understanding your lab results

acria

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Everyone needs lab tests.

If you are living with HIV, lab tests are one of the most important ways you and your healthcare provider can monitor your health. They can help you:

- Decide when to start drugs to treat HIV and other infections;
- Determine whether or not the drugs are working;
- Determine if the drugs are causing certain side effects;
- Watch for other infections and problems associated with HIV infection.

Lab tests come in many different forms. Some require blood samples, while others require urine or stool (feces) samples. Each sample can then be used to conduct a wide range of lab tests, depending on your healthcare provider's orders. A Pap smear, which scrapes cells from the wall of the cervix (and sometimes the anus), is another type of important laboratory test.

This brochure has been produced by the AIDS Community Research Initiative of America (ACRIA) to help you better understand the different types of lab tests commonly recommended by healthcare providers. With this information, we hope that you will be able to talk with your healthcare provider about your lab results in order to better understand your health. Perhaps you'll start keeping copies of your lab reports to monitor your health. Or maybe this brochure will simply help you understand why your doctor, nurse, or laboratory specialist needs to take so many tubes of blood!

Blood Tests

Blood tests are among the most comprehensive – and complex – laboratory tests used to monitor the health of people living with HIV. Very often, healthcare providers will ask for blood to be taken every three to six months, or sometimes more frequently, depending on the patient's health or if he or she is enrolled in a clinical trial.

Blood samples are typically used to perform five different types of tests:

Hematology tests: Used to measure the number and amount of "formed elements" in the blood. Formed elements include red blood cells, white blood cells, and platelets.

Blood chemistry tests: Used to measure chemicals in the blood, such as those produced by the liver, as well as nutritional elements such as vitamins, proteins, fats, and sugar.

Microbiology tests: Used to find certain disease-causing microorganisms in the blood. These can include bacteria, fungi, and parasites.

Serology tests: Used to find antibodies produced by the immune system in response to specific disease-causing microorganisms. The HIV and hepatitis C virus (HCV) antibody tests are examples of serology tests.

HIV-specific tests: Viral load, a measurement of the amount of HIV in a milliliter of blood, is an example of an HIV-specific blood test.

Before going into a more detailed overview of the various blood tests, it's important to understand how the tests are reported. The report sent to your healthcare provider by the laboratory lists the results of your blood tests. It contains a lot of information but is fairly simple to understand. Listed on your lab report are the names of the tests performed, the results of the tests, and the normal reference ranges . Your results are typically reported either as an absolute number per specified unit or as a percentage. These results can then be compared with the reference ranges, which reflect average results found in a healthy population.

It's important to understand, however, that a test result outside a given reference range doesn't necessarily mean that you are sick or having a problem. For starters, different labs use different reference ranges. Blood test results can mean many different things and are often analyzed by healthcare providers in the context of other important factors, such as symptoms (fever,

pain, or diarrhea, for instance) and the results of a physical examination. Moreover, certain blood test results can vary greatly depending on the time of day blood is taken, whether or not you've eaten before having blood drawn, if you've recently received an immunization, or if you're experiencing another illness – for example, the flu or a herpes outbreak – at the time blood is taken. Also, there is always the chance that the lab result is an error. If you have questions about any of your blood tests, be sure to speak with your healthcare provider.

Hematology Tests

The most commonly used hematology tests to monitor HIV infection are the complete blood count (CBC) and lymphocyte subsets. As the name CBC implies, this test measures the number of red blood cells, white blood cells and platelets. The most commonly followed lymphocyte subsets include CD4 and CD8 cell counts and percentages.

The Complete Blood Count (CBC)

Many of the blood cell counts discussed below – including the red blood cells, white blood cells, platelets, differentials, the CD4 cell count, and the CD8 cell count – are listed on lab reports as the number of cells per cubic millimeter (mm^3 or cu.mm) of blood. Sometimes, lab reports list the number of cells per microliter (mL) of blood. A microliter is a thousandth of a milliliter and is the same as a cubic millimeter.

Red Blood Cell count (RBC): Red blood cells, also called erythrocytes, are responsible for delivering oxygen throughout the body. There are between 3.6 to 6.1 million red blood cells in a single cubic millimeter of blood. Anemia, a condition generally defined as a decreased number of red blood cells, can be caused by certain anti-HIV drugs or be a sign of an underlying illness. Women of child-bearing age may also experience anemia as a result of blood loss from their menstrual periods. One of the most common physical symptoms of anemia is fatigue.

Hematocrit and Hemoglobin: Hematocrit measures the percentage of blood volume that is occupied by RBCs. Generally speaking, red blood cells should make up 40% to 52% of the total blood volume in men and 35% to 46% in women. Hemoglobin is a protein normally found within the RBCs that carries oxygen throughout the body. Normal hemoglobin levels range from 12 to 16 grams per deciliter of blood (g/dL). Healthcare providers usually keep track of the hematocrit and hemoglobin rather than the RBC count itself.

Red blood cell indices: This category includes the mean corpuscular hemoglobin (MCH), the mean corpuscular hemoglobin concentration (MCHC), the mean corpuscular volume (MCV), and the red cell distribution width (RDW). These indices are used to help define anemias.

Platelets: Platelets, also called thrombocytes, are elements in the blood that are necessary for blood to clot. A normal platelet count is between 150,000 to 440,000 per cubic millimeter of blood. Some people with HIV have low platelet counts – called thrombocytopenia – which can be caused by some drugs, as well as by HIV itself.

White Blood Cell count (WBC): White blood cells, also called leukocytes, defend the body against infection. They form in the bone marrow and consist of several different types and sub-types. On average, a healthy adult has between 4,000 and 11,000 white cells per cubic millimeter or microliter of blood. A high WBC count often means that an infection is present in the body, while a low number can mean that a specific disease or drug has impaired the bone marrow's ability to produce new cells. Most people with HIV have WBC counts at the low normal end of the range.

Differential white blood cell count: The differential is a count of the number or percentage of WBCs made up by each major type of WBC. Neutrophils (also called polymorphonuclear leukocytes, PMNs, or poly's for short) are WBCs that fight most bacterial infections. The neutrophil count may be lowered by certain medications used by people with HIV, such as Retrovir (AZT) and Cytovene (ganciclovir). If the neutrophil count becomes too low, there is an increased risk of bacterial infections. Lymphocytes are the key WBCs involved in immune responses (see CD4 count below) and are often lowered by HIV infection. Monocytes play important roles in fighting certain types of infections by maturing into macrophages that can ingest bacteria and cellular debris. Eosinophils are involved in fighting certain parasitic infections and are sometimes elevated due to allergic reactions. The function of basophils is not well understood.

Lymphocyte Subsets

CD4 Count (helper T-cell count): Counting the number of helper T-cells – technically called CD4+ lymphocytes – is perhaps the most important tool used to assess the overall health of the immune system in people with HIV. Helper T-cells, as the name implies, are responsible for signaling other immune system cells to fight an infection in the body. The normal CD4 count is somewhere between 500 and 1500 cells per cubic millimeter.

Without anti-HIV treatment, the average HIV-infected person undergoes a decrease in helper T-cell count of about 50 to 100 cells per cubic millimeter each year. Opportunistic infections such as *Pneumocystis* pneumonia (PCP) typically occur once the helper T-cell count falls below 200. Other infections typically occur when the count is less than 50 to 100. For this reason, medications to prophylax (prevent) certain infections are started once the helper T-cell count falls to certain levels, such as below 200 for PCP prophylaxis. The helper T-cell count also plays a major role in deciding when to start anti-HIV treatment. Currently, the U.S. Department of Health and Human Services (DHHS) recommends anti-HIV drug treatment for all HIV-positive people with helper T-cell counts below 200 and encourages treatment for all HIV-positive people with helper T-cell counts below 350.

CD4 Percentage: In a healthy adult, helper T-cells account for between 32% and 68% of the total number of lymphocytes (which includes B-cells and other types of T-cells). The CD4 percentage is sometimes a more reliable measurement than the CD4 count because it tends to vary less between measurements. For example, one person's CD4 count may vary between 160 and 240 over a period of several months while their CD4 percentage remains constant at, say, 15%. The reason for this is that the CD4 count isn't actually a direct count of CD4 cells, but rather a calculation based on the results of three other tests (the CD4 percentage, the lymphocyte percentage, and the WBC count), each of which can vary slightly each time it's measured. Occasionally the CD4 count may be relatively high while the CD4 percentage is low (less than 21%). In this situation, many healthcare providers would consider the immune system to be significantly impaired based on the CD4 percentage.

CD8 count, CD8 percentage, T-cell ratio: CD8 cells, also called suppressor T-cells, play a role in fighting viral infections such as HIV. A healthy adult usually has between 150 and 1,000 CD8 cells per cubic millimeter. In contrast to CD4 cells, people with HIV often have elevated numbers of CD8 cells, the significance of which is not well understood. Lab reports may also list the T-cell ratio, which is the number of CD4 cells divided by the number of CD8 cells. Since the CD4 count is usually lower and the CD8 count higher than normal, the ratio is usually low in people with HIV. A normal T-cell ratio is usually between 0.9 and 6.0. The expected response to effective combination anti-HIV treatment is an increase in CD4 count, a decrease in CD8 count, and an increase in the T-cell ratio.

Blood Chemistry Tests

As with the CBC, healthcare providers will often order blood chemistry tests on a regular basis to monitor your health. The blood chemistry test – also known as the chem screen – measures some of the most important chemicals produced and needed by your body to function properly. While abnormal chem screen test results don't usually mean that HIV disease is progressing, they can sometimes mean that another disease is present in the body or that a specific drug is causing side effects.

A chem screen can involve dozens of different tests, but usually measures between 6 to 24 chemicals. Some of the most important chemical levels in people living with HIV are discussed here:

Liver Enzyme Tests: ALT (SGPT) and AST (SGOT) are two important enzymes produced by the liver. The levels of these enzymes in the blood can vary considerably; the normal range of ALT is between 5 and 60 IU/L (international units per liter) and the normal range of AST is between 5 and 43 IU/L. Liver disease (such as viral hepatitis or liver tumors) and excessive alcohol consumption can cause these enzymes levels to increase.

Other liver tests to watch for include alkaline phosphatase, gamma GT (GGT or GGTP), LDH, albumin, and bilirubin. It is important that anyone taking antivirals and other medication – especially those broken down by the liver (the protease inhibitors, for example) – watch their liver function tests carefully. The protease inhibitors Crixivan (indinavir) and Reyataz (atazanavir) may cause elevations in bilirubin, which can result in jaundice (yellowing of the skin and whites of the eyes), but is usually harmless if levels don't become too high.

Kidney Tests: Blood urea nitrogen (BUN) and creatinine, both of which always appear on a chem screen report, are important blood values associated with kidney health. Normal BUN levels should be between 8 and 23 milligrams per deciliter of blood (mg/dL); normal creatinine levels should be between 0.7 and 1.3 mg/dL. These tests are very important to watch by people taking drugs that may affect the kidneys, such as Foscavir (foscarnet) and Vistide (cidofovir) for CMV and Viread (tenofovir) for HIV. Other important tests which can be affected by kidney function include phosphate and bicarbonate (carbon dioxide).

Pancreatic Tests: Amylase, an enzyme produced by the pancreas to aid in the digestion of carbohydrates is, when elevated, a strong indicator of

pancreatic disease (pancreatitis). Pancreatitis, if not properly dealt with, can cause serious illness and even death. Drugs such as Videx/Videx EC (ddI) can cause pancreatitis, which is often reversible once the offending drug is stopped. Amylase is also found in saliva, and elevated blood levels of amylase are sometimes due to leakage from the salivary glands. Further tests can be done to distinguish between these two sources of amylase.

Electrolytes: Sodium, potassium, and chloride are electrolytes. Electrolytes play a crucial role in the operation of cells and the electrical activity of the heart. Sodium levels should be between 136 and 144 milliequivalents per liter of blood (mEq/L); potassium should be between 3.6 and 5.1 mEq/L; and chloride should be between 99 and 108 mEq/L. Very often, a person with HIV who is experiencing severe diarrhea or vomiting will have abnormal electrolyte levels. Medical care is often necessary for someone with electrolyte imbalances.

Nutritional Values: Food products, no matter what they are, take the form of glucose (sugars), proteins, or fats once inside the bloodstream. A balance of each is necessary to fulfill the body's energy needs and to keep all cells, tissues, and organs functioning properly.

Albumin is one of the major types of protein made by the liver and its level in the blood reflects both dietary intake of protein and the liver's ability to make proteins. Albumin levels, which are normally between 4 and 5 gm/dL, may be low in persons who are sick. Total protein levels, which are normally between 6.6 and 8.3 gm/dL, are often elevated in people with HIV because of abnormally increased production of antibodies.

Normal glucose levels should be between 65 and 125 milligrams per deciliter (mg/dL) of blood. For the most accurate results, it's best to check glucose levels before eating the first meal of the day (known as the fasting glucose level). Sometimes, a healthcare provider may order a post-prandial glucose test: the amount of glucose in the bloodstream two hours after eating a full meal containing sugar. Abnormally high glucose levels, especially fasting glucose levels, is usually a sign of diabetes. Medications like Glucophage (metformin), the "glitazones" Avandia (rosiglitazone) and Actos (pioglitazone), and insulin can be prescribed, along with dietary changes, to help control abnormally high glucose levels.

Normal triglycerides should be between 50 and 200 mg/dL. Like glucose levels, it's best to measure triglyceride levels first thing in the morning, before the first meal of the day. High triglyceride levels are associated with pancreatitis and, quite possibly, heart disease. Pancreatitis becomes a concern when the level of triglycerides is in the thousands. It's not clear if a moderately elevated triglyc-

eride level – triglycerides in the mid to high hundreds – is associated with any immediate health risks. Fibric acid derivatives (fibrates), including TriCor (fenofibrate) and Lopid (gemfibrozil), can be prescribed for elevated triglyceride levels. TriCor is less likely to interact with anti-HIV medications than Lopid.

Cholesterol is another type of fat that is commonly measured in the blood. The three most important cholesterol tests to look for on a lab report are the amounts of total cholesterol, LDL cholesterol, and HDL cholesterol. Total cholesterol is the total amount of cholesterol in the bloodstream and includes both LDL and HDL cholesterol. The desirable total cholesterol level is anything below 200 milligrams per deciliter (mg/dL) of blood. The LDL cholesterol level is the amount of "bad" cholesterol in the bloodstream. The optimal LDL cholesterol level is below 100 mg/dL (the lower the better). LDL cholesterol levels above 160 mg/dL are considered high and increase the risk of cardiovascular disease. The HDL cholesterol level reflects the amount of "good" cholesterol in the bloodstream. A normal HDL cholesterol level is between 40 and 59 mg/dL. An HDL cholesterol level below 40 mg/dL can increase the risk of cardiovascular disease, as there isn't enough good cholesterol to help get rid of artery clogging caused by LDL cholesterol. Maintaining higher-than-normal HDL cholesterol levels – meaning an HDL cholesterol level above 60 mg/dL – may help reduce the risk of cardiovascular disease.

Microbiological Tests

Healthcare providers often recommend microbiological tests when an HIV-positive patient has symptoms of a specific infection. For example, a healthcare provider might order a *Mycobacterium avium* microbiology test for a patient experiencing unexplained fever, weight loss, and anemia. To test for this bacteria, the lab will try to grow out, or "culture," *Mycobacterium avium* complex (MAC) in a chemical mixture that contains the patient's blood, other body fluids, or tissue. If the test is positive, the healthcare provider will know to start treating the patient for MAC.

Some microbiological tests require body fluids other than blood. For example, a patient who has symptoms of pneumonia or tuberculosis may need to produce sputum (phlegm) so that microbiological tests can be conducted. Patients who are thought to have an infection in their brain may need to have microbiological tests of their spinal fluid, which requires a procedure called a lumbar puncture or spinal tap. Stool (feces) is used for various microbiological tests as well and is discussed on page 14.

Serologic Tests

Unlike microbiological tests, which look for the presence of a disease-causing microorganism, serologic tests most often look for specific antibodies produced by the immune system. Also unlike microbiology tests, serology tests are extremely useful to determine if someone has been exposed to an infection before they show signs of disease or to indicate if an infection or disease was present some time in the past.

The HIV tests, known as the ELISA and Western blot assays, are both serologic tests. Neither test looks for the presence of HIV, but rather the antibodies produced by the immune system to fight HIV. Antibody testing has remained one of the cheapest, most reliable methods of diagnosing HIV. HIV antibody testing also allows patients to find out their status many years before they get sick, thus allowing them to start medications to treat HIV and prevent opportunistic infections early. A number of HIV-antibody tests are available to healthcare providers and patients, including standard tests requiring blood samples to be sent to laboratories, tests that can be performed on oral samples, tests that can determine the presence of HIV antibodies in 15 to 30 minutes, and home-collection kits with the results available by phone.

The following is a list of additional serologic tests recommended by healthcare providers for their HIV-positive patients:

Toxoplasma Serology: Toxoplasmosis is a serious infection of the brain. Between 15 to 40 percent of people living with HIV have antibodies to *Toxoplasma gondii*, the protozoan responsible for causing toxoplasmosis. If a patient with HIV is positive for Toxoplasma antibodies and has a T-cell count less than 100, he or she will need to take Bactrim or Septra (TMP/SMX) to prevent the infection from causing disease. TMP/SMX is also the antibiotic used to prevent *Pneumocystis* pneumonia (PCP) when the T-cell count is less than 200.

Syphilis Serology: Syphilis (*Treponema pallidum*) is a potentially fatal bacterial infection usually spread through unsafe sexual activity (vaginal, oral, or anal sex without a condom). If detected early and treated, syphilis can be successfully controlled. If left unchecked, it becomes much more difficult to treat and can result in serious disease of the brain and death. It's generally rec-

ommended that sexually active adults and teenagers be tested for syphilis antibodies every year.

Serology testing can be used to diagnose syphilis and to determine if the infection has responded to therapy. However, syphilis testing isn't always accurate. It's estimated that between 6 to 10 percent of people with HIV will test falsely positive; a much smaller percentage will test falsely negative. No one is sure why this happens, but it may have something to do with abnormalities in the immune system or the presence of yet another infection.

Hepatitis B and Hepatitis C Serology: Hepatitis B virus (HBV) and Hepatitis C virus (HCV) can both cause liver problems in HIV-positive and -negative people. Even though many people with HIV are also infected with HBV, only a small percentage will actually develop symptoms from the infection. HBV isn't usually fatal, but can cause liver problems in a small percentage of those infected. HCV, on the other hand, can cause serious liver disease in some patients infected with the virus.

Tests for HBV and HCV are both available, but their interpretation can be complicated. People who have hepatitis B surface antigen (HBsAg) present in the blood are either carriers of HBV or have active infection with the virus. People who have recovered from HBV (that is, have cleared the virus from their bodies) and those who have had the HBV vaccine will have hepatitis B surface antibody (HBsAb) present in the blood. In other words, in the case of HBV, having the antibody present means that the person is immune to HBV infection, either from having had it in the past or from having had the vaccine. HIV-positive patients who test HBsAg-positive require additional testing to determine the status of the infection. HIV-positive patients who test HBsAg-negative and HBsAb-negative should talk to their healthcare provider about getting vaccinated against hepatitis B.

The presence of antibodies to HCV in the blood means that a person has HCV infection unless proven otherwise. Tests that are similar to viral load tests for HIV can be done for HCV to establish the presence of the hepatitis C virus. So with HCV, having the antibody usually means that a person is infected with the virus rather than immune to it, like in the case of HBV. There is no vaccine for HCV at this time, and the infection is best avoided by not sharing needles or other drug paraphernalia and by practicing safer sex.

HIV-Specific Tests

Viral Load: Viral load tests – measurements of the amount of HIV per milliliter of blood (copies/mL) – are important tests for HIV-positive people. When used in combination with CD4 count results, viral load is useful in determining when to begin therapy and, more importantly, to determine how well therapy is working.

Don't look for this important test in your basic lab report; viral load tests are ordered separately by your healthcare provider and are sometimes conducted at different laboratories than those that perform CBCs. A viral load report will specify which test was used. Typically, labs use either Amplicor polymerase chain reaction (PCR) assays or Quantiplex branched DNA (bDNA) assays. Because these tests measure the amount of virus differently, it's recommended that the same test and, ideally, the same laboratory be used each time to get consistent results.

There is no "normal" range of HIV, since the virus isn't normally present in the body. The reference range on a viral load lab report usually lists the lowest amount of virus that the particular assay can detect. For example, the most commonly used version of Amplicor PCR can't accurately detect less than 50 copies of the virus in a millimeter of blood. If HIV can be detected, the results of the lab report will include the number of HIV copies found (10,000 copies/mL, for example). If HIV can't be detected, the virus is said to be "undetectable." This, however, doesn't mean that HIV is no longer present in the body or that the virus can no longer be transmitted to somebody else; less than 5% of HIV in the body is found in the blood. It's also important to keep in mind that PCR and bDNA can't detect very small amounts of HIV that may be present in the blood.

In terms of deciding when and how to treat HIV based on these results, the goal is simple: to keep the level of HIV as low as possible. If viral load doesn't become undetectable, or becomes detectable again after a period of being undetectable, this is usually a sign that treatment isn't working effectively and that it might be necessary to change the drug regimen being used.

Drug Resistance Tests: While viral load tests can help patients and healthcare providers determine whether or not a treatment is effective, drug resistance tests may help determine why a treatment or combination of treatments may not be working. Drug resistance tests may also be useful in choosing treatments.

There are two types of drug resistance tests: genotype and phenotype. Genotype tests are really nothing more than careful inspections of the HIV in someone's blood. If HIV doesn't appear to be responding to a drug or combination of drugs, the virus' genetic material (RNA) is examined to look for small changes, called "mutations," in its structure. While some mutations are harmless, others may cause HIV to become less sensitive to a drug designed to stop it from reproducing. Over time, this HIV accumulates additional mutations which prevent it from responding to the drug altogether. Genotype tests look for the key mutations associated with resistance to a particular drug. By finding out which mutations are present, it may be possible for patients and their healthcare providers to figure out which treatments they should start with and, if necessary, which treatments they should switch to.

Unlike genotype testing, phenotype testing directly measures the sensitivity of a patient's HIV to particular antiviral drugs. These tests measure the concentration of a drug required to inhibit viral reproduction in the test tube by a defined amount, such as 50% or 95%. This is called IC50 or IC95. IC stands for inhibitory concentration. In other words, a laboratory conducting a phenotype test is trying to determine the amount of drug needed to stop HIV from reproducing. If it only takes a standard amount of the drug to halt viral reproduction – a concentration equal to those used by HIV-positive people – HIV is not resistant to the drug. If higher amounts of the drug are needed to stop HIV from reproducing, HIV is considered to be less sensitive to the drug being tested (the higher the concentration needed, the less sensitive the virus is to the drug being tested). The concentration of drug necessary to inhibit virus replication is expressed in units called nanomoles (nM). For example, if the IC50 of drug-sensitive virus is 100nM and that of the test virus is 400nM, the test virus is considered to be fourfold resistant to the drug being tested. In other words, HIV in the patient is four times less sensitive to the drug. For some drugs, this would be a high-level of resistance. For other drugs, it might mean a low-level of resistance. Phenotype testing is more expensive and takes longer to perform than genotype testing.

In recent years, a lot more information about drug resistance tests has been generated by clinical trials, which means that many healthcare providers are now familiar with how to use them and how to interpret their results. Several studies have demonstrated that using genotype or phenotype testing can help keep viral load undetectable longer than simply reviewing a person's treatment history or switching a regimen based on "common knowledge" about each drug's resistance profile. What's more, drug resistance tests can help figure out which drug in a regimen is no longer working. In other words, it may be possible to switch only one drug instead of all three or four being used in a particular combination.

Therapeutic Drug Monitoring (TDM): At the present time, the doses of medications used to treat HIV are the same for all adults in most cases. For some people, however, it might be necessary to increase or decrease the doses of these drugs. For example, someone experiencing side effects might be able to take a lower dose without compromising the effectiveness of the drug. Similarly, some people, even though they are taking the standard dose, may not have enough of a drug in their bloodstream to keep HIV undetectable, which can lead to drug resistance. This is why researchers are now experimenting with blood tests to check the levels of anti-HIV drugs in the bloodstream, which is better known as therapeutic drug monitoring (TDM).

Drug levels in the bloodstream can vary from person to person for many reasons. Some people metabolize (break down) medications faster, while others metabolize them slower (genetics can play a role here). Someone with a low body weight may have high levels of a drug and someone with a high body weight may have low levels of a drug. Anti-HIV drugs can interact with food, nutritional supplements, and other drugs, which can either increase or decrease the amount of the anti-HIV drugs in the bloodstream. Anti-HIV drug levels can also increase or decrease in HIV-positive women who are pregnant, given hormonal changes and changes in body weight and size. Also, certain diseases that affect the kidneys and liver, such as hepatitis, can have an impact on anti-HIV drug levels in the bloodstream. For all of these – and other – situations, experts are interested in learning more about the usefulness of TDM for people with HIV.

TDM can be used to check levels of protease inhibitors (PIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) in the bloodstream. TDM, in its current form, isn't able to check levels of nucleoside reverse transcriptase inhibitors (NRTIs) in the bloodstream. What matters most with NRTIs is the amount of drug inside cells, not the bloodstream, and most TDM tests don't have the ability to measure cellular levels of these drugs.

Because there are a number of lingering questions regarding how best to use TDM, these tests aren't routinely used or available in the United States (TDM is used regularly in many parts of Europe). As of April 2004, four laboratories in the U.S. are providing commercial TDM services – in Buffalo, New York (The University of Buffalo [716/645-3635 ext. 245]); in Cocoa Beach, Florida (TDM Laboratories [312/784 2880]); in Van Nuys, California (POMG Laboratories [818/994-9714]); and in Washington, DC (Children's National Medical Center [202/884-2096]. TDM testing for anti-HIV drugs is expensive and isn't covered by private or public health insurance plans (including AIDS Drug Assistance Programs).

Urine Tests

Urine tests, usually known as urinalysis or urine culture, are most commonly used by healthcare providers to monitor kidney function and to test for infections in the urinary tract.

Various drugs – including cidofovir, pentamidine, foscarnet, and amphotericin B – can cause serious kidney damage. As a result, it's extremely important for patients on these and other potentially toxic drugs to have their blood and urine tested regularly. While looking for changes in a patient's blood levels of BUN and creatinine (discussed on page 6), it will also be important to keep an eye out for proteinuria (protein in the urine) and glycosuria (glucose in the urine). If significant levels of either develop while someone is taking a drug known to cause kidney problems, the dose of the drug may need to be reduced or stopped altogether. Glycosuria may also be a sign of diabetes.

The presence of red or white blood cells in the urine is usually abnormal and may indicate disease processes such as bladder infection or kidney stones. Blood in the urine isn't usually a cause for alarm for women who are having their periods since blood can sometimes get into the urine specimen during collection. To make sure that urine does not contain blood, it might be necessary for a woman to repeat a urinalysis after her period is over.

Stool Tests

Call it what you will, stool (feces) is an important body substance examined by healthcare providers to check for the presence of disease-causing microorganisms, particularly parasites and bacteria. For the most part, labs use microbiology tests – similar to microbiological blood tests – to determine if disease-causing microorganisms are present.

For an HIV-positive patient with diarrhea, a stool test is often the first step. Labs routinely check for common bacterial and protozoal infections. Very often, these prove to be the cause of the diarrhea and most can be treated relatively easily. If the results of the stool test come back negative, the healthcare provider may need to specifically order stool tests to look for isosporiasis, microsporidiosis, and cryptosporidiosis, three relatively uncommon infections that can cause serious diarrhea in patients with substantially compromised immune systems.

Pap Smears

HIV-positive women may be at an increased risk of developing cervical disease, including cancer. Pap smears are more than 90 percent accurate in determining if cells around or in the cervix are normal or abnormal. HIV-positive women should have a Pap smear every 6 or 12 months. A Pap smear requires a doctor or other trained medical professional to lightly scrape the cervix and its surrounding area with a small spatula. The scraping is applied to a glass slide and sent to a pathology laboratory for examination under the microscope.

Another method of examining the cervix uses a colposcope. A colposcope is a microscope that can examine the cervix carefully for abnormal cell growth and tumors in their very early stages. Both Pap smears and colposcopy examinations can be performed at a healthcare provider's office or clinic.

Some healthcare providers also recommend anal Pap smears and/or anal colposcope to look for abnormal cell growth, including warts and pre-cancerous lesions (dysplasia), inside the anus. Men who have sex with men and women with a history of cervical dysplasia – particularly if they are HIV-positive – are at a higher risk of anal dysplasia caused by human papillomavirus (HPV).

We hope that this booklet has been helpful and will allow you to better understand why laboratory tests are such an important part of your healthcare. However, keep in mind that interpreting laboratory tests can often be a complicated task. Work closely with your provider to interpret test results and to understand just how they could affect your course of treatment. Always feel free to consult your healthcare provider if you have questions about your laboratory report.

Sample Laboratory Report

This example of a lab report may or may not look like the one from your healthcare provider's office or clinic. Different labs report results differently, and tests such as chemistry panels may include slightly different groups of tests. However, the general concepts illustrated here should still apply. Consult your healthcare provider if you have questions about your specific lab results.

Ms. Doe's cholesterol is at the upper end of the reference range and is not reported as "abnormal" or "high". Ideally, the cholesterol level should be less than 200 to reduce the risk of heart disease. So Ms. Doe's healthcare provider might suggest further testing (such as a fasting lipid profile to determine the values of certain types of cholesterol), prescribe cholesterol-lowering drugs, and counsel Ms. Doe on how to change her diet. This example shows how a lab value in the "normal" range may sometimes prompt further evaluation.

Ms. Doe's cholesterol value is greater than 75% of women in the same age range. A cholesterol between the 75th and 90th percentiles indicates a moderate risk and greater than 90th percentile a high risk of developing coronary artery disease.

An "H" means the result is higher than the reference range, and an "L" means it is lower. A high or low value is not necessarily a cause for alarm. 5% of healthy people will have values outside of the reference range. Here, Ms. Doe's liver enzymes are minimally elevated. Her healthcare provider might review her medications for drugs that can cause this, order further blood tests, or simply follow the enzyme levels over time.

Clinical Laboratory Report

Patient Name	Date Drawn	Date Received	Date of Report
Doe, Jane	12/27/03	12/29/03	12/30/03

Sex	Age	Physician Name/Address	I.D. Number	Account Number
F	37	CONCOURSE MEDICAL YOUR DOCTOR, M.D. ANYWHERE, USA 000000	654534565	3443534

Patient I.D./Soc. Sec. #	Time Drawn	Speciman Number
235463746	9:30AM	343477

TEST NAME	RESULT ABNORMAL	NORMAL	UNITS	REFERENCE RANGE
CHEM-SCREEN PANEL				
GLUCOSE		87.0	MG/DL	65.0-125
SODIUM		140.0	MMOL/L	136-144
POTASSIUM		4.6	MMOL/L	3.60-5.10
CHLORIDE		106.0	MMOL/L	99.0-108
CARBON DIOXIDE		28.0	MMOL/L	21.7-30.7
BUN		9.00	MG/DL	8.00-24.00
CREATININE		0.90	MG/DL	0.70-1.30
BUN CREATININE RATIO		10.0		
URIC ACID		6.00	MG/DL	3.00-8.10
CALCIUM		9.60	MG/DL	8.90-10.3
MAGNESIUM		2.09	G/DL	1.50-2.50
CHOLESTEROL		215.0	MG/DL	120-233
CHOL. PERCENTILE	H 75.0		PERCENTILE	
TRIGLYCERIDES	H 230.0		MG/DL	50.0-200
PROTEIN, TOTAL		7.60	GM/DL	6.50-8.30
ALBUMIN		4.10	GM/DL	4.00-5.00
BILIRUBIN, TOTAL		0.41	MG/DL	0.20-1.50
BILIRUBIN, DIRECT		0.06	MG/DL	0.00-0.20
ALK PHOSPHATASE		69.0	UNITS/L	30.0-110
GGT		18.0	UNITS/L	5.00-80.0
AST (SGOT)	H 46.0		IU/L	5.00-43.0
ALT (SGPT)	H 65.0		IU/L	5.00-60.0
AMYLASE, SERUM		33.0	UNITS/	0.00-100
COMPLETE BLOOD COUNT (CBC)				
WHITE BLOOD CELL (WBC) COUNT		5.10	THOUS./CU.MM	4.00-11.0
RED BLOOD CELL (RBC) COUNT	L 3.88		MIL./CU.MM	4.20-5.40*
HEMOGLOBIN (HGB)		14.0	GM/DL	12.0-16.0*
HEMATOCRIT (HCT)		42.3	PERCENT	37.0-47.0*
MCV	H 109.0		FL	80.0-97.0
MCH	H 38.4		PG	27.5-33.5
MCHC		35.2	PERCENT	32.0-36.0
RDW		12.2	PERCENT	11.0-15.0
PLATELET COUNT, AUTO		243.0	THOUS./CU.MM	150-440
T-LYMPH SUBSETS				
CD4+ HELPER (36.0 PCT)		651	CU.MM	500-1500
CD8+ SUPPRESS (44.0 PCT)		796	CU.MM	150-1000
CD4/CD8 RATIO	L 0.81		RATIO	0.90-6.00
DIFFERENTIAL				
POLY (52.2 PCT)		2662	CU.MM	1650-8000
LYMPH (35.5 PCT)		1810	CU.MM	1000-3500
MONO (9.9 PCT)		504	CU.MM	40.0-900
EOS (1.9 PCT)		96	CU.MM	30.0-600
BASO (0.5 PCT)		25	CU.MM	0.00-125

*These reference ranges are for females.
The ranges for men are: RBC=4.7—6.10, HGB=14.0—8.0, HCT=42.0—52.0

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ACRIA is an independent, non-profit community-based AIDS research and education organization committed to improving the length and quality of life for people living with HIV/AIDS through medical research and treatment education.

ACRIA conducts a free Treatment Education Program to offer people living with HIV/AIDS the tools and information to make informed treatment decisions. Education program services include: workshops conducted on site at community-based groups throughout the New York City area in English and Spanish; technical assistance trainings for staff of AIDS service organizations; individual treatment counseling, and publications, including our quarterly treatment newsletter, *ACRIA Update*, and brochures in English and Spanish on specific treatment-related topics. ACRIA's National Treatment Education Technical Assistance Program offers ongoing support to help non-medical service providers and community members in various parts of the country acquire the skills and information needed to provide HIV treatment education in their communities.

To learn more about ACRIA's research studies or the Treatment Education Program, please call 212-924-3934. Information about ACRIA's programs and copies of *ACRIA Update* are also available on our web site: www.acria.org.

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