Quick Guide to Commonly Ordered Lab Tests

for people with mental illness

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Why Blood Tests Are Important

Our blood is one of the easiest ways to better understand what's going on inside the body. There are a wide plethora of blood tests that are available. Blood tests can be used to screen for or diagnose certain ailments, or they may be used for ongoing monitoring.

Fasting bloodwork means that you should have nothing to eat or drink except water for 8-12 hours before the test. Your requisition or the ordering health care provider should let you know exactly what's required for the lab you're going to. The better you adhere to this fasting rule the more accurate the test results are likely to be.

Every lab will have its own reference range for particular test results. These are fairly similar from lab to lab, but there can be some variations depending on how exactly they perform their testing. Because of this, it's going to be the most useful to compare your result to that lab's reference range rather than to a normal range you happen to look up online. There can also be differences from country to country because of different units of measurement. This booklet gives ranges of normal values drawn primarily from the Merck Manual (American) and the Medical Council of Canada (SI units).

If getting blood drawn is difficult for you, there are a couple things you can do to make the process easier. If you're well hydrated, that makes it easier to access a vein. Chances are the lab tech is already telling you to make a fist, but if they're not, you should be doing that. Muscle contraction pushes blood up through the veins, making them easier to access.

If pain is an issue, gels for tooth pain like Orajel and Anbesol contain the local anaesthetic benzocaine, and it only takes about a minute after application for them to take effect. Applying an ice pack beforehand can also help, although if your veins tend to be hard to find, an ice pack will probably make that worse.

Labs use multiple different types of vials, which are colour-coded. These vials are "Vacutainers", and because of this vacuum they will pull the blood into them. Each different colour corresponds to particular reagents. Certain test types will require a specific reagent in the vial. The total number of vials of blood drawn each time you go to the lab will depend on the number of different reagent types required for the particular tests that have been ordered. Most vials will hold a volume of 3 cc (0.1 fl. oz).

While it can sometimes feel like the lab tech is sucking sucking you dry like a vampire, even if you get five vials drawn, that's 15 cc, or one tablespoon. Compare that to a blood donation, which is around 450 mL, or just under 2 cups.

Pharmacogenomic Testing & Psychiatric Medications

There are a number of genetic testing services on the market that offer tests to help guide psychiatric medication selection. These genetic tests looks at several genes. The ones that are most relevant are for variants in the cytochrome P450 enzyme system in the liver, which are involved in the metabolism of a number of different medications.

There are limits to what this type of testing can currently tell you. The biggest thing to keep in mind is that there's currently no genetic test that what medication will or will not be effective for you. What they can tell you is how well your body is likely to metabolize a certain drug. This can give you an indication of whether your body is likely to get rid of the drug too quickly, or if poor metabolism will make side effects more likely. You still won't know if that drug will work, so the test may be best at excluding options that your body would have problems metabolizing. If you're purchasing this test wanting to know the "right" drug for you, you could very well end up disappointed.

Probably at some point pharmacogenomic testing will have advanced to the point that it has a high level of clinical utility. At this point, it probably makes the most sense for people who tend to be very prone to side effects.

Common Lab Tests

This is a quick overview of tests that are routinely ordered for people with mental illness. The site LabTestsOnline is a good resource to look up a wide variety of different lab tests. The reference ranges listed here are taken primarily from the Merck Manual (for American units) and the Canadian Council of Medicine (for international SI units). Links to all of these resources are in the reference section at the end of this booklet.

Complete blood count (CBC)

There are different types of cells that circulate in the blood, and a CBC gives a breakdown of how many of each type of cell there are in a certain volume of blood. A CBC is ordered as a single test rather than all the individual counts being ordered separately.

Red blood cells (RBCs): These are the cells that carry oxygen in the blood, which is attached to the hemoglobin protein component of red blood cells. Along with the red cell count, several other related measurements are given as well, such as hemoglobin and hematocrit. Red blood cells and related counts are used in diagnosing anemia.

- total RBC: 4.0 - 5.2 x 10^12 cells/L (female), 4.4-5.7 x 10^12/L (male) - units may also be written as 10^6/mcL
- hemoglobin: 123-157 g/L (female), 130-170 g/L (male)

White blood cells (WBCs): These are an important part of the immune system. There are several types of white cells, which will each be measured individually if the lab requisition indicates a CBC with differential. Elevated white blood cell counts can be indicative of an infection, while lowered white cell counts can sometimes be a side effect of medication.

- total WBC: 4-10 x 10^9/L

Platelets: These are involved in blood clotting. Some medications, like carbamazepine, can sometimes cause a drop in platelet count, known as thrombocytopenia.

- normal range: 130-400 x 10^9/L (units may also be written as 10^3/mcL)

Blood sugar

Fasting blood glucose (FBG): This is the basic screening test for diabetes. A test that's done in a lab using a blood sample drawn from a large vein gives a more accurate reading than an at-home blood glucose meter. If you haven't been fasting, the result probably isn't reliable.

- Normal range: 70-105 mg/dL (American units) 3.3-5.8 mmol/L (SI units)

Hemoglobin A1c (HbA1c): The other name for this is glycosylated hemoglobin, which involves sugar molecules attaching themselves to hemoglobin. The fraction of hemoglobin with sugar attached is reflective of blood sugar control over the last 3 months. HbA1c is used for monitoring people with diabetes, and is occasionally used for diabetes screening.

- Normal: 4.7-8.5% (Merck Manual), 4-6% (Medical Council of Canada)

Lipid panel

This panel of tests includes HDL and LDL cholesterol, total cholesterol, calculated ratios of the different types of cholesterol, and triglycerides. You need to be fasting overnight for these tests to get an accurate result. Atypical antipsychotic medications can elevate lipid levels, so periodic monitoring should be done.

HDL cholesterol: This is the "good" cholesterol, and a higher number is better.

- > 40 mg/dL (American units) or > 0.9 mmol/L (SI units)

LDL cholesterol: This is the "bad" cholesterol, and a lower number is better. The reference ranges here are for low risk individuals; the target should be lower than this for people considered high risk.

- < 130 mg/dL (American units) or < 3.37 mmol/L (SI units)

Triglycerides: These are a type of fat molecule found in the blood and fatty tissue.

- <150 mg/L (American units) or < 1.7 mmol/L (SI units)

Liver function tests

These enzymes are all involved in the normal functioning of the liver; when the levels are elevated, it means the liver is having to work harder than normal to do its job. Many medications are metabolized by the liver, so it's important that it's functioning properly.

Liver enzymes: these are responsible for various functions in the liver

- ***Alanine aminotransferase (ALT):*** normal range 0-35 Units/L (Merck Manual), 17-63 Units/L (Medical Council of Canada)
- ***Aspartate aminotransferase (AST):*** normal range 0-35 Units/L (Merck Manual), 18-40 Units/L (Medical Council of Canada)
- ***Alkaline phosphatase***: normal range 0-35 Units/L (Merck Manual) 38-126 Units/L (Medical Council of Canada)
- ***GGT, aka Gamma GT***: this liver enzyme in particular tends to be elevated in people who drink heavily, although there are other possible reasons for GGT elevation
  - Normal range: 8-78 Units/L (Merck Manual); 10-30 U/L (female) or 10-48 U/L (male) - Medical Council of Canada

Albumin: Albumin is a protein found in the blood that is produced by the liver. Low albumin can be indicative of liver problems. Albumin may also be tested in the urine.

- Normal range: 3-8.5.4 g/dL (American units) or 35-50 g/L (SI units)

Bilirubin: Bilirubin is produced from the breakdown of the heme (as in hemoglobin) component of red blood cells. Changes in bilirubin levels can indicate anemia, liver problems, or bile duct/gallbladder problems.

- Total bilirubin normal range: 0.3-1.2 mg/dL (Merck Manual), < 26 mmol/L (Medical Council of Canada)

Kidney function

Creatinine: Creatinine comes from creatine phosphate, a normal product of muscle breakdown. Usually it is easily cleared by the kidneys. Increased creatinine can be indicative of problems with kidney function. This is a key parameter to monitor in people who are taking lithium.

- Serum creatinine normal range: 0.7-1.3 mg/dL (Merck Manual); 50-90 mmol/L (female), 70-120 mmol/L (male) - Medical Council of Canada

Blood urea nitrogen (BUN): urea nitrogen is cleared by the kidneys, and a buildup in the blood is an indicator that the kidneys aren't doing their job properly

- Normal range: 8-20 mg/dL (American units), 2.5-8.0 mmol/L (SI units)

Electrolytes

Electrolytes are dissolved salts in the blood that carry an electrical charge. They are involved in multiple functions throughout the body, including muscle and heart function. The kidney works to maintain the proper electrolyte balance, and abnormalities may reflect problems with kidney function. Sodium and potassium are commonly ordered when checking kidney function. Other ions in the blood that may be tested are chloride, bicarbonate magnesium, calcium, and phosphate.

Lithium is chemically very similar to sodium and potassium, so when the electrolytes get out of whack, so can lithium. Sodium and potassium are most important to monitor for people taking lithium, but other electrolytes may be monitored as well. Dehydration can change electrolyte and lithium levels, increasing the risk for toxicity, so it's important to maintain proper hydration.

- ***Sodium***: 136-145 mEq/L (American units) or mmol/L (SI units)
- ***Potassium***: 3.5-5.0 mEq/L (American units) or mmol/L (SI units)
- ***Chloride***: 98-106 mEq/L (American units) or mmol/L (SI units)
- ***Bicarbonate***: 23-28 mEq/L (American units) or mmol/L (SI units)
- ***Calcium (serum)***: 9.0-10.5 mg/dL (American units), 2.18-2.58 mmol/L (SI units)

Hormones

Low thyroid hormone levels are associated with depression, and some medications, such as lithium, can affect thyroid hormone levels. Thyroid hormones regulate metabolic activity in the body, and disturbances in thyroid hormone levels can cause symptoms similar to some mental illness symptoms. Someone with hypothyroidism, or low levels of thyroid hormone, would have low energy, while someone with hyperthyroidism might feel jittery or anxious, have a rapid heartbeat, and experience weight loss.

If it's suspected that you may have an immune condition affecting the thyroid, you might also be checked for TSH receptor antibodies (TRAbs) and thyroid peroxidase (TPO) antibodies. These aren't part of routine checks of thyroid function, though. Typically TSH is the only test that would be ordered for routine screening.

TSH: This is produced by the brain to signal to the thyroid that it needs to make more thyroid hormone, hence the name Thyroid Stimulating Hormone (TSH). It's generally concerned to be a better indicator of potential thyroid problems than measuring thyroid hormone directly. When the thyroid is under-active, TSH will become elevated because the brain is essentially shouting at the thyroid gland to produce more hormone. On the other hand, when the thyroid gland is hyperactive, TSH is low because the thyroid is already stimulated more than enough and the brain is trying its best to put the kibosh on that.

- Normal range: 0.5-5.0 mcIU/mL (American units), 0.4-5.0 mIU/L (SI units)

Free T4: There are two forms of thyroid hormone produced by the thyroid, T3 and T4. Free T4 measures the amount of T4 that's not bound to protein in the blood. Labs will sometime not perform a free T4 test unless the TSH is abnormal. Synthroid (levothyroxine) is a synthetic form of T4.

- Normal range: 0.9-2.4 ng/dL (American units), 8.5-15.2 pmol/L (SI units)

T3 (free or total): This measures the amount of the T3 form of thyroid hormone that's not bound to blood proteins (free T3) or the total amount of circulating T3. T3 varies more throughout the day, so T4 is generally a more stable indicator of thyroid function. T3 is not routinely checked for screening purposes, and is most useful in evaluating for hyperthyroidism. Cytomel (liothyronine) is a synthetic form of T3 that is sometimes used to augment the effectiveness of antidepressants.

- Normal range: 2.6-4.8 pg/mL (American units), 4.0-7.4 pmol/L (SI units)

Prolactin: Prolactin is a hormone produced in the pituitary gland and is involved in lactation. Prolactin levels can be elevated by some antipsychotic medications, primarily the older medications like haloperidol. However, this can also happen with some newer antipsychotics such as risperidone. Symptoms of elevated prolactin include growth of breast tissue in males, lactation, changes in menstrual cycles, and sexual dysfunction. A blood test to check prolactin levels can be a way of evaluating this.

- Normal range (non-pregnant or lactating): 0-20 ng/mL (or mcg/L) in females, 0-15 ng/mL (or mcg/L) in males

Urine tests

The urine can give information about urinary tract health, kidney function, and the passage of certain drugs through the body.

Urinalysis – macroscopic: When the kidneys are functioning properly, there are certain substances that wouldn't pass from the kidneys into the urine except in very small amounts. When there are kidney problems, these substances can become detectable in the urine. This test in combination with blood tests can give a broader picture of what's happening in the body.

- ***Protein***: normally there would be very little protein in the urine, and elevated levels can indicate problems with kidney function.
- ***Glucose***: glucose may be present in the urine if blood glucose is very high, such as in poorly controlled diabetes
- ***Ketones***: ketones show up in the urine when the body has shifted from metabolizing carbohydrates to metabolizing fat. For people on a ketogenic diet, this is seen as desirable. For diabetics, ketones in the urine can be an indicator that they're lacking in insulin.

- ***Hemoglobin:*** indicates some blood in the urine, which may warrant further examination

Urinalysis – microscopic: If there are abnormalities in the macroscopic test, the urine will be examined under a microscope to check for the presence of cells

- ***Red blood cells***: this indicates that there is blood in the urine, but doesn't show where it's from. Urinary tract infections may cause blood to appear in the urine.
- ***White blood cells***: this can indicate a urinary tract infection
- ***Bacteria****:* if a urine culture is to be performed to determine the type of bacteria present, there must be a midstream "clean catch" specimen to ensure any bacteria on the opening of the urethra are washed away so they don't contaminate the specimen.

Electrocardiogram (ECG/EKG)

An ECG measures the electrical activity of the heart. It involves the placement of 12 electrodes around the chest and lower limbs. You are then asked to stay still for several seconds while the machine records the electrical rhythm. The test will show any abnormal rhythms or problems with conduction. An ECG may be done to get a "baseline" before starting medication that can potentially affect the heart rhythm, and may be repeated periodically thereafter.

Medications and Lab Tests

Some medications have what's called a "narrow therapeutic window", meaning there's a relatively small range between the blood level at which they are effective and the blood level at which they can start to be toxic. Medications like this typically require periodic blood testing to ensure you're in the appropriate range. These levels are typically done 12 hours following your last dose to get what's referred to as a "trough level". If you go to the lab 8 hours post-dose, your body won't have cleared as it normally would after 12 hours, so your level may be appear artificially inflated. Similarly, if you go at 16 hours post-dose, your level will appear artificially low.

Examples of drugs that would typically involve blood level monitoring include lithium, divalproex, and carbamazepine. Testing would be done more frequently when getting stabilized on a dose, and then it can be done less frequently on a maintenance basis. If you have a dosage change, it takes about a week for blood levels to re-stabilize, so going a day or two after the dose change isn't going to give a meaningful result.

Some drugs may have the potential to impact the liver or kidneys, so this would be monitored using blood tests. Certain medications can affect blood cells like platelets, which affect blood clotting, or white blood cells, which are part of the immune system. These would be monitored by doing a complete blood count (CBC). Atypical antipsychotics can increase the risk of diabetes and high cholesterol, so these indicators would need to be monitored.

The next two pages will give an overview of some of the tests that may be required if you're taking certain medications. The tests aside from serum drug levels will be explained in the next chapter.

Lithium

- Lithium serum level
  - Target range: 0.6 - 1.2 mmol/L
  - It takes 5 days after a dose change for your level to stabilize
  - The target level for maintenance can often be lower than for an acute episode.
  - Lithium level is influenced by hydration. If you're dehydrated, the lithium will be more concentrated in the blood and the level will go up
- Kidney function tests: lithium has the potential to cause kidney damage, but with regular monitoring this is very unlikely
- Electrolytes
- Thyroid function (TSH) is usually checked periodically, as lithium can occasional affect thyroid hormone levels
- Electrocardiogram (ECG) may be done periodically, as lithium can occasionally cause changes

Valproic acid

- Valproate serum level
  - Target range: 50-100 mcg/L (American units) or 350-700 mmol/L (SI units)
- Liver function tests: valproic acid can negatively affect the liver, so liver enzymes are monitored regularly along with the serum levels

Carbamazepine

- Carbamazepine serum levels
  - Target range: 4-12 mcg/L (American units) or 20-50 mmol/L (SI units)
- Complete blood count (CBC): carbamazepine can cause changes in blood cell counts, so this is an important part of regular monitoring

- People of Asian descent are at increased risk of developing a serious side effect to carbamazepine called Stevens Johnson syndrome. Genotyping to check for a certain HLA variant should be done prior to starting carbamazepine to see if an individual is at increased risk for this side effect.

Clozapine

- Complete blood count (CBC) with differential: the total white blood cell count and absolute neutrophil count must be monitored
  - This testing is required to monitor for a serious condition called agranulocytosis
  - Testing is done weekly, and eventually moves to every 2 weeks and then every 4 weeks as long as test results are normal; if there are multiple abnormal tests in a row, the medication needs to be stopped
- Clozapine serum levels may be tested, but this isn't necessary and levels aren't always a good indicator of clinical effectiveness
- Troponin I and C-reactive protein are typically performed when first starting clozapine to monitor for a rare but serious adverse reaction called myocarditis, which involves inflammation in the heart
- An ECG is performed before initiating clozapine, and then may be performed periodically after starting on it

Atypical antipsychotics

- Periodic "metabolic monitoring" consisting of fasting blood sugar, cholesterol, and triglycerides, because in addition to causing weight gain, these medications can cause diabetes or elevated cholesterol

Lab Tests for Psych Meds

Lithium

- Serum level: target 0.6 - 1.2 mmol/L
- Electrolytes (sodium, potassium)
- Kidney function (creatinine, GFR)

Valproic acid

- Serum level: target 50-100 mcg/L (U.S. units) or 350-700 mmol/L (SI units)
- Liver enzymes

Carbamazepine

- Serum level: target 4-12 mcg/L (American units) or 20-50 mmol/L (SI units)
- Complete blood cell count (CBC)

Clozapine

- Serum level (not routinely checked)
- Complete blood cell count (CBC)

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Interpreting the Results

Depending on the specific test, a small deviation from the normal range may be significant, or it may mean very little.

Blood levels of medications are important to have within the therapeutic range, to ensure that the the medication is neither toxic or at levels too low to be effective. Within the therapeutic range, the level your doctor is targeting may change depending on how ill you are. The more unwell you are, the closer toward the high end of the therapeutic range you'll likely need to be. If you're far off the 12-hour post-dose mark, the level that comes back from the lab probably isn't going to reflect your actual levels.

Various things going on with your physical health can influence what shows up on your lab results, ad a one-off result is often less meaningful than a pattern of values over time. If you're fighting off an infection or if you have an infection, your white count is going to be elevated. That's expected and perfectly normal. If you have a urinary tract infection, there would probably be a number of abnormalities in your urine sample.

Sometimes the medication you take can affect your bloodwork. Lithium may affect thyroid hormone levels. Low thyroid hormone levels are associated with increased likelihood of depression. Sometimes a form of thyroid hormone called Cytomel may be used to boost antidepressant effectiveness regardless of whether the person is hypothyroid. In turn, taking Cytomel can produce changes in thyroid hormone levels.

Sometimes lab results may be available for you to check on your own before meeting with your doctor. This is great if you're familiar with what the various tests mean, but it's easy to get concerned about a result that is minor in the scheme of things.

You deserve to be in the know about what your health care provider is or is not ordering. If you're taking certain medications, the reality is that you are going to need blood tests every so often. However, if you feel like a human pin cushion because you're being sent to the lab so often, your health care provider should be able to come up with a darn good reason. You should always be involved in the decision making, and knowledge is power.

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