

Lab Review



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Basic Metabolic Panel (BMP)/Chemistries

Potassium

Essential to normal cardiac electrical conduction. If too high or low, can predispose to rhythm changes that can be life threatening! Potassium tends to deplete more quickly with loop diuretic usage than magnesium.

Sodium

Where free water goes, sodium will follow to a degree. Therefore, if there is a fluid volume deficit due to dehydration, sodium will typically be elevated because it's concentrated (less water in the bottle!). If there is fluid volume excess, sodium will be diluted and will likely be low (too much water in the bottle!). It is the “foundational” fluid balance electrolyte!

Glucose

Required fuel for metabolism for every cell in the human body, especially the brain. • Relevant with history of diabetes or stress hyperglycemia due to illness. Elevated levels post-op increase can increase risk of infection/sepsis.

Creatinine

GOLD STANDARD for kidney function and adequacy of renal perfusion. The functioning of the renal system impacts EVERY body system, therefore it is ALWAYS relevant!

When creatinine is elevated, this can be due to damage done to the fragile capillary membrane screen of the glomerulus which is like a screen door with larger holes that are letting things through that they shouldn't, such as protein and glucose.

Chloride

Relevant if NG suction or frequent vomiting is present due to loss of hydrochloric acid. Chloride is the Cl⁻ of hydrochloric acid.

CO₂

Relevant when there are acid-base concerns. Though it is CO₂ on a BMP and students may assume it is carbon dioxide, it is actually reflecting the amount of HCO₃⁻!

Anion Gap

This is the difference between primary measured cations (Na⁺ and K⁺) and the primary measured anions (chloride Cl⁻ and bicarbonate HCO₃⁻) in serum. Useful with acid/base concerns typically seen in renal failure.

Calcium

Relevant with renal failure and ETOH abuse. Low albumin can cause hypocalcemia, while elevated levels can be seen with cancer (with and without bone metastases).

BUN

I use creatinine/GFR as most relevant/important lab to determine renal function. I do not consistently use BUN in practice as it can be elevated for other reasons rather than renal, though it is relevant with renal failure to trend with creatinine and will also be elevated with dehydration.

White Blood Cells (WBC)

ALWAYS RELEVANT based on its correlation to the presence of inflammation or infection. Will usually be increased if infection present, though it may be decreased in the elderly or peds <3 months.

Neutrophils

ALWAYS RELEVANT for same reason as WBCs. They are the most common leukocyte and their role as a FIRST RESPONDER to any bacterial infection within several hours is always relevant. The more aggressive or systemic the infection the higher the percentage of neutrophils and WBC. Immature neutrophils (bands) greater than 8 are also clinically significant and must be clustered with WBC and neutrophils to determine if sepsis is a clinical concern.

- **Band forms (3–5%)**
 - Immature neutrophils that are elevated in sepsis as the body attempts to fight infection and releases these prematurely. If elevated, it's a clinical RED FLAG in the context of sepsis. If elevated to >8, it is considered a “shift to the left” which indicates impending sepsis.
- **Lymphocytes (23–33%)**
 - Relevant when there is a known or suspected VIRAL infection.
- **Monocytes (3–7%)**
 - Phagocytes similar to neutrophils, but not as dominant, nor are they as clinically significant and relevant to practice as neutrophils.
- **Eosinophils (1–3%)**
 - Elevated with parasitic infections or allergic responses.
- **Basophils (0–1%)**
 - Phagocytes, but not as dominant, nor are they as clinically significant and relevant to practice as neutrophils.

Hemoglobin

GOLD STANDARD to determine anemia or acute/chronic blood loss.

Hematocrit (male: 39–49% female: 35–45%)

In comparison to hemoglobin, hematocrit is not as relevant, though elevation can confirm fluid volume deficit—will be concentrated and elevated in this context.

RBCs (male: $4.3\text{--}5.7 (\times 10^8/\mu\text{l})$ female: $3.8\text{--}5.1 (\times 10^8/\mu\text{l})$)

Identifies the number of RBCs in a cubic millimeter. In anemia or when there has been a significant blood loss, hemoglobin is the GOLD STANDARD that must be noted. I rarely find this value relevant as most practitioners emphasize the hemoglobin in practice.

Platelet count

Relevant whenever there is a concern for anemia or blood loss or a patient on heparin. If platelets are low, it will obviously be significant and must be noted. Any patient on heparin products must also have this noted because of the clinical possibility of heparin-induced thrombocytopenia (HIT), which develops when the immune system forms antibodies against heparin that causes small clots and lowers platelet levels.

Cardiac

Troponin

When ordered to rule out myocardial infarction, it is ALWAYS RELEVANT. It is the most sensitive cardiac marker and will be elevated if there is cardiac muscle damage. Can take up to six hours after chest pain to elevate so labs are always ordered every 6–8 hours × 3 and each is carefully trended to the prior to see if trend is increasing and positive. Very sensitive cardiac marker that can be slightly elevated and positive in heart failure and unstable angina. Those with renal disease, usually CKD III-IV, will be unable to clear troponin by the kidneys and may have a baseline that is a low level positive. This is why it is so important to TREND the current level to the most recent in the chart and determine if there is a clinical elevation in this context.

CPK-MB

Specific iso-enzyme for cardiac muscle. If this is elevated, confirms presence of MI. Because troponin can be sensitive, many physicians order both troponin and CPK-MB to correlate. If troponins are slightly positive but CPK-MB negative, most physicians would not diagnose an MI. What troponins are to MI, BNP is to heart failure. It is a neurohormone secreted by myocytes in the ventricles. When ventricles are stressed and overloaded, BNP is a compensatory hormone that is a vasodilator and also diuretic to help the body naturally decrease the workload of the heart. It will be elevated in heart failure exacerbation.

Coagulation

PT/INR

Measures time required for a firm fibrin clot to form and measures the clotting cascade. Is dependent on vitamin K synthesis from the liver. Therefore, will be elevated in liver disease without being on warfarin. Standard coagulant ordered for those on warfarin (Coumadin) to maintain therapeutic goal of INR 2–3.

Relevant and must be noted for any patient on warfarin but especially when a bleeding complication secondary to warfarin presents. Warfarin can be reversed quickly if patient is actively bleeding by administering vitamin K IV and or fresh frozen plasma.

Miscellaneous Chemistries

Magnesium

Essential to normal cardiac electrical conduction. If too high or low, can predispose to rhythm changes that can be life threatening!

Lactate

Not routinely done, but when present in chart, it is there for a reason! GOLD STANDARD lab to trend with any shock state, especially sepsis! Elevated levels correlate with higher likelihood of dying. For example, in septic shock, a level >4 reflects a 28 percent mortality. Lactate builds up within the serum and can be seen as a marker of strained cellular metabolism.

Phosphorus (2.5–4.5 mg/dl)

85 percent stored in bones. Primary intracellular anion and responsible for cellular metabolism and formation of bones and teeth. Relevant in renal failure and will be increased due to decreased renal excretion.

Ionized Calcium (1.05–1.46 mmol/L)

Represents Ca⁺⁺ that is metabolically available compared to serum Ca⁺⁺ that is more generalized. This value is more accurate determinate of calcium/I low, serum calcium is usually also decreased. **Amylase (25– 125 U/l)** Digestive enzyme to break down complex carbohydrates. Primarily formed in pancreas and will “leak” into circulation with pancreatic inflammation. Relevant with pancreatitis/cholecystitis and obstruction of common bile duct that leads to pancreatic inflammation.

Lipase (3–73 units/L)

Glycoprotein produced primarily in pancreas to break down fats. Will “leak” into circulation with pancreatic inflammation. Relevant with pancreatitis/cholecystitis and obstruction of common bile duct that leads to pancreatic inflammation.

Ammonia (20–100 mcg/dL)

Blood ammonia comes from two sources: deamination of amino acids during protein metabolism and degradation of proteins by colon bacteria. The liver converts ammonia in the portal blood to urea, which is excreted by the kidneys. When liver function is impaired, ammonia levels rise. Ammonia is potentially toxic to the central nervous system and causes acute confusion and altered mental status. Is a contributing factor to hepatic encephalopathy in end-stage liver disease.

Liver Panel (LFT)**Albumin**

Is a large colloid plasma protein made by the liver. Because it is comprised of protein, it will be decreased in malnutrition. Therefore, it can be a contributing factor to ascites or edema.

Total Bilirubin

Total of both direct/indirect bilirubin. Bilirubin is metabolized by the liver and broken-down by-product of heme protein in RBCs. Relevant in any liver disease.

Alkaline Phosphatase

Nonspecific hepatic iso-enzyme that has a large concentration in liver but found in other parts of the body. If there is a primary liver disease, focus on ALT and AST as these are much more specific to liver function.

ALT

Relevant with any primary liver disease. Enzyme found in liver. Is released into circulation when liver cells are damaged. Has a higher specificity to liver than AST.

AST

Relevant with any primary liver disease. Enzyme found in liver. Is released into circulation when liver cells are damaged.

Urinalysis

Color

Clear to pale yellow is usually seen with aggressive diuresis. Orange color typically due to bilirubin in urine with liver disease. Dark amber is commonly seen with dehydration or fluid volume deficit.

Clarity

Though the context here is a UA, students must recognize the importance of always evaluating the clarity in the tubing of any patient with a Foley catheter. If urine is cloudy or has sediment, patient may have possible urinary tract infection (UTI) and UA should be obtained, especially if new finding.

Specific Gravity

Measures the kidney's ability to concentrate or dilute urine in relation to plasma. Increased with dehydration and decreased with diuresis.

Protein

Relevant when positive in any patient with renal disease. If kidneys have been damaged or there is a new finding of renal failure, proteins, being a large colloid, should be filtered by glomerulus. If there is damage to the glomeruli, the inability to adequately filter urine will be present and therefore will be positive. However, in active young adolescent females there is a phenomenon that produces a higher protein in the urine. A first voiding of the day should be measured with these individuals.

Glucose

Relevant if diabetic. Degree of presence in urine reflects poorly controlled diabetes. Also, same rationale as protein above. Glucose is also a large particle that should be filtered by glomerulus.

Ketones

Ketones are formed from metabolism of fatty acids. Relevant and most commonly seen in DKA and dehydration.

Bilirubin

Must be noted and relevant with liver disease. Should be negative, but with liver disease may be positive.

Blood

Will typically be positive if patient has UTI or renal calculi.

Nitrite

To rule out UTI or determine its presence, nitrites, LET, and WBC micro must be assessed together. Nitrites are relevant because, if positive, they reflect the presence of gram-negative bacteria in the urinary tract, the most common being E. coli. By itself, it is not a predictable indicator of urinary infection.

LET

To rule out UTI or determine if present, nitrites, LET, and WBC micro must be assessed together. LET is relevant—it is an enzyme that is present if WBCs are in the urine. By itself is not a predictable indicator of urinary infection.

UA Micro

RBCs

Must be noted if UTI or renal calculi—this gives number of RBCs present which can correlate with severity.

WBCs

ALWAYS RELEVANT and GOLD STANDARD that by itself indicates the presence of UTI if patient has symptoms. Most clinicians will diagnose UTI if >5 WBCs present in urine and symptomatic. Amount of WBCs present indicates severity. To rule out UTI or determine if present, nitrites, LET, and WBC micro must be clustered and assessed together.

Bacteria

Does not consistently correlate to presence of infection, though it can be clustered with WBC, LET, and nitrites.

Epithelial

Skin cells are present but not relevant in itself.