6-10 AM)
  - High levels: hemosidrosis, hemolytic anemia, aplastic anemia, Pb toxicity, thalassemia
  - Low levels: Iron Def., nephrotic syndrome, hypothyroidism, post surgery, kwashiorkor
Total iron binding capacity (TIBC)

- Transferrin binds ferric iron
- TIBC usually increases in iron deficiency
- High levels: Iron Def., late pregnancy, infancy, hepatitis, OCPs
- Low levels: low pro levels (nephrotic syndrome, malnutrition, cancer, chronic liver disease, chronic inflammatory disease)
Ferritin

- Storage protein for iron
- A small amount of it leaks into the circulation (1 ng/ml of ferritin is approximately 8 mg of stored iron)
- An indicator of body iron storage pool

- It is an acute phase reactant (elevates in 1 to 2 days after onset of acute illness, peaks at 3 to 5 days)

- Infection, metastatic cancer, acute inflammation, lymphoma, ...
• High levels: hemochromatosis, hemosidrosis, acute and chronic liver disease, alcohol abuse, neoplasms (leukemia), chronic inflammation, blood transfusion, minor thalassemia
• Low levels: Iron def.
**RDW (red blood cell distribution width)**

- 11.5 – 14.5%

RBC نشانگری برای تعیین تنوع سایز افراش آن بیانگر تنوع بیشتر در سایز RBC است. افراشی که می‌تواند با آنیمی فقر آهن - MCV + RDW کاهش تالاسمی افراشی باشد: منیا ناشی از کمبود فولات و ویتامین B12 نرمال + کاهش MCV + تالاسمی RDW در تالاسمی مینور است.
Anemia of vitamin B12 / folate deficiency

- **Folate**
  - RBC Folate is calculated by measuring the difference between whole blood folate and serum folate

- **Vitamin B12**
  - Is measured in the serum
  - Schilling test for vitamin B12
Complementary tests

- Stool Exam
- Hb electrophoresis
Blood Glucose

- FBS
- BS
- Glucose Tolerance Test
- HBA1C
✓ For FBS an 8 hour fasting is mandatory

Criteria for the Diagnosis of DM

<table>
<thead>
<tr>
<th>Plasma Glucose</th>
<th>Impaired Fasting Glucose (mg/dl)</th>
<th>Impaired Glucose Tolerance (mg/dl)</th>
<th>DM (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
<td>&gt;/= 100 and &lt;126</td>
<td>-</td>
<td>&gt;126</td>
</tr>
<tr>
<td>2-Hour Post-load</td>
<td>-</td>
<td>&gt;/=140 and &lt;200</td>
<td>&gt;200</td>
</tr>
<tr>
<td>random</td>
<td>-</td>
<td>-</td>
<td>&gt;/=200 with symptoms</td>
</tr>
</tbody>
</table>
Diabetes can be provisionally diagnosed with:

any one of the three criteria listed below. In the absence of unequivocal hyperglycemia with acute metabolic decompensation the diagnosis should be confirmed, on a subsequent day, by any one of the same three criteria.

1. A fasting plasma glucose of >126 mg/dl (after no caloric intake for at least 8 hours) or,

2. A casual plasma glucose >200 mg/dl (taken at any time of day without regard to time of last meal) with classic diabetes symptoms: increased urination, increased thirst and unexplained weight loss or,

3. An oral glucose tolerance test (OGTT) (75 gram dose) of >200 mg/dl for the two hour sample. Oral glucose tolerance testing is not necessary if patient has a fasting plasma glucose level of >126 mg/dl.

- The fasting plasma glucose is the preferred test because of its ease of administration, convenience, acceptability to patients, and lower cost in comparison to the OGTT.
Oral Glucose Tolerance Test

No food or drink 8 to 12 hours prior to test

Drink glucose

Blood is tested two hours later

High glucose level = potential diabetes
Glucose Tolerance Test

Oral Glucose Tolerance Test (OGTT)

- Is the standard for diagnosis of DM
- Defined by WHO: 75 gr glucose load

Gestational DM

<table>
<thead>
<tr>
<th>Plasma Glucose (mg/dl)</th>
<th>50 gr screening test (mg/dl)</th>
<th>75 gr diagnostic test (mg/dl)</th>
<th>100 gr diagnostic test (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
<td>-</td>
<td>&gt;= 95</td>
<td>&gt;= 95</td>
</tr>
<tr>
<td>1 hr</td>
<td>&gt;= 140</td>
<td>&gt;= 180</td>
<td>&gt;= 180</td>
</tr>
<tr>
<td>2 hr</td>
<td>-</td>
<td>&gt;= 155</td>
<td>&gt;= 155</td>
</tr>
<tr>
<td>3 hr</td>
<td>-</td>
<td>-</td>
<td>&gt;= 140</td>
</tr>
</tbody>
</table>
HbA1C

- The A1C test measures the average blood glucose for the past 3 months.
- The patient doesn’t have to fast or drink anything.
- It shows how well diabetes is being controlled.

- **Diabetes is diagnosed at a HbA1C of greater than or equal to 6.5%**
  - Normal: Less than 5.7%
  - Pre-diabetes: 5.7% to 6.4%
  - Diabetes: 6.5% or higher
What is prediabetes?

- Prediabetes is a condition when blood glucose is higher than normal but not high enough to be diabetes.
- This condition puts the patient at risk for developing type 2 diabetes.

**Results indicating prediabetes are:**
- An A1C of 5.7% – 6.4%
- Fasting blood glucose of 100 – 125 mg/dl
- An OGTT 2 hour blood glucose of 140mg/dl – 199 mg/dl
Lipid indexes of cardiovascular risk

12 – 8 fasting is required (no food or drink, except water)

- **Total cholesterol**
  - Acceptable <170 mg/dl
  - Borderline 170-199 mg/dl
  - High >/= 200 mg/dl

- **HDL**
  - Desirable > 40 mg/dl

- **LDL**
  - Friedewald formula:
    \[ \text{LDL} = \text{TC} - \text{-HDL} - \frac{\text{TG}}{5} \]
    - (TG levels should be <400 mg/dl)
  - Acceptable <110 mg/dl
  - Borderline 110-129 mg/dl
  - High >/= 130 mg/dl
Lipid Indices of Cardiovascular Risk

- Total cholesterol
- LDL
- HDL: HDL2a, HDL2b, HDL2c, HDL3a, HDLdb
- IDL
- VLDL
- Lp(a)
### Four Major Lipoprotein Classes

<table>
<thead>
<tr>
<th>Apolipoproteins</th>
<th>High Density</th>
<th>Low Density</th>
<th>Very Low Density</th>
<th>Chylomicrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major core lipids</td>
<td>A-I, A-II, E, Cs</td>
<td>B-100</td>
<td>B-100, Cs, E</td>
<td>B-48, Cs, E, A-I, A-II</td>
</tr>
<tr>
<td>Relative sizes</td>
<td>HDL&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Cholesteryl ester</td>
<td>Cholesteryl ester</td>
<td>Triglyceride</td>
</tr>
<tr>
<td></td>
<td>HDL&lt;sub&gt;3&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• **LDL in more details:**

  • Less than 70 mg/dL for those with **heart** or **blood vessel disease** and for other patients **at very high risk** of heart disease (those with metabolic syndrome)

  • Less than 100 mg/dL **for high risk** patients (e.g., some patients who have multiple heart disease risk factors)

  • Less than 130 mg/dL for individuals who **are at low risk** for coronary artery disease
Triglycerides

Goal is Less than 150 mg/dl

Causes of high triglycerides in the general population

- Overweight and obesity
- Physical inactivity
- Cigarette smoking
- Excess alcohol intake
- Very high carbohydrate diets (>60% of energy)
- Other disease (diabetes, renal failure, nephrosis)
- Drugs: steroids, protease inhibitors, estrogen, etc
- Genetic factors

Risk Classification of Serum Triglycerides

- Normal: <150 mg/dL
- Borderline high: 150–199 mg/dL
- High: 200–499 mg/dL
- Very high: ≥500 mg/dL
Statin Therapy Should be Concomitant with Lifestyle Therapy

- Smoking cessation
- Energy-restricted diet Low cholesterol
  - Low saturated and trans fatty acids
  - Low refined carbohydrates
  - Include viscous fibres, plant sterols, nuts, soy proteins
  - Alcohol in moderation
- Physical activity
Dietary Modifications

- Eat more fiber
- Know your fats
- Smart protein
- Low-carb diet
Eat More Fiber

- Good sources of soluble fiber include whole-grain breads and cereals, oatmeal, fruits, dried fruits, vegetables, and legumes such as kidney beans.
Dietary Modifications

- Eat more fiber
- Know your fats
Know Your Fats

- No more than 35% of your daily calories should come from fat.
- But not all fats are equal
  - Saturated Fats
  - Trans Fats
  - Unsaturated Fats
Know Your Fats

- Saturated fats -- from animal products and tropical oils -- raise LDL cholesterol.
- Trans fats increase bad cholesterol and lowers the good cholesterol.
- These two bad fats are found in many baked goods, fried foods (doughnuts, french fries, chips), stick margarine, and cookies.
Know Your Fats

- Unsaturated fats may lower LDL when combined with other healthy diet changes. They're found in avocados, olive oil, and peanut oil.
Dietary Modifications

- Eat more fiber
- Know your fats
- Smart protein
Smart Protein

- Meat and full-fat milk are protein but they are also major sources of cholesterol.
- Switch to soy protein, such as tofu.
- Fish is rich in omega-3 fatty acids, which can improve cholesterol levels.
- The AHA recommends eating fish at least twice a week.
Dietary Modifications

- Eat more fiber
- Know your fats
- Smart protein
- Low-carb diet
There's growing evidence that low-carb diets may be better than low-fat diets for improving cholesterol levels.

In a two-year study funded by the National Institutes of Health, people who followed a low-carb plan had significantly better HDL (good cholesterol) levels than those who followed a low-fat plan.
Lifestyle Modifications

- Lose weight
- Quit smoking
- Exercise
Lose Weight

- If you're overweight, talk to your doctor about beginning a weight loss program.
- Losing weight can help you reduce your levels of triglycerides, LDL, and total cholesterol.
- Good cholesterol level tends to go up 1 point for every 6 pounds you lose.
A couple were talking, and the wife says, “It’s my birthday tomorrow.”

Her husband responds with, “What do you want for your birthday?”

The wife says, “I want something that goes very fast.”

The next day, the husband comes home and says, “I have a gift for you, which goes from 0 to 300 in 3 seconds.”

The wife asks, “Is it a Ferrari? Or a Lamborghini?”

The husband says, “No, it’s a weighing scale!!!”

...The husband’s funeral is tomorrow.
Lifestyle Modifications

- Lose weight
- Quit smoking
Quit Smoking

- Tobacco use is one of the most important risk factors for CHD
- It is the most preventable cause of death in the US
- 440,000 deaths each year are attributable to tobacco use
- When you stop smoking, your good cholesterol is likely to improve
Lifestyle Modifications

- Lose weight
- Quit smoking
- Exercise
Exercise

- If you're healthy but not very active, starting an aerobic exercise program could increase your good cholesterol by 5% in the first two months.
- Regular exercise also lowers bad cholesterol. Choose an activity that boosts your heart rate, such as running, swimming, or walking briskly.
- Aim for at least 30 minutes on most days of the week. It doesn't have to be 30 continuous minutes; two 15-minute walks works just as well.
Medications

- Statins
- Non-Statins
  - Cholesterol Absorption Inhibitor (Ezetimibe)
  - Nicotinic Acid (Niacin)
  - Bile Acid Sequestrants
  - Fibric Acid Derivatives
  - Omega-3 Fatty Acids
Statins

- Atorvastatin
- Fluvastatin
- Lovastatin
- Pravastatin
- Rosuvastatin
- Simvastatin
Statins

- Decrease LDL by 18 – 55%
- Increase HDL by 5 – 15%
- Decrease TG by 7 – 30%

Non-statins

- Decrease LDL by 18 – 20%
- Increase HDL by 1 – 5%
- Decrease TG by 5 – 11%
Non-Statins:
Omega-3 Fatty Acids

- Decrease TG by 45 %
- Increase HDL by 9 %
- Increase LDL by 44 %
Non-Statins: Omega-3 Fatty Acids

- Fish Oils
- Its major use is in hypertriglyceridemia greater than 500mg/dL
- Contraindicated in patients with known hypersensitivity to fish and in women who are pregnant or breastfeeding
- Adverse effects include eructation, dyspepsia, and taste perversion
Statins

- The drug of choice for elevated LDL levels
- Prevents cardiovascular and cerebrovascular events
- Contraindicated in active or chronic liver disease, pregnancy and lactation
- Adverse effects include myopathy and increase in liver transaminases
Urinalysis (UA)

- Specific Gravity
- PH
- Protein
- Glucose
- Ketones
- Blood
- Bilirubin
- Urobilinogen
- Nitrite
- Leukocyte esterase
### Clinical Chemistry Panels: Urinalysis

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>1.010-1.025 mg/ml</td>
</tr>
<tr>
<td>pH</td>
<td>6-8 (normal diet)</td>
</tr>
<tr>
<td>Protein</td>
<td>2-8 mg/dl</td>
</tr>
<tr>
<td>Glucose</td>
<td>Not detected</td>
</tr>
<tr>
<td>Ketones</td>
<td>Negative</td>
</tr>
<tr>
<td>Blood</td>
<td>Negative</td>
</tr>
<tr>
<td>Bilirubin</td>
<td>Not detected</td>
</tr>
<tr>
<td>Urobilinogen</td>
<td>0.1-1 units/dl</td>
</tr>
<tr>
<td>Nitrite</td>
<td>Negative</td>
</tr>
<tr>
<td>Leukocyte esterase</td>
<td>Negative</td>
</tr>
</tbody>
</table>
CRP

• C-reactive protein is produced by the liver.
• CRP level rises when there is inflammation in the body.
• Normal CRP values vary from lab to lab. Generally, there is no CRP detectable in the blood.
• A positive test means you have inflammation in the body. This may be due to a variety of different conditions:
  • Cancer
  • Connective tissue disease
  • Heart attack
  • Infection
  • Inflammatory bowel disease (IBD)
  • Lupus
  • Pneumococcal pneumonia
  • Rheumatoid arthritis
  • Rheumatic fever
  • Tuberculosis
Remember ...

- Positive CRP results also occur during the last half of pregnancy or with the use of birth control pills (oral contraceptives).

- **hs-CRP** (Risk CVD)
  - $< 1.0 \text{mg/L} = \text{low risk}$
  - $1-3 = \text{average risk}$
  - $> 3 = \text{high risk}$
WHICH ONES?

Some foods increase inflammation (Foods That Hurt)
- Saturated Fats
- Trans Fats
- High Glycemic Index Foods

Some foods decrease inflammation (Foods That Heal)
- Omega-3
- Vitamin D
- Antioxidants
- Extra Virgin Olive Oil
<table>
<thead>
<tr>
<th>Anti-inflammatory foods</th>
<th>Inflammatory foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaskan Salmon (wild)</td>
<td>Sugar, from any source</td>
</tr>
<tr>
<td>Fresh whole fruits, vegetables</td>
<td>Processed foods</td>
</tr>
<tr>
<td>Bright multi-colored vegetables</td>
<td>French Fries</td>
</tr>
<tr>
<td>Green tea</td>
<td>Fast Foods</td>
</tr>
<tr>
<td>Water</td>
<td>White bread</td>
</tr>
<tr>
<td>Olive oil</td>
<td>Pasta</td>
</tr>
<tr>
<td>Lean poultry</td>
<td>Ice Cream</td>
</tr>
<tr>
<td>Nuts, legumes and seeds</td>
<td>Cheddar Cheeses</td>
</tr>
<tr>
<td>Dark green leafy vegetables</td>
<td>Snack Foods</td>
</tr>
<tr>
<td>Old fashioned oatmeal</td>
<td>Oils such as vegetable and corn</td>
</tr>
<tr>
<td>Spices, especially Turmeric and Ginger</td>
<td>Soda, caffeine and alcohol</td>
</tr>
</tbody>
</table>
FOODS THAT HURT: SATURATED FATS

- A study, published in Journal of the American College of Cardiology showed that just one high saturated fat meal increased inflammation. It appears that saturated fats increase inflammation by impairing your body’s natural anti-inflammatory processes.
- The amount of eicosonoids that your body produces is proportional to the amount of saturated fats that you eat. Eicosonoids cause inflammation.
- Saturated fats also increase your levels of total cholesterol and LDL cholesterol (“bad cholesterol”), thus increasing your risk of atherosclerosis.

7 Easy Ways to Lower Saturated Fats

1. Use Egg Whites (Egg Beaters) instead of the whole egg.
2. Trim the skin and visible fat from meat before cooking.
3. Choose lean meats like chicken or fish instead of beef and pork (which tend to have a ton of saturated fat).
4. At restaurants, choose baked, broiled, or grilled instead of fried.
5. Choose low or no fat dairy (for example, skim milk instead of whole milk).
6. Sauces and gravy are loaded with saturated fat. Avoid them or ask for them on the side.
7. When choosing salad, try oil based dressings vs. ranch or blue cheese.
TRANS FATS

EVEN MORE DANGEROUS THAN SATURATED FATS!!!

- The mechanism for this is essentially the same as saturated fats: clogging arteries and increasing inflammation.
- Trans fats go a step further by not only increasing LDL, but decreasing HDL (good cholesterol).
- Avoid this cholesterol double whammy
% Source of Trans Fats in Diet

- Cakes, Cookies, Crackers, Pies, Bread 40%
- Animal Products 21%
- Candy 1%
- Breakfast Cereal 1%
- Salad Dressing 3%
- Shortening 4%
- Potato Chips, Corn Chips, Popcorn 5%
- Fried Potatoes 8%
- Margarine 17%
4 Tips to Avoid Trans Fats

1. Read food labels - Since 2003, the FDA has mandated that trans fat be listed on all food labels. A loophole in the labeling is that foods with a half gram (0.5g) of trans fat or less can still say “trans fat free”

2. Portion Control: While it’s best to avoid these high trans fat foods altogether, if you can limit how much you eat at a sitting, you will be doing your back a big favor.

3. Limit the amount of baked goods - These tend to be the foods that have the most trans fat.

4. When at a restaurant, avoid the deep fried options. The cooking oil, after being used again and again (which is the case at most restaurants), ends up being loaded with trans fat. Grilled, broiled, or sautéed foods are much better options.
The Great Debate: Margarine vs. Butter

• For years, Americans have been confused about whether butter or margarine is a better choice. This is because we have known about the dangers of saturated fat for years, so doctors and dietitians were telling everyone: “avoid butter like the plague, eat margarine!”

• But we now know that trans fat is even worse than saturated fat. Stick margarine has more trans fat than butter. Now these same people are telling everyone to eat butter and avoid margarine.

Who is right?
The Great Debate: Margarine vs. Butter

• Neither butter nor margarine are the healthiest of options and both raise cholesterol quite a bit. In the last few years, a large number of healthier and great-tasting spreads have been released (Olivio, Smart Balance, and Benecol for example are spreads made from olive oil).

• Also, many margarines are now made ‘trans-fat free’. Now that these healthy alternatives are available, these healthy spreads are the best choice.
TRANS FATS

• A study conducted at Harvard University, which appeared in The Journal of Nutrition, set out to find out whether trans fat simply increases cholesterol, or whether it is also pro-inflammatory.

• They found the more trans fats someone ate, the more inflammation was happening in their body. This association was independent of other possible causes of inflammation (e.g. saturated fat intake or obesity).
High Glycemic Index Foods

The higher the GI, the faster blood glucose rises.
High Glycemic Index Foods

- Low GI diets have been shown to lower the risk of many chronic diseases that have an inflammatory cause (i.e. obesity, diabetes, back pain and heart disease).
- When you eat a high GI food, you get a “spike” in blood sugar. In response, your body has to release a ton of insulin to get your blood glucose under control. Insulin is a hormone that your body makes to get glucose out of your blood and into your cells where they belong. If a spike in insulin happens occasionally, your body has no problem adapting.
- However, if this occurs again and again, your body has a tougher time keeping up. Your body’s response to this is increasing inflammation.
High Glycemic Index Foods

- Another study conducted at Harvard University, that appeared in the journal The American Journal of Clinical Nutrition showed a diet of high GI foods increases inflammation.
- They found that the higher the CRP (inflammation), the higher GI the diet tended to be. “Dietary glycemic index is significantly and positively associated with plasma CRP.”

Glycemic Index

Foods High In GI
- Sugary (i.e. candy)
- Processed (i.e. white bread)
- Low in Fiber (i.e. white rice)
- Low in Protein (i.e. rice cakes)

Foods Low in GI
- Produce (i.e. most fruits and vegetables)
- Minimally Processed (i.e. whole wheat bread)
- High in Fiber (i.e. beans)
Foods that Heal: Omega-3 Fats

- Extensive research indicates that Omega-3 fatty acids reduce inflammation and help prevent risk factors associated with chronic disease.

**OMEGA-3s**
- Reduced risk of coronary heart disease
- Reduced blood triglycerides
- Reduced risk of certain cancers
- Decreased chronic inflammation
- *Reduced Crohn’s disease “flare-ups”*
- *Increasing HDL (Good Cholesterol)*
- *Increase Cell Fluidity*

A healthy cell membrane is dependent on omega-3s.
What Are Omega-3s?

There are three main types of Omega-3 fats:

1. Eicosapentaenoic acid (EPA)
2. Docosahexaenoic acid (DHA)
3. Alpha-linolenic acid (ALA)

- Omega-3s are a type of fat categorized as an “essential fatty acid”. It is called this because, unlike other types of fats, your body cannot make Omega-3s.
- EPA and DHA are the best choices because your body turns these into active anti-inflammatory compounds better than ALA.

Fish are an excellent source of omega-3s
Omega-3 Fats

• The research published in the journal Surgical Neurology showed a safe alternative to NSAID for treatment for back pain was fish oil.
• They gave fish oil capsules instead of NSAIDs to patients with chronic low back pain.
• 80% of patients were satisfied with their improvement and 88% said that they would continue taking the supplements.

High Omega 3 Seafood
for 100 gram serving (about 3.5 oz.)

<table>
<thead>
<tr>
<th>Fish</th>
<th>Grams of Omega 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainbow Trout</td>
<td>1.154</td>
</tr>
<tr>
<td>Halibut</td>
<td>1.292</td>
</tr>
<tr>
<td>Oyster</td>
<td>1.416</td>
</tr>
<tr>
<td>Sardine</td>
<td>1.458</td>
</tr>
<tr>
<td>Cisco</td>
<td>1.519</td>
</tr>
<tr>
<td>Tuna</td>
<td>1.664</td>
</tr>
<tr>
<td>Whitefish</td>
<td>1.821</td>
</tr>
<tr>
<td>Sablefish</td>
<td>2.003</td>
</tr>
<tr>
<td>Anchovy</td>
<td>2.096</td>
</tr>
<tr>
<td>Herring</td>
<td>2.224</td>
</tr>
<tr>
<td>Salmon</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Best non-fish sources of Omega-3s

• Flax seeds
• Walnuts
• Tofu
• Beans
• Soybeans
• Winter Squash

To get the maximum benefit from Omega-3s, you should eat 4g (4000mg) at the very least on a daily basis.
Omega 6 to Omega 3 Ratio

- The typical Omega-6 to Omega-3 ratio in the average American diet is about 15:1
- Research is not clear on the “best” ratio of these two fatty acids
- Currently most recommendations should be as close to 1:1 as possible.
What About All That Mercury?

- Certain types of fish contain high levels of certain toxins (specifically heavy metals).
  
  *So isn’t eating too much fish dangerous?*

- The recommendation by the EPA and FDA to limit fish consumption is meant for pregnant women and young children.

- Also, those recommendations advise expecting mothers and children to avoid certain types of fish: large, predatory fish like shark, swordfish, and king mackerel are very high in mercury.

- Other fish, such as salmon, pollock and catfish, are extremely low in mercury.

- Experts agree: “The dangers of not eating fish, including tuna, outweigh the small possible dangers from mercury”.

- The bottom line: unless you are pregnant, eating fish (or taking fish oil capsules) is the best way to get pain fighting Omega-3s.
VITAMIN D

- Vitamin D has the unique property of being made in your skin with the help of sunlight. This is why it is commonly referred to as the “Sunshine vitamin”.
- “Vitamin D deficiency is an unrecognized epidemic in both children and adults throughout the world.”
Vitamin D Influences

• Cell Growth
• Insulin Resistance (Diabetes)
• Immunity
• Muscle Function
• Nervous System
• Cardiovascular System
• Blood Pressure
• Inflammation
• Low Back Pain
Uric Acid

- Is produced from the natural breakdown of body's cells and from the foods we eat.
- High levels of uric acid in the blood can cause gout, kidney stones
- A uric acid blood test is done to:
  - Help diagnose gout
  - Check to see if kidney stones may be caused by high uric acid levels in the body
  - Check to see if medicine that decreases uric acid levels is working
  - Check uric acid levels in people who are undergoing chemotherapy or radiation therapy. These treatments destroy cancer cells that then may leak uric acid into the blood
High uric acid values may be caused by:

- Conditions, such as:
  - Kidney disease or kidney damage
  - Increased breakdown of body cells
  - some types of cancer (including leukemia, lymphoma, and multiple myeloma)
  - cancer treatments
  - Hemolytic anemia, sickle cell anemia, or heart failure.
- Disorders, such as alcohol dependence, preeclampsia, liver disease (cirrhosis), obesity, psoriasis, hypothyroidism, and low blood levels of parathyroid hormone
- Starvation, malnutrition, lead poisoning.
- A rare inherited gene disorder called Lesch-Nyhan syndrome
- Medicines, such as some diuretics, vitamin C, lower doses of aspirin (75 to 100 mg daily), niacin, warfarin, cyclosporine, levodopa
- Eating foods that are very high in purines, such as organ meats (liver, brains), red meats (beef, lamb), some seafood (sardines, herring), game meat, dried beans, dried peas, mushrooms
Collaborative Care

• Dietary measures
  • Weight reduction
  • Avoidance of alcohol
  • Avoidance of foods high in purines
    • High: Sardines, anchovies, herring, mussels, liver, kidney, goose, venison, meat soups, sweetbreads, beer & wine
    • Moderate: Chicken, salmon, crab, veal, mutton, beef
Collaborative Care

- Prevention of renal stones
  - Increase fluid intake to maintain adequate urine output
  - Allopurinol
  - ACE inhibitor losartin (Cozar) – promotes urate diuresis
Stool Exam

- Occult Blood
- Ova
- Parasite
- Undigested food in feces
Thyroid Function Tests (TFT)

- T3
- T4
- T3UP
- TSH
- Anti- TPO
Total T4 & Free T4

Total T4
- Most of the thyroxine (T4) in the blood is attached to thyroxine-binding globulin. Less than 1% of the T4 is unattached. A total T4 blood test measures both bound and free thyroxine.

Free T4
- Free thyroxine affects tissue function in the body, but bound thyroxine does not.
- Free thyroxine (T4) can be measured:
  - directly (FT4)
  - calculated as the free thyroxine index (FTI)
- The FTI tells how much free T4 is present compared to bound T4. The FTI can help tell if abnormal amounts of T4 are present because of abnormal amounts of thyroxine-binding globulin.
Triiodothyronine (T3)

- Most of the T3 in the blood is attached to thyroxine-binding globulin. Less than 1% of the T3 is unattached.
- A T3 blood test measures both bound and free triiodothyronine.
- T3 has a **greater effect** on the way the body uses energy than T4, even though T3 is normally present in **smaller amounts** than T4.
TSH

• **Screening for thyroid dysfunction**
• Serum TSH normal — no further testing performed
• Serum TSH high — free T4 added to determine the degree of hypothyroidism
• Serum TSH low — free T4 and T3 added to determine the degree of hyperthyroidism
• We measure serum free T4 if the patient has convincing symptoms of hyper- or hypothyroidism despite a normal TSH result
T3UP

- Hyperthyroidism — high serum total T4, high T3-resin uptake, high free T4 index

- TBG excess — high serum total T4, low T3-resin uptake, normal free T4 index

- Hypothyroidism — low serum total T4, low T3-resin uptake, low free T4 index

- TBG deficiency — low serum total T4, high T3-resin uptake, normal free T4 index
Micronutrients

- Sodium
- Potassium
- Calcium
- Phosphorous
- Magnesium
- Ceruloplasmin
- Copper
- Zinc
- 25(OH)D - 1,25(OH)D
- Retinol
- Folate
- B12
Others

- Hormones
  - Insulin
  - ACTH
  - Cortisol
- Serum protein electrophoresis
Assessment of Hydration Status

- Dehydration: a state of negative fluid balance caused by decreased intake, increased losses, or fluid shifts
- Overhydration or edema: increase in extracellular fluid volume; fluid shifts from extracellular compartment to interstitial tissues
  - Caused by increase in capillary hydrostatic pressure or permeability
  - Decrease in colloid osmotic pressure
  - Physical inactivity
- Use laboratory and clinical data to evaluate pt
Hypovolemia

Isotonic fluid loss from the extracellular space caused by

- Fluid loss (bleeding, fistulas, nasogastric drainage, excessive diuresis, vomiting and diarrhea)
- Reduced fluid intake
- Third space fluid shift, when fluid moves out of the intravascular space but not into intracellular space (abdominal cavity, pleural cavity, pericardial sac) caused by increased permeability of the capillary membrane or decrease on plasma colloid osmotic pressure
Symptoms of Hypovolemia

- Orthostatic Hypotension (caused by change in position)
- Central venous and pulmonary pressures ↓
- Increased heart rate
- Rapid weight loss
- Decreased urinary output
- Patient cool, clammy
- Decreased cardiac output
- Ask the medical team!!
Treatment of Hypovolemia

- Replace lost fluids with fluids of similar concentration
- Restores blood volume and blood pressure
- Usually isotonic fluid like normal saline or lactated Ringer’s solution given IV
Hypervolemia

- Excess of isotonic fluid (water and sodium) in the extracellular compartment
- Osmolality is usually not affected since fluid and solutes are gained in equal proportion
- Elderly and those with renal and cardiac failure are at risk
Causes of Hypervolemia

- Results from retention or excessive intake of fluid or sodium or shift in fluid from interstitial space into the intravascular space
- Fluid retention: renal failure, CHF, cirrhosis of the liver, corticosteroid therapy, hyperaldosteronism
- Excessive intake: IV replacement tx using normal saline or Lactated Ringer’s, blood or plasma replacement, excessive salt intake
Causes of Hypervolemia

- Fluid shifts into vasculature caused by remobilization of fluids after burn tx, administration of hypertonic fluids, use of colloid oncotic fluids such as albumin
Symptoms of Hypervolemia

- No single diagnostic test, so signs and symptoms are key
- Cardiac output increases
- Pulse rapid and bounding
- BP, CVP, PAP and pulmonary artery wedge pressure rise
- As the heart fails, BP and cardiac output drop
- Distended veins in hands and neck
Symptoms of Hypervolemia

- Anasarca: severe, generalized edema
- Pitting edema: leaves depression in skin when touched
- Pulmonary edema: crackles on auscultation
- Patient SOB and tachypneic
- Labs: low hematocrit, normal serum sodium, lower K+ and BUN (or if high, may mean renal failure)
- ABG: low O2 level, PaCO2 may be low, causing drop in pH and respiratory alkalosis
Treatment of Hypervolemia

- Restriction of sodium and fluid intake
- Diuretics to promote fluid loss; morphine and nitroglycerine to relieve air hunger and dilate blood vessels; digoxin to strengthen heart
- Hemodialysis or CAVH
Dehydration

- Excessive loss of free water
- Loss of fluids causes an increase in the concentration of solutes in the blood (increased osmolality)
- Water shifts out of the cells into the blood
- Causes: prolonged fever, watery diarrhea, failure to respond to thirst, highly concentrated feedings, including TF
Symptoms of Dehydration

- Thirst
- Fever
- Dry skin and mucus membranes, poor skin turgor, sunken eyeballs
- Decreased urine output
- Increased heart rate with falling blood pressure
- Elevated serum osmolality; elevated serum sodium; high urine specific gravity
Treatment of Dehydration

- Use hypotonic IV solutions such as D5W
- Offer oral fluids
- Rehydrate gradually
## Laboratory Values and Hydration: BUN

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypovolemia</th>
<th>Hypervolemia</th>
<th>Other factors influencing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN Normal: 10-20 mg/dl</td>
<td>Increases</td>
<td>Decreases</td>
<td>Low: inadequate dietary protein, severe liver failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: prerenal failure; excessive protein intake, GI bleeding, catabolic state; glucocorticoid therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Creatinine will also rise in severe hypovolemia</td>
</tr>
</tbody>
</table>

# Laboratory Values and Hydration Status: BUN:Creatinine Ratio

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypovolemia</th>
<th>Hypervolemia</th>
<th>Other factors influencing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN: creatinine ratio</td>
<td>Increases</td>
<td>Decreases</td>
<td>Low: inadequate dietary protein, severe liver failure</td>
</tr>
<tr>
<td>Normal: 10-15:1</td>
<td></td>
<td></td>
<td>High: prerenal failure; excessive protein intake, GI bleeding, catabolic state; glucocorticoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>therapy</td>
</tr>
</tbody>
</table>

# Laboratory Values and Hydration: HCT

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypovolemia</th>
<th>Hypervolemia</th>
<th>Other factors influencing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematocrit</td>
<td>Increases</td>
<td>Decreases</td>
<td>Low: anemia, hemorrhage with subsequent hemodilution (occurring after approximately 12-24 hours)</td>
</tr>
<tr>
<td>Normal:</td>
<td></td>
<td></td>
<td>High: chronic hypoxia (chronic pulmonary disease, living at high altitude, heavy smoking, recent transfusion)</td>
</tr>
<tr>
<td>Male:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42-52%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37-47%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Laboratory Values and Hydration: Alb, Na+

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypovolemia</th>
<th>Hypervolemia</th>
<th>Other factors influencing result</th>
</tr>
</thead>
</table>
| Serum albumin     | ↑           | ↓            | Low: malnutrition; acute phase response, liver failure  
|                   |             |              | High: rare except in hemoconcentration                                         |
| Serum sodium      | Typically ↑ can be normal or ↓ | ↓, normal or ↑ | Serum sodium generally reflects fluid status and not sodium balance           |

## Laboratory Values and Hydration Status

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypo-volemia</th>
<th>Hyper-volemia</th>
<th>Other factors influencing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum osmolality (285-295 mosm/kg)</td>
<td>Typically ↑ but can be normal or ↓</td>
<td>Typically ↓ but can be normal or ↑</td>
<td></td>
</tr>
<tr>
<td>Urine sp. Gravity 1.003-1.030</td>
<td>↑</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Urine osmolality (200-1200 mosm/kg)</td>
<td>↑</td>
<td>↓</td>
<td>Low: diuresis, hyponatremia, sickle cell anemia, High: azotemia,</td>
</tr>
</tbody>
</table>

# Laboratory Values and Hydration Status

<table>
<thead>
<tr>
<th>Lab Test</th>
<th>Hypovolemia</th>
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<tbody>
<tr>
<td>Serum albumin</td>
<td>↑</td>
<td>↓</td>
<td>Low: malnutrition; acute phase response, liver failure High: rare except in hemoconcentration</td>
</tr>
<tr>
<td>Serum sodium</td>
<td>Typically ↑can be normal or ↓</td>
<td>↓, normal or ↑</td>
<td></td>
</tr>
</tbody>
</table>

Hypokalemia (K+ < 3.5 mEq/L)

- ↑ renal losses (diuresis)
- ↑ GI losses (diarrhea, vomiting, fistula)
- K+ wasting meds (thiazide and loop diuretics, etc)
- Shift into cells (anabolism, refeeding, correction of glucosuria or DKA)
- Inadequate intake
Hyperkalemia (K+>5.0 mEq/L)

- Decreased renal excretion as in acute or chronic renal failure
- Medications, e.g. potassium sparing diuretics, beta blockers, ACE inhibitors
- Shift out of cells (acidosis, tissue necrosis, GI hemorrhage, hemolysis)
Serum Calcium

- Normal serum 9.0-10.5 mg/dL (includes ionized calcium and calcium bound to protein, primarily albumin, and ions)
- Ionized calcium: 4.5-5.6 mg/dL
- Normal levels maintained by hormonal regulation using skeletal reserves
- Ionized calcium is more accurate, especially in pt with hypoalbuminemia; evaluate before repleting Ca+

Charney and Malone, 2004, p. 89
Hypocalcemia (serum calcium <9.0 mg/dL; ionized Ca+ <4.5 mg/dL)

- Hypoalbuminemia
- Hypoparathyroidism
- Hypomagnesemia
- Renal failure, renal tubular necrosis
- Vitamin D deficiency or impaired metabolism
Hypercalcemia (serum calcium >10.5 mg/dL; ionized Ca+ >5.6 mg/dL)

- Hyperparathyroidism
- Some malignancies, especially breast, lung, kidney; multiple myeloma, leukemia, lymphoma
- Medications: thiazide diuretics, lithium, vitamin A toxicity
- Immobilization
- Hyperthyroidism

Charney and Malone, 2004, p. 91
Serum Phosphorus (normal 3.0-4.5 mg/dL)

- Serum phos a poor reflection of body stores because <1% is in ECF
- Bones serve as a reservoir
Hypophosphatemia (<3.0 mg/dL)

- Impaired absorption (diarrhea, Vitamin D deficiency, impaired metabolism)
- Medications: phosphate binding antacids, sucralfate, insulin, steroids)
- Alcoholism, especially during withdrawal
- Intracellular shifts in alkalosis, anabolism, neoplasms
- Refeeding syndrome
- Increased losses: hyperparathyroidism, renal tubular defects, DKA recovery, hypomagnesemia,

Charney and Malone, 2004, p. 93
Hyperphosphatemia (>4.5 mg/dL)

- Decreased renal excretion: acute or chronic renal failure (GFR < 20-25 mL/min); hypoparathyroidism
- Increased cellular release: tissue necrosis, tumor lysis syndrome
- Increased exogenous phosphorus load or absorption, phosphorus containing laxatives or enemas, vitamin D excess
- Acidosis
Hypomagnesemia <1.3 mEq/L (normal 1.3-2.1 mEq/L)

- Decreased absorption: prolonged diarrhea, intestinal or biliary fistula, intestinal resection or bypass, steatorrhea, ulcerative colitis; upper GI fluid loss, gastric suctioning, vomiting
- Renal losses: osmotic diuresis, DM with glucosuria, correction of DKA, renal disease with magnesium wasting, hypophosphatemia, hypercalcemia, hyperthyroidism
- Alcoholism
- Inadequate intake: malnutrition
- Medications
- Intracellular shift: acute pancreatitis
- Refeeding syndrome
Hypermagnesemia (>2.1 mEq/L)

- Acute or chronic renal failure
Assessment for Protein-Calorie Malnutrition

- Hormonal and cell-mediated response to stress
  - Negative acute-phase respondents
  - Positive acute-phase respondents
- Nitrogen balance
Assessment for Protein-Calorie Malnutrition—cont’d

- Hepatic transport proteins
  - Albumin
  - Transferrin
  - Prealbumin
  - Retinol-binding protein
  - C-reactive protein
  - Creatinine
- Immunocompetence
Hormonal and Cell-Mediated Response to Inflammatory Stress

- Acute illness or trauma causes inflammatory stress
- Cytokines (interleukin-1, interleukin-6 and tumor necrosis factor) reorient hepatic synthesis of plasma proteins
- Although protein-energy malnutrition can occur simultaneously, interpretation of plasma proteins is problematic
Hormonal and Cell-Mediated Response to Inflammatory Stress

- Negative acute-phase respondents (albumin, transthyretin or prealbumin, transferrin, retinol-binding protein) decrease

- Positive acute-phase reactants (C-reactive protein, orosomucoid, fibrinogen) increase

- The change in these proteins is proportional to the physiological insult
Nitrogen Balance Studies

- Oldest biochemical technique for assessment protein status
- Based on the fact that 16% of protein is nitrogen
- Nitrogen intake is compared to nitrogen output, adjusted for insensible losses (skin, hair loss, sweat)
Nitrogen Balance Studies

- Nitrogen balance in healthy adults is 0
- Nitrogen balance is positive in growing children, pregnant women, adults gaining weight or recovering from illness or injury
- Nitrogen balance is negative during starvation, catabolism, PEM
Nitrogen Balance Calculations

- Nitrogen balance = nitrogen intake (g/24 hours) – (urinary nitrogen [g/24 hours] + 2 g/24 hours)
- Use correction of 4 g/24 hours if urinary urea nitrogen is used
- Nitrogen intake = (grams protein/24 hours)/6.25
Nitrogen Balance Challenges

- Urea nitrogen is highly variable as a percent of total nitrogen excreted
- It is nearly impossible to capture an accurate nitrogen intake for patients taking food po
- Most useful in evaluating the appropriateness of defined feedings, e.g. enteral and parenteral feedings
Visceral Proteins: Serum Albumin

- Reference range: 3.5-5.2 g/dl
- Abundant in serum, stable (half-life 3 weeks)
- Preserved in the presence of starvation (marasmus)
- Negative acute phase reactant (declines with the inflammatory process)
- Large extravascular pool (leaves and returns to the circulation, making levels difficult to interpret)
- Therefore, albumin is a mediocre indicator of nutritional status, but a very good predictor of morbidity and mortality
Visceral Proteins: Plasma Transferrin

- Reference range: 200-400 mg/dl
- Half-life: 1 week
- Negative acute phase respondent
- Increases when iron stores are depleted so affected by iron status as well as protein-energy status
- Responds too slowly to be useful in an acute setting
Visceral Proteins: Transthyretin (Prealbumin)

- Reference range: 19-43 mg/dl
- Half-life: 2 days
- Negative acute-phase reactant
- Zinc deficiency reduces levels
- Due to short half-life, it is useful in monitoring improvements in protein-energy status if baseline value is obtained near the nadir as inflammatory response wanes
Visceral Proteins: Retinol-Binding Protein

- Reference range: 2.1-6.4 mg/dl
- Half-life: 12 hours
- Negative acute-phase protein
- Unreliable when vitamin A (retinol) status is compromised
- Elevated in the presence of renal failure, regardless of PEM status
Visceral Proteins: C-Reactive Protein

- Positive acute-phase reactant
- Increases within 4-6 hours of injury or illness
- Can be used to monitor the progress of the stress reaction so aggressive nutrition support can be implemented when reaction is subsiding
- Mildly elevated CRP may be a marker for increased risk for cardiovascular disease
Inflammation

- hs-CRP
- Homocysteine
Urinary Creatinine

- Formed from creatine, produced in muscle tissue
- The body’s muscle protein pool is directly proportional to creatinine excretion
- Skeletal muscle mass (kg) = 4.1 = 18.9 x 24-hour creatinine excretion (g/day)
- Confounded by meat in diet
- Requires 24-hour urine collection, which is difficult
Markers of Malabsorption

• Fecal fat
• Fat-soluble vitamins
• Vitamin D