Common Bedside Labs

Tabel of contents

CBC

- Takes into the consideration of three major cells:
    - Red Blood Cells (RBCs)
        - Hemoglobin and Hematocrit
            - **Hemoglobin**
                - Considered to be a protein that also contains iron
                - Plays a role to bring oxygen and CO2 to the lungs and throughout the body
                - If level is low it indicates generalized nonspecific anemia
            - **Hematocrit**
                - Measures number of RBCs that is within the blood
                - Hematocrit should be a 3:1 ratio for hematocrit/hemoglobin
            - Indications for the following:
                - HGB decreased/ HCT decreased = hemorrhage or nonspecific anemia
                - HGB normal/ HCT decreased = pregro, overhydration
                - HGB normal/ HCT increased =dehydrated
                - HGB elevated/ HCT elevated = COPD, high altitude living
        - **Red Blood Cells (RBCs)**
            - Measures how many RBCs within blood
            - Nonspecific indicator for anemia
                - If HGB and HCT are low use the RBCs to help dictate the type of anemia
        - **Mean Corpuscular Value (MCV)**
            - ***MCHC another test that is the same though measures on a unit of blood***
            - Measures average size and volume for each RBC
            - Lower MCV equals microcytic anemia
            - Higher MCV equals macrocytic anemia
        - **Red Cell Distribution Width (RDW)**
            - Measure the difference between the smallest RBC to the largest RBC
            - Patient with high RDW may indicate nutrient deficiency or acute hemorrhage
        - **Mean Corpuscular Hemoglobin (MCH)**
            - Average amount of HGB in RBC
    - **White Blood Cells (WBCs)**
        - nonspecific indicator for infection or autoimmune disorder
        - increased levels of WBC is called leukocytosis
        - decreased levels of WBC is called leukopenia, due to immunosuppression

- There are 5 different types of WBCs, the following is only provided with a "CBC w/ differential"
  - **Neutrophils**
    - **Bacterial infection usually is the cause of elevation**
  - **Basophils**
    - Decreased levels seen in hyperthyroid, prego, active infection or allergic reaction
    - **Elevated levels seen in hypothyroid, and other chronic diseases such as leukemia, polycythemia vera, myelofibrosis, inflammatory bowel disease, autoimmune disease**
  - **Eosinophils**
    - Decreased levels seen in stress, trauma, surgery, cushings
    - **Elevated levels usually seen in seasonal allergies, asthma, and reactions to medications,** although these are common causes there are still a plethora of other conditions
  - **Lymphocyte**
    - **More commonly elevated for viral**
    - Decreased levels in CHF, renal failure, corticosteroid use
    - Elevated levels in infections such as: tb, syphilis, pertussis. Also can be elevated with autoimmune disease and ulcerative colitis
  - **Monocytes**
    - **Elevated monocytes is often linked with long term infections, blood disorders, or autoimmune conditions**

- **Platelets**
  - measures the count of platelet but does not measure the actual function of the platelets
  - decreased PLT is called thrombocytopenia
  - increased PLT is called thrombocytosis

Metabolic Pannel

- Two types of metabolic test panel
  - **Basic Metabolic Panel (BMP)**
    - **(Primarily looking at electrolyte and kidney function)**
      - **Sodium**
        - General information
          - Helps maintain serum osmolality

- Helps with intervascular and extravascular spaces

- **Hypernatremia**
  - Causes
    - Excessive dehydration
    - Medications
    - Certain diseases:
      - DKA, DI, Cushings syndrome
  - Most symptoms will be neurological deficits
    - Altered mental status
    - Weakness
    - Coma
    - Seizures
    - Irritability
- **Hyponatremia**
  - Causes
    - Excessive fluid intake
    - Reduced renal excretion of water
    - Thiazide diuretics
    - SIADH
    - CHF
    - Renal failure
    - Cirrhosis with ascites present
  - Most patients with hyponatremia will be asymptomatic; however, may still have:
    - Nausea
    - vomiting
    - Headache
    - Cerebral edema
    - Death
    - Lethargy
    - seizures
    - Coma

- **Potassium**
  - General information
    - Helps with:
      - muscle contraction, fluid balance, and nerve transmission
    - will see more potassium within the cell and not in the extravascular space

- potassium has an inverse relationship with the PH and sodium:

- **Hyperkalemia**
  - **Commonly seen with patients with renal failure**
    - Can also be caused by
      - BLOOD TRANSUFSION REACTION
        - May also report lower back pain with blood transfusion reaction, this is life threatening time is of the essence
      - Metabolic acidosis
      - DKA
      - Addisons disease
      - Rhabdomyolysis
      - Excessive potassium intake
  - s/s of hyperkalemia
    - weakness
    - fatigue
    - respiratory failure
    - paresthesia
    - ECG changes resulting in Peaked T-waves
  - the following can be used to treat hyperkalemia
    - Diuretics
    - Kayexalate
    - Dialysis
    - Calcium gluconate
    - Insulin with glucose
    - Using alkalizing drugs to help with PH
    - Beta 2 adrenergic medications
- **Hypokalemia**
  - Common causes
    - Excessive GI lose of potassium
    - Excessive renal excretion of potassium
    - Alkalosis
    - Malnutrition
  - s/s can include
    - weakness
    - fatigue
    - paralysis
    - constipation

        - leg cramps
        - respiratory difficulties
        - ECG changes such as U-wave or flattened T-wave

- **Calcium**
    - General information
        - Most abundant mineral within the body
        - Plays a role in many cellular reaction and processes
    - **Hypercalcemia**
        - Common cause
            - Hyperparathyroidism
        - s/s
            - depression
            - weakness
            - fatigue
            - confusion
            - hallucination
            - hypotonicity
            - seizures
            - coma
            - disorientation
            - possible heart changes such as:
                - decreased contractility of the heart
                - depressed automaticity
                - AV block
                - Cardiac arrest
        - Treatment
            - Saline and Diuresis
            - Loop diuretics
    - **Hypocalcemia**
        - Common causes:
            - Toxic shock syndrome
            - Altered magnesium levels
            - Post thyroid surgery
            - Tumor lysis syndrome
        - s/s
            - paresthesia
            - muscle cramps
            - hyperreflexia
            - tetany

        - stridor breathing
        - seizures
    - treatment
        - calcium gluconate
        - calcium chloride

- **Chloride**
    - General information
        - Used to maintain acid-base balance, it is inversely related to bicarbonate
    - **Hyperchloremia**
        - Can lead to hyperchloremic metabolic acidosis
        - Causes
            - Chloride overload such as overuse of NS
            - Loss of bicarbonate from GI or renal system
    - **Hypochloremia**
        - Causes
            - GI or renal loss of chloride
        - Symptom
            - hypochloremia metabolic alkalosis
- **CO2**
    - General information
        - **NOT THE SAME AS THE CO2 AND BICARB FOR ABG** ABG are from “arterial”. CO2 from a BMP or CMP are from “venous”
        - Is used as a preliminary, cost effective, and practical way to check for overall PH levels, without needing to do an invasive ABG
            - 95% of CO2 measured is bicarb
    - Decreased levels of CO2 or increased levels can indicate a vast array of conditions in which the PH is affected; therefore, a follow up ABG is highly warranted when the CO2 is abnormal
- **Blood Urea Nitrogen (Bun)**
    - General information
        - Not favored by many clinicians to measure for kidney health as many other variables can alter the numbers. There are many variables that can increase BUN:
            - Dehydration
            - UTI obstruction
            - CHF

        - Recent heart attack
        - GI bleed
        - High protein diet
        - Certain meds
        - Severe burns
        - shock
- **Creatinine**
    - General information
        - A more reliable way to measure overall kidney health
    - **Elevated creatinine (higher likelihood to be seen at the bedside)**
        - Causes
            - Kidney disease
            - Poor blood flow to the kidneys
            - Blockage in urinary system
            - Kidney failure
            - Heart failure
            - Diabetes
    - Low creatinine levels (NOT typically seen at the bedside)
        - Causes
            - Malnutrition
            - Muscle loss from aging
            - Severe liver disease
- **Glucose**
    - Measures the blood sugar within the blood during the time of testing, does not measure the long term of glucose within the HGB. HGBA1C measures glucose for three months prior

- **Complete Metabolic Pannel (CMP)**
    - **(primarily looking at electrolyte, kidney function, *"and"* liver function)**
    - **Alkaline Phosphate (ALP)**
        - General information
            - An enzyme to help with certain bodily processes to occur; however, despite the science community studying Alkaline phosphate (ALP) they still don't know the exact function
            - ALP is considered a liver enzyme due to it being primarily found in the liver

        - If ALP is elevated a follow up ALP isoenzyme should be ordered to differentiate if the patient has a liver issue or a bone issue
        - Mildly elevated ALP is not necessarily a pathological condition occurring, often times providers will just continue to monitor ensuring it does not increase
    - Causes for elevation in ALP
        - Damage to the liver
        - Bone disorder
    - Causes for low ALP
        - Malnutrition
        - Zinc deficiency
        - Magnesium deficiency
        - Hypothyroidism
        - Rare genetic disorders
- **Aspartate Aminotransferase (AST)**
    - General information
        - Primarily used for overall liver health, measures short term liver health
        - Helpful way to remember AST "A Short Time"
    - Common causes for elevated AST
        - statin drugs
        - acetaminophen
        - fatty liver
        - alcohol
        - hemochromatosis
        - hepatitis A, B, or C
        - alcoholic hepatitis
        - autoimmune hepatitis
        - herbal supplements
            - chaparral
            - comfrey tea
            - iron
            - vitamin A
- **Alanine Transaminase (ALT)**
    - General information
        - Measure long term health of liver
            - Easy way to remember ALT= "A Long Time"

        - More specific for liver damage in comparison to the AST test, though AST and ALT should be used to complement one another
        - Although less common elevated ALT levels can still indicate injury to other cells that aren't in the liver
    - **Causes for elevated levels (more common to see at bedside)**
        - Liver damage
    - Causes for low levels (less common to see at bedside)
        - Vitamin B6 deficiency
        - Chronic kidney disease
- **Bilirubin**
    - General information
        - Bilirubin is a byproduct of broken-down old RBCs. RBCs travel to the liver for processing, where it then gets converted into bilirubin, the bilirubin than gets added to the bile. Bile exits the body through GI
            - Normally, urine doesn't have any bilirubin. If there is bilirubin in the urine, it may be an early sign of a liver condition.
        - Bilirubin is yellow in color
    - **Hyperbilirubinemia (more common than hypobilirubinemia)**
        - Causes
            - Hemolytic anemia
            - Chronic liver disease
            - Mechanical blockage to bile ducts or gallbladder
        - Signs & symptoms
            - Yellowing of skin AKA Jaundice of skin (often the first sign)
            - Yellowing of sclera AKA jaundice of eyes (often the first sign)
            - Urine becomes darker
            - If bilirubin isn't being excreted properly it may lead to lighter or clay colored stools
            - Very high bilirubin can make you itch AKA pruritus
    - **Hypobilirubinemia** (low levels aren't usually a concern)
        - Potential causes
            - Antibiotics

- Birth control pills
- Sleeping pills
- Seizure meds

- **Total Protein**
  - General information
    - Measures the total amount of two classes of proteins called albumin and globulin
      - Albumin helps keep the internal contents within the cells from leaking out
      - Globulins is important for the immune system
    - **Hyperproteinemia**
      - Causes
        - Dehydration
        - Chronic inflammation or other inflammatory disorders
        - Viral infections
          - HIV/AIDS
          - Hepatitis B or C
        - Cancer in the blood
        - Severe liver or kidney disease
- **Albumin**
  - Albumin is made in the liver
  - Albumin helps keep the internal contents within the cells from leaking out

Cardiac Biomarkers

- **Lactate Dehydrogenase**
  - LDH is an enzyme that helps your cells make energy
  - Also known as LD, LDH, lactic acid dehydrogenase
    - NOT TO BE CONFUSED WITH LDL
  - LDH is found in almost all the tissues in the body
  - Most abundant amounts of LDH are
    - Muscles
    - Liver
    - Kidney
    - RBCs
  - An LDH test alone can't show what is damaging the tissues or where the damage is located. So, an LDH test is usually done with other types of tests that can help diagnose the problem

- Test indications
  - Help diagnose and/or monitor diseases that affect the:
    - Blood, including anemia
    - Liver
    - Lungs
    - Kidneys
    - Heart, including heart attack
    - Pancreas
    - Brain and spinal cord, such as encephalitis and bacterial meningitis
  - Help monitor conditions that may get worse over time, such as muscular dystrophy and HIV
  - Help diagnose certain severe infections
  - Find out how serious certain types of cancer may be, including multiple myeloma, lymphoma, leukemia, testicular cancer, and melanoma.
  - Check whether treatment for certain types of cancer is working

- **Brain Natriuretic Peptide (BNP)**
  - Helpful in diagnosis of heart failure.
  - A normal BNP level makes Heart failure less likely, allowing medical providers to find other potential causes that is causing shortness of breath or fluid retention
  - BNP levels can also determine how well managed heart failure is, the higher the BNP the worse the heart failure
- **Creatine Kinase-Myocardial Band (CK-MB)**
  - Measures a specific enzyme that is most commonly found within the heart, however, it can also mean there could be damage to other muscles in the body.
    - The demand for this test has decreased because of better and more sophisticated test that can detect exclusively heart damage
- **Myoglobin**
  - Myoglobin is found within skeletal muscles, and cardiac muscles. The samples to test for myoglobin can be through blood or urine
    - Urine myoglobin levels reflect the degree of muscle injury, the more myoglobin in the urine the more severe the muscle injury
  - Myoglobin is extremely toxic to the kidneys therefore main treatment is to flush the patient with fluids to help excrete the myoglobin
- **Troponin T**
  - Cardiac specific, if elevated within the blood it is cardiac related
    - Please note troponin C is not cardiac specific as it may as well be found within the skeletal muscles, hence why it is not traditionally ordered.
- **Troponin I**

  - Cardiac specific, if elevated within the blood it is cardiac related
    - Please note troponin C is not cardiac specific as it may as well be found within the skeletal muscles, hence why it is not traditionally ordered.
- **Troponin High Sensitivity (Troponin HS)**
  - Cardiac specific just like Troponin T & Troponin I; however, Troponin HS can measure cardiac enzymes at much lower concentrations, making it more idealistic

Inflammatory Biomarkers

- **C-Reactive Protein (CRP)**
  - CRP is the preferred first test to support a diagnosis of inflammatory or infectious conditions, rather than ESR.
    - There is no indication for ordering ESR when CRP is elevated
  - This test does not determine where the inflammation is coming from
  - The higher the CRP the more inflammation the patient has
  - Causes for elevation in CRP
    - Bacterial or viral infections
    - Chron's disease
    - Ulcerative colitis
    - Lupus
    - Rheumatoid arthritis
    - Vasculitis
    - Asthma
- **ESR**
  - ESR is used to determine if the patient is experiencing inflammation. This test does not determine where the inflammation is coming from
  - Other names for this test
    - SED rate
    - Sedimentation rate
    - Western sedimentation rate
  - Measures how fast the red blood cells settle or sink to the bottom of the tube
  - Normally red blood cells sink slowly; however with inflammation the RBCs becomes clumped together.
    - The clumped RBCs sinks to the bottom of the tube faster, since they weigh more. The faster the sinking rate, the higher the inflammation
  - Causes for elevated ESR
    - Arteritis
    - Arthritis
    - Systemic vasculitis

- Polymyalgia rheumatica
- Inflammatory bowel disease
- Kidney disease
- Infection
- Rheumatoid arthritis and other autoimmune diseases
- Heart disease
- Certain cancers

Sepsis Biomarker

- **Lactic Acid**
  - **Most commonly used biomarker to diagnose septicemia instead of procalcitonin**
  - Measures levels of lactate also known as lactic acid
  - Latic acid levels of 4 or greater be highly suspicious of septicemia
  - Most infections that leads to sepsis most often start in:
    - Lungs, urinary tract, skin, or digestive system
  - Latic acid may be also elevated from vigorous exercises
  - Certain meds can cause high lactate levels
    - Metformin
    - Aspirin
    - Certain HIV meds
- **Procalcitonin**
  - Test is usually used to determine if the prescribed antibiotics are working against the infection
  - Despite a lack of evidence to support this practice, many institutions and guidelines support the use of procalcitonin to limit antibiotic (empiric or therapeutic) use in critically ill patients with suspected infection
    - However, procalcitonin's greatest utility is in guiding antibiotic discontinuation in patients with known community-acquired pneumonia and acute bronchitis; thus measuring procalcitonin in these populations being appropriate.
  - Most infections that leads to sepsis most often start in:
    - Lungs, urinary tract, skin, or digestive system

Lipid Profile

- **Total Cholesterol**

- Total sum of cholesterol content

- **LDL Cholesterol**
  - Measures cholesterol circulating within the arteries
  - Remember L in LDL for LOW cholesterol, as we want low amounts of LDL
  - Considered to be the "bad" cholesterol
  - Too much within the blood leads to plaque buildup within the arteries aka atherosclerosis
- **HDL Cholesterol**
  - Considered to be the "good" cholesterol as it removes cholesterol within the blood and transported to the liver where it is metabolized into bile and or excreted through feces
  - Remember H in HDL for HAPPY cholesterol, as we want it higher than the LDL
- **Triglycerides**
  - Measures the free circulating fat, from the excess calories that the body doesn't need for metabolic needs
  - High triglycerides are associated with
    - ***Eating too many sweets***
    - Excessive alcohol intake
    - Smoking
    - Sedentary
    - Diabetes

Miscellaneous Labs

- **Ionized Calcium (not the same as CMP/BMP calcium)**
  - General information
    - It measures calcium that is readily available for the body to use, 50% of calcium is already bounded to the albumin
    - Has an inverse relationship with albumin
- **Phosphorus**
  - General information
    - Plays a role in bones and muscle contraction
    - Has an inverse relationship with calcium
  - **Hyperphosphatemia**
    - Causes
      - Renal disease
      - Liver disease
      - Hypocalcemia
      - Low PTH
  - **Hypophosphatemia**
    - causes

- ETOH abuse
- Poor nutrition
- High PTH
- Hypercalcemia

- **Magnesium**
  - General information
    - Helps transfer potassium and sodium into and out of cells
    - Magnesium has the most narrowest therapeutic range for electrolytes
  - **Hypermagnesemia**
    - Causes
      - **Commonly caused by renal failure**
    - s/s
      - muscle weakness
      - paralysis
      - vasodilation
      - ataxia
      - drowsiness
      - confusion
      - bradycardia
      - heart arrhythmia
    - treatment
      - binding with calcium
      - dialysis
  - **Hypomagnesemia**
    - causes
      - decrease absorption of mag in GI/renal
      - increase loss of mag from GI/Renal
      - T3 and T4 levels
    - s/s
      - tremors
      - tetany
      - ataxia
      - altered mental status
      - seizures
      - Torsade de point

Sepsis Overview

*****Always refer to your facility protocol as they may vary greatly*****

- As per literature if sepsis is suspected the following should be ordered by the provider:
  - Suggested routine Labs
    - Every six hours the following should be specifically ordered, until the values normalize or until a baseline is established
      - Platelet count
        - Low platelet count is seen up to 20% of sepsis cases. Low platelet count is associated with higher risk of mortality, and a increased time in the ICU
        - CMP
          - Also ensure hyperchloremia is avoided during fluid resuscitation, if hyperchloremia occurs consider switching to low chloride containing solutions
  - ABG analysis
    - It is critical to perform an ABG for worsening conditions or to ensure resolution of gas exchange abnormalities
      - A worsening of gas exchange may be a clue to presence of pulmonary edema related to excessive fluid resuscitation. A worsening of gas exchanges may also help detect other complications such as pneumothorax from central catheter placement, acute respiratory distress syndrome, or a venous blood clot
    - Performing an ABG will help establish the severity and type of acidosis
      - For example:
        - Resolution of metabolic acidosis and now the new development of hyperchloremic acidosis due to excessive fluid resuscitation
  - Microbiology
    - The doctor may also do some other tests to see how your body is responding to the infection. These might include a routine blood test (complete blood count) and taking samples of any pus or bodily fluids (cultures) to see what kind of germ is causing the infection. Results should prompt alteration of antibiotic choice if a better and safer regimen can be substituted and/or investigations directed toward source control.
  - Lactate level
    - Repeat lactate every six hours in patients with sepsis until lactate values has shown considerable improvement
      - Lactate levels aren't helpful to determine if proper perfusion is occurring to the organs if it is trending downwards; "HOWEVER", a rising level of lactate should warrant reevaluation of organ perfusion

Anion Gap

- The anion gap measures the difference—or gap—between the negatively charged and positively charged electrolytes in your blood. If the anion gap is too high, your blood is more acidic than normal. If the anion gap is too low, your blood isn't acidic enough.
    - The most common cause of a low anion gap is a low level of albumin, a protein in the blood.

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