PREANALYTICAL VARIABLES AND THE IMPACT ON QUALITY TEST RESULTS
• Laboratory Science is a Complex Specialty
• Each Laboratory is Composed of Multiple Departments
• Each Department has Numerous Tests
• Each Test has Specific Specimen Requirements
• Phlebotomists Bear the Burden of Specimen Collection
FACTS

• The preanalytical phase of the testing process is complex and labor intensive.

• The more steps involved in a process, the more likely there will be errors committed.

• “Between 32 and 75% of all test errors occur in the preanalytical phase.”
LABORATORY APPLICATION TO THE PROCESS APPROACH

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<th>Patient Variables</th>
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What are preanalytical variables?

These are variables that can occur from the time when the test is ordered by the physician until the sample is ready for analysis.
Examples of possible preanalytical variables:

- **Patient Identification**: It is important to identify a patient accurately so that blood is collected from the correct person. Drawing blood from the wrong person, or labeling the correct patient’s sample with a different patient’s label can certainly contribute to laboratory error. (Mislabling ???)
Selecting the Site: Selecting the appropriate site for venipuncture can contribute to a better quality sample. The preferred site is the median cubital vein. This vein is usually the easiest to access. Generally, there is less need to probe to find the vein, which in turn should cause less trauma during the venipuncture. This will usually be the most comfortable for the patient.

Site Preparation: Prior to venipuncture, the site should be cleansed with alcohol. Cleansing starts at the center of the vein, and should continue outward in concentric circles. Before performing the venipuncture, the alcohol should be allowed to air dry. This will help to ensure that the specimen is not contaminated with alcohol, as this can lead to hemolysis. Hemolysis can result in the spurious elevation of such analytes as potassium, lactate dehydrogenase (LD), iron and magnesium in the chemistry lab.
Proper Venipuncture Technique: During phlebotomy, avoid probing to find the vein and achieve blood flow. Excessive probing and/or “fishing” to find a vein can result in a poor quality sample, including hemolysis. As mentioned previously, hemolysis can affect several chemistry analytes.

Proper Tube Mixing: All tubes with additives need to be inverted to mix the additive evenly with the blood.

Correct Specimen Volume: All blood collection tubes need to be filled to the correct volume. This will ensure the proper amount of blood for the amount of additive in the tube (blood to additive ratio).
Physiological factors that affect laboratory test values fall into two categories:

- can be controlled (short-lived effects)  
  (Standardization is possible)
- Cannot be controlled (effects of long duration)
Posture: during the transition from a supine to an upright position, the shift in body water from the vascular to the interstitial compartment is approximately 8% (blood volume of an adult is about 600 to 700 ml less). Proteins and protein bound compounds are increased by about 3-8%.
<table>
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<tr>
<th>Constituent</th>
<th>Average increase (%)</th>
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<tr>
<td>Alanine aminotransferase</td>
<td>7</td>
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<td>Albumin</td>
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<tr>
<td>Alkaline Phosphatase</td>
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<td>IgA</td>
<td>7</td>
</tr>
<tr>
<td>IgG</td>
<td>7</td>
</tr>
<tr>
<td>IgM</td>
<td>5</td>
</tr>
<tr>
<td>Thyroxine</td>
<td>11</td>
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<tr>
<td>Triglycerides</td>
<td>6</td>
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</table>
Duration of venous compression

- Venous compression has the same effect as the postural change from a horizontal to a vertical position.
- All high-molecular mass components increase.
- 10-min compression period: total protein rises by up to 20%.
- Short compression periods up to maximally 2 min cause but insignificant changes.
Pumping of the fist before vein puncture:
causes an increase in:

- Plasma Potassium
- Phosphate
- Lactate

Causes a decrease of pH due to accumulation of lactate
Decreased ionised calcium (reverts to normal 10 min. after releasing the torniquet)
Last food intake: causes a rise in

Glucose       Iron       Total lipids

The extent of the fat intake determines the triglyceride level.

Individuals who are blood group O Lewis positive show a significant increase in alkaline phosphatase (ALP) after a fatty meal.

A light breakfast with a low fat content has no significant impact on the concentration of many blood components
• important prerequisites include adherence to a 12-h fast prior to obtaining a blood sample for the evaluation of the fat metabolism
• intake of a diet rich in carbohydrates for several days prior to a glucose challenge test.
Physical exertion:

The effect of exercise on blood composition depends upon the duration and intensity of the activity and the physical condition of the patient. However, even moderate muscular activity will elevate levels of a number of blood components, such as lactic acid, creatinine, protein, and certain enzymes.

- temporary fluid shifts from the intravascular compartment to the interstitial space lead to hemoconcentration with a rise in proteins, protein-bound components and blood cells
- A rise in muscle enzymes such as CK, AST, LD does not occur until hours later, especially in untrained individuals, due to exertion-induced cell damage
Stress:
Stress may have profound effects on laboratory results, due to endogenous **corticosteroid** and/or **adrenaline** release.

Every effort should be taken to minimize stress during blood sample collection.
Drug Therapy:

Drug interference can be grouped into two general categories:

1. Physiological (in vivo) effects of the drug or metabolites on the analyte to be measured
2. In vitro effects due to some physical or chemical property of the drug or its metabolites, which interfere with the actual assay procedure.

Whenever possible, the laboratory should be informed of any drug medication so steps can be taken to minimize the effect of the drug on assay performance.
For example,

- Thiazide diuretics often cause increased calcium levels and may cause low potassium levels.
- Chemotherapy drugs often cause a decrease in the cells of the blood, especially WBCs and platelets.
- Numerous drugs are toxic to the liver, causing an increase in liver enzymes such as serum glutamic-oxaloacetic transaminase (aspartate transaminase), alkaline phosphatase, and lactate dehydrogenase- (LDH/LD).
- Steroids and diuretics can cause pancreatitis and an increase in serum amylase and lipase values.
- Intramuscular injections of certain drugs, e.g. benzodiazepines, dolantin, pentazocine, Chlorpromazine, lidocaine, phenobarbital, promethazine, may lead to an increase of CK and myoglobin.
Drugs may also interfere with the performance of the test in the laboratory, causing false increases or decreases in test results. A drug may compete with the test reagents for the substance being tested causing a false-negative or false low result, or the drug may enhance the reaction, causing a false-positive or false high result.
Diagnostic measures:

- Palpation of the prostate prior to blood collection results in an elevated acid phosphatase.
- During a glucose challenge test, the concentrations of potassium, phosphate, and magnesium rise.
- Surgical procedures raise the concentration of acute phase proteins and thus also increase the erythrocyte sedimentation rate.
Timing of blood sample collection:

significant diurnal variation of the iron concentration is measured with a maximum in the afternoon, of cortisol, epinephrine, and norepinephrine with maximal levels in the morning and of renin, aldosterone, growth hormone, and parathyroid hormone with maximal levels late in the night. Daily variations can be large. For example, cortisol levels and iron levels can differ by 50% or more between 8 AM and 4 PM.
Smoking
Nicotine affects a number of blood components. The extent of the effect depends upon the number of cigarettes smoked. Patients who smoke before specimen collection may have increased cortisol levels (of 40% within 5 min. of the start of smoking), and white blood counts. Chronic smoking often leads to decreased pulmonary function and increased hemoglobin levels.
Basel State:

- The ideal time to collect blood from a patient is when the patient is in a basal state.
- Basal state is the condition of the body when a patient has refrained from strenuous exercise and has not ingested food or beverage except water for 12 hours (fasting).
- Collecting a basal state specimen minimizes or eliminates the effects of diet, exercise, and other controllable factors on test results.
- Also provides the ideal specimen for establishing reference ranges or normal values for laboratory tests on inpatients.
Non controllable Variables

- Age
- Gender
- Race
- Blood type
- Environmental factors (as altitude)
- Menstrual cycle
- Obesity
- Diet
- Pregnancy
Prepare Yourself for Correct Lab Results

1. 24 Hours Prior: No Heavy Physical Exercise
   - Crossed out image of exercising
   - Clock showing 19:00

2. 12 Hours Prior: No Food or Drinks
   - Crossed out image of food
   - Clock showing 07:00

3. 1 Hour Prior: No Smoking
   - Crossed out image of smoking
   - Person reading

4. 10-15 Minutes Prior: Seated & Relaxed
   - Person sitting
   - Clock showing 10:00

5. Inform about Insulin Syringes, Drug / Medication and Nutritional Supplements
   - Images of insulin syringes and medication

6. Blood Collection
   - Images of blood collection equipment