

BLOOD WORK:

A COMPLETE GUIDE FOR MONITORING HIV

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Lab tests, or blood work, can give important clues about your overall health and HIV disease. Many of these tests should be done shortly after learning that you're HIV-positive. This will establish a “baseline” measure of your immune health and show how active HIV is. Knowing this information will help you watch for changes in your health over time as well as check the impact of any treatments that you take. Factors such as age, gender, stress, medicines, active infections and others can all affect these test results. Lab results should be considered with these factors in mind.

Understanding your test results may seem difficult at first. However, they can help you take charge of your health and understand why your doctor prescribes certain tests and medicines. With practice over time, it becomes easier to understand these results.

Nearly all lab reports make it simpler to understand test results by including a “normal” range, or high and low values. The results that fall outside normal ranges are likely the most important ones. Those that are above or below normal are often highlighted on your lab report by being bolded, printed in a different color or printed in a different column.

It is your right to have and keep copies of all of your medical records. You can then keep track of your results to look for overall trends. Ask for and keep copies of your lab reports, and make a chart or table of them to note trends or changes. For examples of these charts, read Project Inform's publication, *Personal Tracking Charts*, available at 1-800-822-7422 or www.projectinform.org.

WHAT'S INSIDE

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Although this publication may seem long and involved, it gives a thorough background to the types of tests that you may need to take over time. There are 5 key points to keep in mind when reading this material:

1

“Normal” test values can differ. For example, lower cholesterol values may be considered normal in an HIV-positive person not on HIV treatment. Be sure to discuss these differences with your doctor. Test results outside the lab’s “normal” range may not be cause for alarm.

2

No single test result provides all the answers. Most results need to be considered along with other reports and within the context of your overall health.

3

Different labs can get different results from the same blood sample because they use different methods or equipment. If for some reason you cannot use the same lab, you may need to establish a new baseline at the new lab. In the case of viral load tests, try to have the same type of test (bDNA, PCR, etc.) done each time. If your doctor sends you to the same place to give blood for testing, it’s likely the same labs and types of tests are being used. If you move or if you change doctors or health plans, it’s a good idea to check and see if your lab has changed as well. If you ever see dramatic changes in your lab results, you might ask your doctor if the lab or type of test have changed.

4

Several things can impact your test results. For example, they can vary due to the time of day your blood is drawn. If possible, try to schedule blood draws at the same time of day every time. If you’re sick or have an infection, like a cold or flu, these can also affect your test results. You may want to wait to have lab work done or repeat the tests after you’ve become well again. Getting a flu shot or other vaccination can also alter lab results, as it stimulates the immune system and can increase how active HIV becomes. HIV levels usually return to “baseline” within a month after a vaccination.

5

A dramatic change in results may be due to testing errors. As for CD4 cell counts and HIV levels, it’s wise to have the test run again and to not make therapy decisions from any one test result.

Complete blood count (CBC)

The CBC is the most common blood test that doctors order. It checks levels of white blood cells, red blood cells and platelets. Generally, even people without symptoms of HIV disease should have a CBC test done at least every 6–12 months. People whose blood work trends are changing may want to have their CBCs done every three months, or more often. People with symptoms of HIV disease should have a CBC every 3–6 months.

CBC testing is done more often in people with symptoms of low red blood cells (*anemia*), low white blood cells (*leukopenia*) and low platelets (*thrombocytopenia*). In each case, if a change occurs that worries you or your doctor, the tests should be done again a few weeks later. Of the tests explained in this publication, the most important ones are the red blood cell, white blood cell and platelet counts.

Platelet count

Platelets are the part of the blood that helps it to clot. They travel to the site of an injury where they “stick” and help develop a clot or scab to stop the bleeding. A normal count is 150,000–440,000. A low count can be caused by HIV infection or by some drugs.

Although a platelet count below 150,000 is considered low, most people are not at risk of uncontrolled bleeding with counts of 50,000 or even lower. However, because platelets are necessary for blood clotting, the chance of major bleeding rises as the platelet count drops. If your platelet count is very low (in the 10,000 range) and/or you have symptoms related to thrombocytopenia, your doctor may want to change your treatment, or may teach you special ways to prevent bleeding.



Above 500 CD4+ cells

- › No unusual conditions likely. Emphasize good health habits and health care maintenance, including vaccines and nutrition.

200–500 CD4+ cells

- › Increased risk for shingles (zoster), thrush (candida), skin infections, bacterial sinus and lung infections, and TB.
- › Life-threatening OIs (such as PCP, MAC and CMV) are rare.
- › HIV treatment is generally suggested at 300-500 CD4s and recommended when CD4 cell counts falls to 200 to 350.

50–200 CD4+ cells

- › Increased risk for PCP and other life-threatening OIs.
- › Preventive treatment for PCP is indicated.
- › If counts are below 100, consider preventive treatment for MAC, CMV and invasive fungal infections.

Below 50 CD4+ cells

- › Increased risk for OIs, including MAC and CMV.
- › Continue preventive medications.

Red blood cells: the oxygen carriers

Red Blood Cell (RBC) Count

RBCs are produced in your bone marrow, and they carry oxygen and carbon dioxide through your body. The RBC count is the number of red blood cells found in a small amount of blood called a cubic milliliter, or mL. Normal levels for men range from 4.5–6.1 million/mL, and for women 4.0–5.3 million/mL. It's not uncommon for people with HIV to have RBC values below normal.

Slightly lower values should not be cause for alarm. However, greatly lower numbers can be a sign of anemia. Symptoms include fatigue, shortness of breath, pale skin color and menstrual problems. Anemia can be caused by some medicines and/or illness. Low RBC counts occur with lower hemoglobin and hematocrit levels. Anemia may be treated with iron supplements, erythropoietin (Epoen) or in severe instances, a blood transfusion.

Hemoglobin

Hemoglobin is a RBC protein that carries oxygen through the body. Normal levels in women are 12–16 grams per deciliter (g/dl) and in men 14–18g/dl. It's not uncommon for people with HIV to have lower than normal hemoglobin levels. This is usually due to fewer RBCs produced by the bone marrow because of HIV or some anti-HIV drugs that suppress the marrow.



Hematocrit

The hematocrit is another way to measure RBCs. It is the percentage of blood cells in your body that are red blood cells. Normal values range in men from 40–54% and in women 37–47%. Hematocrit values indicate the thickness of the blood as well as its ability to carry oxygen. A low hematocrit also indicates anemia.

Mean Corpuscular Volume (MCV)

The MCV measures the average size of red blood cells. The average MCV ranges from 80–100 femtoliters (fL). A low MCV shows that cells are smaller than normal. This may be due to an iron deficiency or chronic disease. MCV is generally higher than normal in people taking Retrovir (zidovudine, AZT) or in people with vitamin B12 and folic acid deficiencies.

Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC)

These measure the amount and volume of hemoglobin in an average cell. These are less important but help to detect various anemias and leukemias.

White blood cells: infection fighters



White Blood Cell (WBC) Count

WBCs, or *leukocytes*, help prevent and fight infections. A normal count ranges from 4,000–11,000/mm³ in a healthy adult. A high count may mean that your body is fighting an infection. Low counts may result from taking certain drugs (AZT or ganciclovir), minor viral infections, stress or more serious opportunistic infections such as tuberculosis, histoplasmosis or other infection. Low counts also indicate a greater risk to infection. White Cell Differential: This is a breakdown of the different types of white blood cells as percentages of the total WBC count. The three main groups of WBCs are:

1. lymphocytes
2. granulocytes
3. monocytes.

Lymphocytes

Lymphocytes are WBCs that produce antibodies and keep the immune system working. They make up 10–45% of your WBCs. There are two main types: B cells and T cells, and they fight infection in different ways. CD4 cells—a type of T cell—are cells that HIV uses to infect and/or destroy. You may have heard the term “CD4 count” or “T cell count.” This refers to a kind of T cell that controls the activity of other immune cells. (See the section “Lymphocyte Subsets” on page 8 for more information.)

Monocytes

These circulate in the blood for about 24 hours. From there they move into tissues and mature into macro-

phages, which then eat up infection and foreign bodies. (Macrophage means “big eater.”)

Granulocytes (polymorphonuclear cells or PMNs)

These are the most common types of WBCs, making up 55–80% of your total WBC count. PMNs help fight bacterial infections. Specific PMNs include:

NEUTROPHILS

The most common PMN. They fight infection and play a key role in destroying bacteria and other foreign matters in the body. Some drugs used to treat HIV or HIV-related conditions can decrease neutrophil counts.

EOSINOPHILS

These PMNs are involved in fighting parasitic infections and allergic reactions. Their numbers will rise during an allergic reaction or asthma attack.

BASOPHILS

These are very important for releasing histamine. This is the substance that makes you feel congested and miserable during a cold or allergies. However, they help your body heal by making the blood vessels “leakier” so that cells can travel faster to the areas of infection.

Chemistry screen (CHEM-25 OR SMA-25)

A chemistry panel (chem panel, chem screen) tests the levels of 25 chemicals in the blood. It can help determine if your body is working properly. (Other types test 12, 14 or 20 chemicals and are called SMA12, SMA14 and SMA20.) A chem screen should be done once a year in people not taking medications and more often in people who are. Some of the important values follow.

Sodium (Na)

The normal range is 135–145 mEq/liter.

Sodium is a part of table salt and is important for keeping the balance of fluid in your body, nervous system and muscle tissue (including the heart). Too much of it can be a symptom of being dehydrated while too little can be caused by excessive IV fluids or may indicate kidney problems. Eating salty foods will not affect your sodium level as long as you're drinking fluids.

Potassium (K)

The normal range is 3.5–5 mEq/liter.

Potassium is mostly found inside your cells and helps to regulate nerve impulses and heart muscle. A high level may indicate kidney failure and severe injuries. A low level can occur after severe vomiting, diarrhea, long periods without food and in people on high doses of pills to reduce water retention (*diuretics*). Potassium is found in most foods. People who eat a fairly balanced diet will have no problem getting enough of it.

Chloride and Magnesium (Cl and Mg)

The normal range of chloride is 100–106 mEq/liter.

The normal range of magnesium is 1.5–2.0 mEq/liter.

Chloride and Magnesium are two important elements in your blood. Chloride is important for controlling your body's balance of fluid. Magnesium is involved in muscle contractions and processing protein.

Glucose

Normal levels are 75–125mg/dl.

Glucose is sugar, and glucose values are used to check for diabetes. Some drugs may alter glucose levels, such as Pentam (IV pentamidine) or drugs that affect the pancreas. Insulin resistance is one cause of high blood glucose. Insulin resistance occurs when insulin (the hormone that moves sugar into cells) is less effective than usual in your body. This may occur with long-term use of anti-HIV drugs, from HIV itself or from both HIV and the drugs. It is treatable with medications.

Cholesterol and triglycerides

Normal cholesterol levels are 150–250mg/dl. Triglycerides can range from 47–175mg/dl.

Cholesterol and triglycerides are fatty substances in the body. Their levels help measure the risk for conditions such as heart disease and wasting. Triglycerides often decrease in people with HIV, possibly due to malnutrition or wasting in advanced stages of disease. High cholesterol and triglycerides may occur among people living with HIV for many years. They can also be a side effect of anti-HIV drugs.



Liver Function Tests (LFTs)

LFTs include a number of lab results that help the health of the liver. These include ALT (SGPT), AST (SGOT), LDH, alkaline phosphatase and total bilirubin. Elevated liver enzymes are caused by some medications. It can also be caused by liver disease such as hepatitis B or C, injuries and tumors. Abnormal LFTs are common in 60–70% of people with HIV, but liver failure is unusual. High alkaline phosphatase levels along with normal bilirubin levels can show serious disease and are often seen in people with MAC (*Mycobacterium Avium Complex*), CMV (cytomegalovirus), histoplasmosis, drug side effects or KS (Kaposi's Sarcoma). Bilirubin, a product of dead red blood cells, is removed through the liver. High bilirubin levels can be a sign of hepatitis (perhaps with a yellow skin color), bile duct obstruction and other liver problems. Some HIV drugs—specifically Reyataz (atazanavir) and Crixivan (indinavir)—can cause high bilirubin levels. However, this may not be a sign of liver problems. If a pregnant woman has high bilirubin, this can harm the unborn child.

Amylase

Normal levels are 25–125 milliunits/mL.

Amylase is secreted by the saliva glands as well as in the pancreas. Elevated levels may be an early sign of inflammation of the pancreas, or pancreatitis. This is a serious side effect of some common medications used to treat HIV and its conditions.

Kidney Function Tests

Two indicators are used to assess kidney function—creatinine and BUN (blood urea nitrogen). High levels of both indicate kidney disease or being dehydrated. High uric acid levels can be a sign of kidney deficiency but may also indicate other conditions like lymphoma or inflammation. Kidney problems in people with HIV can be caused by HIV itself (HIV Associated Nephrotoxicity, HIVAN) and/or may result from drug side effects.

Proteins

Albumin and globulin are the two main types of protein in the blood. High albumin levels indicate dehydration and low levels can signify malnutrition, liver failure or kidney disease. Globulin levels are less important.

Lymphocyte subsets and viral load: specific tests for people with HIV

Lymphocytes are a type of white blood cell. Routine counts provide information about the state of your immune health. Three types of lymphocytes are routinely tested: B cells, T cells (CD4 and CD8 cells) and NK cells (natural killer cells). B cells are involved in the production of antibodies. They also deal with infections that are outside cells. CD8 cells deal with infections that are inside cells. CD4 cells “help” B cells and CD8 cells do their jobs.

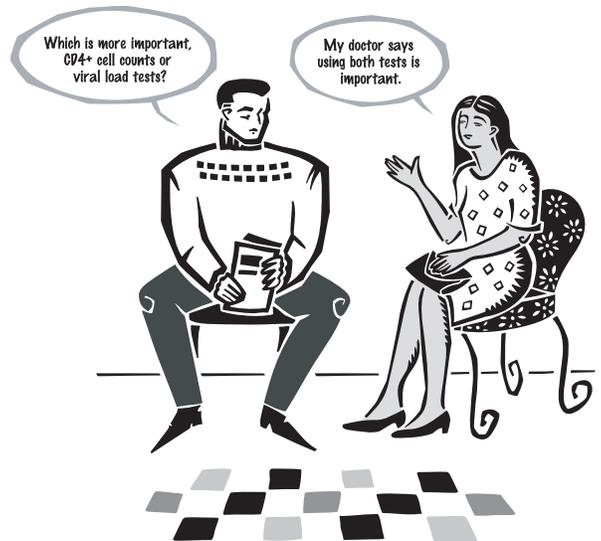
CD4 and CD8 cell counts

CD4 cells help control the activity of other cells. HIV infects CD4 cells and makes more copies of itself. Over time, HIV causes a decline in the number of these cells. So getting routine CD4 cell counts done is the main way to keep track of your immune health.

In HIV-negative people, normal CD4 cell counts are 500–1,500/mm³ of blood. Normal CD8 cell counts are 300–800/mm³. In general, people have 2-to-1 ratios of CD4 to CD8 cells. So for every two CD4 cells, an HIV-negative person has one CD8 cell in their blood. However, in most people living with HIV who are not on anti-HIV therapy, it's common for the normal CD4/CD8 ratio to be reversed.

It's also helpful to look at the percentages of CD4 and CD8 cells in a blood sample. The CD4 percentage is the percentage of CD4 cells in the total lymphocyte count. The normal range is 28–58%. Another helpful measure is the CD4/CD8 ratio.

CD4 cell counts are also the best guide for when to start preventive therapy for opportunistic infections, or



OIs. CD4 cell counts may vary due to many factors, such as the time of day, an active infection, stress or lab variations. Therefore, it's important to look at your CD4 cell count trends over time and not be alarmed by any one test result. CD4 cell counts also are used to make decisions on when to start or change therapy. (Found on page 3)

Viral load tests

Viral load tests measure the amount of HIV in a drop of blood. They are important for monitoring HIV disease and how well therapy is working. When HIV levels de-

crease or stay low and stable over time, it's a sign that potent HIV treatment is working. When the levels increase, it's often a sign that a regimen has stopped working.

At first, two tests should be taken about 2–4 weeks apart to establish a baseline level. After that, viral load tests should be done every 3–4 months. People should generally avoid having viral load tests done during an active infection (like a cold), after a vaccination (like flu) or during flare-ups of infections (like a cold sore). These can all cause HIV levels to briefly increase. They usually return to normal within a few weeks after a vaccination or the end of the infection.

A viral load test should also be done 3–4 weeks after starting or changing therapies. To get accurate results and trends over time, it's wise to get the same brand of test done each time at the same lab. The trend of viral loads over time is the most important and not an individual result.

Low, stable and decreasing viral load is considered a good thing. High or increasing levels call for attention as it may point to the failure of a regimen. Viral load below 10,000 copies is generally considered “low.” Viral load above 100,000 copies is generally considered “high.”

Women may have a “naturally” lower viral load than men, especially in early HIV infection. Therefore, women should be aware that a viral load above 30,000 or even 60,000 might indicate a “high” viral load for them.

People with “undetectable” viral load should remember that it does not mean that their HIV is gone. HIV may actually be there, but just in too small of a quantity to detect.

Resistance tests

HIV can change itself so that HIV drugs do not work as well. This is called drug resistance, and it's one of the most common reasons why therapy fails. There are two different types of resistance tests. **Genotypic** tests look for changes in the genes of HIV that are linked to drug resistance. **Phenotypic** tests assess which drugs can stop HIV growing in a lab setting. Several different labs offer these tests.

People who use resistance test results to help make treatment decisions face a better and more sustained reduction in HIV levels than those who make decisions based on their treatment history and viral load results. To accurately test drug resistance, people should have a viral load over 1,000 copies. Otherwise, the results may not be accurate or the test cannot be done.

A replication capacity test measures whether HIV can reproduce and how fast. This is sometimes called viral fitness. The test is usually done along with a resistance test. It is thought to be most useful for people with fewer treatment options who are trying to put the best possible regimen together.

Another test that looks at HIV is called a tropism assay. It looks at which of two common proteins—called CCR5 (R5) and CXCR4 (X4)—HIV uses to enter CD4 cells. This test will be used for people wanting to block R5 with HIV drugs, like maraviroc. Four results are possible: uses R5 only (*R5 tropic*), uses X4 only (*X4 tropic*), can use either (*dual tropic*), or some combination of the first three (*mixed tropic*).

Other tests that may be done

The following tests are considered routine in people living with HIV, but do not need to be done as often as CD4 cell counts and viral load tests.

PPD Skin Test and Chest X-ray

A PPD tests the skin to detect an earlier exposure to tuberculosis (TB). If you've been exposed, the PPD causes a bump to appear within several days at the site of the test. A positive or inconclusive PPD is followed up by a chest x-ray and sputum culture to determine active TB disease.

Pap Smear

Women should have a cervical Pap smear done at least once every three years. Women living with HIV should talk about when and how often they should get a Pap test done with their doctors, as they may recommend more regular tests based upon your health and risk factors. If the results are abnormal, follow up with other types of tests may be needed. To take a Pap test, your healthcare provider uses a "Pap stick" or cotton swab to take one or more samples of cells from the cervix and cervical canal. You may feel a slight scraping sensation. The process may be uncomfortable but usually not painful. It may hurt if there is inflammation and sensitivity in the area. For more information about HIV and GYN exams, read Project Inform's publications, *Gynecological Conditions and HIV Disease* and *Positive? How Are You Feeling?*

Anal Pap

This test is done in the anus to look for damage caused by HPV (human papillomavirus). High rates

of anal HPV occur in HIV-positive men and women, including those who do not report having anal intercourse. For this reason it's important that all HIV-positive people have an anal Pap. If the results are abnormal, more tests may be needed.

Hepatitis Serology

As stated before, liver function tests can show hepatitis infection. Other tests can be done to find antibodies to hepatitis B (HBV) and C (HCV)—diseases that affect the liver. These tests should be done after first learning your HIV status, if you have not been tested before. Learn about how to protect yourself from getting HBV and HCV if you have not been exposed to them. There is a vaccine to prevent HBV infection. For more on protecting the liver problems, read Project Inform's publication, *Towards a Healthy Liver, Hepatitis and Liver Problems*, and *Hepatitis C*.

Toxoplasmosis Serology

This test may be done to detect antibodies to the toxoplasmosis (toxoplasma) organism. Toxo can cause problems in the brain and central nervous system. A positive test result may help to decide on preventive therapy. The test is usually done when people first find out their HIV status. That way, if they're negative for toxo, they can take precautions to prevent contact with it. For more information, read Project Inform's publication, *Toxoplasmosis*.

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Table of common tests and ranges

Each lab typically provides “normal” ranges of values along with the test results. Some labs may differ in the exact ranges of the normal values. Remember to ask your doctor for a copy of your lab report for your own personal records, so that you can track trends of your lab results.

LAB TEST	RANGE OF NORMAL VALUE	UNIT OF MEASUREMENT
Red Blood Cells (RBCs)		
RBC Count	Female: 4.0–5.3. Male: 4.5–6.1.	million cells per cubic millimeter (million/mm ³)
Hemoglobin (HB or HGB)	Female: 12–16. Male: 14–18.	grams per deciliter (g/dL)
Hematocrit (HCT)	Female: 37–47. Male: 42–52.	%
White Blood Cells (WBCs)		
WBC Count	4.3–10.8	thousand cells per cubic millimeter (thousand/mm ³)
Percentage of White Blood Cells		
Basophil %	0–3	%
Eosinophil %	0–7	%
Lymphocyte %	12–50	%
Monocyte %	0–12	%
Neutrophil %	40–73	%
Lymphocyte Subsets		
Total T Lymphocytes (CD3)	990–1,910	cells/mm ³
Total CD4 T-cells	590–1,120	cells/mm ³
Total CD8 T-cells	330–790	cells/mm ³
T-lymphocyte percentage (CD3 %)	61–85	%
CD4 T-cell percentage (CD4 %)	28–58	%
CD8 T-cell percentage (CD8 %)	19–48	%
Platelet Count	140,000–440,000	cells/mm³
Liver Function Tests		
ALT (SGPT, Alanine aminotransferase)	0–45	units/liter (u/L)
AST (SGOT, Aspartate aminotransferase)	0–41	u/L
Lactic Dehydrogenase (LDH)	50–115	u/L
Phosphatase (alkaline)	36–125	u/L
Bilirubin (total)	0.1–1.2	mg/dL
Kidney Function Tests		
BUN (Blood Urea Nitrogen)	7–28	mg/dL
Creatinine	0.6–1.5	mg/dL
Uric Acid	3–7	mg/dL
Red Blood Cell Indices		
Mean Corpuscular Hemoglobin (MCH)	27–33	picogram per red blood cell
MCH Concentration (MCHC)	32–36	%
Mean Corpuscular Volume (MCV)	79–100	femtoliters (fL)
Amylase	53–160*	units/liter (u/L)
Calcium (urine)	Female: <250. Male: <300.	mg/day
Cholesterol	120–220	mg/dL
Creatine Phosphokinase (CK or CPK)	Female: 10–79. Male: 17–148.	u/L
Glucose	70–125	mg/dL
Magnesium	0.6–1.0	mmol/L
Potassium	3.5–5.3	mmol/L
Sodium	135–146	mmol/L
Protein	6.0–8.3	g/dL
Total Albumin	3.2–5.5	g/dL
Globulin	1.5–3.8	g/dL
Triglycerides	35–160	mg/dL
Urea Nitrogen (see BUN)	7–28	mg/dL

* In our review of lab reports, the normal range for amylase, in particular, varied widely. As with all these values, it's important to examine your report to find the normal ranges for your lab.

Interpreting your viral load numbers

Copies HIV RNA	Log Value	Copies HIV RNA	Log Value
100,000,000	8	6,000	3.75
60,000,000	7.75	3,000	3.5
30,000,000	7.5	2,000	3.25
20,000,000	7.25	1,000	3
10,000,000	7	600	2.75
6,000,000	6.75	300	2.5
3,000,000	6.5	200	2.25
2,000,000	6.25	100	2
1,000,000	6	60	1.75
600,000	5.75	30	1.5
300,000	5.5	20	1.25
200,000	5.25	10	1
100,000	5	6	0.75
60,000	4.75	3	0.5
30,000	4.5	2	0.25
20,000	4.25	1	~0
10,000	4		

Some other guidelines to help you better understand logs.

If your viral load value decreases by:	Your change is:
1/2 (original divided by 2)	0.3 log
1/3 (original divided by 3)	0.5 log
1/4 (original divided by 4)	0.6 log
1/5 (original divided by 5)	0.7 log
1/10 (original divided by 10)	1.0 log
1/100 (original divided by 100)	2.0 log
If your viral load value increases by:	Your change is:
2 (original times 2)	0.3 log
3 (original times 3)	0.5 log
4 (original times 4)	0.6 log
5 (original times 5)	0.7 log
10 (original times 10)	1.0 log
100 (original times 100)	2.0 log

If you have other questions on logs, please call Project Inform's HIV Health Infoline at 1-800-822-7422.

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