Lab Values: Predicting Your Patient’s Future

Objectives

At the conclusion of this course, the participant will be able to:

- Identify the reasons for utilization of lab testing for patient care
- Name common hematology lab values and their indications for patient-specific problems.
- Name common chemistry and hepatic panels and their indications for patient-specific problems.

Objectives

- Identify and evaluate lab tests for specific patient problems.
- Apply knowledge of clinical laboratory results to patient presentation and patient care.
**Why Perform Lab Testing?**

- **Screening** - for evidence of disease
- **Diagnosis** - helps detect the presence of a condition
- **Monitoring** - to correlate serum levels with patient’s response

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**Collection Tubes**

- Why does the order in which blood tubes are drawn matter?

When in doubt as to what tube to use, look it up!!!

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**Decision Making**

- **Findings**
- **Explanations for Findings**
- **Additional Information**
**Principles to Consider**

- The most common lab abnormalities come from *fluids or drugs*.
- The most common drugs that affect lab testing:
  - Oxygen
  - NSAIDS
  - Antibiotics
  - Diuretics

**Lab Profiles**

- Complete Blood Count (CBC) with/without differential, Platelet Disorders, Anemias
- Urinalysis
- Basic Metabolic Panel (BMP)
- Hepatic Function
- Amylase, Lipase
- Arterial Blood Gas (ABG)
- Brain Natriuretic Protein (BNP)
- Clotting Factors (INR, PT/PTT)
- D-Dimer
- BNP
- Cardiac Enzymes

**Complete Blood Count (CBC)**

<table>
<thead>
<tr>
<th></th>
<th>Normal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>(4.70-6.10 million)</td>
<td># of red cells per cc/blood</td>
</tr>
<tr>
<td>Hgb</td>
<td>(14-18 gm/dL)</td>
<td>O2 carrying protein</td>
</tr>
<tr>
<td>Hct</td>
<td>(42-52%)</td>
<td>Packed vol of RBCs, % of total vol.</td>
</tr>
<tr>
<td>MCV</td>
<td>(80-94%)</td>
<td>Cell size (normocytic, macro and micro)</td>
</tr>
<tr>
<td>MCH</td>
<td>(27-33 FL)</td>
<td>Amt of Hgb per cell</td>
</tr>
<tr>
<td>MCHC</td>
<td>(33-37% PG)</td>
<td>Hgb/Hct per 100mL/RBCs (norma, hypo, hyperchromic)</td>
</tr>
<tr>
<td>RDW</td>
<td>(11.5-14.5%)</td>
<td>Red cell distribution width, should be normal</td>
</tr>
<tr>
<td>Platelet</td>
<td>(130-400 K/cumm)</td>
<td># of plt. per cc/blood</td>
</tr>
<tr>
<td>WBC</td>
<td>(5.0-10 K/cumm)</td>
<td># of white cells per cc/blood</td>
</tr>
</tbody>
</table>
**CBC with Differential**

- Differential
  - Neutrophil (40-75%)
  - Bands (0-8%)
  - Lymph (16-46%)
  - Mono (0-12%)
  - Eosin (0-7%)
  - Baso (0-5%)

**Common Indications for CBC**

- Infection
- Weakness or Anemia
- Bleeding
- Fluid Status

**Platelet Disorders**

- **Thrombocytopenia:**
  - too few platelets
  - counts below 50,000 = significant bleeding

- **Thrombocytosis:**
  - too many platelets
  - risk of clotting is greatest with counts > 1 million, though > 600,000 can be a problem

- **Disorders of platelet function:**
  - variety of conditions, especially drugs, can cause abnormal clotting of platelets, despite normal platelet counts
Anemia

- Decrease in number of RBC's (erythrocytes)
- Impaired RBC production
- Blood loss
- RBC destruction
- Combination of above three

Classification
- Etiology
- Morphology

Interpretation of Results

- Anemia
- MCV

<table>
<thead>
<tr>
<th>Low</th>
<th>Normal</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;microcytic&quot;</td>
<td>&quot;normocytic&quot;</td>
<td>&quot;macrocytic&quot;</td>
</tr>
<tr>
<td>Hgb problem</td>
<td>RBC's are good Just not enough</td>
<td>DNA problem</td>
</tr>
</tbody>
</table>

Case Study #1

- 44 yo female who had abdominal surgery 7 days ago. Has had an uneventful post-op recovery and expects to be discharged soon. Today she is not feeling well and has a fever of 102°F. You note yellowish drainage on her abdominal dressing. Her CBC shows the following:
  - WBC 13.9
  - Hgb 13.0
  - Hct 40.1
Case Study #2

50 yo male post-op for gunshot wound to abdomen with major blood loss from his injury. Yesterday’s surgery was several hours long, followed by admission to ICU where he has been stable and now weaned from the ventilator and extubated. He has been a healthy individual.

His pain has been controlled with Morphine q2h for the past 6 hours. He is now requiring it every hour with little relief. Your assessment reveals a patient who is clutching his abdomen which is rigid upon palpation, absent bowel sounds, and NGT with 100cc dark green drainage q1h.

- Hgb/Hct: 14.1/42.0
- Platelet Ct: 160,000
- WBC/RBC: 22.6/4.9

Case Study #3

56 yo male with history of alcohol-associated liver disease who had surgical repair of esophageal varices 3 days ago.

- 5-21-11: Platelet Ct = 138,000
- 5-22-11: Platelet Ct = 77,000

0800 Vitals: 1200 Vitals
100.3 90 20 101.7 106 30
134/80 110/64
Urinalysis

- Color: yellow
- Character: clear
- Glucose: negative
- Ketones: negative
- Bilirubin: negative
- Specific gravity: 1.003 - 1.030
- Blood: negative
- pH: 5 - 8
- Protein: negative
- Urobilinogen: negative
- Nitrate: negative
- Leukocytes: negative
- WBC: 0 - 2/HPF
- RBC casts: 0/HPF
- Bacteria: negative

Common Indications for Urinalysis

- Dysuria
- Fluid balance
- Kidney status
- Liver Function

Interpretation of Results

- Color
  - Over hydration
  - ETOH
  - Diuretics
  - Nephritis
  - Dehydration
  - Blood
  - Drugs
  - Foods

- Appearance
  - Clear
  - Cloudy
  - Red
Interpretation of Results

- **Glucose**
  - Hyperglycemia
  - Renal tubule disease
  - Cushing’s disease
  - Stress
  - Heavy meals

- **Ketones**
  - Diabetes
  - Starvation/fasting
  - Vomiting
  - Acute illness
  - ETOH
  - Reduced carb intake

Interpretation of Results

- **Bilirubin**
  - Hepatitis
  - Liver disease
  - Biliary obstruction

- **Blood**
  - Hemoglobinuria
  - Myoglobinuria
  - Hematuria
  - Kidney stones

- **Specific Gravity**
  - Hydration status
  - Radiopaque dye
  - Renal disease

- **pH**
  - Acidic
  - Alkalotic

Interpretation of Results

- **Protein**
  - Kidney disease
  - Hypertension
  - Chronic UTI’s
  - Fever/infection
  - Trauma
  - Pre-eclampsia
  - Diabetes
  - Poisonings
  - Leukemia

- **Urobilinogen**
  - RBC destruction
  - Liver damage
  - Biliary obstruction

- **Nitrate**
  - Significant bacteria
Interpretation of Results

- **Leukocytes (WBC)**
  - Bacterial infection
  - Renal disease
  - Fever
  - Exercise
  - Appendicitis
  - Bladder tumors

- **Bacteria**
  - UTI

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Basic Metabolic Panel (BMP)

- **Sodium** (135 - 145 mmol/L)
- **Potassium** (3.5 - 5.3 mmol/L)
- **Chloride** (99 - 112 mmol/L)
- **Calcium** (8 - 10.5 mg/dL)
- **Glucose** (70 - 110 mg/dL)
- **BUN** (5 - 25 mg/dL)
- **Creatinine** (0.5 - 1.4 gm/dL)

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Common Indications for BMP

- Baseline electrolytes
  - Na, K, Cl, HCO₃, Mg
  - Many disease processes
- **Glucose**
  - Diabetes, altered LOC
- **Kidney Function**
  - BUN, Creatinine
Interpretation of Results

- **Sodium**
  - Most common ECF cation
  - Maintains osmotic pressure, acid balance
  - Transmits nerve impulses
  - Reflects changes in water/salt balance

Patient Presentation

- **Hyponatremia**
  - Lethargic
  - Confusion, altered LOC
  - Seizures, coma
  - Edema, venous distention
  - Weight gain, decreased urine
  - Tachycardia
  - Hypotensive

- **Hypernatremia**
  - Thirsty
  - Restless
  - Seizures
  - Acute pulmonary edema
  - Dry mucous membranes
  - Weight gain, edema

Interpretation of Results

- **Potassium**: major intracellular cation
  - Nerve conduction
  - Muscle function
  - Acid/base balance, osmotic pressure
  - Rate and force of heart contraction
**Patient Presentation**

- **Hypokalemia**
  - Thirsty
  - Muscular irritability
  - Lethargic
  - EKG
    - Flattened T-waves
    - U-wave present

- **Hyperkalemia**
  - Cramping, diarrhea
  - Muscle weakness
  - Paralysis
  - EKG
    - Peaked T-waves
    - Flattened P-wave
    - Widened QRS

**Interpretation of Results**

- **Chloride:**
  - maintains cellular integrity via influence on osmotic pressure, acid/base balance, water balance
  - increases/decreases in response to other ion concentrations
  - transport is passive and usually follows sodium

**Patient Presentation**

- **Hypochloremia**
  - Vomiting
  - Diarrhea
  - Intestinal fistulas
  - Gastric suctioning
  - Diabetic
  - Hyponatremia

- **Hyperchloremia**
  - No specific symptoms
  - Dehydration
  - Hyperventilation
  - Diabetes insipidus
  - Hypernatremia
**Interpretation of Results**

- **Calcium:**
  - Bone and teeth formation
  - Blood clotting
  - Muscle contraction
  - Nerve impulse conduction
  - Influenced by many factors

**Patient Presentation**

- **Hypocalcemia**
  - Carpal pedal spasm
  - Tetany, seizures
  - Paresthesias (mouth, fingers, toes)
  - Laryngo and bronchospasms
  - Prolonged QT intervals, torsades, heart blocks
  - Chvostek’s sign
  - Trousseau’s sign

- **Hypercalcemia**
  - Lethargy, drowsy
  - Confusion, coma
  - N. V. constipation
  - Kidney stones
  - Abdominal/joint pain
  - Hypertensive
  - Shortened QT
  - Bradycardia

**Interpretation of Results**

- **Glucose:**
  - Energy for cells formed by carb digestion
  - Conversion of glycogen to glucose by the liver
Patient Presentation

- **Hypoglycemia**
  - Confusion, coma
  - Tachycardia
  - Restless, tremors
  - Personality change
  - Seizures
  - Appears drunk

- **Hyperglycemia**
  - Polyuria, polydipsia, polyphagia
  - Hypotensive
  - Headache, drowsy
  - Lethargic, coma
  - Hyporeflexia
  - Muscle weakness
  - Hot, dry flushed skin
  - Poor skin turgor
  - Acetone breath
  - Kussmaul’s breathing

Interpretation of Results

- **BUN (blood urea nitrogen):**
  - Final product of protein metabolism.
  - Varies directly with protein intake and excretion
  - Decreased levels: Due to liver failure, increased activity of the adrenal glands and/or increased excretion
  - Azotemia (increased levels): Due to impaired renal function

Interpretation of Results

- **Creatinine:**
  - By-product of muscle creatine phosphate
  - Produced at a constant rate
  - Excreted by kidneys
  - Decreased levels: are not usually clinically significant
  - Increased levels: due to impaired renal function, muscle diseases
Magnesium

- Intracellular cation
- Normal value: 1.8 – 2.4 mEq/L
- Metabolized via kidneys
- Closely tied to calcium levels
- Watch your EKG

Patient Presentation

Hypomagnesemia
- Tetany, tremor, twitching
- Nausea, vomiting
- Prolonged PR and QT intervals
- Flat T-waves
- PVC’s, VT/VF
- Torsades

Hypermagnesemia
- Lethargy, drowsy
- Nausea, vomiting
- Slurred speech
- Respiratory depression
- Weak
- Prolonged PR and QT intervals
- Widened QRS
- Bradycardia

Case Study #1

Admission @ 4pm: 98.6°F - 84 - 18
128/70

Admission labs: 8am next day
- Glucose 290 650
- Na 138 144
- K+ 4.8 5.8
- Cl 101 100
- Hgb/Hct 15.9/48
- Urine Ketones moderate large
Case Study #2

4pm vital signs: 102.2°F - 90 - 22
136/90

Electrolytes:
- Na 128
- K+ 3.1
- Cl 94

Case Study #3

<table>
<thead>
<tr>
<th></th>
<th>5/21</th>
<th>5/22</th>
<th>5/23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake</td>
<td>900mL</td>
<td>500mL</td>
<td>300mL</td>
</tr>
<tr>
<td>Output</td>
<td>1000mL</td>
<td>600mL</td>
<td>200mL</td>
</tr>
</tbody>
</table>

Labs:
- BUN: 25 → 50
- Cr: 2.1 → 3.6
- K+: 4.0 → 4.4
- Cl: 100 → 102

Hepatic Function Test

- Albumin (3.5 - 5 gm/dL)
- AST (10 - 42 IU/L)
- Alk Phos (40 - 112 IU/L)
- ALT (4 - 25 IU/L)
- Bili Total (0.2 - 1.8 mg/dL)
- Direct Bili (0 - 0.2 mg/dL)
- Ammonia (11 - 35 Umol/L)

Most of these tests are included in a CMP
Common Indications for Hepatic Functions

- Jaundice
- Weight loss
- Abdominal Pain
- Alcohol Abuse
- Edema

Hepatic Components

- **Albumin**: regulates oncotic pressures
- **AST**: present in tissue with high metabolic activity
- **Alkaline Phosphatase**: originates in bone, liver and placenta
- **ALT/SGPT**: occurs in high concentrations in liver
- **Bilirubin**: byproduct of hemoglobin breakdown; usually present in small amount
- **Ammonia**: end product of protein metabolism; can affect acid-base balance

Interpretation of Results

**Albumin**
- Increased with IV infusion, dehydration
- Decreased in presence of decreased protein synthesis

**AST**
- Increased with hepatitis, cirrhosis, MI, heat stroke, brain trauma
- Decreased in renal failure, chronic dialysis
Interpretation of Results

- **Alkaline Phosphatase**
  - Increased with liver/bone disease, pulmonary/cardiac infarctions, bowel perforations, sepsis, chronic renal failure
  - Decreased with malnutrition, hypothyroidism

- **ALT**
  - Increased with cirrhosis, metastatic liver tumor, obstructive jaundice, severe burns, shock, pancreatitis, skeletal muscle trauma

- **Total Bilirubin**
  - Increased with excessive RBC destruction or if liver unable to excrete normal amounts produced

- **Direct Bilirubin**
  - Increase usually due to blockage or tumors in biliary tract

- **Ammonia**
  - Increased with severe liver disease, alcoholism, Reye's syndrome, GI bleeding, shock
Amylase
- Pancreatic test that is helpful in the evaluation of abdominal pain
- Normal < 130 U/L
- Elevated levels:
  - Many abdominal diagnoses, DKA, various cancers, salivary gland inflammation
- Decreased levels:
  - Hepatic necrosis, advanced chronic pancreatitis

Lipase
- Enzyme secreted by pancreas into small intestines
- Helps in the breakdown of triglycerides into fatty acids
- Highly specific for pancreatic diseases, more so than amylase
- Normal level: < 160 U/L
- Elevated levels:
  - Acute pancreatitis, early pancreatic cancer, perforated ulcer
- Decreased level:
  - Acute severe pancreatitis

Case Study #1
- 8am 12pm
- B/P 144/86 156/94
- P 82 98
- NH₄ 5/21 5/22
- 52 72
### Case Study #2

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>8am</th>
<th>8am</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/P</td>
<td>122/80</td>
<td>108/72</td>
</tr>
<tr>
<td>P</td>
<td>82</td>
<td>94</td>
</tr>
<tr>
<td>R</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>T</td>
<td>98.6 (R)</td>
<td>101.0 (R)</td>
</tr>
<tr>
<td>Glucose</td>
<td>106</td>
<td>70</td>
</tr>
<tr>
<td>BUN/Cr</td>
<td>18/1.5</td>
<td>32/2.6</td>
</tr>
<tr>
<td>Alk. Phos</td>
<td>295</td>
<td>330</td>
</tr>
<tr>
<td>Bili</td>
<td>2.4</td>
<td>4.8</td>
</tr>
<tr>
<td>SGOT/AST</td>
<td>92</td>
<td>130</td>
</tr>
</tbody>
</table>

### Case Study #3

<table>
<thead>
<tr>
<th>Time</th>
<th>8am</th>
<th>8pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>165</td>
<td>240</td>
</tr>
<tr>
<td>Amylase</td>
<td>200</td>
<td>270</td>
</tr>
<tr>
<td>Lipase</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Hct</td>
<td>42</td>
<td>46</td>
</tr>
<tr>
<td>WBC</td>
<td>11,800</td>
<td>16,000</td>
</tr>
</tbody>
</table>

### Arterial Blood Gas

- **pH**: (7.35 - 7.45)
- **pCO₂**: (35 - 45 mmHg)
- **HCO₃⁻**: (22 - 28 mmol/L)
- **pO₂**: (80 - 100 mmol/L)
- **O₂ sat**: (90 - 100%)

Is it a metabolic problem or respiratory problem?
Common Indications for ABG’s:

- Adequacy of Oxygenation
- Adequacy of Ventilation/Respiration
- Acid / Base Balance
- Activation of Buffer System

Components of the ABG

- **pO₂**: indicates the oxygen content in arterial blood
  - Normal is 80 – 100 mmHg (patients < 60yo)
  - Every year over 60, drops by 1 mmHg
  - Accounts for 3% of O₂ in blood; other 97% is bound to hemoglobin
  - Can be affected by altitudes
- **SaO₂**: oxygen bound to hemoglobin
  - Normal is 95 – 100%

Components of ABG

- **pH**: indicates hydrogen ion concentration in the body
  - Normal is 7.35 – 7.45
  - < 7.35 is a higher H concentration = acidosis
  - > 7.45 is a lower H concentration = alkalosis
- **pCO₂**: respiratory acid; byproduct of metabolic activity controlled by respiratory system
  - Normal is 35 – 45 mmHg
  - Poor ventilation causes retention of CO₂ = drop in pH below 7.35
  - Hyperventilation causes loss of CO₂ = rise in pH above 7.45
Components of ABG

- **HCO3**: metabolic component which reflects amount of base available to buffer acids; most important buffer system in body
  - Normal is 22 – 28
  - Too much bicarb causes pH to rise above 7.45 = alkalosis
  - Too little causes pH to fall below 7.35 = acidosis

ABG Interpretation

- **Assess the pH**
  - Is patient acidotic (pH < 7.35)
  - Is patient alkalotic (pH > 7.45)

- **Assess pCO2**
  - If normal, does not have primary respiratory problem
  - pCO2 increased; pH decreased, problem is respiratory acidosis
  - pCO2 decreased and pH increased, problem is respiratory alkalosis

- **Assess the HCO3**
  - If normal, does not have primary metabolic problem
  - HCO3 and pH increased, problem is metabolic alkalosis
  - HCO3 and pH decreased, problem is metabolic acidosis

- **Assess the PO2**
  - Normal is 80 – 100
  - 70 – 80 is mild hypoxemia
  - 60 – 70 is moderate hypoxemia
  - < 60 is severe hypoxemia
Common Acid/Base Disturbances:

**Respiratory Acidosis**
- COPD
- Pneumonia, Atelectasis
- Mechanical ventilation
- Near drowning
- Obesity
- Barbiturate or sedative overdose

**Respiratory Alkalosis**
- Hyperventilation (fear, pain, anxiety)
- Stimulation of respiratory center (brain injury, septicemia, encephalitis)
- Mechanical over-ventilation

**Metabolic Acidosis**
- DKA
- Lactic acidosis
- Severe diarrhea
- Starvation
- Renal failure

**Metabolic Alkalosis**
- Excessive gastric suctioning
- Severe vomiting
- Diuretic therapy
- Potassium depletion
- Excess sodium bicarb intake

Interpretation of Results

<table>
<thead>
<tr>
<th></th>
<th>Respiratory Acidosis</th>
<th>Respiratory Alkalosis</th>
<th>Metabolic Acidosis</th>
<th>Metabolic Alkalosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>↓</td>
<td>↑</td>
<td>Normal (change = compensation)</td>
<td></td>
</tr>
<tr>
<td>pCO₂</td>
<td>↑</td>
<td>↓</td>
<td>Normal (change = compensation)</td>
<td></td>
</tr>
<tr>
<td>pCO₂</td>
<td>↓</td>
<td>↑</td>
<td>Normal (change = compensation)</td>
<td></td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td></td>
</tr>
</tbody>
</table>

Case Study #1

ABG results:
- FiO₂ 21%
- PO₂ 64
- PCO₂ 48
- pH 7.36
Clotting Factors

**PT:**
Protime 11 - 13 seconds

**PTT:**
Partial thromboplastin time 30 - 45 seconds

**INR:**
International normalized ratio 1.0-1.5

Common Indications for Clotting Factors:

- Monitor the effectiveness of anticoagulation therapy
- Evaluate bleeding
- Evaluate liver function

Interpretation of Results

**INR:**
- the comparison of the patient’s PT to an international standard
- INR = patient's PT / International Reference Thromboplastin
- felt to be a more sensitive way to monitor oral anticoagulation.
- reproducible between laboratories, not lab-specific
Interpretation of Results

**PT:**
- monitors stage II of the clotting cascade.
- evaluates clotting ability of prothrombin, fibrinogen, factor V, factor VII, Factor X
- used to monitor oral therapy (coumadin or warfarin)

**Increased Values:**
- Vitamin K deficiency; deficiency of Vitamin K - dependent clotting factors (II, VII, IX, X); liver disease; biliary obstruction; DIC; lupus; anticoagulant therapy; aspirin OD

**Decreased Values:**
- ovarian hyperfunction, regional enteritis or intestinal inflammation

Interpretation of Results

**PTT:**
- screens for defects in the intrinsic clotting pathway
- most often used to monitor heparin therapy

**Increased clotting times:**
- congenital deficiencies (Hemophilia A and B)
- heparin and warfarin therapy
- Vitamin K deficiencies, liver disease, DIC

**Decreased clotting times:**
- extensive cancer without liver involvement
- immediately after acute hemorrhage

D-Dimer

- Coagulation study
- Used to rule out, diagnose, monitor problems of hypercoagulability
- Should be adjunct test

**Normal range**
- < 500

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Case Study #1

<table>
<thead>
<tr>
<th></th>
<th>2/21 @ 8am</th>
<th>2/22 @ 8am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hct</td>
<td>39.0</td>
<td>32.1</td>
</tr>
<tr>
<td>Hgb</td>
<td>13.0</td>
<td>10.2</td>
</tr>
<tr>
<td>WBC</td>
<td>16.1</td>
<td>13.8</td>
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<tr>
<td>Platelets</td>
<td>184,000</td>
<td>92,000</td>
</tr>
<tr>
<td>PT</td>
<td>15.4/11.9</td>
<td>23.1/11.2</td>
</tr>
<tr>
<td>PTT</td>
<td>48.2/30.2</td>
<td>80.5/29.8</td>
</tr>
<tr>
<td>Fibrinogen</td>
<td>225</td>
<td>122</td>
</tr>
</tbody>
</table>

Brain Natriuretic Protein

- Protein present in the cardiac muscle
- Released in response to ventricular stretching
- Effects: sodium diuresis and vasodilation to decrease workload of the heart

- Increased level:
  - > 500 pg/mL usually due to left ventricular heart failure

Cardiac Enzymes

- Utilized to determine the presence of cardiac damage due to an MI; can also be used to identify patient risk for acute coronary syndromes
- Increase due to cellular damage
- Pattern of change is significant
Cardiac Enzymes

- **Creatinine Kinase (CK)**
  - Increased in 90% of MI’s
  - Begins to rise in 4 - 6 hours
  - Peaks at 24 hours; normal in 3 - 4 days

- **CK-MB Isoenzyme**
  - Specific for cardiac injury

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Cardiac Enzymes

- **Myoglobin**
  - Found in striated muscle (cardiac & skeletal)
  - Rises 1 - 4 hours from symptom onset
  - Peaks at 6 - 9 hours; normal at 18 - 24 hours

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Cardiac Enzymes

- **Troponin**
  - Preferred marker; specific for cardiac injury
  - Contractile protein in myofibril; not in serum of healthy person
  - Rises in 4 - 6 hours
  - Remains elevated for a week
Cardiac Enzymes

Principles to Remember

- Normal lab may not = Normal Patient
- Abnormal lab may not = Abnormal Patient
- Compare what's right and what's wrong
- Lab results usually confirm the already suspected
- NO patient is textbook!

Case Studies

Read each case study carefully. Compare lab data with symptoms to make inference to patient's diagnoses and treatment options.

Use practice handouts for writing notes and comparing results.
**Case Study #1**

An 80 yo male from a local nursing home was brought to the ED. He has been unresponsive for the last 4 hours. He has labored respirations with rales throughout. His history includes CHF and a-fib. He is a DNR.

Current VS: T 103.7; P 122; RR 47; BP 102/56

Review lab handouts

Diagnoses? Additional tests?

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**Case Study #2**

A 55 yo male was brought in to the ED via ambulance. Co-workers had called the police because he had not been to work in 3 days. The last time they saw him he was somewhat confused. One co-worker states that he has a long history of alcohol abuse. He is very thin in appearance, jaundiced, has moderate ascites, and scattered petechia on both arms. He is responsive but only oriented to self.

Current VS: T - 98.2; P - 112; R - 22; BP - 120/62.

Review lab handouts

Diagnoses? Additional tests?

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**Case Study #3**

A 32 yo female presents with RUQ pain, chest pain. She has had N/V for the last 6 hours.

Current VS: T - 98.4; P - 92; R - 24; BP - 138/86,

Review lab handouts

Diagnoses?

Additional tests?
Case Study #4
74 yo male, 5 days post-op from radical head/neck surgery for cancer. He has had nothing via NG tube or mouth. He has received only IV fluids of D5½NS since surgery. During rounds, you assess that the patient is much less responsive than when you last saw him.

Review lab handouts
Diagnosis? Additional tests?

Resources

Resources
### Case Study #1
(80 yo male)

<table>
<thead>
<tr>
<th>CBC with differential</th>
<th>Comprehensive Metabolic Panel (CMP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC 4.21 *</td>
<td>Sodium 147</td>
</tr>
<tr>
<td>Hgb 13.9 *</td>
<td>Potassium 4.1</td>
</tr>
<tr>
<td>Hct 40.9 *</td>
<td>Chloride 120 *</td>
</tr>
<tr>
<td>MCV 96.9 *</td>
<td>Glucose 161 *</td>
</tr>
<tr>
<td>MCH 35 *</td>
<td>BUN 70 *</td>
</tr>
<tr>
<td>MCHC 34</td>
<td>Creatinine 2.2 *</td>
</tr>
<tr>
<td>RDW 14.1</td>
<td>Total protein 6.2 *</td>
</tr>
<tr>
<td>Platelet 260</td>
<td>Albumin 2.6 *</td>
</tr>
<tr>
<td>WBC 9.2</td>
<td>Ca 8.8</td>
</tr>
<tr>
<td>Neutrophil 68 *</td>
<td>AST 27</td>
</tr>
<tr>
<td>Bands 24 *</td>
<td>Alk phos 67</td>
</tr>
<tr>
<td>Lymph 8 *</td>
<td>Bili total 0.7</td>
</tr>
<tr>
<td>Mono 0</td>
<td>A:G ratio 0.7 *</td>
</tr>
<tr>
<td>Eosin 0</td>
<td>Osmolality 316 *</td>
</tr>
<tr>
<td>Baso 0</td>
<td></td>
</tr>
</tbody>
</table>

### Arterial Blood Gas

| pH 7.51 *             |                                     |
| pCO2 16.5 *           |                                     |
| HCO3 12.1 *           |                                     |
| pO2 62.1 *            |                                     |
| O2 sat 83% *          |                                     |
| 100% non-rebreather mask |                                 |

### Diagnosis

### Additional labs or Diagnostics
## Case Study #2
(55 yo male)

### CBC with differential

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>2.49  *</td>
</tr>
<tr>
<td>Hgb</td>
<td>9.2   *</td>
</tr>
<tr>
<td>MCV</td>
<td>101.6 *</td>
</tr>
<tr>
<td>MCH</td>
<td>36.9  *</td>
</tr>
<tr>
<td>MCHC</td>
<td>36.4</td>
</tr>
<tr>
<td>RDW</td>
<td>17.9  *</td>
</tr>
<tr>
<td>Platelet</td>
<td>31    *</td>
</tr>
<tr>
<td>WBC</td>
<td>7.0</td>
</tr>
<tr>
<td>Neutrophil</td>
<td>77.5  *</td>
</tr>
<tr>
<td>Bands</td>
<td>1</td>
</tr>
<tr>
<td>Lymph</td>
<td>11.7  *</td>
</tr>
<tr>
<td>Mono</td>
<td>8.4</td>
</tr>
<tr>
<td>Eosin</td>
<td>0</td>
</tr>
<tr>
<td>Baso</td>
<td>0</td>
</tr>
</tbody>
</table>

### Hepatic Function

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>2.7   *</td>
</tr>
<tr>
<td>AST</td>
<td>234   *</td>
</tr>
<tr>
<td>Alk Phos</td>
<td>129   *</td>
</tr>
<tr>
<td>ALT</td>
<td>80    *</td>
</tr>
<tr>
<td>Bili total</td>
<td>7.5   *</td>
</tr>
<tr>
<td>Direct bili</td>
<td>5.3   *</td>
</tr>
<tr>
<td>Ammonia</td>
<td>81    *</td>
</tr>
</tbody>
</table>

### Basic Metabolic Panel

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>124   *</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.2</td>
</tr>
<tr>
<td>Chloride</td>
<td>99</td>
</tr>
<tr>
<td>CO2</td>
<td>22.4  *</td>
</tr>
<tr>
<td>Glucose</td>
<td>33    *</td>
</tr>
<tr>
<td>BUN</td>
<td>53    *</td>
</tr>
<tr>
<td>Creatinine</td>
<td>2.5   *</td>
</tr>
</tbody>
</table>

### Labs that reflect possible causes for confusion:
- Sodium
- Potassium
- Chloride
- CO2
- Glucose
- BUN
- Creatinine

### Diagnosis

### Additional labs or Diagnostics
## Case Study #3
(32 yo female)

<table>
<thead>
<tr>
<th>CBC with differential</th>
<th>Hepatic Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC 5.84</td>
<td>Albumin 4.6</td>
</tr>
<tr>
<td>Hgb 18.3 *</td>
<td>AST 145 *</td>
</tr>
<tr>
<td>Hct 53.1 *</td>
<td>Alk Phos 88</td>
</tr>
<tr>
<td>MCV 90.8</td>
<td>Bili total 1.4</td>
</tr>
<tr>
<td>MCH 31.4</td>
<td>Dir bili 0.1</td>
</tr>
<tr>
<td>MCHC 34.6</td>
<td>ALT 128 *</td>
</tr>
<tr>
<td>RDW 14.0</td>
<td></td>
</tr>
<tr>
<td>Platelet 193</td>
<td></td>
</tr>
<tr>
<td>WBC 9.6</td>
<td>Amylase 716 *</td>
</tr>
<tr>
<td>Neutrophil 62.3</td>
<td>Alcohol 215 *</td>
</tr>
<tr>
<td>Bands 0</td>
<td>(24-125 U/L)</td>
</tr>
<tr>
<td>Lymph 26.0</td>
<td></td>
</tr>
<tr>
<td>Mono 8.0</td>
<td></td>
</tr>
<tr>
<td>Eosin 0.5</td>
<td></td>
</tr>
<tr>
<td>Baso 3.2</td>
<td></td>
</tr>
</tbody>
</table>

### Urinalysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Yellow</td>
</tr>
<tr>
<td>Character</td>
<td>Hazy</td>
</tr>
<tr>
<td>Glucose</td>
<td>Neg</td>
</tr>
<tr>
<td>Bili</td>
<td>Neg</td>
</tr>
<tr>
<td>Ketones</td>
<td>40 mg/dL *</td>
</tr>
<tr>
<td>Sp gravity</td>
<td>1.035 *</td>
</tr>
<tr>
<td>Blood</td>
<td>Neg</td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
</tr>
<tr>
<td>Protein</td>
<td>30 mg/dL *</td>
</tr>
<tr>
<td>Urobilinogen</td>
<td>1.0</td>
</tr>
<tr>
<td>Nitrite</td>
<td>Neg</td>
</tr>
<tr>
<td>Leuko</td>
<td>Neg</td>
</tr>
<tr>
<td>WBC</td>
<td>Neg</td>
</tr>
<tr>
<td>RBC</td>
<td>Neg</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Trace *</td>
</tr>
</tbody>
</table>

### Diagnoses

### Additional labs or Diagnostics
Case #4
74 yo male

Sodium 105 *
Potassium 3.0 *
Chloride 78 *
Bicarbonate 35 *
Glucose 60 *
BUN 5.0 *
Creatinine 0.8

Diagnosis

Additional Labs or Diagnostics
LABORATORY NORMS
(may vary from lab to lab)

Complete Blood Count with Differential (CBC)

- **RBC** (4.70-6.10 million) - # of red cells per cc/blood
- **Hgb** (14-18 gm/dL) - O2 carrying protein
- **Hct** (42-52%) - packed vol of RBCs, % of total vol.
- **MCV** (80-94%) - cell size (normocytic, macro and micro)
- **MCH** (27-33 FL) - amt of Hgb per cell
- **MCHC** (33-37% PG) - Hgb/Hct per 100mL/RBCs (normo, hypo, hyperchromic)
- **RDW** (11.5-14.5%) - red cell distribution width, should be nml
- **Platelet** (130-400 K/cumm) - # of plt. per cc/blood
- **WBC** (5.0-10 K/cumm) - # of white cells per cc/blood

- Neutrophil (40-75%)
- Bands (0-8%)
- Lymph (16-46%)
- Mono (0-12%)
- Eosin (0-7%)
- Baso (0-5%)

Urinalysis (UA)

- **Color** yellow
- **Character** clear
- **Glucose** negative
- **Ketones** negative
- **Bili** negative
- **Sp gravity** 1.003 - 1.030
- **Blood** negative
- **pH** 5 - 8
- **Protein** negative
- **Urobilinogen** negative
- **Nitrate** negative
- **Leuko** negative
- **WBC** 0 - 2/HPF
- **RBC** casts 0/HPF
- **Bacteria** negative

Hepatic Functions (also included on CMP)

- **Albumin** (3.5 - 5 gm/dL)
- **AST** (10 - 42 IU/L)
- **Alk Phos** (40 - 112 IU/L)
- **ALT** (4 - 25 IU/L)
- **Bili Total** (0.2 - 1.8 mg/dL)
- **Direct Bili** (0 - 0.2 mg/dL)
- **Ammonia** (11 - 35 Umol/L)

Arterial Blood Gas (ABG)

- **pH** (7.35 - 7.45)
- **pCO2** (35 - 45 mm/Hg)
- **HCO3** (22 - 28 mmol/L)
- **pO2** (80 - 100 mmol/L)
- **O2 sat** (90 - 100%)

Clotting Factors

- **PT**: 11 - 13 seconds
- **PTT**: Partial thromboplastin time 30 - 45 seconds
- **INR**: International normalized ratio 1.0-1.5

Basic Metabolic Panel (BMP)

- **Sodium** (135 - 145 mmol/L)
- **Potassium** (3.5 - 5.3 mmol/L)
- **Chloride** (99 - 112 mmol/L)
- **Ca** (8 - 10.5 mg/dL)
- **Glucose** (70 - 110 mg/dL)
- **BUN** (5 - 25 mg/dL)
- **Creatinine** (0.5 - 1.4 gm/dL)

- **Amylase** < 130 U/L
- **BNP** > 500 usually due to LVF
- **Lipase** < 160 U/L
# ABG Interpretation

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>pH</th>
<th>pCO₂</th>
<th>HCO₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Acidosis</td>
<td>↓</td>
<td>↑</td>
<td>Normal (change = compensation)</td>
</tr>
<tr>
<td>Respiratory Alkalosis</td>
<td>↑</td>
<td>↓</td>
<td>Normal (change = compensation)</td>
</tr>
<tr>
<td>Metabolic Acidosis</td>
<td>↓</td>
<td></td>
<td>Normal (change = compensation)</td>
</tr>
<tr>
<td>Metabolic Alkalosis</td>
<td>↑</td>
<td></td>
<td>Normal (change = compensation)</td>
</tr>
</tbody>
</table>