Medical Laboratory Assessment

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http://rc-edconsultant.com/

Learning Objectives:
- Recognize normal value ranges for common hematology tests.
- Explain the implications of abnormal values from common hematology tests.
- Recognize normal value ranges for common blood chemistry tests.
- Explain the implications of abnormal values from common blood chemistry tests.

Hematology

Complete Blood Count (CBC)
- Hemoglobin- g/dl
- Hematocrit
- RBC count
- WBC count
- Differential count
- Platelet count

FYI - click for additional information on CBC
http://www.medicinenet.com/complete_blood_count/article.htm

Complete Blood Count (CBC)
- Hemoglobin
  - Normal = 13-17 g/dl
  - Decreased with:
    - hemorrhage
    - hemodilution
    - decreased RBC production (anemia)
    - hemolysis
  - Increased with
    - hemoconcentration- dehydration
    - polycythemia; e.g., chronic bronchitis
Complete Blood Count (CBC)

- Hematocrit - percentage of formed elements in whole blood
  - normal = 40-50 Vol%
  - decreased with:
    - hemorrhage
    - anemia
    - hemodilution

Click for description of hematocrit measurement
http://faculty.weber.edu/nokazaki/Human_Physiology/Laboratory/Hematocrit-lab.htm

Complete Blood Count (CBC)

- Hematocrit
  - estimated as Hb x 3
  - elevated Hct ==> increased blood viscosity
  - increased with:
    - hemoconcentration
    - polycythemia - excessive RBCs
    - leukemia - excessive WBCs

Complete Blood Count (CBC)

- RBC count
  - normal = 4.2-5.7 M/mm³
  - decreased with:
    - hemorrhage
    - hemodilution
    - hemolytic diseases
    - decreased production - bone marrow or kidney disease
    - exposure to leeches, vampires, etc.

- increased with:
  - polycythemia
  - hemoconcentration

Complete Blood Count (CBC)

- WBC count - number per mm³
  - normal = 4-11 k/mm³
  - increased with:
    - infection
    - leukemia

- decreased with:
  - immunosuppression - AIDS, CIDS, steroids, cyclosporine
  - overwhelming infection - WBCs are used up
Complete Blood Count (CBC)

Differential count - % of each WBC type:
- Neutrophils - 38-80%
- Lymphocytes - 15-49%
- Monocytes - 0-13% (alveolar macrophages)
- Eosinophils - 0-8.0%
- Basophils - 0-2.0% (mast cells)

Click to see the WBC types
http://www.nceus.com/cbc/whitecells.jpg

Increased:
- Neutrophils - bacterial infection
- Lymphocytes - viral infection; e.g., mononucleosis
- Monocytes - leukemia, viral infections

Click to see the WBC types
http://www.rnceus.com/cbc/whitecells.jpg

Complete Blood Count (CBC)

Differential count
- Increased:
  - Neutrophils - bacterial infection
  - Lymphocytes - viral infection; e.g., mononucleosis
  - Monocytes - leukemia, viral infections

Complete Blood Count (CBC)

Differential count
- Increased:
  - Neutrophils - bacterial infection
  - Lymphocytes - viral infection
  - Monocytes - leukemia, viral infections
  - Eosinophils - allergy, parasitic infection
  - Basophils - lymphoma, viral infections, inflammation

Complete Blood Count (CBC)

Platelet count
- Platelets necessary for coagulation
- Normal value = 140-390 k/mm3
- Decreased with:
  - Immune reactions
  - Disseminated intravascular coagulopathy (DIC)
  - Medications - heparin, aspirin

FYI - Click to see platelets
http://www.flickr.com/photos/16401073@N05/2481966671/

Hematology

International Normalized Ratio (INR)
- Index of coagulation
- Derived from prothrombin time - not a separate test
- Normal = 1.0
- Range for anticoagulation = 2.0-3.0
- Surgical risk > 4.5

Blood Chemistry
Serum Electrolytes

- Electrolyte balance affects all organ systems.
- All nerve transmission and muscular contraction operate by exchange of ions across cell membranes.
- Types:
  - Cation - positive charge; e.g., Na+
  - Anion - negative charge; e.g., Cl-

Serum Electrolyte- Normals

<table>
<thead>
<tr>
<th>Ion</th>
<th>Normal Range</th>
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<tbody>
<tr>
<td>Na+</td>
<td>137-147 mEq/dl</td>
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<tr>
<td>K+</td>
<td>3.5-5.0 mEq/dl</td>
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<tr>
<td>Ca++</td>
<td>8.5-10.9 mg/dL</td>
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<tr>
<td>Mg++</td>
<td>1.8-3.0 mg/dL</td>
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<tr>
<td>Cl-</td>
<td>101-111 mmol/L</td>
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<tr>
<td>CO2</td>
<td>20-29 mmol/L</td>
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<tr>
<td>PO4--</td>
<td>2.4-4.1 mg/dL</td>
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</tbody>
</table>

Serum Electrolytes- Abnormals

<table>
<thead>
<tr>
<th>Ion</th>
<th>Decreased- Causes</th>
<th>Increased- Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na+</td>
<td>Diarrhea, vomiting</td>
<td>H2O loss</td>
</tr>
<tr>
<td></td>
<td>Renal failure</td>
<td>Excessive intake</td>
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<tr>
<td></td>
<td>Diabetes insipidus</td>
<td>Renal disease</td>
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<tr>
<td></td>
<td>Inadequate intake</td>
<td>Increased- Sequelae</td>
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<tr>
<td></td>
<td>Decreased- Sequelae</td>
<td>altered mental status</td>
</tr>
<tr>
<td></td>
<td>cerebral edema</td>
<td>seizures</td>
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<tr>
<td></td>
<td>confusion, seizures</td>
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<td>shock</td>
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<td>Mg depletion</td>
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<td>Diuretics</td>
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<td>Decreased- Sequelae</td>
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<tr>
<td></td>
<td>Tachydysrhythmias</td>
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<td>Muscle weakness</td>
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<td>Increased- Sequelae</td>
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<td>Bradydysrhythmias</td>
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<td>Parathyroid Dx</td>
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<td>CHF</td>
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<tr>
<td>HPO4-</td>
<td>skeletal dx, fx renal failure hypoparathyroidism</td>
<td>K+, Mg++ depletion ketoacidemia renal disease</td>
</tr>
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<td>paresthesia convulsions cardiac arrest</td>
<td>muscle weakness bone deformities weight loss</td>
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<td>excessive intake respiratory acidemia</td>
<td>metabolic acidemia diarrhea diuretics</td>
</tr>
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<td></td>
<td>metabolic alkalemia hypochloremia</td>
<td>metabolic acidemia</td>
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### Anion gap

- Anion gap = [(Na) - (Cl + HCO3)]
- Normal = [(140) - (100 + 24)] = 16
- Applications
  - determine origin of metabolic acidemia
  - determine biochemical severity of metabolic acidemia

FYI - Click for more information on anion gap
http://fitsweb.uchc.edu/student/selectives/TimurGraham/Anion_Gap.html

- Elevated gap ==> fixed acids
  - Ketoacidosis
  - Kidney failure.
  - Lactic acidosis
  - Ingestion excessive amounts of:
    - aspirin
    - salicylates
    - alcohols; e.g. methanol
### Anion gap

- **Acidemia with normal anion gap**
  - Gastrointestinal loss of HCO3-
  - Renal loss of HCO3-
  - Ammonium chloride
  - Hyperalimentation fluids

Click to see anion gap calculator
http://www.valuemd.com/medical-calculator-anion_gap.html

### Renal Function

- **Blood urea nitrogen (BUN)**
  - Normal = 8-20 mg/dL
  - Increased with:
    - Kidney dx
    - Liver dx
    - Heart dx

FYI - Click for information on Chem 20

### Renal Function

- **Creatinine**
  - Normal = 0.8-1.4 mg/dL
  - Increased with:
    - Kidney failure
    - Dehydration
    - Eclampsia
    - Muscular dystrophy

### Cardiac Enzyme Panel

- **Total Creatine Kinase (CK)**
  - Normal = 55-170 IU/L
- **Creatine Kinase (MB)** - more specific for myocardial infarction
  - Normal = 0-7 IU/L

FYI - Click for more information on cardiac enzymes
http://en.wikipedia.org/wiki/Cardiac_markers

### Cardiac Enzyme Panel

- **Troponin - gold standard**
  - Serum troponin rises within 4 to 6 hours post-MI
  - Reach peak 0 to 24 hours
  - Fall to normal within 10 to 15 days
  - Levels above 1.5 ng/mL support a diagnosis of heart attack.

### D-dimer

- **Component of blood clot**
- **Diagnostic for:**
  - Deep vein thrombosis (DVT)
  - Pulmonary embolus
  - Aortic aneurysm dissection
- **Positive d-dimer > 300 ng/mL**

FYI - Link to article on d-dimer
Brain natriuretic peptide (BNP)
- Secreted by ventricles in response to stretch
- Endogenous vasodilator
- BNP level used to diagnose CHF
- Can predict weaning failure*
- Interpretation of results:
  ◆ BNP < 50 pg/mL..........not CHF
  ◆ BNP > 150 pg/mL.........CHF

Liver Enzymes
- SGOT (Serum Glutamic-Oxalocetic Transaminase - AST)
- SGPT (Serum Glutamic-Pyruvic Transaminase - ALT)
- Alkaline phosphatase
- GGT (Gamma-Glutamyl Transpeptidase)
- LDH (Lactic Acid Dehydrogenase)

Proteins
- Parameters:
  ◆ albumin
  ◆ globulin
  ◆ total protein
- Decreased by:
  ◆ liver dx - the liver synthesizes proteins
  ◆ malnutrition
  ◆ chronic inflammation

Proteins
- Function in capillary fluid exchange
  ◆ exert colloid osmotic pressure
  ◆ causes H2O reentry at venous side of capillary
  ◆ depleted proteins ==> decreased COP ==> interstitial edema

Pancreatic Enzymes
- increased- pancreatitis, often with ARDS
  ◆ Serum amylase
  ◆ Serum lipase

Glucose
- normal = 60-120 mg/dL
- hyperglycemia
  ◆ caused by diabetes mellitus (DM)
  ◆ may result in ketoacidemia

Glucose
- Normal = 60-120 mg/dL
- Hyperglycemia
  - Caused by diabetes mellitus (DM)
  - May result in ketoacidemia
- Hypoglycemia
  - Excessive insulin
  - Inadequate dietary intake
  - Excessive exercise

Lipids
- Cholesterol
  - Normal = 120-240 mg/dL
  - Increased with:
    - Atherosclerosis
    - Diabetes
    - Pregnancy
  - Decreased with:
    - Depression
    - Malnutrition

Lipids
- Triglycerides
  - Normal = 0-200 mg/dL
  - Increased with:
    - Atherosclerosis
    - Liver disease
    - Myocardial infarction
  - Decreased with:
    - COPD
    - Malnutrition, malabsorption

Lipids
- High-density lipoprotein (good)
  - Normal = 35-135 mg/dL
  - High level ==> healthy metabolism

Summary & Review
- Hematology
  - CBC
  - INR
- Blood chemistry
  - Electrolytes
  - Renal function
  - Cardiac, liver and pancreatic enzymes
  - Proteins
  - Glucose
  - Lipids
END