

What is a CMP?

A CMP is a simple and safe blood test. The test provides important information about your body's chemical balance and metabolism, which is the way in which your body uses food and energy. Some of the tests included in the CMP provide information about your:

- Kidneys
- Electrolytes
- Calcium
- Protein
- Liver
- Blood sugar

How do I read my results?

| Test | Purpose | Normal ranges ¹ |
|---|---|--------------------------------|
| <u>Albumin</u> | Albumin is an important protein found in the blood. | 3.4 to 5.4 g/dL (34 to 54 g/L) |
| ALP (alkaline phosphatase) ² | This is an important enzyme found in the liver, kidneys, and bones. | 20 to 130 U/L |
| ALT (alanine aminotransferase) ² | ALT is an important enzyme found mostly in the liver. | 4 to 36 U/L |

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|---|--|---|
| AST (aspartate aminotransferase) | AST is an important enzyme found in the liver, heart, and muscles. | 8 to 33 U/L |
| BUN (blood urea nitrogen) | Urea nitrogen is a normal waste product that occurs from the breakdown of protein. The kidneys remove it from the blood, so if kidney function slows down, BUN levels rise. | 6 to 20 mg/dL (2.14 to 7.14 mmol/L) |
| Serum calcium | This is a mineral stored mainly in your bones. | 8.5 to 10.2 mg/dL (2.13 to 2.55 mmol/L) |
| Chloride | An electrolyte used to help control fluid in the body. | 96 to 106 mEq/L (96 to 106 mmol/L) |
| CO2 (carbon dioxide) | An electrolyte used to help control fluid in the body. | 23 to 29 mEq/L (23 to 29 mmol/L) |
| Creatinine | Creatinine is a waste product from muscle wear and tear that everyone has in their blood. Too much may indicate kidney issues. Doctors use these results to help determine eGFR . | 0.6 to 1.3 mg/dL (53 to 114.9 µmol/L) |
| Glucose (sugar) | Sugar is an important energy source for the body but high or uncontrolled blood sugar can cause damage. This test checks for diabetes, the leading cause of kidney failure. | 70 to 100 mg/dL (3.9 to 5.6 mmol/L) |
| Potassium | Potassium is a mineral found in many foods that help keep heartbeats regular and muscles working right. | 3.7 to 5.2 mEq/L (3.70 to 5.20 mmol/L) |
| Sodium | Sodium is a mineral found in foods and is a major part of table salt. If the kidneys are not healthy, sodium and fluid can build up in the body. | 135 to 145 mEq/L (135 to 145 mmol/L) |
| Total bilirubin | Found in a fluid made by the liver. | 0.1 to 1.2 mg/dL (2 to 21 µmol/L) |
| Total protein | Protein helps build muscle, heal, fight infection, and stay healthy. | 6.0 to 8.3 g/dL (60 to 83 g/L) |

LABORATORY TESTS

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|-----------------------------|--|----------|--------------------------------------|---|
| Albumin | 3.5-5.0 g/dL SI units: 35-50 g/L | | WNL for the laboratory or ideal >4.0 | High: severe dehydration, albumin infusion Low: fluid overload, chronic liver/pancreatic disease, steatorrhea, nephrotic syndrome, protein-energy malnutrition, inflammatory GI disease, infection |
| Alkaline Phosphatase | 30-85 IU/L SI Units: 42-128 U/L | | WNL | High: renal osteodystrophy, healing of fractures, malignancies Low: congenital hypophosphatemia, possibly in kwashiorkor, general debility, anemia, nephrotic syndrome |
| Aluminum | <7 µg/L | | <20 µg/L >60 perform DFO test | High: Ingestion of aluminum-containing medications Other potential sources: parenteral fluids, injections, antiperspirants, dialysate |
| Ammonia Levels | 15-110 µg/dL SI Units: 47-65 µmol/L | | WNL | High: primary hepatocellular disease, Reye's syndrome, portal HTN, GI bleeding/obstruction w/mild liver disease Low: essential or malignant hypertension |

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LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|----------------------------------|--|----------|---|---|
| B₁₂ | 100-700 pg/mL SI Units: 74-517 pmol/L | | WNL | High: leukemia, polycythemia vera, severe liver dysfunction Low: pernicious anemia, atrophic gastritis, malabsorption syndrome, inflammatory bowel disease, Zollinger-Ellison syndrome, achlorhydria, pregnancy, vitamin C or folic acid deficiency |
| Blood Urea Nitrogen (BUN) | 10-20 mg/dL SI Units: 3.6-7.1 mmol/L | | 60-80 mg/dL (anuric, well dialyzed and eating adequate protein) | High: w/excessive protein intake, GI bleeding, dehydration, hypercatabolism, CHF (a 9 in cardiac output causes a 9 GFR), transplant rejection, inadequate dialysis Low: hepatic failure, over-hydration, acute low protein intake, malabsorption, τ secretion of anabolic hormones |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--|--|----------|---------------|--|
| Serum Calcium* *May be adjusted for low albumin, but value is questionable | 9.0-10.5 mg/dL SI Units: 2.25-2.75 mmol/L | | WNL (low end) | High: excess vit D/calcium, τ GI absorption, osteolytic disease, excess vit A, carcinoma, immobilization, primary SHPT, ABD, dehydration, prolonged use of tourniquet Low: insufficient vit D, during bone building, malabsorption, post-parathyroid-ectomy, long term Dilantin therapy, hypo-parathyroidism with low albumin (lack of carrier), but ionized is usually WNL |
| Ceruloplasmin (Cp) | 23-43 mg/dL | | WNL | High: acute inflammatory response, cancer, biliary cirrhosis, pregnancy, copper intoxication Low: nephrotic syndrome, infants, kwashiorkor, sprue, hyperalimentation |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|---|--|----------|---------------|--|
| Carbon Dioxide CO₂ | 23-30 mEq/L SI Units: 23-30 mmol/L | | WNL τ 22 | High: metabolic alkalosis Low: metabolic acidosis |
| Chloride | 100-106 mEq/L SI Units: 98-106 mmol/L | | WNL | High: excess salt, dehydration, some forms of metabolic acidosis, excessive use of chloride-containing meds, primary hypoparathyroidism Low: diabetic acidosis, K ⁺ deficiency, metabolic alkalosis, excessive sweating, starvation, abnormal GI losses, chronic pyelonephritis, dilution (fluid excess), chloride is affected by the same conditions as sodium/ moves in same direction |
| Cholesterol | <200 mg/dL SI Units: <5.2 mmol/L | | WNL | High: high chol/saturated fat diet, disorders of lipid metabolism, nephrotic syndrome, glucocorticoid use Low: acute infection, starvation, PEM |
| CHR Reticulocyte Hemoglobin Content | 24.5-31.8 pg/cell | | >29 pg/cell | High: iron supplementation Low: iron deficiency |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|---------------------------|--|----------|---|---|
| Creatinine | 0.5-1.1 mg/dL C 0.6-1.2 mg/dL o) SI Units: 44-97 μmol/L C 53-106 μmol/L o | | 2-15 mg/dL (based on muscle mass, GFR and/or dialysis clearance) | High: muscle damage, catabolism, MI, muscular dystrophy, ARF/CKD, use of cephalothin/cimetidine, excess protein intake, inadequate dialysis, transplant rejection Low: in chronic dialysis <10 may indicate PEM/wasting of muscle |
| C-Reactive Protein | <0.8 mg/dL SI Units: N/A | | WNL | High: arthritis, Crohn's disease, lupus, tissue infarction or damage, acute MI, kidney or bone marrow transplant rejection, soft tissue trauma, bacterial infection, postoperative wound infection, UTI, TB, malignant disease |
| Fecal Fat | <5 gm/24 hr SI Units: N/A | | WNL | High: cystic fibrosis, malabsorption, short- gut syndrome, maldigestion due to obstruction of pancreatic or biliary tree, pancreatic insufficiency or fibrosis |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|-------------------|--|----------|---|---|
| Ferritin | 12-300 ng/mL o 10-150 ng/mL C SI Units: 12-300 µg/L o 10-150 µg/L C | | HD ≥200 ng/mL PD/CKD >100 ng/mL >500 unknown benefit/harm | High: iron overload, many transfusions, dehydration, inflammatory state, falsely elevated in active liver disease Low: iron deficiency |
| Folic Acid | 5-20 µg/mL SI Units: 14-34 mmol/L | | WNL | High: pernicious anemia, recent massive blood transfusion, vegetarianism Low: folic acid deficiency, hemolytic anemia, malnutrition, malabsorption, malignancy, liver disease, pregnancy, alcoholism, anorexia nervosa |
| Globulin | 2.3-3.4 g/dL SI Units: 23-35 g/L | | WNL | High: infection, liver disease, leukemia, hyperlipidemia Low: malnutrition |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--------------------------|---|----------|----------------------------|---|
| Glucose (Fasting) | 70-105 mg/dL SI Units: 3.9-5.8 mmol/L Peak post prandial capillary glucose <180 mg/dL (<10 mmol/L) | | WNL <200 non-fasting | High: DM, chronic hepatic disease, hyperthyroidism, malignancy, acute/emotional stress, burns, diabetic acidosis, pancreatic insufficiency, glucose intolerance Low: hyperinsulinemia, ETOH abuse, pancreatic tumors, liver failure, pituitary dysfunction, malnutrition, extreme exercise |
| Hematocrit | 42-52% _o 37-47% _C SI Units: 0.42-0.52 _o 0.37-0.47 _C volume fraction | | 33-36% <39% | High: polycythemia, dehydration Low: anemias, blood loss (endogenous & dialysis), CKD, insufficient ESA |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--|---|----------|---|--|
| Hemoglobin | 14-18 g/dL _o ** 12-16 g/dL _C SI Units: mmol/L 8.7-11.2 _o 7.4-9.9 _C | | Variable 10-12 g/dL <13g/dL FDA ≤12 g/dL | High: dehydration Low: over-hydration, prolonged iron deficiency, anemias, blood loss, CKD |
| Hemoglobin A_{1c} (Glycosolated hemoglobin GHb, GHB) | Adult: 4-8% “Good” control <7% “Fair” control 10% <6 not desirable SI Units: N/A | | WNL <7% | High: newly diagnosed/poorly controlled DM, splenectomy, pregnancy, non-diabetic hyperglycemia Low: hemolytic anemia, chronic blood loss, early CKD |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|---------------------|---|----------|-----------|---|
| Iron | 60-175 µg/dL o 50-170 µg/dL C SI Units: 13-31 µmol/L | | WNL | High: Fe overload, sideroblastic anemias, estrogen/oral contraceptives, hemolysis, τ for 1-2 wks after IV iron-dose dependent Low: iron deficiency, t iron intake, blood loss; diurnal/day-to-day differences are common, but minimal if sample taken in same time frame |
| Lipoproteins | HDL: >45 mg/dL o >55 mg/dL C LDL: 60-180 mg/dL VLDL: 25-50 mg/dL SI Units: mmol/L HDL: >0.75 mmol/L o >0.91 mmol/L C LDL: <3.37 mmol/L VLDL: N/A | | WNL | High: HDL (familial lipoproteinemia excessive exercise) LDL/VLDL- familial lipoproteinemias, nephrotic syndrome, hypothyroidism, chronic liver disease, poor glycemic control Low: HDL- familial hypolipoproteinemia, hepatocellular disease, hypoproteinemia (malnutrition or nephrotic syndrome) LDL/VLDL- familial hypolipoproteinemia, hypoproteinemia due to severe burns, malabsorption or malnutrition) |

LABORATORY TESTS (Cont)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--|--|----------|-----------------------------------|---|
| Lymphocyte Count (Total = % Lymphocytes x WBC) | 1500-4000 mm ³ SI Units: N/A | | WNL Investigate <1200-1500 | High: acute viral infections, collagen disease, hyperthyroidism, high altitude Low: malnutrition (synthesis requires adequate calories/protein), adds power to significance of ϑ albumin, stress |
| Magnesium | 1.2-2.0 mEq/L SI Units: 0.6-1.0 mmol/L | | WNL | High: w/excess intake of Mg ⁺ in water, dialysate, Mg-containing parenteral infusion or OTC meds, dehydration Low: w/some diuretics, ketoacidosis, hypercalcemia, ETOH abuse, refeeding syndrome, diarrhea/malabsorption, malnutrition |
| Mean Corpuscular Volume (MCV) | 80-95 μm^3 SI Units: N/A | | WNL | High: folic acid/B ₁₂ deficiency, cirrhosis, reticulocytosis, chronic alcoholism Low: chronic iron deficiency, anemia of chronic disease (MCV levels indicative of anemias: pernicious >120; microcytic <78; often seen with iron deficiency <64) |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|-------------------|---|----------|--|--|
| Phosphorus | 3.0-4.5 mg/dL SI Units: 0.97-1.45 mmol/L | | WNL 3.5-5.5 mg/dL (KDIGO rec “towards normal”) | High: CKD, osteodystrophy, vit D intoxication, diurnal rhythm - evening or afternoon as much as 2x the am level, excessive intake, inadequate P binder Low: vit D deficiency, low intake, excess P binding, malabsorption/diarrhea/vomiting, alkalosis, diabetic acidosis, diuretic therapy, alcoholism, refeeding syndrome, post parathyroidectomy, osteomalacia |
| Potassium | 3.5-5.0 mEq/L SI Units: 3.5-5.0 mmol/L | | WNL 3.5-6.0 mEq/L | High: CKD, tissue destruction, shock, acidosis, dehydration, hyperglycemia, aldosterone antagonistic overuse, diuretics, false τ w/tourniquet, excessive oral intake, inadequate dialysis, inappropriate dialysate K^+ , compression/fist clenching prior to sample Low: diuretic therapy, ETOH abuse, diarrhea/vomiting/laxative or enema abuse, malabsorption, correction of diabetic acidosis |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--|---|----------|---|--|
| Prealbumin/ Transthyretin | 15-36 mg/dL SI Units: 150-360 mg/L | | 30 mg/dL | High: administration of corticoids Low: neonate, liver disease, malnutrition, inflammation |
| Protein, Total | 6.4-8.3 g/dL SI Units: 64-83 g/L | | WNL | High: dehydration, acute/chronic infectious disease, leukemia/multiple myeloma Low: malnutrition, malabsorption, cirrhosis, steatorrhea, edema, nephrotic syndrome |
| Intact Parathyroid Hormone (iPTH) | Intact: 10-65 pg/mL SI Units: N/A | | KDOQI: 150-300 pg/mL KDIGO: between 2 and 9 x normal limit; avoid extremes | High: hyperparathyroidism, non-PTH producing tumors, lung or kidney cancer, hypocalcemia, malabsorption, vit D deficiency, rickets Low: hypoparathyroidism, hypercalcemia, metastatic bone tumor, sarcoidosis, vit D intoxication, hypomagnesemia |

Editorial Note: Variance between third and second generation iPTH depends on the patient-specific level of PTH fragment (7-84) that is measured by the second generation iPTH. Observational studies suggest PTH levels that may increase relative risk of death; however, there are no RCTs that show correction of PTH to a specific level absolutely translates into improved patient level outcomes. KDIGO stresses that there is insufficient research to establish absolute PTH targets, but suggests avoiding extremes and using trends rather than single measurements to guide therapy.

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|--|---|----------|-----------------------------|--|
| Reticulocyte Count | 0.5%-2% | | Variable in response to EPO | Index of bone marrow activity; reflects early change in RBC production High: hemolytic anemia, acute bleed Low: certain anemias due to ineffective erythropoiesis (defic. of iron, B ₁₂ , folic acid, B ₆) or anemia of chronic disease |
| RBC Count Multiply automatic counter values x 1 million for total #) | million/mm ³ 4.7-6.1 o 4.2-5.4 C SI Units: N/A | | WNL | High: high altitude, temporarily w/strong emotion, diurnally, cold shower, reduced plasma volume, dehydration Low: anemia, hemorrhage, infectious disease, iron deficiency |
| Sodium | 136-145 mEq/L SI Units: 136-145 mmol/L | | WNL | High: dehydration, diabetes insipidus, often masked by water retention Low: overhydration, inappropriate ADH diuretic use, burns, starvation, adrenal insufficiency, nephritis, hyperglycemia, diabetic acidosis, hyperproteinemia |

LABORATORY TESTS (Cont.)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|---|--|----------|-----------------------------------|---|
| TIBC Transferrin = (0.8 x TIBC) - 43 | 250-420 µg/dL SI Units: 45-73 µmol/L | | WNL Varies with iron stores | High: chronic iron deficiency, acute hepatitis, pregnancy, alcoholism Low: cirrhosis, malnutrition, collagen or chronic disease/infection/inflammation |
| Transferrin | Adult:mg/dL 215-365 o 250-380 C SI Units: N/A | | WNL | High: chronic iron deficiency, acute hepatitis, pregnancy, alcoholism Low: cirrhosis, malnutrition, collagen or chronic disease/infection/inflammation |
| Transferrin Saturation | 20-50% o •• 15-50% C SI Units: N/A | | 20% | High: iron overload, pregnancy, acute hepatitis, alcoholism Low: cirrhosis, malnutrition, collagen or chronic disease/infection, iron deficiency |
| Triglycerides | 40-160 mg/dL o 35-135 mg/dL C SI Units: 0.45-1.81 mmol/L 0.40-1.52 mmol/L | | WNL <200 mg/dL | High: liver disease, gout, pancreatitis, ETOH abuse, MI, diabetes, PD, use of steroids, nephrotic syndrome Low: malnutrition, malabsorption |

LABORATORY TESTS (End)

| Test | Ref. Range | Your Lab | CKD Range | Significance of Abnormal |
|------------------|---|----------|-----------|---|
| Uric Acid | 2.1-8.5 mg/dL o 2.0-6.6 mg/dL C SI Units: (mmol/L) 0.15-0.48 o 0.09-0.36 C | | WNL | High: gout, early CKD, thiazide diuretics, starvation Low: with high salicylate doses, hepatic failure |
| WBC Count | 5000-10,000 mm ³ SI Units: 5-10 x 10 ⁹ /L | | WNL | High: leukemic neoplasia, acute infection or inflammation, fever, anemia, tissue necrosis, trauma, stress Low: radiation, chemotherapy, bone marrow failure, dietary deficiencies, overwhelming infection, autoimmune diseases |
| Zinc | 85-120 µg/dL | | WNL | High: contaminated sample, hemolysis Low: low intake or absorption/ increased loss or needs, alcoholism, cirrhosis of the liver |

References: Pagana KD, Pagana TJ. *Mosby's Manual of Diagnostic and Laboratory Tests*. 2nd ed. St. Louis, MO: Mosby, Inc.; 2002.
Treseler, KM. *Clinical Laboratory and Diagnostic Tests: Significance and Nursing Implications*. 3rd ed. Norwalk, CT: Appleton & Lange; 1995.
Ravel R. *Clinical Laboratory Medicine*. Chicago: Yearbook Medical Publishers; 1984.

POTENTIAL SIGNS AND SYMPTOMS OF ABNORMAL SERUM POTASSIUM

| System | Hypokalemia | Hyperkalemia |
|-------------------|--|---|
| Laboratory | <3.5 mEq/L | >6.0 mEq/L (>5.0 in non-CKD) |
| Clinical finding | Frequently none until serum potassium levels are very high or low | |
| Skeletal/muscle | General muscle weakness, leg cramps | Usually no symptoms; could have general muscle weakness, difficult ambulation |
| Cardiac effects | Dizziness, hypotension, arrhythmias, tachycardia with cardiac block/arrest at <2.5 mEq/L, ECG changes (elevated U waves, flattened ST segment) | Tachycardia and later bradycardia, cardiac block or arrest at >7 mEq/L, ECG changes (prolonged PR interval, widened QRS, tall T-waves, flattened P-waves) |
| GI/smooth muscle | Decreased peristalsis, early nausea/vomiting, constipation, abdominal distention, anorexia, diarrhea | Decreased peristalsis leading to nausea and diarrhea, abdominal cramps |
| Nervous system | Listlessness, lethargy, confusion, speech changes, respiratory paralysis, decreased reflexes | Hyperreflexia progressing to weakness, numbness, tingling, flaccid paralysis |
| Acid-base balance | Metabolic alkalosis | Metabolic acidosis |
| Genitourinary | Polyuria | Oliguria, anuria |

References: *Professional Guide to Diseases*. 9th ed. Philadelphia: Lippincott Williams & Wilkins; 2008.

<http://www.nephrologychannel.com/electrolytes>

Tisher C, Wilcox C. *Nephrology for the House Officer*. Baltimore, MD: Williams & Wilkins; 1993.

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