

Understanding Lab and Imaging Tests



Revised **2020**

Support for this publication provided by



A six-word narrative about living with blood cancer from patients in our LLS Community

Stay strong and keep moving forward. Find the positive in every day. Be your own best patient advocate. Changed my life for the better. Accept, learn and focus on present. Learning to live a different life. Sudden and life changing—be positive. Waiting, worrying, anxiousness/happy I'm alive! Embrace a new normal each day. 5 years, 41 infusions, constant fatigue. Patience, positive attitude, hope and faith. Test to test, I will survive! Treatment, fatigue, treatment, fatigue and survival. Love life, live better every day. I don't look back only forward. So far, so good, live life. Meditation, mindfulness, wellness, faith, nutrition and optimism. Finding the joy while living with uncertainty. Watch, wait, treat, regroup, rest, re-energize. Blessed to be doing so well! Eye opening needed learning and healing. Feel great: uncertain travel plans annoying. Renewed faith, meditation, diet, mindfulness, gratitude. Watchful waiting can be watchful worrying. Scary, expensive, grateful, blessings, hope, faith. Thank god for stem cell transplants! Do not know what to expect. Extraordinarily grateful, I love my life. Diagnosed; frightened; tested; treating; waiting; hoping. I'm more generous, impatient less often. Embrace your treatment day after day. Live today, accept tomorrow, forget yesterday. Strength you never realized you had. Challenging to our hearts and minds. Life is what we make it. Live life in a beautiful way.



Discover what thousands already have at
www.LLS.org/Community

Join our online social network for people who are living with or supporting someone who has a blood cancer. Members will find

- Thousands of patients and caregivers sharing experiences and information, with support from knowledgeable staff
- Accurate and cutting-edge disease updates
- The opportunity to participate in surveys that will help improve care.

Inside This Booklet

2 Introduction

3 Part 1

About Laboratory Tests

About Imaging Tests

Questions to Ask Your Healthcare Provider Before
Having Medical Tests

Preparing for Tests

Keeping Track of Test Results

10 Part 2

Index of Tests

The Tests: Details

47 Part 3

Resources and Information

Health Terms

Acknowledgements

The Leukemia & Lymphoma Society appreciates the review of this material by

Mallory Bowker, MSN, RN, OCN

Memorial Sloan Kettering Cancer Center
New York, NY

and

Devin Callan, MSN, RN, OCN

Memorial Sloan Kettering Cancer Center
New York, NY

This publication is designed to provide accurate and authoritative information. It is distributed as a public service by The Leukemia & Lymphoma Society (LLS), with the understanding that LLS is not engaged in rendering medical or other professional services.

Introduction

Blood cancer patients undergo many different types of medical tests. The test results help doctors diagnose, treat and manage blood cancers, as well as many other health conditions. Doctors may order blood and bone marrow tests, genetic tests, imaging studies, and heart and lung function tests.

The tests and the results may be used to

- Diagnose cancer
- Identify a cancer subtype (some cancers are classified into subtypes)
- Identify genetic mutations in cancer cells
- Stage the cancer (staging is the process of finding out how much cancer is in the body and where it is located.)
- Predict a patient's prognosis (the likely outcome or course of a disease)
- Plan treatment options
- Understand how the disease has affected a patient's overall health and major organs
- Understand how the disease affects other medical conditions (comorbidities) such as heart disease, kidney disease, diabetes or other illnesses. Comorbidities may affect the body's ability to fight infection, tolerate therapy or complicate therapy
- Monitor a patient's health during treatment
- Check for side effects of therapy or predict potential side effects
- Measure the patient's response to treatment either during and/or after therapy
- Determine if either more or different treatment is needed
- Test for a small number of cancer cells that may remain in the body after cancer treatment
- Determine whether the cancer has come back.

This booklet explains the various medical tests that blood cancer patients may undergo, how the tests work and what to expect. It also includes tips for keeping track of test results, questions to ask members of your healthcare team and information about how The Leukemia & Lymphoma Society (LLS) can help.

Part 1 provides general information about laboratory tests, imaging tests, preparing for tests and keeping track of test results. See page 3.

Part 2 describes different types of laboratory and imaging tests and includes information about normal blood cell counts.

The tests in **Part 2** are listed in alphabetical order, starting on page 10.



This symbol designates laboratory tests that are done by analyzing either a sample of blood, urine, bone marrow, spinal fluid or other tissue from your body.



This symbol designates imaging tests.



This symbol designates tests for which patients may have either sedation medication or anesthesia. Check with members of your healthcare team about driving after these procedures.

Part 3 provides a list of resources and a list of definitions of health terms that may be new to you. See page 47.

Visit www.LLS.org/booklets to view, print or order the free LLS booklets about leukemia, lymphoma, myeloma, myelodysplastic syndromes and myeloproliferative neoplasms. You can also view, print or order the free LLS booklet *Cancer and Your Finances* for help understanding and organizing the financial aspects of cancer care.

PART 1

About Laboratory Tests

A laboratory (lab) test uses a sample of blood, urine, or other tissues/fluids obtained from a patient's body. The sample is tested and the results provide information about a patient's health. Some of that information is used to diagnose specific health problems. Other, more general information, helps doctors to either identify or rule out possible health concerns.

Blood Tests. Doctors order blood tests to check the patient's general health and look for signs of disease. Blood tests can be done, along with other tests, to confirm a diagnosis of blood cancer and stage the disease. Blood tests may be repeated to check how well treatment is working. They can also be used to check for side effects and other health concerns (comorbidities).

There are three main types of blood cells. They are

- Red blood cells (RBCs). These cells carry oxygen throughout the body.

- White blood cells (WBCs). These cells help fight infections and cancer.
- Platelets (plts). These are fragments of cells that help control bleeding.

Blood cancers and certain treatments for blood cancers can affect blood cell counts. Blood cell counts may be either lower or higher than usual, depending on a number of factors. Be sure to talk with your doctor about your blood cell counts. If you are receiving cancer treatment, such as chemotherapy or radiation therapy, these treatments may affect your blood cell counts. Blood cell counts usually return to normal between treatment cycles or after treatment is completed.

A “blood draw” is a procedure in which a needle is used to withdraw blood from a vein. Blood may be drawn by a phlebotomist, a person trained to draw blood. When the needle is inserted, some people may feel moderate pain. Others may only feel a slight prick. Afterwards, there may be some throbbing or bruising. Some patients may feel dizzy either during or after the blood draw.

Some blood test results can be affected by certain foods and medications. For this reason, the doctor may tell you not to eat (fast) or drink for several hours before the test or to delay taking medications until after the test. The blood sample will then be sent to a laboratory for testing.

How to Interpret Laboratory Results. Laboratory results are typically shown as a set of numbers known as a “reference range.” A patient’s test results are considered normal if they fall between the lower and upper limits of the range.

The ranges that appear on a laboratory report are established and supplied by the laboratory that performed the test. When healthy people take such tests, it is expected that their results will fall within the normal range 95 percent of the time. Each laboratory has its own reference range for what is considered a normal value for laboratory tests, so it is important to know this range when looking at results. Laboratory processing equipment varies from one laboratory to another so that a normal reference range for one laboratory may not be the same as the reference range provided by another laboratory. As a rule, the normal ranges are printed on the laboratory report, next to the patient’s test results.

Sometimes healthy people get results that fall outside of the reference range, and sometimes people with health problems have results that fall within the normal range. If a patient’s results fall outside of the reference range, or if a patient is experiencing signs and/or symptoms despite normal results, more testing may be needed. The doctor should notify a patient if a laboratory result falls outside of the reference range and is either a matter of concern or requires further testing. If patients do not hear back after a laboratory test, they should always follow up and check with members of their healthcare team and confirm that their results fell within the normal reference range.

Factors That Can Affect Test Results. Many factors can affect the accuracy of laboratory test results. Some of these are

- Illness
- Medications
- Stress
- Food and beverages
- Vigorous exercise
- Variations in laboratory procedures
- Dehydration.

It is important for patients to obtain copies of their laboratory results so that they can compare their test results to the normal ranges. This information makes it easier for patients to ask doctors questions about the results and what they mean.

Biopsy. The removal of cells or tissues for examination is called a “biopsy.” There are different types of biopsies. Common biopsies for blood cancer patients include:

- **A bone marrow aspiration and biopsy.** Procedures (usually done at the same time) in which a small sample of liquid bone marrow and bone is removed. Most often, the bone marrow sample and biopsy are taken from the back of the hip bone using specialized hollow biopsy needles.
- **A spinal tap (lumbar puncture).** A procedure in which a thin biopsy needle is inserted between two lumbar vertebrae in the lower part of the spine to collect a sample of the cerebrospinal fluid from the spine for testing.
- **A lymph node biopsy.** A procedure in which a biopsy needle is inserted into a lymph node and either all or part of a lymph node is removed and tested.
- **A skin biopsy.** A procedure in which a small sample of skin is removed and tested.
- **A tissue biopsy.** A procedure in which a hollow biopsy needle is put into a body part or a mass and a sample of tissue is removed and tested.

Pathology. At the laboratory, a pathologist examines the sample. A “pathologist” is a doctor who identifies disease by examining a patient’s tissues, blood and other bodily fluids. For blood cancer patients, the pathologist should be a hematopathologist, a doctor who specializes in the diagnosis of blood disorders and blood cancers.

The hematopathologist looks at the blood or tissue sample under a microscope and examines the size of the cells, the shape of the cells, the type of cells and other features of the cells. This test is called a “cell assessment” or a

“morphological assessment.” After the cell assessment, the hematopathologist may perform additional, more specialized tests on the same sample, such as flow cytometry and molecular analysis.

Understanding a Pathology Report. All laboratory results are recorded in the pathology report. A pathology report is prepared each time a sample is removed from the body and tested. The report provides information that will be helpful when your doctor is making a diagnosis and planning your treatment. Usually, your doctor will receive the pathology report within 7 to 10 days after the biopsy. You should request a copy of the pathology report and review it with your doctor.

The pathology report is divided into several sections, including:

- **Patient Information.** This section includes the patient’s name, date of birth and other personal information. It also includes the date of the lab test and the unique number of the specimen (assigned by the laboratory).
- **Gross Description.** This section includes a description of what the the pathologist observes with the naked eye, and generally may not be very important to the patient. The description may include the color, weight, size, and/or consistency of the sample.
- **Microscopic Description.** This is the most technical section of the report. It describes what the cells look like when viewed under a microscope and how these cells compare with normal cells. Results of any other studies done, such as flow cytometry and molecular tests, may also be noted in the microscopic description, or they may be noted in a separate section.
- **Diagnosis.** The most important part of the pathology report is termed the “final diagnosis.” If the final diagnosis is cancer, the type of cancer will be noted.
- **Comment.** After the final diagnosis is determined, the pathologist may include other information that could be helpful for the members of the patient’s healthcare team. The comment section is also often used to clarify a concern or recommend further testing.

Second opinion. Some types of blood cancers can be difficult to classify, even for an expert. It may be helpful for another pathologist to review the samples (slides).

About Imaging Tests

Imaging or radiology tests create detailed images of areas inside of the body. The information provided by imaging tests may be used by doctors to diagnose disease, plan treatment, or find out how well treatment is working.

Examples of imaging tests include:

- X-rays
- Ultrasonography scans (using ultrasound)
- CT (computed tomography) scans
- MRI (magnetic resonance imaging) scans
- PET (positron emission tomography) scans.

Imaging tests are generally used to look for signs of disease, to better characterize the disease and/or to check to see if the disease has spread to other areas of the body, such as the lymph nodes, chest or lungs. If you are either pregnant or may be pregnant, it is important to tell your doctor right away. Some imaging tests use small amounts of radiation that can harm an unborn baby.

Results of imaging tests may not be available immediately. A radiologist needs to review the images so it may take several days before your doctor gets a report. The doctor who specializes in reading imaging tests is called a “radiologist.”

Questions to Ask Your Healthcare Provider Before Having Medical Tests

Asking questions to members of your medical team can help you understand why a certain test is being done. They can provide you with information that will help you take an active role in managing your own care. If you do not understand the answers or any part of this information, ask for it to be explained again—but in a different way. Bring a copy of the following questions with you to your healthcare appointment or have them on hand if you are speaking to a member of your healthcare team on the phone.

- Why is this test being done?
- How accurate is the test?
- How is the test done?
- How do I prepare for the test?
- Are there any potential side effects from the test?
- Is this test covered by my healthcare plan/insurance provider?

- Where will the test take place?
- How long will the test take?
- Will I be awake during the test?
- Will I feel pain?
- Will I be able to go back to work or to school after the test?
- Do I need someone to bring me home after the test?
- How do I contact you if I have questions before/after the test?
- How soon will I get the test results? Will you contact me?
- Will the test need to be repeated?

Visit www.LLS.org/WhatToAsk to print out other free question guides.

Preparing for Tests

Many people feel some stress or anxiety about having a test, waiting for test results and getting test results. Many people are uncomfortable having blood drawn, getting injections (shots) or being in an enclosed space (necessary for certain imaging tests). Make sure you discuss any such concerns with your doctor or mention them to the staff member when you schedule your appointment.

It is important to

- Ask questions so that you understand why a specific test is being ordered and what to expect (see page 7)
- Write down or record the answers to your questions.

It is also a good idea to bring a friend or family member with you to the doctor's office and/or the laboratory to help you understand and remember the information.

For more information about stress and ways to cope, visit www.LLS.org/booklets to view, print or order the free LLS booklet *Managing Stress: How stress affects you and ways to cope*.

Keeping Track of Test Results

Needing tests and waiting for test results can raise anxiety levels. Remember though, many of the tests described in this booklet are also used to identify and track other, more common conditions. No single test result provides all the answers. Most results need to be considered along with information from other reports, a physical examination and as part of your overall health status.

The following helpful tips can help you to get organized and manage your health:

- Ask your doctor why certain tests are being done and what to expect (see page 7).
- Discuss test results with members of your healthcare team. Understanding these results can help you to be an active partner in your care. Ask your nurse or doctor to review your test results and explain how they compare to the laboratory's normal reference ranges.
- Find out whether additional follow-up tests are needed and, if so, when they need to be completed. Sometimes, follow-up tests and appointments are required to make sure health problems are identified early and that a patient is responding to treatment. These appointments provide an opportunity to talk with your healthcare team about any health concerns or questions you may have.
- Depending on the type of test and why it has been ordered, you may want to bring someone with you to listen, help ask questions and take notes. He or she can also provide emotional support.
- Ask for and keep copies of laboratory reports from your healthcare providers. You might consider creating your own file folder or using a three-ring binder. Some people prefer to use online or mobile tracking tools. Choose the system that works best for you. You may want to organize your test results by the type of test. For example, one file could be for blood test results and another file for imaging test results. Be sure to organize test reports chronologically (by date) so that they are easy to find.

Setting up a folder or binder will help you

- Keep all of your test results and health information in one place
- Compile information from different doctor's offices
- Play an active (and more informed) role in your care
- Review and refer to reports when you talk with a member of your healthcare team
- Track trends or changes over time. For example, decreasing levels of vitamin B₁₂, iron or folate can play a role in anemia (low red blood cell production).

As you organize your health records, you will save time and feel more knowledgeable about your health.

Index of Tests

Tests used to detect or monitor blood cancers are listed on this page and page 11. A detailed description of each test and an explanation of why that test has been ordered and the meaning of the results (findings) follow in the section *The Tests: Details*, beginning on page 12.

Test	Page
Albumin	
See Blood chemistry (chemistry panels)	12
Beta₂-microglobulin (B₂M) tumor marker test	12
Blood chemistry (chemistry panels)	12
Blood smear (also called a peripheral blood smear , a manual differential)	14
Bone marrow aspiration and biopsy	14
Chest x-ray	17
Colonoscopy	17
Complete blood count (CBC)	18
Comprehensive metabolic panel	
See Blood chemistry (chemistry panels)	12
Computed tomography (CT) scan	21
Cytogenetic testing (including information about karyotypes)	23
Differential (diff)	
See Complete blood count (CBC)	18
Echocardiogram (echo)	24
Electrocardiogram (EKG or ECG)	25
Endoscopy	25
FISH (fluorescence in situ hybridization)	26
Flow cytometry	28

Test	Page
Hepatitis B testing	29
HIV (human immunodeficiency virus) testing	30
Human leukocyte antigen (HLA) testing	31
Immunophenotyping See Flow cytometry	28
Lactate dehydrogenase (LDH)	32
Lumbar puncture See Spinal tap	43
Lymph node biopsy	32
Magnetic resonance imaging (MRI)	33
Molecular testing/next-generation sequencing (NGS)	35
MUGA (multigated acquisition) scan	36
PET (positron emission tomography) scan	37
Protein electrophoresis	38
Pulmonary function tests	38
Quantitative polymerase chain reaction (qPCR)	39
Serum protein electrophoresis (SPEP) See Protein electrophoresis	38
Skin biopsy	41
Spinal tap (also called lumbar puncture)	43
Ultrasound (also called sonography)	45
Uric acid	46
Urinalysis	46
Urine protein electrophoresis (UPEP) See Protein electrophoresis	38
White blood cell differential See Complete blood count	18

The Tests: Details



Beta₂-microglobulin (B₂M) Tumor Marker Test

Why is this test done?

The beta₂-microglobulin tumor marker test measures the amount of a protein called “beta₂-microglobulin (B₂M)” in the blood, urine or cerebrospinal fluid. Beta₂-microglobulin is a small protein made by many types of cells in the body. Healthy people have small amounts of B₂M in their blood and urine, but people with some blood cancers have high levels of B₂M in their blood or urine.

A B₂M tumor marker test is not used to diagnose cancer. It can, however, provide important information about a patient’s cancer. The test may be used to

- Determine the severity of certain cancers
- Guide treatment
- Find out if cancer treatment is effective.

How is it done?

A B₂M test is usually a blood test, but it may also be tested through a urine test or, rarely, a spinal tap/lumbar puncture.

What do the results mean?

If the test is used for staging, the results may show how much cancer is in the body and whether it is likely to spread.

If the test is used to check the effectiveness of treatment, increasing levels of B₂M may mean that the cancer is spreading and/or the treatment is not working. If the B₂M levels are decreasing, it may mean that the treatment is working.



Blood chemistry (chemistry panels)

Why is the test done?

This test is often ordered as a comprehensive metabolic panel (CMP) which is a group of 14 blood tests that measure the levels of different chemicals in the blood. It can also be ordered as a basic metabolic profile (BMP) which tests for fewer chemicals. Each chemical can also be ordered individually for testing.



Lab Test



Imaging Test



Sedation or Anesthesia

These tests can provide information about a person's liver and kidneys, blood sugar, protein levels, cholesterol levels, electrolyte levels (for example, sodium or potassium) and fluid balance. These tests provide information about the body's chemistry and the way it uses energy.

Higher levels of certain proteins in the blood, including albumin, beta₂-microglobulin (B₂M), immunoglobulins (Igs) (IgM, IgG and others) and lactate dehydrogenase (LDH) can be signs of disease severity (for example, size and growth rate of tumors). Measures of uric acid levels and erythrocyte sedimentation rate (ESR) may also be important for your doctor to note. For example, certain diseases or treatments increase uric acid levels. Medications can be given to reduce high uric acid levels.

Other chemicals in the body that are measured include:

- Antibodies, including those we develop from our vaccinations (such as poliovirus antibodies)
- Hormones (such as thyroid hormone)
- Minerals (such as iron, calcium or potassium)
- Vitamins (such as B₁₂ or folate).

How is it done?

For a blood chemistry test, blood is drawn from a patient's vein and the blood is placed in an empty tube and usually allowed to clot. The fluid portion of the blood after clotting, called "serum," is then used for the various chemical studies. You may be asked to fast (not eat) or drink anything except water for up to 12 hours before the test. You should follow any additional special instructions given to you by members of your healthcare team.

What do the results mean?

The results will provide members of your healthcare team with information about your overall health and identify potential problems that may need treatment. Abnormal levels of these chemicals in the blood may be a sign that an organ is not working well. These abnormal levels may be caused by disease or they may be a side effect of treatment.



Lab Test



Imaging Test



Sedation or Anesthesia



Blood smear

(also called a **peripheral blood smear**, a **manual differential**)

Why is the test done?

A blood smear may be done when the results of a complete blood count (CBC) are either abnormal or unclear. It may also be ordered if the patient has signs and/or symptoms of a blood disorder or disease that may be disrupting normal cell production.

A blood smear is a sample of blood that is placed on a slide so that it can be viewed under a microscope. A pathologist examines the size, shape, type and maturity of red blood cells, white blood cells and platelets. This test helps determine whether red blood cells, white blood cells and platelets are normal in appearance and number. It is also used to determine the proportion of each type of white blood cell relative to the total white blood cell count.

How is it done?

A single drop of blood is spread on a glass slide, dried, and then stained with a special dye. The sample is then examined under the microscope. The pathologist will compare the size, shape, color, number and general appearance of the sampled cells to normal cells.

What do the results mean?

The results of a blood smear are either normal or abnormal. There are ranges for the number of red blood cells, white blood cells and platelets that the healthcare team can use to review your results. Also, cells are expected to appear a certain way. The presence of abnormal cells or abnormal numbers of cells in the sample may signal health problems which require further testing.



Bone marrow aspiration and biopsy

Why is the test done?

New red blood cells, platelets and most white blood cells are formed in the bone marrow, the spongy tissue that is found in the central cavity of certain bones. Blood stem cells are constantly dividing and changing into different types of blood cells, replacing older and worn-out blood cells. Bone marrow aspiration



Lab Test



Imaging Test



Sedation or Anesthesia

and biopsy are two tests that are done to evaluate how well the bone marrow is producing blood cells and to check for any signs of cancer in the bone marrow.

Bone marrow tests can provide information to

- Confirm a blood cancer diagnosis or a bone marrow disorder
- Determine the cause of severe anemia (low red blood cell count) or thrombocytopenia (low platelet count)
- Look for chromosome abnormalities (to assess risk and plan treatment)
- Stage the cancer, along with findings from other diagnostic tests
- Evaluate the appropriateness of certain medications, drugs or other treatments for a patient
- Help track a patient's response to treatment for certain blood cancers.

How is it done?

The bone marrow aspiration and biopsy samples are usually taken from the patient's hip bone. First, the patient's skin is numbed with a local anesthetic; then the local anesthetic is injected under the skin and into the tissues. Some patients are lightly sedated before the test (check with your doctor to find out whether sedation or premedications are given at your treatment center/hospital).

Bone marrow has both a solid and liquid part. For a bone marrow aspiration, a special hollow biopsy needle is inserted through the hip bone and into the marrow to remove (aspirate) a liquid sample containing cells. For a bone marrow biopsy, a specialized wider gauge biopsy needle is used so that a core sample of solid bone that contains marrow can be removed. The sample is typically small in size, approximately as big around as a pencil eraser and no more than a few centimeters long. These two tests are almost always done together. In most cases, the entire procedure takes 20 to 30 minutes. A dressing will be applied to the area after the procedure.

Some patients may experience slight bone pain, bruising or discomfort, either during or for a few days after the procedure. Other risks associated with this procedure include bleeding, a small risk of infection at the incision site and a small risk of nerve injury due to the location of the biopsy.



Lab Test

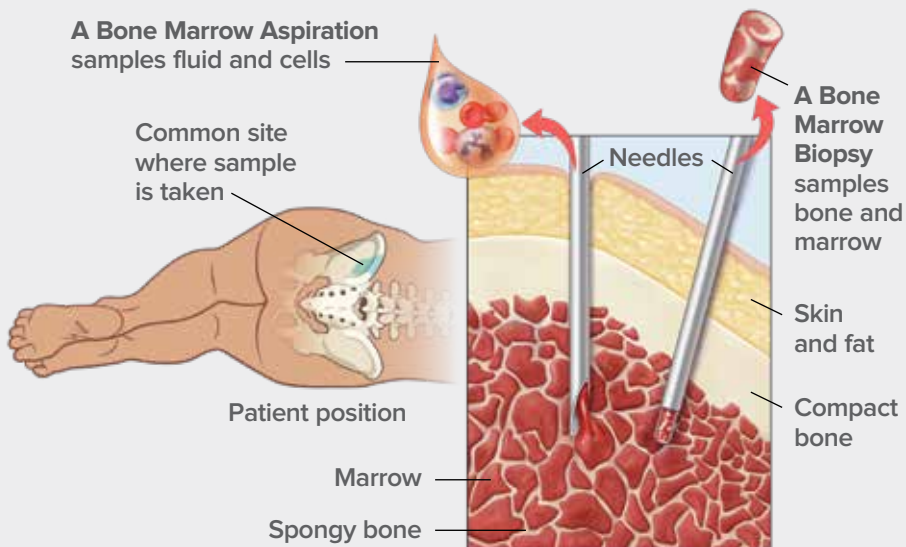


Imaging Test



Sedation or Anesthesia

Bone Marrow Aspiration and Biopsy



Left: The place on the back of the patient's pelvic bone where a bone marrow aspiration or biopsy is done. **Right:** Where one needle goes into bone marrow to get a liquid sample for aspiration and the other needle goes inside the bone for a bone biopsy. The needles are different sizes.

What do the results mean?

Both samples are examined under a microscope to look for the presence and number of any abnormal cells. If your bone marrow test results are positive for cancer cells, your doctor will explain to you what this means for your prognosis and treatment plan. The sample of cells can also be used for more specialized testing, including flow cytometry and molecular testing.

Results from the biopsies can help the doctor

- Provide information about the patient's immune system
- Confirm or rule out a diagnosis
- Determine how advanced a disease is
- Understand the presence and extent of cancer or other disease
- Evaluate whether treatment is working.



Lab Test



Imaging Test



Sedation or Anesthesia



Chest x-ray

Why is the test done?

A chest x-ray provides images of the chest, lungs, heart, large arteries, ribs and diaphragm. Radiologists check these images and look for signs of disease, including infection or tumors. An abnormal collection of fluid seen on an x-ray image might be a sign of infection or a tumor.

How is it done?

You will be asked to undress, put on a gown and remove all jewelry. You will be positioned in front of the machine. Usually two pictures are taken, one from the back of the chest and another from the side. You must hold your breath when the x-ray is taken to prevent movement of the body from distorting the x-ray image. The technician will give you detailed instructions.

Radiation from an x-ray can harm an unborn baby, so it is important to tell your doctor and the technician if you are (or think you may be) pregnant.

What do the results mean?

A chest x-ray can show evidence of an infection, such as pneumonia or tuberculosis, a tumor or enlarged lymph nodes that cannot be felt during a physical examination, as well as other signs of internal injury. If the findings on the chest x-ray film are abnormal, your doctor may ask you to get a more sensitive or detailed imaging test, such as a CT (computed tomography) scan or an MRI (magnetic resonance imaging) scan, to better view the chest.



Colonoscopy

Why is this test done?

Some blood cancers can develop in the colon or the large intestine. A colonoscopy is an examination of the entire length of the colon. During the test, special instruments are used to view the colon and remove (biopsy) suspicious-looking areas of tissue for examination.

How is this test done?

During a colonoscopy, the doctor, usually a gastroenterologist (a doctor who specializes in diagnosing and treating gastrointestinal [GI] disorders), inserts a



Lab Test



Imaging Test



Sedation or Anesthesia

thin, flexible tube called an “endoscope” through the rectum to the other end of the large intestine. The endoscope has a light, small camera and biopsy tool on the end allowing the doctor to visualize the lower GI tract.

For a colonoscopy, it is best if the colon is empty and clean so the doctor can view the entire inner lining of the colon. You will be given specific instructions by a member of your healthcare team or staff member at your radiology facility when you set up your appointment as there are different ways to prepare for the test. Instructions may include a special diet, laxatives, enemas and/or antibiotics.

To keep you comfortable and calm during the examination, you may be lightly sedated. You will need someone to bring you home after the test. For most people, the sedation makes them unable to remember the procedure afterwards.

During the test, you will be asked to lie on your side with your knees pulled up. The endoscope is lubricated so it can be inserted easily into the rectum. If the doctor sees suspicious tissue, it may be removed (biopsied) and sent to the laboratory for examination.

What do the results mean?

Biopsy results can help doctors to diagnose or rule out cancer and other conditions.



Complete blood count (CBC)

Why is the test done?

A complete blood count is a very common test that tells your healthcare team about the cells in your blood. Your doctor may order a CBC on a regular basis to monitor your condition or to track your response to treatment. A CBC measures

- The number of red blood cells (RBCs)
- The number of white blood cells (WBCs)
- The total amount of hemoglobin (Hgb) in your blood (Hgb is a protein inside red blood cells that carries oxygen.)
- Hematocrit (Hct), the amount of your blood that is made up of red blood cells
- The number of platelets.



Lab Test



Imaging Test



Sedation or Anesthesia

The doctor's order (request) for a CBC usually includes an order for a differential (diff) that measures the different types of white blood cells in the sample. These are

- Neutrophils and monocytes. These are cells called “phagocytes.” They ingest and destroy bacteria and fungi. Unlike red blood cells and platelets, monocytes can leave the bloodstream and enter tissues to attack invading organisms and fight off infection.
- Eosinophils and basophils. These are the white blood cells (WBCs) that respond to allergens or parasites.
- Lymphocytes. These WBCs are found mostly in the lymph nodes, spleen and lymphatic channels, key parts of the immune system. Some lymphocytes enter the bloodstream. There are three major types of lymphocytes. They are
 - T lymphocytes (T cells)
 - B lymphocytes (B cells)
 - Natural killer cells (NK cells).

How is it done?

A sample of blood is withdrawn from a vein. The blood is placed in a tube containing an anticoagulant (to prevent the blood from clotting) and sent to a laboratory.

What do the results mean?

Blood counts should fall within an established reference range for normal, healthy men and women. Nearly all laboratory reports make it easier to understand test results by including a normal range or high and low values. Your cell count is compared to those of healthy individuals of similar age and sex. If a cell count is either higher or lower than normal, your doctor will try to determine the reason(s). For example, low hemoglobin or hematocrit values or a low red blood cell count are all signs of anemia.

Anemia may account for changes in your energy levels or an inability to carry out everyday tasks. Low red blood cell counts may also be due to a vitamin deficiency (for example, not getting enough folic acid and/or vitamin B₁₂). High white blood cell counts may indicate a bacterial infection. A very low white blood cell count may mean a person is at increased risk for infection. If the platelet count is very low, a person may bleed or bruise more easily. A high platelet count may place the person at increased risk of blood clots or stroke.



Lab Test



Imaging Test



Sedation or Anesthesia

Your doctor may use the following terms to explain the test results:

- Cytopenia (pancytopenia). A lower-than-normal number of all types of blood cells
- Anemia. A lower-than-normal number of red blood cells
- Leukopenia. A lower-than-normal number of leukocytes (a type of white blood cell)
- Neutropenia. A lower-than-normal number of neutrophils (a type of white blood cell)
- Thrombocytopenia. A lower-than-normal number of platelets.

What Are Normal Blood Cell Counts?

Blood Cell Counts				
Red Blood Cells (per microliter [μ L] of blood)	White Blood Cells (per microliter [μ L] of blood)	Platelets (per microliter [μ L] of blood)	Hematocrit (% of blood composed of red blood cells)	Hemoglobin (substance in red blood cells that carries oxygen) (grams per deciliter [g/dL])
Men				
4.7-6.1 million	5,000-10,000	150,000-400,000	42%-52%	14-18
Women (who are not pregnant)				
4.2-5.4 million	4,500-11,000	150,000-400,000	37%-47%	12-16
Children*				
4.0-5.5 million	5,000-10,000	150,000-400,000	32%-44%	9.5-15.5

*These ranges are for children from infancy to adolescence, so be sure to speak with your doctor to find out specific values for infants and young children.

Note: The ratio of hematocrit to hemoglobin is about 3 to 1.



Lab Test



Imaging Test



Sedation or Anesthesia

A white blood cell differential provides information that doctors can use to look for diseases that affect the white blood cells, such as blood cancers.

White Blood Cell (WBC) Differential

Type of White Blood Cell Measured	The percentage (%) of these cells in the blood
Neutrophils	55-70
Band neutrophils	0-3
Lymphocytes*	20-40
Monocytes	2-8
Eosinophils	1-4
Basophils	0.5-1

*Until children are over 4 years of age, they have a higher percentage of lymphocytes in their blood than adults.



Computed tomography (CT) scan

Why is the test done?

A computed tomography (CT) scan is a type of imaging test that uses x-rays to make many detailed images of the inside of the body. A computer combines all the images into a single picture. A CT scan of the chest, abdomen and/or pelvis (the area of the body below the abdomen that contains the hip bones, bladder and rectum) can help the doctor detect enlarged lymph nodes or abnormalities in body parts such as the liver, pancreas, lungs, bones and spleen. A CT scan of the head may be needed if a patient has signs and/or symptoms indicating that disease may have spread to the brain and spinal cord.

How is it done?

You will be asked to undress, put on a gown and remove any jewelry or metal objects. The technician or nurse may place a peripheral intravenous (IV) line in your arm so you can be given any medications you may need for the procedure. The technician or nurse will then take you to the examination room and position you (usually flat on your back) on the CT examination table. The table is connected to a doughnut-shaped machine, which is the scanner. The



Lab Test



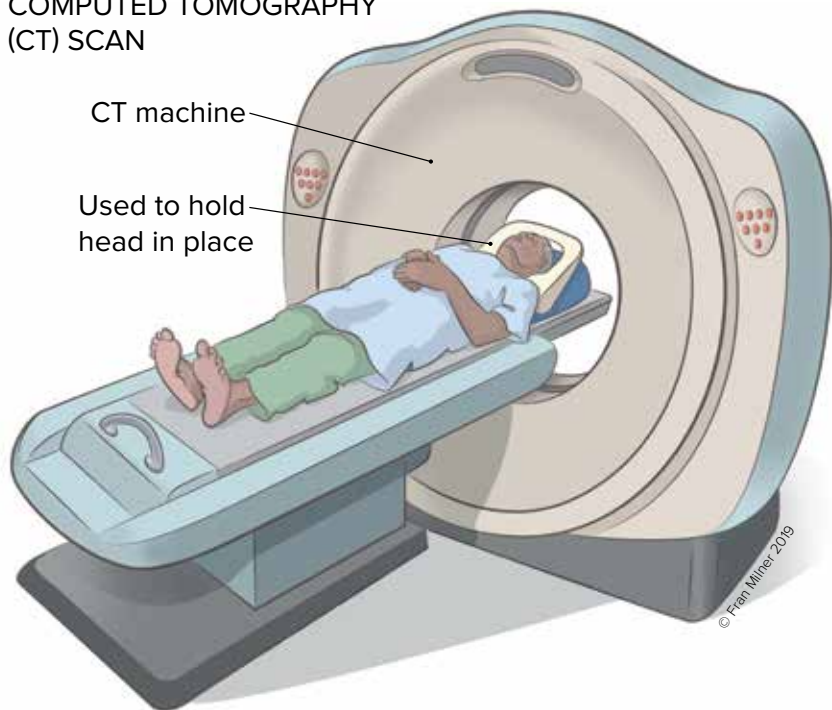
Imaging Test



Sedation or Anesthesia

table slowly passes through the center of the CT machine. With some types of CT scanners, the table stays still, and the machine moves around the person. At times during a CT procedure, you may be asked to hold your breath because movement can cause blurring of the images.

COMPUTED TOMOGRAPHY (CT) SCAN



In some cases, you may be asked not to eat (fast) or drink for several hours before the examination. If this examination is for the abdominal area, laxatives, enemas or suppositories, or a temporary change in what you eat and drink may be prescribed to cleanse the bowel before the scan.

For certain CT tests, a special dye (a contrast medium) is used to highlight specific areas inside the body, resulting in clearer pictures. You may drink the contrast dye or it may be injected into an IV line. When the contrast medium is injected, some patients will experience a warm flushing sensation travelling across their bodies. In very rare cases, the contrast agents can cause allergic reactions. Some people experience mild itching or hives (small bumps on the skin). Symptoms of a more serious allergic reaction include shortness of



Lab Test



Imaging Test



Sedation or Anesthesia

breath and swelling of the throat or other parts of the body. You should tell the technician or nurse immediately if you experience any of these symptoms so that you can be treated promptly.

Computed tomography scans should not cause any pain. For some people, however, lying in one position during the procedure may be slightly uncomfortable. The CT procedure can last from a few minutes up to half an hour. For most people, the CT is performed on an outpatient basis at a hospital or a radiology center.

What do the results mean?

A CT scan may reveal masses (tumors), injuries or abnormalities in the body. The test may be repeated over time so that doctors can see how a tumor is changing. This may indicate a response to therapy. Scans may also be used to detect any return of the cancer after treatment is completed.



Cytogenetic Testing (including information about **karyotypes**)

Why is the test done?

Cytogenetic testing examines the chromosomes inside of cells under a microscope. This type of test is used to look for abnormal changes in the chromosomes of cancer cells. Certain chromosome changes in cancer cells can affect prognosis, treatment options and prognosis. The test may also be repeated to check treatment results.

How is it done?

Normal human cells contain 46 human chromosomes in 23 pairs (including sex chromosomes), each of which are a certain size, shape and structure. In some cases, the chromosomes of cancer cells have abnormal changes that can be seen under a microscope. Cytogenetic testing is done using either a bone marrow or blood sample. The cancer cells in the sample are allowed to grow in the laboratory and then are stained prior to examination. The stained sample is examined under a microscope and then photographed to show the arrangement of the chromosomes. The arrangement of chromosomes is called a “karyotype.” The karyotype will show any abnormal changes in the size, shape, structure or number of chromosomes in the cancer cells.

What do the results mean?

Chromosome abnormalities can contribute to the development of cancer either by damaging or removing genes that regulate cell growth or by adding genes



Lab Test



Imaging Test



Sedation or Anesthesia

that fuel abnormal cell growth. There are many types of chromosome defects. Part of a chromosome, or a whole chromosome, may either be missing or there may be an extra copy of a chromosome. Sometimes, parts of chromosomes break off and switch places with each other. This is called a “translocation.”

Cytogenetic analysis provides information that is important when determining a patient’s treatment options and prognosis. This information can predict how the disease will respond to therapy.



Echocardiogram (echo)

Why is this test done?

An echocardiogram is a procedure that is used to check how well your heart is working. It is an imaging test that uses high-frequency sound waves (ultrasound) to display pictures of your heart, including different chambers and valves. An echo shows the heart while it is beating and pumping blood.

Some cancer treatments can damage the heart. To plan treatment, the doctor may order an echo to determine if your heart is strong enough to endure some treatments. If it is not working well, the doctor may plan a different treatment.

How is it done?

During this test, you will be lying down. A sonographer conducts the test, but a cardiologist (a heart doctor), interprets the results. The sonographer slides a probe with gel on it across your bare chest. The probe releases high-frequency sound waves and picks up the echoes of sound waves which the echocardiography machine converts into a moving picture of the heart.

What do the results mean?

The echo results will show if your heart is pumping strongly enough to tolerate certain treatments. This information will help the doctor to decide on the most appropriate type of treatment for you.



Lab Test



Imaging Test



Sedation or Anesthesia



Electrocardiogram (EKG or ECG)

Why is this test done?

This test shows the electrical activity of the heart. It can allow doctors to know if certain areas of the heart may not be getting enough blood or if there are areas that are injured. It also allows doctors to monitor how fast or slow the heart is beating along with the heart rhythm, or whether all heart chambers are beating like they should.

How is it done?

This test may be performed by a nurse or radiology technician. Small sensors are placed on specified areas of the chest around the heart, and on arms and legs. It takes only a few seconds to actually run the test, most of the time is taken setting up the sensors. Clothes and undergarments may be removed.

What do the results mean?

The EKG results give doctors pieces of information, like whether you have a normal heart rate and rhythm, if you have had a heart attack, or if there are any structural abnormalities (like with your heart valves) that can help them determine if you can tolerate certain treatments and medications. If abnormalities are found, additional tests may be ordered to provide more information.



Endoscopy

Why is this test done?

Some blood cancers affect the gastrointestinal (GI) tract. The gastrointestinal tract is a group of organs through which food passes after it is eaten. These organs include the mouth, throat, esophagus, stomach, small intestine, large intestine, rectum and anus. The GI tract is part of the digestive system. Endoscopy is a procedure that allows the doctor to examine the upper GI tract, including the esophagus, stomach and the beginning of the small intestine.

How is it done?

An endoscopy is done with an instrument called an “endoscope.” The endoscope is a thin, long tube with a camera lens, very small light, and



Lab Test



Imaging Test



Sedation or Anesthesia

biopsy tool at one end of it. At the other end, there is an eyepiece through which the doctor can see the images shown by the camera. If the doctor finds any lesions, they may be removed (biopsied) and sent to the laboratory for further examination.

What do the results mean?

The biopsy results may confirm or rule out disease or other abnormalities. For patients diagnosed with cancer, your doctor may order a second endoscopy so that he or she can assess how well your treatment is working.



FISH (fluorescence in situ hybridization)

Why is this test done?

Cancer is a disease that is caused by abnormal changes (mutations) in the DNA (deoxyribonucleic acid) of one cell or a small group of cells. Each cancer is characterized by a unique set of changes in the DNA of the cancer cells. Technological developments have made it possible to detect these changes.

A highly sensitive laboratory test, FISH, is used to check for changes to genes and chromosomes in cells and tissues. Information from this test helps doctors to diagnose diseases such as cancer and helps them to develop individualized treatment plans. This test provides doctors with more information than the information that they get from looking at single cells under a microscope.

If cytogenetic abnormalities are detected, your doctor may use this test to monitor you for residual disease and to see if the treatment is working. This is done by measuring the number of cells with abnormal chromosomes that remain following treatment.

How is it done?

Cells and/or tissue are taken from blood or bone marrow. In the laboratory, a dye is added to cells or tissues on a glass slide. This dye attaches to certain parts of the DNA and glows when viewed under a microscope that has a special light.



Lab Test

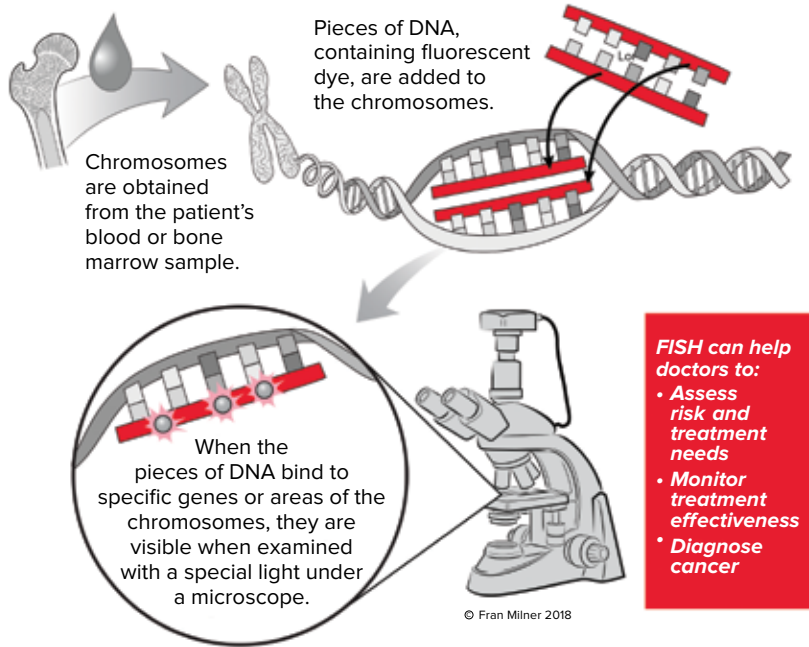


Imaging Test



Sedation or Anesthesia

Fluorescence in situ Hybridization (FISH)



What do the results mean?

Fluorescence in situ hybridization testing helps provide more information about genetic abnormalities specific to your cancer. This information can be used to help your doctor to diagnose your cancer and its subtype and provide a prognosis. This information can also be helpful when your doctor is selecting treatment options. After treatment, FISH can be used to monitor for minimal residual disease, a very small number of cancer cells that may remain in the body during or after treatment. Detecting minimal residual disease allows doctors to determine which patients need additional treatment and which patients do not.

For more information about minimal residual disease (MRD), visit www.LLS.org/booklets to view, print or order the free LLS booklet *Minimal Residual Disease (MRD)*.



Lab Test



Imaging Test



Sedation or Anesthesia



Flow cytometry

Why is this test done?

Flow cytometry can identify the type of cells in a biopsy sample, including the types of cancer cells. It detects types of cancer cells based on either the presence or the absence of certain protein markers (antigens) on a cell's surface. The most common use of flow cytometry is in the identification of markers on cells, particularly in the immune system (called immunophenotyping). The cells are stained with a light-sensitive dye, placed in a fluid stream and passed through a laser or some other type of light. The measurements are based on how the light-sensitive dye reacts to the light. The measurements provide information that doctors can use to diagnose and classify certain blood cancers.

How is it done?

A sample of cells from the blood or a bone marrow biopsy is treated with special antibodies created in the laboratory. Each antibody only sticks to certain types of cells that have the antigens that fit with it. The cells are then passed through a laser beam. If the cells have the antibodies attached to them, they will give off light that is then measured and analyzed by a computer.

What do the results mean?

Flow cytometry can provide information that is used to diagnose, stage and monitor blood cancers including leukemia, lymphoma, myelodysplastic syndromes, myeloma and myeloproliferative disorders. It can also be used to test for minimal residual disease (MRD), the number of cancer cells remaining in the body after treatment. Detecting MRD helps doctors to determine which patients need additional treatment and which patients do not. Evaluating for MRD in your blood may also help your doctor to decide how to monitor your disease and how to follow you after your treatment is complete.

For more information about minimal residual disease (MRD), visit www.LLS.org/booklets to view, print or order the free LLS booklet *Minimal Residual Disease (MRD)*.



Lab Test



Imaging Test



Sedation or Anesthesia



Hepatitis B testing

Why is this test done?

Your liver is the largest organ inside your body. It helps your body digest food, store energy and break down waste products in your blood. Hepatitis B is a serious liver infection caused by the hepatitis B virus. The virus is usually spread through contact with an infected person's blood, semen or other body fluids and you may not even know you have been exposed to it.

If you have ever had hepatitis B, some cancers and certain cancer treatments may cause the inactive hepatitis B virus in your body to become active again. This is referred to as "reactivation" of the virus. It can lead to serious liver problems and complicate cancer treatment.

Talk with your doctor about whether you need hepatitis B testing given your health, history, and risk factors for hepatitis B infection and your cancer treatment plan. Your doctor may test you for hepatitis B before you begin treatment, even if you do not have any signs and/or symptoms of hepatitis B infection.

How is it done?

A blood sample is drawn from a vein in your arm.

What do the results mean?

If your test results are positive for hepatitis B, you may need to be treated with antiviral therapy to avoid hepatitis B reactivation before you can receive certain cancer treatments. Patients who need antiviral medication may also need to take it during cancer treatment and for 6 months to 1 year after cancer treatment has ended. Additionally, patients receiving antiviral medication may need to see a hepatologist, a doctor who specializes in the diagnosis and treatment of diseases of the liver, gallbladder, and pancreas. (Hepar means liver.)



Lab Test



Imaging Test



Sedation or Anesthesia



HIV (human immunodeficiency virus) testing

Why is this test done?

Human immunodeficiency virus (HIV) can attack and weaken the immune system by destroying white blood cells that fight infection. As the immune system weakens, a person is at risk of getting life-threatening infections and certain cancers. When this occurs, the illness is called “AIDS (acquired immunodeficiency syndrome).” It is the final stage of infection with HIV. Not everyone with HIV will develop AIDS.

Human immunodeficiency virus most often spreads through unprotected sex with a person who has HIV. It may also spread by sharing needles or through contact with the blood of a person who has HIV. The human body cannot get rid of HIV completely (unlike some other viruses), even with treatment. So, once you are infected with HIV, you have it for life.

For patients who have HIV and cancer, taking HIV medications will improve how well the cancer treatment works. Since some people are unaware that they are infected with HIV, it is important for cancer patients to get tested.

How is it done?

Most HIV tests are antibody tests. Your immune system produces antibodies when you are exposed to bacteria or viruses such as HIV. An HIV antibody test looks for antibodies to the HIV virus. The most common antibody tests use samples from

- Blood. This sample is obtained by drawing blood from a vein or from a finger stick.
- Oral fluid. This sample is obtained by swabbing inside of the cheeks or on the gums. Testing checks for antibodies in the cells of the mouth. This test is less accurate than a blood test.

After becoming infected, it can take from 3 to 12 weeks for the body to produce enough HIV antibodies for the antibody test to detect them. Ask your doctor if you will need a follow-up test to confirm your results.

What do the results mean?

If the test results indicate that you are HIV positive, it is very important that you receive antiretroviral treatment during and after your cancer treatments. Antiretroviral treatment can effectively control the HIV virus in most patients. Better control of the HIV infection decreases the side effects of many of the cancer treatments and can improve your chance of recovery from cancer.



Lab Test



Imaging Test



Sedation or Anesthesia



Human leukocyte antigen (HLA) testing

Why is this test done?

Human leukocyte antigen (HLA) is a protein that is found on the surface of almost all cells in the body. The antigens make up a person's tissue type. They vary from person to person. The immune system uses these markers to identify which cells belong in the body and which cells do not.

Human leukocyte antigen typing is a blood test that identifies a person's HLA type. Human leukocyte antigen testing is done before a patient undergoes allogeneic stem cell transplantation (a treatment option for some blood cancer patients). The test can identify a donor who is an HLA match for the person who will receive the transplant. A close HLA match is important because it improves the chances for a successful transplantation. It is an important test for some newly diagnosed blood cancer patients if an allogeneic stem cell transplantation is being considered as a treatment option.

How is it done?

Both the patient and any potential donor are tested to see if they are an HLA match. A blood test or a cheek swab is required for HLA typing.

Blood samples or cheek swabs are obtained from you and your family members. The samples will be tested and typed. An HLA match is most likely to be found among siblings who have the same mother and father. You have a 1 in 4 chance (25%) of inheriting the same HLA markers as a sibling. If you do not have a family member who is a match, your doctor will begin the search for an unrelated donor.

What do the results mean?

There are many HLA markers but HLA typing is usually based on 8 or 10 HLA markers. When two people share the same HLA markers, they are considered to be a good match. The more markers that two people share, the better the match. In many transplant centers, doctors may require at least 6 or 7 matching markers in order to perform the transplantation. Some centers will perform transplants with family members that are half matches or "haploidentical."



Lab Test



Imaging Test



Sedation or Anesthesia



Lactate dehydrogenase (LDH)

Why is this test done?

Lactate dehydrogenase (LDH) is a protein that is in most cells. When a cell is damaged, it releases LDH into the blood. Usually, there is very little LDH in the blood. Elevated LDH levels in the blood may be a sign of tissue damage and some types of cancer or other diseases.

How is it done?

A blood sample is drawn from a vein in your arm.

What do the results mean? The LDH level is not used to diagnose cancer, but it can be used to monitor your condition and determine how well your treatment is working. Lactate dehydrogenase levels that drop during cancer treatment may indicate that the cancer is responding to the treatment.



Lymph node biopsy

Why is the test done?

This is a test in which either all or part of a lymph node is removed and examined under a microscope to see if there are signs of infection or disease such as cancer. A pathologist or hematopathologist examines the lymph node tissue to determine if there are abnormalities and to determine the type(s) of cells present in the sample.

How is it done?

There are several types of lymph node biopsies, including:

- Excisional biopsy. The removal of the entire lymph node
- Incisional biopsy. The removal of part of a lymph node
- Core needle biopsy. The removal of tissue from a lymph node using a wide gauge biopsy needle
- Fine needle aspiration biopsy. The removal of tissue from a lymph node using a thin biopsy needle.

The doctor will decide on the best type of biopsy, based on the location and



Lab Test



Imaging Test



Sedation or Anesthesia

size of the lymph node. For excisional and incisional biopsies, you may be given general anesthesia or the area around the biopsy site will be numbed. A small cut in the skin will be made to access the lymph node, and either the lymph node or a sample of the lymph node will be removed.

Core needle biopsy and a fine needle aspiration biopsy remove very small samples of tissue with hollow biopsy needles. Local anesthesia is used to numb the area around the biopsy site or general anesthesia is used. Once the area is numb, the needle will be inserted into the lymph node and the cells will be removed. The sample will be checked to make sure there is enough tissue. If there is enough tissue, the needle will be removed. If there is not enough, another sample will be taken.

What do the results mean?

The examination of the tissue may show cancerous or noncancerous cells, or the presence of infection. The information the biopsy provides can also determine how aggressive your cancer is, based on how the cells look under a microscope. It might take a few days for your doctor to get the pathology report and see the results.



Magnetic resonance imaging (MRI)

Why is the test done?

A magnetic resonance imaging (MRI) scan is an imaging test that uses radio waves and powerful magnets to create detailed images of the inside of the body. An MRI does not use x-rays or other forms of radiation. Magnetic resonance imaging scans create clear pictures of internal organs, soft tissues, blood vessels, bones and bone marrow. The scans can also create images of the brain and spinal cord.

How is it done?

Before you have an MRI scan, you will be asked to remove any metal objects, including jewelry. Let the doctor know if you have any metal objects inside your body (for example, artificial joints, stents, or pacemakers).

An MRI scan may be done either with or without contrast dye. You may have to swallow the contrast medium, or it may be given through a peripheral (IV) line that has been placed in your arm or hand. The contrast medium used for an MRI examination is not the same as the contrast dye used in CT (computed



Lab Test



Imaging Test



Sedation or Anesthesia

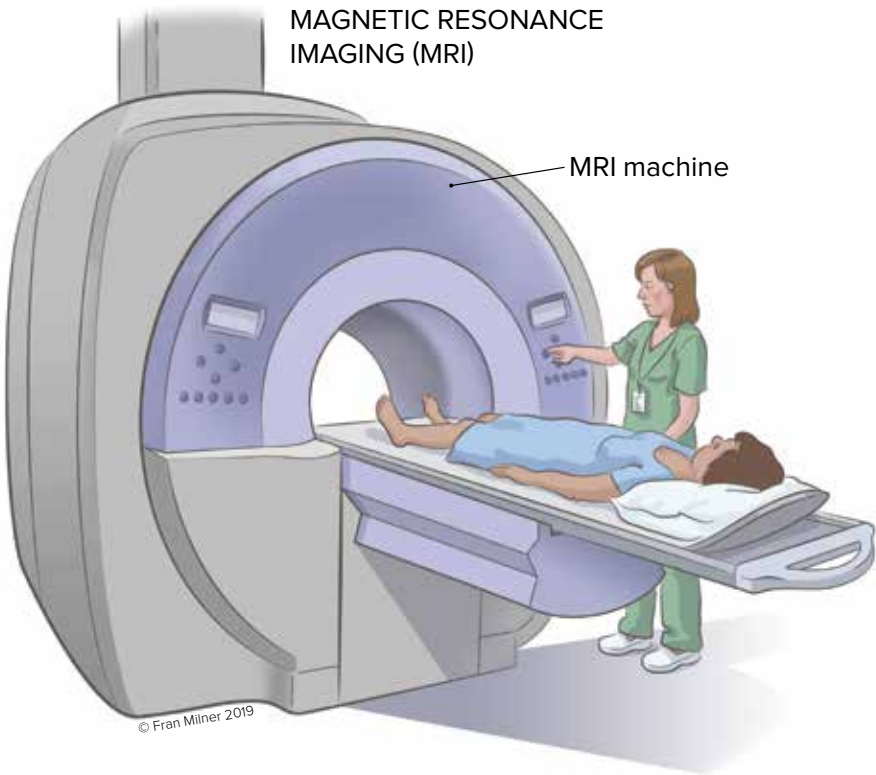
tomography) scans. If you have ever had a reaction to contrast dye, let your doctor or the technician know.

In the examination room you will lie on a table. This table slides into the MRI machine. It is shaped like a tunnel so patients who have a problem being in small, enclosed spaces, should discuss this concern with their doctor and/or the radiology technologist before the scan. Sometimes talking with the radiology technologist or a patient counselor before the scheduled test can help.

The radiology technologist will position you in the machine. Multiple images will be created, and you will hear a series of loud knocking sounds. You may be given earplugs or headphones with music to block noise out during the scan. The MRI usually takes from 15 to 45 minutes, depending on the area being scanned.

What do the results mean?

Images can reveal abnormalities inside the body that may be tumors or infection involving blood vessels, organs, soft tissues or bones. It also allows doctors to gain detailed images which may be used to plan treatment, especially before surgery or radiation treatments.



Lab Test



Imaging Test



Sedation or Anesthesia



Molecular testing/next-generation sequencing (NGS)

Why is this test done?

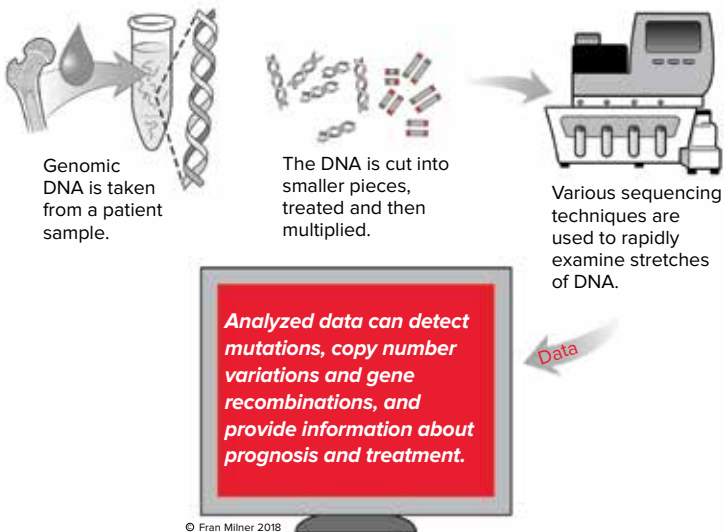
Cancer is a disease that is caused by abnormal changes (mutations) in the DNA (deoxyribonucleic acid) of one cell or a small group of cells. Each cancer has a unique set of changes in the DNA of the cancer cells. Technological advances allow doctors to examine the DNA and genes of your cancer cells for these changes.

Next-generation sequencing is a laboratory test that is used to look for mutations and other critical changes in the genes of cancer cells. The combination of mutations is called a “molecular profile.” Doctors can use information about the cancer cells’ genetic changes to decide whether one treatment may work better than another for you.

How is it done?

A sample of tissue, blood, or other body fluid is taken. Two DNA samples from the patient are sequenced and compared: DNA from the cancer cells and DNA from normal, healthy cells. Comparing the cancer cell’s genome to the genome of a healthy cell ensures that the mutations detected are specific to the cancer cells. Laboratory technicians use special machines to test the DNA found in these specimens.

Next-Generation Sequencing (NGS)



Lab Test



Imaging Test



Sedation or Anesthesia

What do the results mean?

Next-generation sequencing provides important information about genetic mutations in cancer cells. This information allows doctors to create more individualized treatment plans.

Next-generation sequencing can also be an important tool in detecting cancer cells after treatment. For certain cancers, the blood and bone marrow may be checked for any remaining cancer cells once treatment is completed. Next-generation sequencing can detect one cancer cell in 1 million cells checked.



MUGA (multigated acquisition) scan

Why is this test done?

The MUGA scan is a highly accurate test used to determine how well the heart is pumping blood. Some cancer therapies can damage the heart. The doctor may test how well a patient's heart is working and obtain a baseline of the patient's cardiac function in order to be sure that the heart is healthy enough before treatment starts. The baseline can be compared to scans taken during treatment to measure how treatments may be affecting the heart's functioning.

How is it done?

For this test, a technician will attach electrodes to the skin on your chest to track your heartbeat. Then a small amount of a radioactive tracer is injected into a vein. The tracer attaches to red blood cells and passes through the heart. A special camera that can detect the cells with the attached tracer is used to take pictures of your heart.

What do the results mean?

The results will show if your heart is pumping strongly enough to tolerate certain treatments. This will help the doctor to decide on the most appropriate type of treatment for you.



Lab Test



Imaging Test



Sedation or Anesthesia



PET (positron emission tomography) scan

Why is this test done?

A positron emission tomography (PET) scan is a type of imaging test that uses a radioactive substance called a “tracer” to look for cancer cells in the body.

How is it done?

Before a PET scan, a radioactive tracer (the most commonly used is called “FDG [fluorodeoxyglucose]”) is injected into the bloodstream through a vein using an IV line placed in your arm or hand. This tracer is attracted to areas of the body that absorb high amounts of sugar. It takes about 60 minutes for the tracer to travel through the body and be absorbed. You will stay in a special room during this time to limit the radioactive exposure to others. The technician will then help position you on the examination table and the imaging will begin.

A PET scanner is similar to a CT (computed tomography) scanner. It is a large doughnut-shaped machine with a round hole in the middle. The PET scanner detects signals from the tracer. A computer changes these signals into images that show areas in the body where large amounts of sugar are being used. Sugar is used as a source of energy in the body. Cancer cells also use sugar for energy. In the images, the cancer cells appear brighter than the normal cells because they use sugar more quickly.

You will need to remain very still during the test. Once the scan is over, you may be asked to wait until the technician has checked the images and made sure that no additional images are needed. This test is painless. You may feel a cold sensation move up your arm when the radioactive tracer is injected into your arm, but, generally, there are no side effects. The amount of exposure to radiation is small.

Before the test, you usually have to fast (not eat) to make sure that your blood sugar level is not high. You will be able to drink water but no other beverages. You should not participate in any strenuous activity that requires a lot of energy. If you have either type 1 or type 2 diabetes, it is important to discuss your medications and the timing of your scan with your doctor.

What do the results mean?

This test can help identify areas of the body in which there is cancer. This will help doctors understand the diagnosis and select the best treatment approach. This test can also be used to check how well cancer is responding to treatment, either during treatment or after treatment is completed.



Lab Test



Imaging Test



Sedation or Anesthesia



Protein electrophoresis

Why is the test done?

Protein electrophoresis may be ordered to help in the diagnosis of a disease or to monitor treatment. Serum protein electrophoresis (SPEP) and urine protein electrophoresis (UPEP) are tests used to measure specific antibodies (proteins) in the blood and urine. Some antibodies commonly tested for include immunoglobulin (Ig) G, IgA, IgM, IgE, or IgD. If there is disease present, these antibodies sometimes show up in the urine or blood.

How is it done?

For an SPEP test, blood is drawn from a patient's vein and placed in an empty tube. For a UPEP test, a 24-hour urine collection is used. You may be asked not to eat (to fast) or drink for 12 hours before your test. Your healthcare provider may ask you to stop taking drugs that could affect the test. Do not stop taking any medications without first talking to your healthcare provider. The sample is subjected to protein electrophoresis to separate the proteins into several groups, based on their size and electrical charge.

What do the results mean?

Protein electrophoresis tests give your doctor rough estimates of the number of proteins that are present in the blood and urine. These tests may also tell your doctor if any abnormal proteins are present.



Pulmonary function tests

Why is this test done?

Pulmonary function tests are a group of tests that measure how well the lungs are working. They measure how much air the lungs can hold and how quickly air is moved into and out of the lungs.

Some cancer treatments can damage the lungs. Pulmonary function tests may be given to

- Ensure that the lungs are healthy enough for certain treatments



Lab Test



Imaging Test



Sedation or Anesthesia

- Obtain a baseline before treatment starts that can be compared with other tests taken later during treatment
- Measure how certain treatments may be affecting the lungs.

How is this test done?

Pulmonary function tests are usually done by a trained respiratory therapist. These tests may include:

- Spirometry. During a spirometry test, you will breathe into a tube attached to a machine called a “spirometer.” The spirometer measures the amount of air you breathe in and out and the speed of your breathing (respiratory rate).
- Lung diffusion test. This test measures how well oxygen moves from the lungs to the blood and how well carbon dioxide moves from the blood to the lungs. The respiratory therapist may have you breathe in (inhale) a harmless gas. The therapist will then measure how much you breathe out (exhale). The therapist can then test the exhaled gas and measure how much of the gas was absorbed during the breath that you took. This shows how much oxygen traveled from your lungs into your blood.
- Body plethysmography. This test measures how much air is in your lungs after you take in a deep breath. It also measures the amount of air left in your lungs after you exhale as much as you can. During this test, you will sit in an enclosed area and breathe through a mouthpiece.

What do the results mean?

The test helps determine whether your lungs are strong enough for certain treatments. If your lungs are not working well with the treatment you are getting, your doctor may order a different treatment.



Quantitative polymerase chain reaction (qPCR)

Why is the test done?

A quantitative polymerase chain reaction (qPCR) is a very sensitive test that can be used to look for gene mutations in cells, information that may help your doctor to diagnose a disease such as cancer. A qPCR test can also be useful after treatment to see if any cancer cells are still present in the blood or bone marrow.



Lab Test



Imaging Test

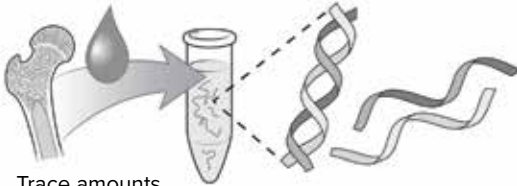


Sedation or Anesthesia

How is it done?

A qPCR test identifies cancer cells based on their characteristic genetic abnormalities, such as mutations or chromosomal changes. Polymerase chain reaction essentially increases (amplifies) small amounts of specific pieces of either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) so that the pieces are easier to detect and count. As a result, genetic abnormalities can be detected by qPCR testing, even when these abnormalities are only present in very few cells. With qPCR testing, it is possible to identify one cancer cell within 100,000 to 1 million normal cells. The test uses specimens from the patient's bone marrow or blood. It may be several weeks before results are available.

Quantitative Polymerase Chain Reaction (qPCR)



Trace amounts of DNA are taken from a blood or bone marrow sample.

An individual segment is extracted, and the DNA strands are separated.



Synthetic DNA fragments are added that bind in a determined position. A specific gene signal can be amplified, so that even small amounts can be detected to indicate the presence (or absence) of the cancer gene.



Further processing in the lab produces two new complete copies of the DNA strands.



By repeating the process, these DNA strands are separated and doubled in number. The process is repeated over and over again, resulting in millions of copies.

This technique allows specific segments of DNA to be examined.

It can detect cancer cells in amounts too small to be seen under a microscope.

© Fran Milner 2018



Lab Test



Imaging Test



Sedation or Anesthesia

What do the results mean?

A qPCR test can be used to test for minimal residual disease (MRD), the number of cancer cells remaining in the body after treatment. After a patient has been treated, the doctor will evaluate MRD to measure the effectiveness of treatment and to predict which patients are at risk of disease relapse. It can also help the doctor to confirm and monitor remissions and identify an early return of the cancer.

Visit www.LLS.org/booklets to view, print or order the free LLS booklet *Minimal Residual Disease (MRD)*.



Skin biopsy

Why is this test done?

Some blood cancers involve the skin. Patients may have lesions such as a rash or bumps on the skin. Samples of skin lesions are removed and tested. The findings provide information that help doctors to make an accurate diagnosis.

How is it done?

A skin biopsy is a procedure in which a doctor, typically a dermatologist, removes a sample of the skin lesion so that it can be viewed under a microscope. Before a skin biopsy, your skin will be numbed with local anesthesia. You may feel pressure during the biopsy, but should not feel pain. There are several different types of skin biopsies. Your doctor will order one of the following types of skin biopsies for you, depending on the size and location of the abnormal skin lesion:

- A punch biopsy. The doctor uses a circular tool to remove a small but deep circle of tissue from all of the skin layers (epidermis [outermost layer of the skin], dermis [the inner layer of the skin] and superficial fat). See image on page 42.
- A shave biopsy. The doctor uses a tool, similar to a razor, to remove the outermost layer of skin (epidermis) and part of the second layer of skin (a portion of the dermis). See image on page 43.
- An incisional biopsy. The doctor uses a scalpel, a small knife, to remove a small sample of the abnormal area.
- An excisional biopsy. The doctor uses a scalpel to remove the entire area of abnormal skin, including a portion of normal skin around the lesion.



Lab Test



Imaging Test



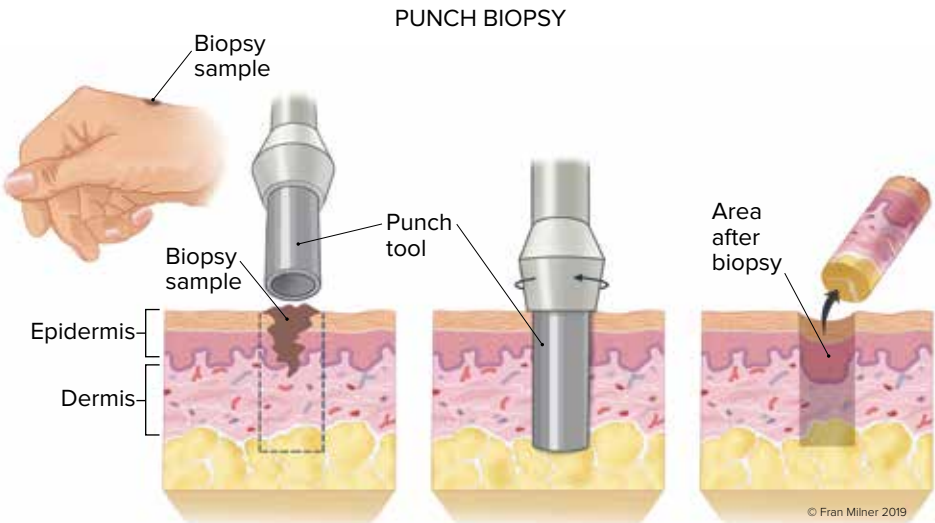
Sedation or Anesthesia

After the doctor has biopsied the lesion, the wound is closed and covered with a sterile dressing. Generally, there are no side effects, but sometimes, people do develop scars.

A pathologist (or a pathologist who has special training and expertise in reviewing skin samples [a dermatopathologist]), will examine the samples under a microscope. The same skin sample may be used for other tests, such as flow cytometry and/or molecular testing, and may provide more information about the lesion.

What do the results mean?

The examination of the tissue may show cancerous and/or noncancerous cells. It may also show the presence of an infection or other skin conditions.



Lab Test

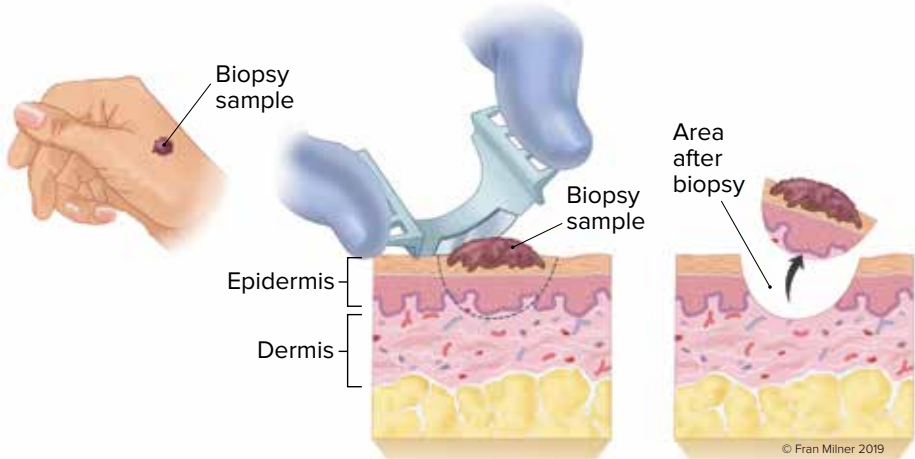


Imaging Test



Sedation or Anesthesia

SHAVE BIOPSY



Spinal tap (also called lumbar puncture)

Why is the test done?

Some types of blood cancers can spread to the fluid that surrounds the brain and spinal cord. This is called the “cerebrospinal fluid (CSF).” To determine whether the cancer has spread to the CSF, a sample must be tested. A spinal tap is a procedure that is used to collect and examine the CSF.

How is it done?

During a spinal tap, you will either lie down or sit on the examination table. If you are lying down, your knees will be tucked up near your chest. If you are sitting, you will lean slightly forward and down toward your knees. The lower part of your back over your spine will be numbed with a local anesthetic. Next, a thin, hollow biopsy needle will be inserted between the bones (vertebrae) in your spine and into the space around your spinal cord. You may feel some pressure during the procedure. Once the needle is properly positioned, the sample of CSF is collected. It usually takes several minutes to collect the sample of fluid as it is allowed to flow out on its own. Once the needle is removed, a dressing will be placed on the site. The sample of CSF is then sent to the laboratory for analysis. Your healthcare team will provide you specific instructions about how to care for yourself after a spinal tap.



Lab Test

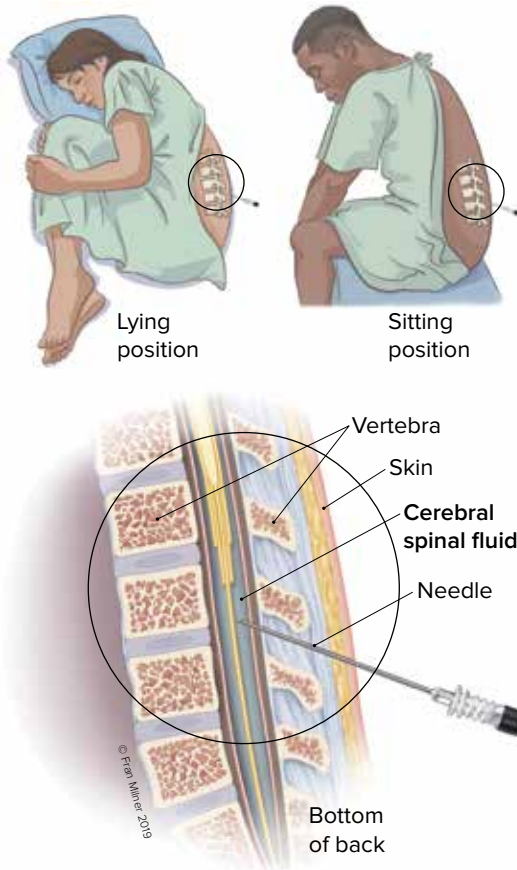


Imaging Test



Sedation or Anesthesia

SPINAL TAP (LUMBAR PUNCTURE)



What do the results mean?

A spinal tap may provide evidence of blood cancer cells or infection in the cerebrospinal fluid.



Lab Test



Imaging Test



Sedation or Anesthesia



Ultrasound (also called sonography)

Why is the test done?

This imaging test uses high-frequency sound waves (ultrasound) to create images of the inside of the body. The sound waves make echoes that form pictures of the inside of the body on a computer screen (a sonogram). Unlike some other imaging tests (x-ray, CT [computed tomography] scan), sonography does not use radiation.

How is it done?

A gel is applied to the area being studied. The gel helps prevent air pockets which can block the sound waves that create the images. The technician slides the handheld ultrasound instrument across the skin. This instrument transmits sound waves into the body, collects the ones that bounce back and sends them to a computer which creates the pictures. Your doctor may provide specific instructions regarding how to prepare for your test, such as instructions regarding eating and drinking.

What do the results mean?

A sonogram may reveal masses (tumors), injuries, or abnormalities in the area(s) being studied.

ULTRASOUND
(SONOGRAPHY)



Lab Test



Imaging Test



Sedation or Anesthesia



Uric acid

Why is this test done?

Some blood cancer patients undergoing strong cancer treatments are at risk for tumor lysis syndrome. This syndrome can be life threatening. It occurs when many cancer cells die very quickly due to treatment. As cancer cells die, they release their contents into the blood. This can cause very high levels of certain chemicals in the blood, including uric acid. High levels of uric acid can cause serious damage to internal organs such as the kidneys and heart.

How is it done?

A blood sample is drawn from a vein in the arm or a 24-hour urine sample is used.

What do the results mean?

Your doctors may want to know your uric acid level both before and during treatment. If your uric acid levels are elevated, you may be given certain medications that can help lower them.



Urinalysis

Why is the test done?

A urinalysis is used to measure levels of proteins, blood cells and chemicals that may be found in the urine. This test can provide information about how your body is functioning and is often used to help diagnose kidney and other health problems.

How is it done?

Some prescription medications, nonprescription medications and supplements can affect the results of a urinalysis. Before a urinalysis, it is important to tell your doctor about any medications, vitamins or supplements that you are taking.

Depending on your situation, you may collect the urine sample either at home or at your doctor's office. Your doctor will give you a container for the urine sample and specific instructions on how to collect the urine.



Lab Test



Imaging Test



Sedation or Anesthesia

At the laboratory or at the doctor’s office, the urine sample may be examined three ways.

- Physical examination. A laboratory technician examines the color of the urine, its appearance (whether it is clear or cloudy), and whether there is any odor.
- Chemical examination. This test is also known as a “dipstick” test. A thin plastic stick that has been treated with chemicals and that will detect any abnormalities is placed in the urine. The chemicals on the stick react and change color if certain substances are present or if their levels are above normal. A dipstick indicates
 - pH level (the measurement of acidity and its opposite, alkalinity in a solution)
 - Substances that are not normally present in urine, such as blood, too much protein, glucose, ketones and bilirubin
 - Evidence of infection
 - High concentration of particles.
- Microscopic examination. A microscopic examination either may or may not be done as a part of a routine urinalysis. It is usually done when there are abnormal findings on the physical or chemical examination. During a microscopic examination, several drops of urine are viewed under a microscope. If above-average levels of white blood cells, red blood cells, bacteria, yeasts, crystals, or casts (tube-shaped proteins) are observed, additional testing may be needed.

What do the results mean?

Urine test results can mean many things. Other information, such as your medical history and your signs and/or symptoms, must be considered when interpreting these results. Discuss your specific results with your doctor.

PART 3

Resources and Information

LLS offers free information and services to patients and families affected by blood cancers. This section of the booklet lists various resources available to you. Use this information to learn more, to ask questions and to make the most of the knowledge and skills of the members of your healthcare team.

For Help and Information

Consult With an Information Specialist. Information Specialists are master's level oncology social workers, nurses and health educators. They offer up-to-date disease and treatment information. Language services are available. For more information, please

- Call: (800) 955-4572 (Monday through Friday, 9 am to 9 pm ET)
- Email: infocenter@LLS.org
- Live chat: www.LLS.org/InformationSpecialists
- Visit: www.LLS.org/InformationSpecialists

Clinical Trials Support Center (CTSC). Research is ongoing to develop new treatment options for patients. LLS offers help for patients and caregivers in understanding, identifying and accessing clinical trials. When appropriate, patients and caregivers can work with Clinical Trial Nurse Navigators who will help find clinical trials and personally assist patients throughout the entire clinical trial process. Visit www.LLS.org/CTSC for more information.

Free Information Booklets. LLS offers free education and support booklets that can be either read online or ordered. Please visit www.LLS.org/booklets for more information.

Telephone/Web Education Programs. LLS offers free telephone/Web and video education programs for patients, caregivers and healthcare professionals. Please visit www.LLS.org/programs for more information.

Financial Assistance. LLS offers financial assistance to individuals with blood cancer. Visit www.LLS.org/finances for more information.

Co-Pay Assistance Program. LLS offers insurance premium and medication co-pay assistance for eligible patients. For more information, please

- Call: (877) 557-2672
- Visit: www.LLS.org/copay

LLS Health Manager™ App. This free mobile app helps you manage your health by tracking side effects, medication, food and hydration, questions for your doctor, and more. Export the information you've tracked in a calendar format and share it with your doctor. You can also set up reminders to take medications, hydrate, and eat. Visit www.LLS.org/HealthManager to download for free.

One-on One Nutrition Consultations. Access free one-on-one nutrition consultations with a registered dietitian who has experience in oncology nutrition. Dietitians assist callers with information about healthy eating strategies, side effect management and survivorship nutrition. They also provide additional

nutrition resources. Please visit www.LLS.org/nutrition to schedule a consultation or for more information.

Podcast. The *Bloodline with LLS* is here to remind you that after a diagnosis comes hope. Listen in as patients, caregivers, advocates, doctors and other healthcare professionals discuss diagnosis, treatment options, quality-of-life concerns, treatment side effects, doctor-patient communication and other important survivorship topics. Visit www.LLS.org/TheBloodline for more information and to subscribe.

Suggested Reading. LLS provides a list of selected books recommended for patients, caregivers, children and teens. Visit www.LLS.org/SuggestedReading to find out more.

Continuing Education. LLS offers free continuing education programs for healthcare professionals. Please visit www.LLS.org/ProfessionalEd for more information.

Community Resources and Networking

LLS Community. The one-stop virtual meeting place for talking with other patients, finding the latest blood cancer resources and getting information. Share your experiences with other patients and caregivers and get personalized support from trained LLS staff. Visit www.LLS.org/community to join.

Weekly Online Chats. Moderated online chats can provide support and help cancer patients to reach out and share information. Please visit www.LLS.org/chat to join.

LLS Chapters. LLS offers community support and services in the United States and Canada, including the *Patti Robinson Kaufmann First Connection Program* (a peer-to-peer support program), in-person support groups and other great resources. For more information about these programs or to contact your chapter, please

- Call: (800) 955-4572
- Visit: www.LLS.org/ChapterFind

Other Helpful Organizations. LLS offers an extensive list of resources for patients and families. There are resources that provide help with financial assistance, counseling, transportation, patient care and other needs. For more information, please visit www.LLS.org/ResourceDirectory to obtain our directory.

Advocacy. The LLS Office of Public Policy (OPP) engages volunteers in advocating for policies and laws that encourage the development of new treatments and improve access to quality medical care. For more information, please

- Call: (800) 955-4572
- Visit: www.LLS.org/advocacy

Additional Help for Specific Populations

Información en español (LLS information in Spanish). Please visit www.LLS.org/espanol for more information.

Language Services. Let members of your healthcare team know if you need a language interpreter or other assistance, such as a sign language interpreter. Often, these services are free.

Information for Veterans. Veterans who were exposed to Agent Orange while serving in Vietnam may be able to get help from the United States Department of Veterans Affairs. For more information, please

- Call: the VA (800) 749-8387
- Visit: www.publichealth.va.gov/exposures/AgentOrange

World Trade Center (WTC) Survivors. People involved in the aftermath of the 9/11 attacks and subsequently diagnosed with a blood cancer may be eligible for help from the World Trade Center (WTC) Health Program. People eligible for help include

- Responders
- Workers and volunteers who helped with rescue, recovery and cleanup at the WTC-related sites in New York City (NYC)
- Survivors who were in the NYC disaster area, lived, worked or were in school in the area
- Responders to the Pentagon and the Shanksville, PA crashes.

For more information, please

- Call: WTC Health Program at (888) 982-4748
- Visit: www.cdc.gov/wtc/faq.html

People Suffering from Depression. Treating depression has benefits for cancer patients. Seek medical advice if your mood does not improve over time, for example, if you feel depressed every day for a 2-week period. For more information, please

- Call: The National Institute of Mental Health (NIMH) at (866) 615-6464
- Visit: NIMH at www.nimh.nih.gov. Enter “depression” in the search box.

Health Terms

Absolute neutrophil count (ANC). A test that measures the number of neutrophils (a type of white blood cell) in the blood. The lower a person's ANC is, the higher the person's risk of getting an infection.

Albumin. A protein made in the liver. Low levels of albumin can signal illness, including liver or kidney disease.

Allogeneic Stem Cell Transplantation. A treatment that uses donor stem cells to restore a patient's bone marrow and blood cells.

Anemia. A health condition in which the number of red blood cells is below normal. This results in a diminished ability of the blood to carry oxygen. Severe anemia can cause a pale complexion, weakness, fatigue and shortness of breath.

Basophil. A type of white blood cell that participates in certain allergic reactions.

Beta₂-microglobulin (B₂M). A protein that is found on the surface of many cells. A high level of beta₂-microglobulin may be a sign of certain diseases including some types of cancer, such as lymphoma or myeloma.

Biomarker (molecular marker, tumor marker). A molecule found in blood, other bodily fluids or tissues that is a sign of a condition or disease. A biomarker may be used to see how well the body responds to a treatment for a disease or condition.

Bone Marrow. The spongy tissue in the hollow central cavity of the bones that is the site of blood cell formation.

Cardiologist. A doctor who has special training to diagnose and treat diseases of the heart and blood vessels.

Cerebrospinal fluid. The fluid that flows in and around the hollow spaces of the brain and spinal cord.

Chemotherapy. Treatment that stops the growth of cancer cells, either by killing the cancer cells or by stopping them from dividing.

Chromosome. A threadlike structure within cells that carries genes in a linear order. Human cells have 23 pairs of chromosomes.

Comorbidity. The condition of having two or more diseases at the same time.

Contrast dye. A substance used during certain types of imaging tests to help distinguish between different body tissues and to clarify test findings. It is usually injected into a vein or given by mouth before the test. Contrast dyes are also called “contrast agents” or referred to as “contrast mediums.”

Cytogenetics. The study of chromosomes, which are long strands of DNA and protein that contain most of the genetic information in a cell. Cytogenetics involves testing samples of tissue, blood, or bone marrow in a laboratory to look for changes in chromosomes, including broken, missing, rearranged, or extra chromosomes. Changes in certain chromosomes may be a sign of a genetic disease or condition or some types of cancer. Cytogenetics may be used to help diagnose a disease or condition, plan treatment, or find out how well treatment is working.

Dermatologist. A doctor who has special training to diagnose and treat skin problems.

Dermatopathologist. A doctor who has special training and expertise in reviewing skin cells and tissue under a microscope.

Dermis. The inner layer of the skin. The dermis has connective tissue, blood vessels, oil and sweat glands, nerves, hair follicles, and other structures.

DNA. The molecules inside cells that carry genetic information and pass it from one generation to the next. Also called deoxyribonucleic acid.

Electrolyte. An electrolyte is a mineral in the body that has an electric charge. Electrolytes help balance the amount of water in the body; move nutrients into cells; move waste out of cells; and make sure that the nerves, muscles, the heart and the brain work as they should. Sodium, calcium, potassium, chlorine, phosphate and magnesium are all electrolytes.

Enzyme. A protein in the body that speeds up chemical reactions.

Eosinophil. A type of white blood cell that participates in allergic reactions and helps fight certain parasitic infections.

Epidermis. The outer layer of the skin.

Esophagus. The tube that carries food and liquids from the mouth to the stomach.

Gastroenterologist. A doctor who has special training in diagnosing and treating disorders of the digestive system.

Gene. The functional and physical unit of heredity passed from parent to offspring. Genes are pieces of DNA, and most genes contain the information for making a specific protein.

Hematocrit. The percentage of whole blood that is made up of red blood cells. The normal range for men is 40 to 54 percent and 35 to 47 percent in women. Anemia occurs when the hematocrit level is below this reference range.

Hematologist. A doctor who specializes in treating blood cell diseases.

Hematopathologist. A doctor who has special training in identifying diseases of the blood cells by examining blood, bone marrow, lymph and other tissues under a microscope.

Hemoglobin. The iron-containing substance in red blood cells that carries oxygen throughout the body. Hemoglobin concentration decreases when there is a reduction in the number of red blood cells. This condition is called “anemia.”

Imaging test. A medical test that makes detailed pictures of areas inside the body. An imaging test may be used to help diagnose disease, plan treatment, or find out how well treatment is working. Examples of imaging tests are x-ray, CT (computed tomography), PET (positron emission tomography) scan and MRI (magnetic resonance imaging) scans.

Immune system. A complex network of cells, tissues and organs that work together to defend the body against infections.

Immunoglobulin (Ig). A protein that helps the body fight infection. Measurements of the amount of specific immunoglobulins in the blood and urine may help the doctor to diagnose cancer, to find out how well treatment is working or if cancer has come back.

Immunophenotyping. A process that uses antibodies to find specific types of cells based on the types of antigens or markers on the surface of the cells.

Karyotype. An organized profile of a person's chromosomes. It exhibits the size, shape and number of chromosomes in a sample of cells.

Lactate dehydrogenase (LDH). A protein found in tissue cells that is released into the bloodstream when cells are damaged or destroyed. High LDH levels may be a sign of tissue damage and some cancers and other diseases.

Leukocyte. A type of white blood cell that is part of the body's immune system. It defends the body against infections and other diseases. Types of leukocytes include granulocytes (neutrophils, eosinophils and basophils), monocytes and lymphocytes (T cells and B cells). See White Blood Cell.

Lymph node. A bean-shaped structure that is part of the body's immune system. Throughout the body, there are hundreds of lymph nodes that contain large numbers of lymphocytes (white blood cells that help fight infection and disease).

Lymphocyte. A type of white blood cell that is important to the body's immune system. There are three major types of lymphocytes: B lymphocytes, which produce antibodies to help combat infections; T lymphocytes, which have several functions, including assisting B lymphocytes in making antibodies; and natural killer (NK) cells, which can attack virus-infected cells or tumor cells.

Macrophage. A type of white blood cell that surrounds and kills microorganisms, eats dead cells and helps lymphocytes with their immunity functions.

Microliter (μL) of blood. A measurement used for some blood test results. One microliter (μL) is an amount equal to one one-millionth of a liter. A liter is almost equal to a quart of blood.

Molecular test. A laboratory test that checks for certain genes, proteins or other molecules in a sample of tissue, blood or other body fluid. Molecular tests also check for changes in genes or chromosomes that may cause a specific disease or disorder such as cancer.

Monocyte/macrophage. A type of white blood cell that is made in the bone marrow and travels through the blood to tissues in the body. In the tissues it becomes a macrophage. Monocytes comprise about 5 to 10 percent of the cells in normal human blood. The macrophage is the monocyte-in-action: It can combat infection in the tissues, ingest dead cells (in this function it is called a "scavenger cell") and assist

lymphocytes in their immune functions.

Neutropenia. A condition in which there is a lower-than-normal number of neutrophils, a type of white blood cell, in the blood.

Neutrophil. A type of white blood cell and principal phagocyte (microbe-eating cell) in the blood. It is the main type of cell that combats infection. People with some blood cancers, or those who have received treatment (such as chemotherapy) for cancer, often have low neutrophil counts. People with low neutrophil counts are very susceptible to infections.

Pathologist. A doctor who has special training in identifying diseases by studying cells and tissues under a microscope.

Phlebotomist. A person specifically trained to draw blood.

Platelet. A small fragment of a cell that helps to control bleeding. Platelets are found in the blood and spleen. They cluster at the site of a wound and help form blood clots to stop bleeding. Also known as “thrombocyte.”

Prognosis. The probable outcome or expected course of a disease. The likelihood of recovery or recurrence of disease.

Quantitative polymerase chain reaction (qPCR). A technique used to expand trace amounts of DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) so that the specific type of DNA or RNA can be studied. This technique has become useful in detecting a very low concentration of residual blood cancer cells, too few to be seen under a microscope. A qPCR can detect the presence of one blood cancer cell among 100,000 to one million healthy blood cells.

Radiologist. A doctor who has special training in creating and interpreting pictures of areas inside the body using medical imaging techniques such as x-rays, MRI (magnetic resonance imaging), PET (positron emission tomography) scan and CT (computed tomography) scans.

Red blood cell (erythrocyte). A blood cell that carries hemoglobin, which binds oxygen and carries it to the tissues of the body. Red blood cells make up about 40 to 45 percent of the volume of the blood in healthy individuals.

Relapse (recurrence). The return of a disease after a period of improvement.

Remission. When signs and symptoms of a disease disappear. This usually follows treatment.

Serum. The clear liquid part of the blood that remains after blood cells and clotting proteins have been removed.

Thrombocytopenia. A health condition in which there is a lower-than-normal number of platelets in the blood.

Translocation. A chromosomal abnormality in which a piece of one chromosome breaks off and attaches to another chromosome. The location at which the break occurs may affect nearby genes.

Tumor marker. A substance found in tissue, blood or other bodily fluids that is produced by cancer or by other cells in the body in response to cancer.

White blood cell. A blood cell that is part of the body's immune system. The five types of infection-fighting white blood cells in the blood are neutrophils, eosinophils, basophils, monocytes and lymphocytes. White blood cells are also called "leukocytes."



Get support. Reach out to our **INFORMATION SPECIALISTS**

The Leukemia & Lymphoma Society team consists of master's level oncology social workers, nurses and health educators who are available by phone Monday through Friday, 9 a.m. to 9 p.m. (ET).

- Get one-on-one personalized support and information about blood cancers
- Know the questions to ask your doctor
- Discuss financial resources
- Receive individual clinical-trial searches



Contact us at
800-955-4572 or
**www.LLS.org/
informationspecialists**

(Language interpreters can be requested)



For more information, please
contact our Information Specialists
800.955.4572 (Language interpreters
available upon request).

**BEATING
CANCER
IS IN
OUR BLOOD.**

National Office 3 International Drive, Suite 200 Rye Brook, NY 10573

The mission of The Leukemia & Lymphoma Society (LLS) is to cure leukemia, lymphoma, Hodgkin's disease and myeloma, and improve the quality of life of patients and their families. Find out more at www.LLS.org.