Learning that you have cancer can be overwhelming.

The goal of this book is to help you get the best cancer treatment. It explains which cancer tests and treatments are recommended by experts of mantle cell lymphoma.

The National Comprehensive Cancer Network® (NCCN®) is a not-for-profit alliance of 27 leading cancer centers. Experts from NCCN have written treatment guidelines for doctors who treat mantle cell lymphoma. These treatment guidelines suggest what the best practice is for cancer care. The information in this patient book is based on the guidelines written for doctors.

This book focuses on the treatment of mantle cell lymphoma. Key points of the book are summarized in the NCCN Quick Guide™. NCCN also offers patient books on diffuse large B-cell lymphoma, chronic lymphocytic leukemia, chronic myelogenous leukemia, acute lymphoblastic leukemia, and many other cancer types. Visit NCCN.org/patients for the full library of patient books, summaries, and other resources.
These patient guidelines for cancer care are produced by the National Comprehensive Cancer Network® (NCCN®).

The mission of NCCN is to improve cancer care so people can live better lives. At the core of NCCN are the NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®). NCCN Guidelines® contain information to help health care workers plan the best cancer care. They list options for cancer care that are most likely to have the best results. The NCCN Guidelines for Patients® present the information from the NCCN Guidelines in an easy-to-learn format.

Panels of experts create the NCCN Guidelines. Most of the experts are from NCCN Member Institutions. Their areas of expertise are diverse. Many panels also include a patient advocate. Recommendations in the NCCN Guidelines are based on clinical trials and the experience of the panelists. The NCCN Guidelines are updated at least once a year. When funded, the patient books are updated to reflect the most recent version of the NCCN Guidelines for doctors.

For more information about the NCCN Guidelines, visit NCCN.org/clinical.asp.

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NCCN Foundation was founded by NCCN to raise funds for patient education based on the NCCN Guidelines. NCCN Foundation offers guidance to people with cancer and their caregivers at every step of their cancer journey. This is done by sharing key information from leading cancer experts. This information can be found in a library of NCCN Guidelines for Patients® and other patient education resources. NCCN Foundation is also committed to advancing cancer treatment by funding the nation’s promising doctors at the center of cancer research, education, and progress of cancer therapies.

For more information about NCCN Foundation, visit NCCNFoundation.org.
Endorsed by

The Leukemia & Lymphoma Society (LLS)
LLS is dedicated to developing better outcomes for blood cancer patients through research, education and patient services and is happy to have this comprehensive resource available to patients. LLS.org/informationspecialists.
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Who should read this book?

Mantle cell lymphoma is the focus of this book. Information on diagnosis, treatment planning, and treatment options are included. People with mantle cell lymphoma and those who support them—caregivers, family, and friends—may find this book helpful. It is a good starting point to learn what your options may be.

Does this book include all options?

This book includes information for many people. Your treatment team can point out what applies to you. They can also give you more information. While reading, make a list of questions to ask your doctors.

The treatment options are based on science and the experience of NCCN experts. However, their recommendations may not be right for you. Your doctors may suggest other options based on your health and other factors. If other options are given, ask your treatment team questions.

Are the book chapters in a certain order?

Early chapters explain concepts that are repeated in later chapters. Starting with Part 1 may help. It explains what mantle cell lymphoma is. Knowing more about this lymphoma may help you better understand its treatment.

Parts 2 through 5 address issues related to treatment. Part 2 lists which health tests and other steps of care are needed before treatment. Part 3 briefly describes all the types of treatments so you can understand your options that are listed in Part 4. Tips for talking and deciding your options with your doctor are presented in Part 5.

Help! What do the words mean?

In this book, many medical words are included. These are words that your treatment team may say to you. Most of these words may be new to you. It may be a lot to learn.

Don’t be discouraged as you read. Keep reading and review the information. Ask your treatment team to explain a word or phrase that you do not understand.

Words that you may not know are defined in the text or in the Dictionary. Acronyms are also defined when first used and in the Glossary. Acronyms are short words formed from the first letters of several words. One example is DNA for deoxyribonucleic acid.
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Lymphatic system

Before learning about mantle cell lymphoma, it is helpful to know about the lymphatic system. It is one of 13 systems of the human body. It transports fluids to the bloodstream and fights germs. As such, it supports your blood-flowing (cardiovascular) and disease-fighting (immune) systems.

Lymph

Cells are the building blocks of tissue in the body. The spaces between cells are filled with fluid. This fluid is called interstitial or tissue fluid. Most tissue fluid comes from parts of blood plasma that have passed out of blood vessels. Cells also release waste and other products into tissue fluid.

When tissue fluid increases, it drains into vessels. Almost all of tissue fluid drains back into blood vessels. The rest of it drains into lymph vessels. Once inside of lymph vessels, tissue fluid is called lymph. Lymph travels in lymph vessels back to the bloodstream.

The lymphatic system also collects fat and some vitamins from your gut. After you eat, your stomach turns food into a liquid. Then, the liquid drains into your small intestine. Within your small intestine, fat and some vitamins are absorbed into lymph vessels. This fatty lymph, called chyle, travels in lymph vessels to the bloodstream.

Lymphoid tissues

As lymph travels, it will pass through and be filtered by lymph nodes. Lymph nodes are organized masses of lymphoid tissue. There are hundreds of lymph nodes throughout your body. See Figure 1. High numbers of lymph nodes exist in the middle of your chest, neck, armpit, groin, pelvis, and along your gut.

Lymph nodes and other lymphoid tissue are defined by high numbers of lymphocytes. Lymph also has lymphocytes. Lymphocytes are a type of white blood cell. They help fight germs. The three types of lymphocytes are NK (natural killer) cells, B-cells, and T-cells. Lymphocytes are made in bone marrow then are moved by blood to the lymphatic system.

Other parts of your body that have many lymphocytes are included in the lymphatic system. In children, the thymus stores T-cells until they are able to fight germs. Germs in blood are filtered and destroyed by lymphocytes within your spleen. Your tonsils kill germs in lymph that enter through your mouth and nose. There are also small clumps of lymphatic tissue in your gut, thyroid, breasts, lungs, eyes, and skin.

A disease of cells

Your body is made of trillions of cells. Cancer is a disease of cells. Each type of cancer is named after the cell from which it derived.

Lymphoma

Lymphomas are cancers of lymphocytes within the lymphatic system. There are two main types of lymphomas. Hodgkin lymphoma is defined by the presence of Reed-Sternberg or related cells. Non-Hodgkin’s lymphoma includes all the other types of lymphoma.
Most non-Hodgkin’s lymphomas—85 out of every 100—are B-cell lymphomas. About 10 out of 100 are T-cell lymphomas. A few have unknown cell origin. It is now known that most Hodgkin lymphomas are also from B-cells. Thus, Hodgkin and non-Hodgkin’s lymphomas are more related than first thought.

Mantle cell lymphoma
Mantle cell lymphoma is a type of non-Hodgkin’s lymphoma. It is a cancer of B-cells. There are many types of B-cells and, thus, many B-cell cancers. B-cells differ from one another based on the cell’s stage of development. As B-cells “mature” they change in their ability to make antibodies.

Antibodies are Y-shaped proteins that are made in response to the presence of antigens. Some antigens enter your body from outside. Such antigens include viruses, bacteria, chemicals, and pollen. Some antigens are formed inside your body like those found on tissue cells. Antibodies attach to antigens, which triggers a response from your immune system.

Naïve B-cells
Germinal centers are short-lived structures within lymph nodes. They form in response to an outside antigen. Within germinal centers, B-cells undergo changes to prepare them for making antibodies.

Most mantle cell lymphomas start from B-cells that have not passed through a germinal center. These “naïve” B-cells can be found in mantle zones that surround germinal centers. Of interest, a subset of mantle cell lymphomas appears to start from B-cells that have passed through germinal centers.

Figure 1
Lymphatic system

The lymphatic system kills germs in the body and collects and transports lymph to the bloodstream.
**Mutations**
Cells have a control center called the nucleus. The nucleus contains chromosomes, which are long strands of DNA (deoxyribonucleic acid) tightly wrapped around proteins. See Figure 2. Within DNA are coded instructions for building new cells and controlling how cells behave. These instructions are called genes.

There can be abnormal changes in genes called mutations. Some types of mutations that are linked to cancer are present in all cells. Other mutations are present only in cancer cells. Mutations cause cancer cells to not behave like normal cells and, sometimes, to look very different from normal cells. Researchers are still trying to learn what causes genes to mutate and cause cancer.

**Cancer’s threat**
Cancer cells don’t behave like normal cells. First, the mutations cause cancer cells to grow more quickly and live longer than normal cells. Normal cells grow and then divide to form new cells when needed. They also die when old or damaged as shown in Figure 3. In contrast, cancer cells make new cells that aren’t needed and don’t die quickly when old or damaged. Over time, the lymphoma cells may build up in tissues and may travel in blood or lymph to other sites. Without treatment, the cancer may cause organs not to work.

**Diagnosis**

One of the first signs of mantle cell lymphoma may be a swelling of lymph nodes. These nodes may be in your neck, armpit, or groin area. The cancer may also affect your GI (gastrointestinal) tract and bone marrow. GI symptoms include pain in your gut, diarrhea, and bloody stools. Tests needed to confirm (diagnose) mantle cell lymphoma are described next.

**Biopsy**
The only way to know if you have cancer is to test tissue or fluid. A biopsy is a procedure that removes samples of fluid or tissue for testing. There are many types of biopsy.

For mantle cell lymphoma, an incisional or excisional biopsy is advised. An incisional biopsy removes only a part of the tumor through a cut made into your body. An excisional biopsy removes the whole tumor and not much else. The methods used to do either biopsy depend on where the tumor is in your body.

FNA (fine-needle aspiration) and a core needle biopsy remove very small samples with a needle. Neither should be used alone to diagnosis mantle cell lymphoma. You may have cancer even if these biopsies find no cancer.

**Hematopathology review**
The biopsy samples will be sent to a special type of pathologist. A pathologist is a doctor who’s an expert in testing cells to find disease. For mantle cell lymphoma, the pathologist should be a specialist in hematopathology.

Hematopathologists spend all of their time looking at blood, bone marrow, and lymph nodes. They become very good at diagnosing blood cancers. The hematopathologist will first examine the samples using a microscope.
Figure 2
Genetic material in cells

Most human cells contain the “blueprint of life”—the plan by which our bodies are made and work. The plan is found inside of chromosomes, which are long strands of DNA that are tightly wrapped around proteins. Genes are small pieces of DNA that contain instructions for building new cells and controlling how cells behave. Humans have an estimated 20,000 to 25,000 genes.

Figure 3
Normal cell growth vs. cancer cell growth

Normal cells increase in number when they are needed and die when old or damaged. In contrast, cancer cells quickly make new cells and live longer because of abnormal changes in genes.
Mantle cell lymphoma basics

The hematopathologist will assess the rate of cancer growth by noting how the cells look. Compared to other lymphomas, most mantle cell lymphomas don’t grow slowly but don’t grow very fast either. Doctors describe the growth as “moderately aggressive.” However, there are some mantle cell lymphomas that grow slowly and others that grow quite fast.

**Protein tests**

For diagnosis, the hematopathologist needs to study the proteins in the cells' surface (membrane). This is called immunophenotyping. Mantle cell lymphoma has a common pattern or “signature” of proteins. 

**See Figure 4.** An IHC (immunohistochemistry) panel is a test for such proteins. It involves applying a chemical marker to cells and then looking at them with a microscope.

**IHC panel**

The IHC panel should test for BCL2, BCL6, CD3, CD5, CD10, CD20, CD21, CD23, cyclin D1, and Ki-67. Mantle cell lymphoma cells often have CD5, CD20, CD43, and high levels of cyclin D1. Rare cases may have normal cyclin D1 levels. CD10 and CD23 are found on most but not all mantle cell lymphoma cells.

Sometimes it is helpful to include LEF1 and SOX11 in the IHC panel. If LEF1 is found, the cancer is likely chronic lymphocytic leukemia and not mantle cell lymphoma. SOX11 is found in almost every case of mantle cell lymphoma. Thus, SOX11 is helpful for diagnosis when the cells have normal levels of cyclin D1. On the other hand, a low or absent SOX11 level is a good marker of slow-growing mantle cell lymphoma.

**Figure 4**

**CD20 protein**

Mantle cell lymphoma cells have a common pattern of proteins in their membrane. This pattern includes the presence of CD5, CD20, CD43, and high levels of cyclin D1. CD10 and CD23 are found on most but not all cells. Immunophenotyping is the process of identifying the proteins in cells' membranes.

Derivative work of Rituximab Binding to CD20 on a B Cell Surface by NIAID available at commons.wikimedia.org/wiki/File:Rituxima_Binding_to_CD20_on_a_B_Cell_Surface_(6830897205).jpg under a Creative Commons Attribution 2.0 Generic license
Flow cytometry
Flow cytometry is a newer method that can also be used to assess the surface proteins on lymphoma cells. This method involves first adding a marker—a light-sensitive dye—to cells. Then, your blood will be passed through a flow cytometry machine. The machine measures surface proteins on thousands of cells.

Flow cytometry may be done in addition to an IHC panel. If done, it should test for CD5, CD10, CD19, CD20, CD23, and kappa and lambda light chain proteins. Light chain proteins are part of antibodies.

It may be helpful to test for CD200 if the type of cancer is unclear. Mantle cell lymphoma cells do not have CD200. Chronic lymphocytic leukemia cells do.

Genetic tests
Mantle cell lymphoma has common abnormal changes in chromosomes and genes. A translocation is a switching of parts between two chromosomes. A gene rearrangement is the fusion of one gene with another gene to create a new gene. Genetic testing may be useful.

t(11;14)
Besides a protein signature, mantle cell lymphomas often have a translocation. The translocation in mantle cell lymphoma occurs between chromosomes 11 and 14—referred to as t(11;14). See Figure 5.

t(11;14) often involves the switching of the CCND1 gene on chromosome 11 with the IgH locus on chromosome 14. The result is too much cyclin D1. If cyclin D1 is normal on the IHC panel, it may be useful to test for t(11;14).

Figure 5
t(11;14)
A translocation is a switching of parts between chromosomes. In mantle cell lymphoma cells, a translocation between chromosomes 11 and 14 is often present. The result is too much cyclin D1 on the surface of cancer cells.
Tests that detect translocations are a karyotype or FISH (fluorescence in situ hybridization).

**IGHV mutations or SOX11**
Some mantle cell lymphomas have mutations in the *IGHV* (immunoglobulin heavy-chain variable) region genes. These lymphomas appear to have started from B-cells that have passed through germinal centers. They often have low or absent SOX11 levels.

It may be useful to test for *IGHV* mutations since they are a sign of slow-growing mantle cell lymphoma.

**DNA sequencing** is a lab test of blood or marrow that is used to look for mutations in genes. This test reveals the order of the chemicals that make up DNA.

**Other genetic errors**
Other genetic tests may be useful if the type of cancer is unclear. A karyotype or FISH to test for translocation of chromosomes 14 and 18 may be done. This translocation is often found in follicular lymphoma and sometimes diffuse large B-cell lymphoma. If present, the cancer is unlikely mantle cell lymphoma. Likewise, the cancer is likely to be chronic lymphocytic leukemia if a FISH panel shows defects in chromosomes 11, 12, 13, or 17.

**Pathology report**
All lab results are recorded in a pathology report. A report will be written each time tissue is removed from your body and tested. These reports are vital to diagnosis and planning treatment.

Review your pathology report(s) with your doctor. Ask questions if you don't understand. This information can be complex. It's also a good idea to get a copy of your pathology report(s) and take notes.
## Treatment planning

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Doctors plan treatment with many sources of information. One of these sources is tests of your health and the cancer. Part 2 describes who should receive which tests before treatment. Some of these tests are repeated during and after treatment. Besides tests, Part 2 describes other types of care that are important to receive before cancer treatment.

Medical history

Your medical history includes any health events and medicines you’ve taken in your life. You will be asked about illnesses, injuries, health conditions, and more. It may help to make a list of old and new medications while at home to bring to your doctor’s office.

Symptoms are a part of your medical history. Some symptoms of mantle cell lymphoma are tiredness, a feeling of fullness in your belly, and getting sick. This cancer may also cause “B symptoms.” It’s important that your doctor knows if you have them. These symptoms include fevers, chills, night sweats, and weight loss without dieting.

Some cancers and other health conditions can run in families. Thus, your doctor will ask about the medical history of your blood relatives. Your doctor may ask about the health of your siblings, your parents and their siblings, and your grandparents and their siblings. Be prepared to tell who in your family has had what diseases and at what ages.

A medical history is one of the tests needed for treatment planning. See Guide 1 for a complete list of care that is recommended prior to treatment. Some types of care are for anyone with mantle cell lymphoma while others may be useful for some people.

Guide 1. Health care before cancer treatment

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Physical exam

Doctors should perform a physical exam along with taking a medical history. A physical exam is a study of your body for signs of disease. To start, your basic body functions will be measured. These functions include your temperature, blood pressure, and pulse and breathing (respiration) rate. Your weight will also be checked.

During the exam, your doctor will listen to your lungs, heart, and gut. Your doctor will also look at and feel parts of your body. This is done to see if organs are of normal size, are soft or hard, or cause pain when touched. Cancer and other health conditions can cause organs to become enlarged and hard.

Enlarged structures
For mantle cell lymphoma, there are certain parts of your body that should be checked. Mantle cell lymphoma is often found in lymph nodes. Thus, areas with lots of lymph nodes should be examined. High numbers of lymph nodes exist in the middle of your chest, neck, throat, armpit, groin, pelvis, and along your gut. The size of your spleen and liver should also be assessed.

Performance status
Results of your medical history and physical exam will be used to rate your performance status. Performance status is your ability to do daily activities. It is used by doctors to assess if you can undergo certain treatments.

Blood tests

Blood tests are used to learn if cancer treatment might be needed now. They are also used to find unknown diseases including those related to lymphoma. It’s important to treat all illnesses.

Blood tests require a sample of your blood. Samples of blood can be removed with a blood draw. Before a blood draw, you might need to stop drinking and eating for several hours.

A needle will be inserted into your vein to remove blood. The needle may bruise your skin. You may feel dizzy from the blood draw. Your blood sample will be sent to a lab for testing.

Complete blood count with differential
A CBC (complete blood count) measures parts of the blood. It is often done with a machine. Test results include counts of white blood cells, red blood cells, and platelets. Your blood counts may be low or high because of cancer or another health problem. It is an essential test that gives a picture of your overall health.

There are several types of white blood cells. A differential counts the number of each type of cell. It also checks if the counts are in balance with each other. Your doctor can determine the cause of an abnormal white blood count from this test.

Comprehensive metabolic panel
Chemicals in your blood come from your liver, bone, and other organs. A comprehensive metabolic panel often includes tests for up to 14 chemicals. The tests show if the levels of chemicals are too low or high. Abnormal levels can be caused by cancer or other health problems.

LDH
LDH (lactate dehydrogenase) is a protein that is in most cells. It gets into your blood when a cell is
damaged. Thus, a high level of LDH is a sign of cell damage. High levels can be caused by cancer or other health problems. If related to cancer, high levels may be a sign that treatment may be needed now or soon.

**Beta-2 microglobulin**
Beta-2 microglobulin is a small protein made by many types of cells, including lymphoma cells. It is measured with a blood chemistry test. If related to cancer, high levels may be a sign that treatment may be needed now or soon.

**Hepatitis testing**
Hepatitis B can be an important factor in the treatment of mantle cell lymphoma. Hepatitis B can become active again due to the cancer or some of its treatments. Thus, tell your treatment team if you’ve ever been infected with hepatitis. If you’re unsure, ask your treatment team if you should get tested. Testing may be needed if you will be treated with a drug called rituximab.

**Uric acid**
Some people with mantle cell lymphoma are at risk for TLS (tumor lysis syndrome). This syndrome can be life threatening. It occurs when the waste released by dead cells is not quickly cleared out of your body. This results in kidney damage and severe blood electrolyte disturbances.

TLS can occur among people with mantle cell lymphoma who are undergoing strong cancer treatments. The cancer treatment kills many cancer cells. In turn, too much tumor cell waste is released within a short period of time.

Your doctors may want to know your uric acid level before starting treatment. You may be given certain medications that can help prevent TLS. Also, drinking plenty of water throughout chemotherapy can help. Ask your treatment team for more information.

**Imaging tests**
Imaging tests make pictures (images) of the insides of your body. They can show which sites have cancer. This information helps your doctors stage the cancer. More information on cancer staging is in Part 4.

Your treatment team will tell you how to prepare for the test. You may need to stop taking some medicines and stop eating and drinking for a few hours before the scan. Tell your doctors if you get nervous when in small spaces. You may be given a sedative to help you relax.

Imaging machines are large. You will likely be lying down during testing. At least part of your body will be in the machine. Figure 6 shows a CT machine, which is described next.

After the test, you will likely be able to resume your activities right away. If you took a sedative, you will have a waiting period. You may not learn of the results for a few days since a radiologist needs to see the pictures. A radiologist is a doctor who’s an expert in reading the images.

**Diagnostic CT**
A CT (computed tomography) of your chest, belly area, and between your hip bones is needed. A CT of your neck is sometimes useful to learn if cancer is present.

CT takes many pictures of a body part from different angles using x-rays. A computer combines the x-rays to make detailed pictures. The picture is saved for later viewing by the radiologist.

A contrast dye is used for diagnostic CT. It makes the pictures clearer. The dye will be injected into a vein in your hand or arm. You will also be given a liquid contrast to drink.
The contrast may cause you to feel flushed or get hives. Rarely, serious allergic reactions occur. Tell your doctor and the technicians if you have had problems with contrast in the past.

**Whole-body PET/CT**
Sometimes CT is combined with PET (positron emission tomography). When used together, they are called a PET/CT scan. PET/CT may be done with one or two machines depending on the cancer center.

For PET, a sugar radiotracer will be injected into your body. The radiotracer is detected with a special camera. Cancer cells appear brighter than normal cells because they use sugar more quickly. PET/CT may be done with one or two machines depending on the cancer center.

Whole-body PET/CT may be given in addition to or instead of CT. It can show the presence of cancer when other tests do not. PET/CT is also used to assess if treatment is working.
Scopes

It is common for mantle cell lymphoma to spread to the GI tract. Endoscopy and colonoscopy are procedures during which a “scope” is inserted into the GI tract. The scope is used to remove tissue that will be tested for cancer.

Testing for cancer in your GI tract may not be needed. It may not be needed if your treatment options wouldn’t be affected. NCCN experts do advise GI testing to confirm there’s only local disease. A second scope will be done to assess how well treatment worked for local disease.

Endoscopy
An endoscopy allows your doctor to see the insides of your esophagus and stomach. It is done with an endoscope. An endoscope has a thin, long tube that will be guided into your body, often through the mouth. At the end of the tube is a very small light, camera lens, and cutting tool. At the other end of the endoscope is an eyepiece. Your doctor will look through it to see the images shown by the camera.

You will likely be sedated during the exam, but sometimes general anesthesia is used. Air may be pumped into your esophagus and stomach for better viewing. After the exam, your throat may feel sore and you may feel bloated from the air.

Colonoscopy
A colonoscopy allows your doctor to see inside your colon. It is done with a colonoscope, which looks and works much like an endoscope. You will be asked to wear a hospital gown and lie on your side during the exam as shown in Figure 7.

The colonoscope will be inserted into your anus and gently guided through your intestine. Air may be pumped into your intestine to make it bigger for better viewing. You may be asked to shift a little during the test to help your doctor guide the colonoscope. The picture from the colonoscope will be viewed by your doctor on a screen.

To prepare for this test, your doctor may place you on a liquid diet for 1 to 3 days. You may also be given a laxative or an enema to clean out your intestine the night before the test. Right before the test, you may be given a sedative. The day after the test, you are likely to feel normal. If you have severe pain, bloody stools, or weakness, contact your doctor.

Figure 7
Colonoscopy
Tissue samples from your GI tract may be removed to test for cancer. The tissue samples from your colon may be removed during a procedure called a colonoscopy as shown below. An endoscopy is a procedure that removes tissue samples from the upper GI tract, which includes your esophagus and stomach.
Bone marrow exam

Mantle cell lymphoma is often but not always found in bone marrow at diagnosis. Thus, a bone marrow exam is advised. This exam will confirm if there is cancer or not.

A bone marrow exam consists of two procedures. A bone marrow aspiration removes a small amount of liquid bone marrow. A bone marrow biopsy removes a sample of bone and soft bone marrow.

Often, these procedures are done at the same time. They are performed on the back of hip bone. You may receive a light sedative beforehand. You will likely lie on your side as shown in Figure 8. Some people lie on their belly. Your doctor will first clean and numb your skin.

For aspiration, a hollow needle will be inserted into your skin and pushed into the bone. Liquid bone marrow will then be drawn into a syringe. For the biopsy, a wider needle will be inserted into your bone and rotated to remove a core sample.

The samples will be sent to a lab for testing. You may feel bone pain during and after the procedures for a few days. Your skin may bruise.

My initial symptom was an enlarged spleen. A bone marrow biopsy determined I had mantle cell lymphoma. It is a good thing my primary care doctor found the enlarged spleen because I did not have any of the usual symptoms.

– Scott

Survivor, Diagnosed at age 54

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Spinal fluid tests

Mantle cell lymphoma rarely spreads into the fluid around the brain and spinal cord. This fluid is called cerebrospinal fluid or spinal fluid. It may spread for blastic variant subtype. It may have spread into your spinal fluid if certain symptoms are present. To confirm that cancer is in spinal fluid, a sample must be removed and tested.

A lumbar puncture is a procedure that removes spinal fluid. It is also called a spinal tap. A lumbar puncture is advised if you have the blastoid type of mantle cell lymphoma or have symptoms of cancer in your CNS (central nervous system). Such symptoms include a loss of balance, loss of sensation, muscle weakness, seizures, headaches, and vision changes.

During a spinal tap, you will be lying down or sitting on an exam table. If lying down, your knees must be tucked up near your chest. If sitting, you must lean slightly forward and down toward your knees as shown in Figure 9.

The lower part of your back over your spine will be numbed with a local anesthetic. Next, a thin needle will be inserted between the bones of your spine and into the space around your spinal cord. You may feel some pressure during the procedure. The fluid sample will then be sent to a lab for testing.

Heart tests

Some cancer treatments can damage your heart. Thus, your doctor may test how well your heart works to plan treatment. You may receive one of the two tests described next. If your heart isn’t working well, you may receive other treatment.

Echocardiogram

An echocardiogram is an imaging test of your heart. It uses sound waves (ultrasound) to make pictures. During this test, you will be lying down. Small patches will be placed on your chest to track your heartbeat. Next, a probe with gel on its tip will be slid across part of your bare chest. A picture of your beating heart will be seen at once on a screen. The pictures will be recorded for future viewing.

MUGA

A MUGA (multi-gated acquisition) scan measures how well your heart is pumping blood. For this test, patches will be placed on your chest to track your heartbeat. Also, a radiotracer will be injected into...
your vein. Pictures of your heart will be taken with a special camera that can detect the radiation released by the tracer.

Fertility and pregnancy

Some cancer treatments can limit your ability to have a baby. If you want the choice of having babies after treatment or are unsure, tell your doctors. It may also help to talk with a fertility specialist before you begin cancer treatment.

A fertility specialist is an expert in helping people have babies. The fertility specialist can discuss with you how to have a baby after treatment. Some methods of fertility preservation are discussed next. If you are a woman of childbearing age, important information on pregnancy is also addressed.

Sperm banking

Men who want to father children after cancer treatment can use sperm banking. Sperm banking stores semen for later use. This is done by freezing semen with sperm in liquid nitrogen. Talk to your treatment team about the costs of and how well sperm banking works.

Egg freezing and more

Like sperm banking, a woman’s eggs can be removed, frozen, and stored for later use. Your frozen eggs can be fertilized with sperm beforehand. Also, a part of your ovary that contains eggs can be frozen and stored.

Pregnancy test

Some cancer treatments can harm an unborn baby. Get a pregnancy test before treatment if you may be pregnant now. Your treatment options will depend on the results. During treatment, take steps to avoid getting pregnant. Your doctors can tell you which birth control methods are best to use.

Review

Tell your doctor if you have recently had fevers, night sweats, and weight loss without dieting. These can be symptoms of mantle cell lymphoma.

Your doctor will examine your body for signs of disease. He or she will check if your lymph nodes, liver, or spleen are large. Your doctor will also rate your ability to do everyday activities.

Blood tests can be done to assess if cancer treatment is needed and for other health conditions.

Imaging tests allow your doctors to see inside your body without cutting into it. CT, PET/CT, or both is needed.

Endoscopy or colonoscopy may be done to collect tissue samples from your GI tract in order to confirm local disease and treatment response.

A bone marrow biopsy removes a piece of bone and marrow to test for cancer cells. An aspirate removes liquid marrow. These tests may be helpful before starting treatment.

A lumbar puncture may be needed to confirm if the cancer has spread into your spinal fluid.

You may undergo heart tests to see if you are healthy enough to have certain cancer treatments.

Talk to a fertility specialist to learn about ways to have babies after cancer treatment. If you may be pregnant now, get a pregnancy test since some cancer treatments can harm unborn babies.
Overview of cancer treatments

25 Immunotherapy
26 Immunomodulators
27 Chemotherapy
29 Steroids
30 Targeted therapy
31 Radiation therapy
33 Blood stem cell transplant
34 Clinical trials
35 Review
In Part 3, the main treatment types for mantle cell lymphoma are briefly described. Knowing what a treatment is will help you understand your treatment options listed in Part 4. There is more than one treatment for mantle cell lymphoma. Not every person will receive every treatment described in this chapter.

### Immunotherapy

The immune system is your body’s natural defense against disease. Immunotherapy increases the activity of this system. As a result, it improves your body’s ability to find and destroy cancer cells.

Immunotherapy is a common treatment for mantle cell lymphoma.

Immunotherapy for mantle cell lymphoma uses rituximab. It is an anti-CD20 monoclonal antibody. This human-made antibody attaches to CD20 on the surface of lymphoma cells. See Figure 10. It works by marking the cells for destruction. It may directly kill cells, too.

Rituximab is sold as Rituxan®. It is a liquid that will be slowly injected into your vein. It often takes a few hours to receive the full dose. How often rituximab is received differs among people. Ask your doctor for more information.

Rituximab is also sold as Rituxan Hycela™. This medicine is injected under the skin for treatment of certain lymphomas. Injections may be received

---

**Figure 10**  
**Anti-CD20 monoclonal antibody**

Anti-CD20 monoclonal antibodies attach to lymphoma cells to mark them for destruction by your immune system.
after the first dose of rituximab by infusion. Also, injections may be an option as long as rituximab isn’t being used with ibritumomab tiuxetan. Injections last between 5 and 7 minutes.

Side effects are unhealthy or unpleasant physical or emotional responses to treatment. Ask your treatment team for a full list of common and rare side effects.

You may have an allergic reaction while receiving rituximab. Other common side effects are chills, infections, body aches, tiredness, and low blood cell counts. Rituximab also increases your chances for tumor lysis syndrome, heart problems, and blockage and tears in your gut.

Immunomodulators

Immunomodulators are drugs that modify different parts of the immune system. Lenalidomide (Revlimid®) is an immunomodulator. It is received with rituximab as a first-line treatment. For second-line treatment, rituximab or rituximab with ibrutinib may be added.

Lenalidomide treats lymphoma in more than one way. As an immunomodulator, it boosts the immune system. It also helps stop cancer cells from increasing in number. Third, it also works like a type of targeted therapy called an angiogenesis inhibitor. Angiogenesis inhibitors stop the growth of new blood vessels that would provide food (nutrients) to the cancer.

Lenalidomide is made in pill form. It is given in cycles of treatment days followed by days of rest. A cycle may consist of 3 weeks of treatment and 1 week of rest. It may also be given for 4 straight weeks. Cycles may repeat until the cancer grows or side effects become severe.

Common side effects include low blood counts, diarrhea, itching, rash, and fatigue. Serious but less common side effects include blood clots, bleeding disorders, loss of vision, and skin cancer. Ask your treatment team for a full list of side effects.

“Maintaining a positive attitude is important. Reach out to your family and friends for support.

– Scott
  Husband and survivor
Chemotherapy

Chemotherapy, or “chemo,” includes drugs that disrupt the life cycle of cancer cells. The types of chemotherapy differ in the way they work. Some kill cancer cells by damaging their DNA or by disrupting the making of DNA. Others interfere with cell parts that are needed for making new cells. Thus, no new cells are made to replace dying cells. Chemotherapy can affect both cancer and normal cells.

Some chemotherapy drugs work when cells are in an active growth phase. See Figure 11. During the active growth phase, cells grow and divide to form a new cell. Chemotherapy that disrupts the growth phase works well for cancer cells that are growing and dividing quickly. Other chemotherapy drugs work in any growth or resting phase.

Figure 11
Chemotherapy and the cell cycle

A cell goes through many changes to divide into two cells. Science has grouped these changes into 7 main phases. There may be another phase of rest, too. Some chemotherapy drugs work in any phase. Other chemotherapy drugs work in one or two growth phases. In growth phases, DNA is copied and two full sets of chromosomes are made. A full set of chromosomes is pulled into each end of the cell. The cell then divides into two cells each with their own set of chromosomes.
3  Overview of cancer treatments  Chemotherapy

What to expect
Chemotherapy used to treat mantle cell lymphoma is listed in Guide 2. Most are liquids that are slowly injected into a vein. Some are a pill that is swallowed. By any method, the drugs travel in your bloodstream to treat cancer throughout your body. Doctors use the term “systemic” when talking about a cancer treatment for the whole body.

Chemotherapy is given in cycles of treatment days followed by days of rest. This allows your body to recover before the next cycle. Cycles vary in length depending on which drugs are used. Often, a cycle is 2 to 4 weeks long. If you will have chemotherapy, ask your doctor how many cycles will be given. Also ask how many days of treatment there are within a cycle.

Chemotherapy may consist of one or more drugs. When only one drug is used, it is called a single

Guide 2. Chemotherapy

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<tbody>
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agent. However, not all drugs work the same way, so often more than one drug is used. A combination regimen is the use of two or more chemotherapy drugs. A steroid, immunotherapy, or both are often added to chemotherapy.

Side effects of chemotherapy
Side effects are unhealthy or unpleasant physical or emotional responses to treatment. They differ among people. Some people have many side effects. Other people have few. Some side effects can be very serious. Others can be unpleasant but not serious.

Side effects of chemotherapy depend on multiple factors. These factors include the drug type, amount taken, length of treatment, and the person. In general, side effects are caused by the death of fast-growing cells.

Fast-growing cells are found in the hair follicles, gut, mouth, and blood. Death of these cells can cause low blood cell counts, not feeling hungry, nausea, vomiting, diarrhea, hair loss, and mouth sores. Lung damage may also occur at the time of treatment.

Most side effects appear shortly after treatment starts and will stop after treatment. However, other side effects are long-term or may appear years later. Late side effects include another type of cancer, heart disease, low levels of thyroid hormones (hypothyroidism), and problems having babies (infertility).

Not all side effects of chemotherapy are listed here. Please ask your treatment team for a complete list of common and rare side effects. If a side effect bothers you, tell your treatment team. There may be ways to help you feel better. There are also ways to prevent some side effects.

Steroids
Steroid is the short name for corticosteroid. It is a type of drug that is often used to relieve inflammation. Steroids also are toxic to lymphoma cells. They have strong anti-cancer effects. The steroids used to treat mantle cell lymphoma are listed in Guide 3.

Steroids are a part of some chemotherapy regimens. They are often given on the same days as chemotherapy but only for a few days or a week. Prednisone is made in pill form but dexamethasone and methylprednisolone are made both as a liquid to be injected or a pill to be swallowed.

Most side effects of steroids fade away once the drugs are stopped. Common side effects include feeling hungry, upset stomach, and mood changes. You may have trouble sleeping. Wounds may be slow to heal. Swelling of ankles, feet, or hands is also common.

Guide 3. Steroids

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<td>Methylprednisolone sodium succinate</td>
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<tr>
<td>Prednisone</td>
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Targeted therapy

Targeted therapy is a class of drugs. These drugs stop the action of molecules that help cancer cells grow. They are less likely to harm normal cells than chemotherapy. Targeted therapy for mantle cell lymphoma uses kinase or BCL-2 inhibitors.

Ibrutinib
Ibrutinib is sold as Imbruvica®. It is a kinase inhibitor. Kinases are molecules that move chemicals, called phosphates, from one molecule to another. Kinase inhibitors stop the phosphate from being moved.

Ibrutinib stops a kinase called BTK (Bruton’s tyrosine kinase). This kinase is found inside of B-cells. It helps cells grow and survive.

Ibrutinib slows down mantle cell lymphoma. It works by causing cell death. It also stops the cells from quickly making new cells. Third, it stops the cells from moving into your bone and marrow.

Ibrutinib is made in pill form. It is taken once a day around the same time. Your doctor will tell you how many pills you need for your dose.

Ask your treatment team for a full list of side effects of ibrutinib. Some common side effects are fatigue, diarrhea, muscle and bone pain, bruising, bleeding, nausea, and rash. Blood counts are often low when taking this medicine. However, there may be a short-lived increase in white blood cells.

Your doctor will assess for serious but uncommon side effects. These include heart and kidney problems. You may develop serious bleeding and infections. Ibrutinib may increase your chances for other cancers.

Venetoclax
Venetoclax is sold as Venclexta™. It is a BCL-2 inhibitor. BCL-2 is a protein inside of B-cells that helps prevent cell death.

In some non-Hodgkin lymphomas, there is a large amount of BCL-2. BCL-2 inhibitors attach to BCL-2 and stop them from working. Thus, the lymphoma cells are able to die.

Venetoclax is made in pill form. It is taken once a day with food and water. Your doctor will tell you how many pills you need for your dose.

Ask your treatment team for a full list of side effects of venetoclax. Some common side effects are fatigue, diarrhea, nausea, and lung infection. Blood counts are often low. Your doctor will assess for serious but uncommon side effects. Venetoclax may cause TLS.

Supportive care

Supportive care doesn’t aim to treat cancer but aims to improve quality of life. It is also called palliative care. It can address many needs. One example is treatment for physical and emotional symptoms.

Supportive care can also help with treatment decisions as you may have more than one option. It can also help with coordination of care between health providers. Talk with your treatment team to plan the best supportive care for you.
Radiation therapy

Radiation therapy uses high-energy x-rays to treat mantle cell lymphoma. The x-rays damage DNA in cancer cells. This either kills the cancer cells or stops new cancer cells from being made.

A radiation oncologist will oversee your radiation treatment. A radiation oncologist is a doctor who’s an expert in treating cancer with radiation. He or she will tailor treatment to you.

External beam radiation therapy

Mantle cell lymphoma may be treated with one of two types of radiation therapy. ISRT (involved-site radiation therapy) can treat lymph nodes in which the cancer first started. It may also treat cancer near to these nodes. Radiation delivered to a larger area is called IFRT (involved-field radiation therapy).

Both are given with a method called EBRT (external beam radiation therapy). A large machine makes high energy x-rays used for treatment. This machine is called a LINAC (linear accelerator). See Figure 12.

Planning and setup sessions

A planning session is needed to map out your treatment. The planning process is called simulation. It involves obtaining a scan of your body in the position that is needed for treatment. The scan is only used for treatment planning.

A CT scan with contrast is used. PET/CT and MRI (magnetic resonance imaging) often enhance treatment planning for ISRT. For tumors near the breastbone, 4D-CT (four-dimensional computed tomography) or fluoroscopy can account for tumor movement from breathing. If your breathing causes large movements, motion control methods during the scans may be used.

After simulation, your radiation team will further plan your treatment. Plans are made by viewing your scans on the treatment planning computer. Your radiation oncologist will work closely with a dosimetrist. They will plan the best dose, number and shape of radiation beams, and number of treatments. Your plan will be designed to treat the cancer while sparing normal tissue.

Once your treatment plan is made, a setup session is needed. This session is sometimes called “port film” day or dress rehearsal. The setup session occurs in the treatment room.

Treatment sessions

During treatment, you will lie on a table in the same position as done for simulation. Devices may be used
3 Overview of cancer treatments

Radiation therapy

to keep you from moving. You will be alone while the therapists operate the machine from the nearby control room.

The therapists will be able to see, hear, and speak with you. As treatment is given, you may hear noises. One session takes less than 10 minutes. The types of EBRT include:

- **3D-CRT (three-dimensional conformal radiation therapy)** delivers, from different angles, a photon beam that matches the shape of the target.

- **IMRT** (intensity-modulated radiation therapy) is a form of 3D-CRT. It further modifies the beam’s intensity during treatment.

- **Proton therapy** uses proton beams that deliver radiation mostly within the tumor.

IGRT (image-guided radiation therapy) can improve how well the radiation beam targets some tumors. IGRT uses the machine that delivers the radiation to also take images of the tumor and normal body structures. This can be done right before or during treatment. These images are compared to the ones taken during simulation. If needed, changes will be made to your body position or the radiation beams.

**Side effects**

Side effects from radiation therapy differ among people. Factors like treatment site, radiation dose, and length of treatment play a role. Side effects are cumulative. This means they build up slowly and are worse at the end of treatment. Your doctor will check on you every week during treatment. He or she will review skin care, medicines, and other options to help you feel better.

**Acute effects**

Acute effects are those that happen during treatment or shortly after the last session. Many people feel fatigue. Changes in skin are also common right after treatment. Your treated skin may look and feel as if it has a mild sunburn. It may also become dry, sore, and feel painful when touched. You may also have short-term hair loss, but only where treated.

Treatment to the head and neck can cause mouth sores, dry mouth, changes in taste, and a sore throat. Chest radiation can cause a dry cough or a sensation of a lump when you swallow. Radiation near your belly can cause nausea and maybe vomiting, and when given between your hip bones, diarrhea and cramps.

**Late effects**

Late effects are those that happen after treatment. Some do not go away. The effects depend on the treatment site. Examples include dry mouth, dental cavities, hypothyroidism, lung scarring, heart disease, infertility, and second cancers.

Not all side effects of radiation are listed here. Please ask your treatment team for a complete list of common and rare side effects. If a side effect bothers you, tell your treatment team. There may be ways to help you feel better. There are also ways to prevent some side effects.
Blood stem cell transplant

Blood (hematopoietic) stem cells are cells from which all blood cells are formed. They mainly exist in bone marrow. Cancer or its treatment can damage or destroy blood stem cells.

A blood stem cell transplant replaces damaged or destroyed stem cells with healthy stem cells. The healthy stem cells form new marrow and blood cells. A transplant is sometimes an option for advanced mantle cell lymphoma. There are two types of blood stem cell transplants.

**Autologous blood stem cell transplant**

Autologous blood stem cell transplant uses your healthy stem cells to repair bone marrow. This treatment is also called HDT/ASCR (high-dose therapy with autologous stem cell rescue). Your healthy stem cells will be collected when imaging tests show that cancer treatment is working. You will then receive intense chemotherapy and maybe radiation to destroy any remaining cancer cells. This intense treatment will also destroy bone marrow. Your healthy stem cells will be put back into your body to “rescue” your marrow.

**Allogeneic blood stem cell transplant**

Allogeneic blood stem cell transplant uses healthy stem cells from a donor. HLA (human leukocyte antigen) typing is the test used to check if the donor and your tissue type are a good fit. Chemotherapy will be given to destroy cancer cells and suppress your immune system from attacking the donor cells.

The transplanted stem cells will form new marrow and attack remaining cancer cells. This attack is known as the GVT (graft-versus-tumor) effect. On the other hand, there is a serious risk of GVHD (graft-versus-host disease). GVHD is when the donated cells see the cells in your body as foreign and attack them.

Complementary and alternative medicine

CAM (complementary and alternative medicine) is a group of treatments that aren’t often given by doctors. There is much interest today in CAM for cancer. Many CAMs are being studied to see if they are truly helpful.

Complementary medicines are treatments given along with usual medical treatments. While CAMs aren’t known to kill cancer cells, they may improve your comfort and well-being. Two examples are acupuncture for pain management and yoga for relaxation.

Alternative medicine is used in place of usual medicine. Some alternative medicines are sold as cures even though they haven’t been proven to work in clinical trials. If there was good proof that CAMs or other treatments cured cancer, they would be included in this book.

It is important to tell your treatment team if you are using any CAMs. They can tell you which CAMs may be helpful and which CAMs may limit how well medical treatments work.
Clinical trials

One of your treatment choices may be to join a clinical trial. Joining a clinical trial is strongly supported. NCCN believes that you will receive the best management in a clinical trial.

New tests and treatments aren’t offered to the public as soon as they’re made. They first need to be studied. A clinical trial is a type of research that studies a test or treatment in people.

Clinical trials study how safe and helpful tests and treatments are for people. When found to be safe and helpful, they may become tomorrow’s standard treatment. Because of clinical trials, the tests and treatments in this book are now widely used to help people with lymphoma. Future tests and treatments that may have better results will depend on clinical trials.

New tests and treatments go through a series of clinical trials. These trials aim to ensure they’re safe and work. Without clinical trials, there is no way to know if a test or treatment is safe or helpful. Clinical trials have four phases. Some examples of the four phases for treatment are:

- **Phase I trials** aim to find the safest and best dose of a new drug. Another aim is to find the best way to give the drug with the fewest side effects. These trials often involve about 20 people.

- **Phase II trials** assess if a drug works for a specific type of cancer. These trials often involve 20 to 100 people.

- **Phase III trials** compare a new drug to a standard treatment head-to-head. These trials often involve hundreds or thousands of people.

- **Phase IV trials** test drugs approved by the U.S. FDA (Food and Drug Administration) to learn more about side effects with long-term use.

Joining a clinical trial has benefits. First, you’ll have access to the most current cancer care. However, please note that it is unknown how well new treatments work if at all. Second, you will receive the best management of care. Third, the results of your treatment—both good and bad—will be carefully tracked. Fourth, you may help other people who will have cancer in the future.

Clinical trials have risks, too. Like any test or treatment, there may be side effects. Also, new tests or treatments may or may not improve your health. In fact, your health may worsen during a trial. Other downsides may include more hospital trips, paperwork, and extra costs for you.

To join a clinical trial, you must meet the conditions of the study. Patients in a clinical trial are often alike in terms of their cancer and general health. Thus, if patients improve, it’s because of the treatment and not because of differences between them.

To join, you’ll need to review and sign an informed consent form. This form describes the study in detail. The study’s risks and benefits should be described and may include others than those described above.

Ask your treatment team if there is an open clinical trial that you can join. There may be clinical trials where you’re getting treatment or at other treatment centers nearby. You can also find clinical trials through the websites listed in Part 5.
Overview of cancer treatments

Review

- Immunotherapy improves your body’s ability to find and destroy cancer cells.

- Immunomodulators treat lymphoma by modifying your immune system and by other means.

- Chemotherapy stops the life cycle of cancer cells so they can’t increase in number.

- Some steroids have anti-lymphoma effect and may be used with chemotherapy.

- Targeted therapy helps kill lymphoma cells by stopping key molecules within the cells.

- Radiation therapy for mantle cell lymphoma uses high-energy x-rays to kill cancer cells within and near to lymph nodes.

- A blood stem cell transplant treats lymphoma by giving a person healthy blood stem cells.

- Clinical trials give people access to new tests and treatments that otherwise can’t usually be received. These new tests and treatments may in time be approved by the FDA.

My first chemo was rather harsh. The second chemo was was so much easier. That is the progress of newer, better chemo drugs.

– Scott
Survivor, Relapsed at age 60
4

Treatment guide

37 Watch and wait
38 Stage I and limited stage II
42 Extensive stage II and stages III-IV
45 Review
Part 4 is a guide to the treatment options for mantle cell lymphoma. It starts with explaining a rare “watch and wait” approach. Then, treatment options by stage are listed. Your doctor may suggest other options based on your health and wishes. Fully discuss your options with your doctor.

Watch and wait

There are rare times when mantle cell lymphoma does not need to be treated right away. Instead, a “watch and wait” approach can be started. Watch and wait is a period of close observation to see if the cancer grows and treatment is needed.

Watch and wait may be an option for mantle cell lymphoma that isn’t causing symptoms. It is more likely an option if you have a good performance score and the cancer prognosis is fairly good.

Watch and wait may also be an option for slow-growing mantle cell lymphoma. As described in Part 1, these cancers have mutations in the IGHV region genes and often have low or absent SOX11 levels.
Stage I and limited stage II

Guide 4 lists treatment options for stage I and limited stage II cancers. These cancers are rare. They are either above or below the diaphragm. If the cancer is in more than one cluster of lymph nodes, it is confined to a small area. More research is needed to learn what treatments are best.

First-line treatment
Two options are advised by NCCN experts. The first option is immunochemotherapy. Radiation therapy may follow. The second option is radiation therapy alone. Radiation therapy appears to be a good treatment for limited mantle cell lymphomas.

For first-line treatment, immunochemotherapy options are divided into two groups. Less toxic treatments include drugs that are less likely to harm your body than other drugs. Less toxic treatments are for people who are: 1) 70 years of age and older; and 2) younger than 70 years but who have serious health problems in addition to cancer. Some doctors use a younger age to decide who can have more or fewer toxic drugs.

More toxic treatments include drugs that can cause severe side effects. However, the lymphoma doesn’t come back for some time. These drugs are for people younger than age 70, who have good health other than cancer.

Supportive care
During and after cancer treatment, you may be treated to prevent or control other health conditions. Such actions are a part of supportive care. Health conditions that are a concern for some people include TLS, reactivated viruses, and other infections. Talk to your doctor about which health conditions you may develop as a result of cancer treatment.

Treatment response
At the end of treatment, you will receive an imaging test to check the results. Imaging may be done with CT or PET/CT. If there are no signs of cancer, you may start follow-up care. If there are signs of cancer, read Guide 6 for options.

Guide 4. First-line treatment

What are the options?

- Immunochemotherapy ± radiation therapy

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<td>◦ Lenalidomide + rituximab</td>
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<td>◦ Modified R-Hyper-CVAD</td>
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- Radiation therapy alone

NCCN Guidelines for Patients®: Mantle Cell Lymphoma, 2017
Primer on first-line drug regimens

Combinations of drugs are almost always used to treat mantle cell lymphomas. These combination regimens can be complex. Below, the first-line regimens that are listed in Part 4 are briefly described. Ask your treatment team for more information.

**Bendamustine + rituximab**, or BR, is given for up to 6 cycles. Each cycle is 28 days long.

**CALGB 59909** is a series of treatments, which includes:

- Two or three cycles of R-M-CHOP (rituximab, methotrexate, cyclophosphamide, doxorubicin, vincristine, prednisone);
- One cycle of etoposide, cytarabine, and rituximab;
- One cycle of high-dose carmustine, etoposide, and cyclophosphamide followed by autologous stem cell transplant;
- Rituximab maintenance weekly for two weeks.

**Cladribine + rituximab** is given for up to 6 cycles. Each cycle is 28 days long.

**Lenalidomide + rituximab** is given for 12 cycles. Each cycle is 28 days long.

**Modified R-Hyper-CVAD** is given for up to 6 cycles. Each cycle is 28 days long. This regimen is given only to people older than 65 years. No methotrexate or cytarabine is received. Rituximab maintenance is received weekly for 4 weeks then repeated every 6 months for two years.

**NORDIC** is a 6-cycle regimen. Each cycle is 21 days long. Cycle 1 consists of maxi-CHOP (dose-intensified cyclophosphamide, vincristine, doxorubicin, prednisone) and cycles 3 and 5 consist of maxi-CHOP with rituximab. Cycles 2, 4, and 6 consist of rituximab and high-dose cytarabine.

**RCHOP** is given for up to 6 cycles. Each cycle is 28 days long. RCHOP consists of rituximab, cyclophosphamide, doxorubicin, vincristine, and prednisone.

**RDHAP** is a 4-cycle regimen. Each cycle is 21 days long. RDHAP consists of rituximab, dexamethasone, cisplatin, and cytarabine.

**RCHOP/RDHAP** is a 6-cycle regimen. Each cycle is 21 days long. Cycles 1 and 2 consist of CHOP (cyclophosphamide, doxorubicin, vincristine, prednisone). Cycle 3 consists of RCHOP. Cycles 4–6 consist of RDHAP.

**RCHOP/RICE** is a 6- or 7-cycle regimen. Each cycle is 21 days long. The first 4 cycles consist of RCHOP. You may then receive two or three cycles of RICE (rituximab, ifosfamide, carboplatin, etoposide).

**R-Hyper-CVAD** is an 8-cycle regimen. Each cycle is 21 days long. Cycles 1, 3, 5, and 7 consist of rituximab, cyclophosphamide, vincristine, doxorubicin, and dexamethasone. Cycles 2, 4, 6, and 8 consist of rituximab, high-dose methotrexate, and cytarabine.
Follow-up care
Guide 5 lists follow-up care for when there are no signs of cancer after treatment. This care may include a medical history, physical exam, imaging, and blood tests. A test schedule is listed in the Guide. However, these tests may be done whenever there are signs or symptoms of cancer. A biopsy is often needed to confirm there’s cancer. If the cancer returns (relapse), read Guide 6 for options.

Second-line treatment
Guide 6 lists options for second-line treatment. These options are used if first-treatment didn't work. They are also used if the lymphoma reappears on tests. Options are based on your prior treatment.

Prior immunotherapy ± radiation therapy
You may have three options. One option is a clinical trial of new drugs or of a stem cell transplant. The second option is radiation therapy if you didn’t receive it before. The third option is a drug regimen listed in the Guide, or sometimes a regimen for diffuse large B-cell lymphoma is tried.

Prior radiation therapy only
Your first-line treatment may have consisted only of radiation therapy. In this case, you may be able to join a clinical trial. The other option is immunotherapy. Read Guide 7 for options.
### Guide 5. Follow-up care

<table>
<thead>
<tr>
<th>Type of care</th>
<th>How often is this care needed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical history, physical exam, blood counts, lactate dehydrogenase, metabolic panel, imaging</td>
<td>• Every 3–6 months for 5 years</td>
</tr>
<tr>
<td></td>
<td>◦ If normal, then repeat every year or when needed</td>
</tr>
</tbody>
</table>

### Guide 6. Second-line treatment

<table>
<thead>
<tr>
<th>Prior first-line treatment</th>
<th>What are the options?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunochemotherapy ± radiation therapy</td>
<td>• Clinical trial</td>
</tr>
<tr>
<td></td>
<td>• Radiation therapy</td>
</tr>
<tr>
<td></td>
<td>• Drug treatment</td>
</tr>
<tr>
<td></td>
<td>◦ Bendamustine ± rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Bendamustine, bortezomib, and rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Bortezomib ± rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Cladribine + rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Ibrutinib</td>
</tr>
<tr>
<td></td>
<td>◦ Ibrutinib, lenalidomide, rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Lenalidomide ± rituximab</td>
</tr>
<tr>
<td></td>
<td>◦ Venetoclax</td>
</tr>
<tr>
<td>Radiation therapy only</td>
<td>• Clinical trial</td>
</tr>
<tr>
<td></td>
<td>• Immunochemotherapy (see Guide 7)</td>
</tr>
</tbody>
</table>
Extensive stage II and stages III–IV

Guide 7 lists options for extensive stage II and stages III and IV. These lymphomas involve a large area either above or below the diaphragm, are on both sides of the diaphragm, or have widely spread outside the lymphatic system.

Without blood stem cell transplant
You may be unable to receive a stem cell transplant. In this case, a clinical trial is an option. Another option is immunochemotherapy that is not too harsh on the body.

Imunochemotherapy
Options are listed in Guide 7. They are for people who are 1) 70 years of age and older; and 2) younger than 70 years but who have serious health problems in addition to cancer. Some doctors use a younger age to decide who should receive these drugs. These regimens are further explained on page 39.

Supportive care
During and after cancer treatment, you may be treated to prevent or control other health conditions. Such actions are a part of supportive care. Health conditions that are a concern for some people include TLS, reactivated viruses, and other infections. Talk to your doctor about which health conditions you may develop as a result of cancer treatment.

Treatment response
CT or PET/CT will be used to assess the results of immunochemotherapy. If there are no signs of the cancer, you may join a clinical trial. Another option may be rituximab. It is received every 8 to 12 weeks for 2 years or sometimes longer.

There may be less cancer after treatment. In this case, a second-line treatment may be received. The goal is to fully treat the cancer so there are no cancer signs with imaging.

The cancer may be the same or worse after immunochemotherapy. In this case, read Guide 9 for options.

With blood stem cell transplant
You may be able to receive a stem cell transplant. In this case, a clinical trial is an option. Another option is immunochemotherapy followed by an autologous blood stem cell transplant. This option is for people who are typically younger than age 70 and who have good health other than cancer. Immunotherapy regimens are further explained on page 39.

Supportive care
During and after cancer treatment, you may be treated to prevent or control other health conditions. Such actions are a part of supportive care. Health conditions that are a concern for some people include TLS, reactivated viruses, and other infections. Talk to your doctor about which health conditions you may develop as a result of cancer treatment.

Treatment response
CT or PET/CT will be used to assess the results of immunochemotherapy. If the cancer can’t be seen, you may join a clinical trial or have an autologous stem cell transplant. After the transplant, you may re-start rituximab. It is received every 8 to 12 weeks for 2 years or sometimes longer.

There may be less cancer after treatment. In this case, a second-line treatment may be received. The goal is to fully treat the cancer so a stem cell transplant is an option.

The lymphoma may be the same or worse after immunochemotherapy. In this case, read Guide 9 for options.
Guide 7. First-line treatment

**Without blood stem cell transplant**

<table>
<thead>
<tr>
<th>Immunochemotherapy</th>
<th>Results</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bendamustine + rituximab</td>
<td>No signs of cancer</td>
<td>• Clinical trial</td>
</tr>
<tr>
<td>• VR-CAP</td>
<td></td>
<td>• Consider rituximab maintenance</td>
</tr>
<tr>
<td>• Cladribine + rituximab</td>
<td>Cancer looks smaller</td>
<td>• Consider second-line treatment</td>
</tr>
<tr>
<td>• RCHOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lenalidomide + rituximab</td>
<td>Cancer looks the same or larger</td>
<td>• Read Guide 9</td>
</tr>
<tr>
<td>• Modified R-Hyper-CVAD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**With blood stem cell transplant**

<table>
<thead>
<tr>
<th>Immunochemotherapy</th>
<th>Results</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CALGB 59909</td>
<td>No signs of cancer</td>
<td>• Clinical trial</td>
</tr>
<tr>
<td>• R-Hyper-CVAD</td>
<td></td>
<td>• Autologous stem cell transplant with rituximab maintenance</td>
</tr>
<tr>
<td>• NORDIC</td>
<td>Cancer looks smaller</td>
<td>• Consider second-line treatment</td>
</tr>
<tr>
<td>• RCHOP/RDHAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• RDHAP</td>
<td>Cancer looks the same or larger</td>
<td>• Read Guide 9</td>
</tr>
<tr>
<td>• RCHOP/RICE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Guide 8. Follow-up care

<table>
<thead>
<tr>
<th>Type of care</th>
<th>How often is this care needed?</th>
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</thead>
<tbody>
<tr>
<td>Medical history, physical exam, blood counts, lactate dehydrogenase, metabolic panel, imaging</td>
<td>• Every 3–6 months for 5 years  ◦ If normal, then repeat every year or when needed</td>
</tr>
</tbody>
</table>

**Follow-up care**

**Guide 8** lists follow-up care for when there are no signs of cancer after treatment. This care may include a medical history, physical exam, imaging, and blood tests. A test schedule is listed in the Guide. However, these tests may be done whenever there are signs or symptoms of lymphoma. A biopsy is often needed to confirm there’s cancer. If the cancer returns (relapses), read **Guide 9** for options.
Second-line treatment

Guide 9 lists options for second-line treatment. These options are used if first-treatment didn't work. They are also used if the lymphoma reappears on tests. The best treatment approach is unknown. More research is needed.

One option is to join a clinical trial of new drugs or a stem cell transplant. A second option is radiation therapy if you have not received it before. The third option is a drug regimen listed in Guide 9. Sometimes, a regimen for diffuse large B-cell lymphoma is tried.

If the lymphoma is fully treated, your doctor may suggest a blood stem cell transplant. An allogeneic transplant is an option. You must be fairly healthy to have this treatment.


<table>
<thead>
<tr>
<th>What are the options?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Clinical trial</td>
</tr>
<tr>
<td>• Radiation therapy</td>
</tr>
<tr>
<td>• Drug treatment</td>
</tr>
<tr>
<td>• Bendamustine ± rituximab</td>
</tr>
<tr>
<td>• Bendamustine, bortezomib, and rituximab</td>
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</tr>
<tr>
<td>• Lenalidomide ± rituximab</td>
</tr>
<tr>
<td>• Venetoclax</td>
</tr>
</tbody>
</table>
Review

- Treatment options for mantle cell lymphoma are based on the cancer stage and your health.

- For stage I and limited stage II cancers, options for first-line treatments are immunochemotherapy with or without radiation therapy and radiation therapy alone.

- Joining a clinical trial is an option if you have extensive stage II or stage III or IV cancer. Besides a clinical trial, most of these cancers are treated with immunochemotherapy alone. If your body can endure severe side effects, you may receive immunochemotherapy followed by a stem cell transplant.

- During and after cancer treatment, you may be treated to prevent or control other health conditions. Such actions are a part of supportive care.

- Follow-up care is for cancers that were fully treated. Your doctor will look for signs of cancer growth. If tests suggest cancer growth, more treatment will be needed.

- If immunochemotherapy doesn’t work as planned or the cancer returns, there are multiple treatment options. You may join a clinical trial, receive radiation therapy if not received before, or start a drug regimen that is advised by NCCN experts.
5 Making treatment decisions

47 It’s your choice
47 Questions to ask your doctors
52 Deciding between options
53 Websites
53 Review
Making treatment decisions

It's your choice | Questions to ask

Having cancer is very stressful. While absorbing the fact that you have cancer, you have to learn about tests and treatments. In addition, the time you have to accept a treatment plan feels short. Parts 1 through 4 described the cancer and treatment options. Part 5 aims to help you make decisions that are in line with your beliefs, wishes, and values.

It's your choice

The role each person wants in choosing his or her treatment differs. You may feel uneasy about making treatment decisions. This may be due to a high level of stress. It may be hard to hear or know what others are saying. Stress, pain, and drugs can limit your ability to make good decisions. You may feel uneasy because you don’t know much about cancer. You’ve never heard the words used to describe cancer, tests, or treatments. Likewise, you may think that your judgment isn’t any better than your doctors’.

Letting others decide which option is best may make you feel more at ease. But, whom do you want to make the decisions? You may rely on your doctors alone to make the right decisions. However, your doctors may not tell you which option to choose if you have multiple good options. You can also have loved ones help. They can gather information, speak on your behalf, and share in decision-making with your doctors. Even if others decide which treatment you will receive, you still have to agree by signing a consent form.

On the other hand, you may want to take the lead or share in decision-making. Most patients do. In shared decision-making, you and your doctors share information, weigh the options, and agree on a treatment plan. Your doctors know the science behind your plan but you know your concerns and goals. By working together, you are likely to get a higher quality of care and be more satisfied. You’ll likely get the treatment you want, at the place you want, and by the doctors you want.

Questions to ask your doctors

You may meet with experts from different fields of medicine. Strive to have helpful talks with each person. Prepare questions before your visit and ask questions if the person isn’t clear. You can also take notes and get copies of your medical records.

It may be helpful to have your spouse, partner, family member, or a friend with you at these visits. A patient advocate or navigator might also be able to come. They can help to ask questions and remember what was said. Suggested questions to ask are listed on the following pages.
What’s my diagnosis and prognosis?

It’s important to know that there are different types of cancer. Cancer can greatly differ even when people have a tumor in the same organ. Based on your test results, your doctor can tell you which type of cancer you have. He or she can also give a prognosis. A prognosis is a prediction of the pattern and outcome of a disease. Knowing the prognosis may affect what you decide about treatment.

1. Where did the cancer start? In what type of cell? Is this cancer common?
2. What is the cancer stage? Does this stage mean the cancer is advanced?
3. Is this a fast- or slow-growing lymphoma?
4. What tests do you recommend for me?
5. Where will the tests take place? How long will the tests take and will any test hurt?
6. What if I am pregnant?
7. How do I prepare for testing?
8. Should I bring a list of my medications?
9. Should I bring someone with me?
10. How often are these tests wrong?
11. Would you give me a copy of the pathology report and other test results?
12. Who will talk with me about the next steps? When?
What are my options?

There is no single treatment practice that is best for all people. There is often more than one treatment option along with clinical trial options. Your doctor will review your test results and recommend treatment options.

1. What will happen if I do nothing?

2. Can I just carefully monitor the cancer?

3. Do you consult NCCN recommendations when considering options?

4. Are you suggesting options other than what NCCN recommends? If yes, why?

5. Do your suggested options include clinical trials? Please explain why.

6. How do my age, health, and other factors affect my options? What if I am pregnant?

7. Which option is proven to work best?

8. Which options lack scientific proof?

9. What are the benefits of each option? Does any option offer a cure or long-term cancer control? Are my chances any better for one option than another? Less time-consuming? Less expensive?

10. What are the risks of each option? What are possible complications? What are the rare and common side effects? Short-lived and long-lasting side effects? Serious or mild side effects? Other risks?

11. How do you know if treatment is working?

12. What are my options if my treatment stops working?

13. What can be done to prevent or relieve the side effects of treatment?
What does each option require of me?

Many patients consider how each option will practically affect their lives. This information may be important because you have family, jobs, and other duties to take care of. You also may be concerned about getting the help you need. If you have more than one option, choosing the option that is the least taxing may be important to you:

1. Will I have to go to the hospital or elsewhere? How often? How long is each visit?

2. What do I need to think about if I will travel for treatment?

3. Do I have a choice of when to begin treatment? Can I choose the days and times of treatment?

4. How do I prepare for treatment? Do I have to stop taking any of my medicines? Are there foods I will have to avoid?

5. Should I bring someone with me when I get treated?

6. Will the treatment hurt?

7. How much will the treatment cost me? What does my insurance cover?

8. Will I miss work or school? Will I be able to drive?

9. Is home care after treatment needed? If yes, what type?

10. How soon will I be able to manage my own health?

11. When will I be able to return to my normal activities?
What is your experience?

More and more research is finding that patients treated by more experienced doctors have better results. It is important to learn if a doctor is an expert in the cancer treatment he or she is offering.

1. Are you board certified? If yes, in what area?

2. How many patients like me have you treated?

3. How many procedures like the one you’re suggesting have you done?

4. Is this treatment a major part of your practice?

5. How many of your patients have had complications?
Deciding between options

Deciding which option is best can be hard. Doctors from different fields of medicine may have different opinions on which option is best for you. This can be very confusing. Your spouse or partner may disagree with which option you want. This can be stressful. In some cases, one option hasn’t been shown to work better than another. Some ways to decide on treatment are discussed next.

2nd opinion

The time around deciding a treatment is very stressful. People with cancer often want to get treated as soon as possible. They want to make their cancer go away before it spreads farther. While cancer can’t be ignored, usually there is time to think about and choose which option is best for you.

You may wish to have another doctor review your test results and suggest a treatment plan. This is called getting a 2nd opinion. You may completely trust your doctor, but a 2nd opinion about which option is best can help.

Copies of the pathology report, a DVD of the imaging tests, and other test results need to be sent to the doctor giving the 2nd opinion. Some people feel uneasy asking for copies from their doctors. However, a 2nd opinion is a normal part of cancer care.

When doctors have cancer, most will talk with more than one doctor before choosing their treatment. What’s more, some health plans require a 2nd opinion. If your health plan doesn’t cover the cost of a 2nd opinion, you have the choice of paying for it yourself.

If the two opinions are the same, you may feel more at peace about the treatment you accept to have. If the two opinions differ, think about getting a 3rd opinion. A 3rd opinion may help you decide between your options. Choosing your cancer treatment is a very important decision. It can affect your length and quality of life.

Support groups

Besides talking to health experts, it may help to talk to other people who have walked in your shoes. At support groups, you can ask questions and hear about the experiences of other people with lymphoma. Find a support group at the websites listed on page 53.

Compare benefits and downsides

Every option has benefits and downsides. Consider these when deciding which option is best for you. Talking to others can help identify benefits and downsides you haven’t thought of. Scoring each factor from 0 to 10 can also help since some factors may be more important to you than others.
Websites

American Cancer Society
cancer.org/cancer/non-hodgkin-lymphoma

Leukemia & Lymphoma Society
LLS.org/informationspecialists

National Cancer Institute (NCI)
cancer.gov/types/lymphoma

National Coalition for Cancer Survivorship
canceradvocacy.org/toolbox

NCCN for Patients®
nccn.org/patients

Review

▶ Shared decision-making is a process in which you and your doctors plan treatment together.

▶ Asking your doctors questions is vital to getting the information you need to make informed decisions.

▶ Getting a 2nd opinion, attending support groups, and comparing benefits and downsides may help you decide which treatment is best for you.

“LLS provides a number of ways to assist newly diagnosed patients from peer to peer counseling to financial assistance to family support groups.
– Scott
  Survivor, Current age 66
allogeneic blood stem cell transplant
A cancer treatment that replaces blood stem cells with donor stem cells which in turn make a new immune system and attack the lymphoma.

anesthesia
Loss of feeling with or without loss of wakefulness that is caused by drugs.

antibody
A protein made by white blood cells that helps fight off infection. Also called an immunoglobulin.

antigen
Any substance that activates the immune system.

autologous blood stem cell transplant
A cancer treatment that destroys cancer cells with high doses of chemotherapy then rebuilds destroyed bone marrow with your own healthy blood stem cells. Also called an HDT/ASCR (high-dose therapy with autologous stem cell rescue).

B symptoms
Fever, heavy night sweats, and weight loss without dieting caused by B-cell cancers.

B-cell
One of three types of a white blood cell called a lymphocyte.

beta-2 microglobulin
A small protein made by many types of cells.

biopsy
Removal of small amounts of tissue or fluid to be tested for disease.

bone marrow
Soft, sponge-like tissue in the center of most bones where blood cells are made.

bone marrow aspiration
Removal of a small amount of bone marrow that is liquid to test for disease.

bone marrow biopsy
Removal of a small amount of solid bone and bone marrow to test for disease.

cancer stage
Ratings of tumors that suggest the outlook of the disease.

chemotherapy
Drugs that stop the life cycle of cells so they don’t increase in number.

chromosome
Strands of genetic material inside of cells.

chyle
A fatty liquid absorbed from the gut into the lymphatic system.

clinical trial
Research on a test or treatment to assess its safety or how well it works.

colonoscopy
Use of a thin, long tool that is guided into the colon to view or remove tissue.

complete blood count (CBC)
A test of the number of blood cells in a sample.

comprehensive metabolic panel
Tests of up to 14 chemicals in your blood.

computed tomography (CT)
A test that uses x-rays to view body parts.

contrast
A dye put into your body to make clearer pictures during imaging tests.

deoxyribonucleic acid (DNA)
A chain of chemicals inside cells that contains coded instructions for making and controlling cells.

diagnose
To identify a disease.

differential
Measurement of the different types of white blood cells present in a blood sample.

echocardiogram
A test that uses sound waves to make pictures of the heart.
endoscopy
Use of a thin, long tool that is guided into the digestive track to view or remove tissue.

external beam radiation therapy (EBRT)
Treatment with radiation that is delivered by a machine into the body.

fatigue
Severe tiredness despite getting enough sleep that limits one’s ability to function.

fertility specialist
An expert who helps men and women have babies.

flow cytometry
A test that looks at certain substances on the surface of cells to identify the type of cells present.

fluorescence in situ hybridization (FISH)
A lab test that uses special dyes to look for abnormal chromosomes.

four-dimensional computed tomography (4D-CT)
A CT scan that can show the movement of organs.

gastrointestinal (GI) tract
The group of organs through which food passes after being eaten.

gene
Instructions in cells for making and controlling cells.

general anesthesia
A controlled loss of wakefulness from drugs.

germinal center
A short-lived structure that forms within a lymphatic organ in response to germs.

human leukocyte antigen (HLA) typing
A blood test that finds a person’s unique set of proteins on cells.

image-guided radiation therapy (IGRT)
Radiation therapy that uses imaging tests during treatment to better target the tumor.

imaging test
A test that makes pictures (images) of the inside of the body.

immune system
The body’s natural defense against infection.

immunochemotherapy
The use of both chemotherapy and other drugs that trigger a response from the immune system.

immunohistochemistry (IHC)
A test of cancer cells to find specific cell traits involved in abnormal cell growth.

immunomodulator
A type of drug that modifies some parts of the body's disease-fighting system.

intensity-modulated radiation therapy (IMRT)
Radiation therapy that uses small beams of different strengths based on the thickness of the tissue.

involved-site radiation therapy (ISRT)
Treatment with high-energy rays (radiation) that is delivered to lymph nodes and nearby sites with cancer.

karyotype
A test that uses a microscope to examine a cell’s chromosomes.

kinase inhibitor
Cancer treatment that stops the transfer of phosphates, which blocks growth signals to cancer cells.

lactate dehydrogenase
A protein that helps to make energy in cells.

liver
Organ that removes waste from the blood and helps to digest food.

local anesthesia
A controlled loss of feeling in a small area of the body caused by drugs.

lumbar puncture
A procedure in which a thin needle is inserted between the bones of the spine to remove a sample of spinal fluid or give drugs into the spinal fluid.

lymph
A clear fluid containing white blood cells.

lymph node
Small groups of special disease-fighting cells located throughout the body.

lymph vessel
Tube-shaped ducts that carry lymph throughout the body.
lymphatic system
Network in the body that collects and transports a fluid (lymph) and fights germs.

lymphocyte
A type of white blood cell that helps protect the body from illness.

lymphoma
Cancer that begins in white blood cells called lymphocytes that are within the lymphatic system.

magnetic resonance imaging (MRI)
A test that uses a magnetic field and radio waves to make pictures of the insides of the body.

mantle zone
An area within lymph nodes containing B-cells that can’t make antibodies yet.

medical history
All health events and medications taken to date.

monoclonal antibody
Man-made antibodies that attach proteins on cancer cells.

multi-gated acquisition (MUGA) scan
A test of the heart that uses radiation to make pictures.

natural killer (NK) cell
One of three types of a white blood cell called a lymphocyte.

pathologist
A doctor who’s an expert in testing cells to find disease.

performance status
A rating of one’s ability to do daily activities.

physical exam
A review of the body by a health expert for signs of disease.

positron emission tomography (PET)
A test that uses radioactive material to see the shape and function of body parts.

positron emission tomography/computed tomography (PET/CT)
A test that uses radioactive material and x-rays to view the shape and function of organs and tissues.

proton therapy
Radiation therapy that uses protons to treat a disease. Also called hadron therapy.

radiation therapy
The use of radiation to treat cancer.

regional anesthesia
A type of drug used for short-term loss of feeling or awareness in a part of the body without loss of wakefulness.

sedative
A drug that helps a person to relax or go to sleep.

side effect
An unplanned physical or emotional response to treatment.

spleen
An organ to the left of the stomach that helps protect the body from disease.

stem cell transplant
A cancer treatment that destroys bone marrow then replaces it by adding healthy blood stem cells.

steroid
A drug used to reduce redness, swelling, and pain, but also to kill cancer cells.

supportive care
Treatment for the symptoms or health conditions caused by cancer or cancer treatment.

targeted therapy
Drugs that stop the growth process that is specific to cancer cells.

T-cell
One of three types of a white blood cell called a lymphocyte.

three-dimensional conformal radiation therapy (3D-CRT)
Radiation therapy that uses beams that match the shape of the tumor.

thymus
A gland located behind the breastbone.

tonsil
A group of tissue within the throat that contains many white blood cells called lymphocytes and fights germs that enter the mouth and nose.

translocation
The switching of parts between two chromosomes.
tumor lysis syndrome
A condition that occurs when many cancer cells die very quickly and release their contents into the blood, which can damage the kidneys and other organs.

ultrasound
A test that uses sound waves to take pictures of the inside of the body.

uric acid
A chemical that is made and released into the blood when cells and other substances in the body break down.
Acronyms

3D-CRT
three-dimensional conformal radiation therapy

4D-CT
four-dimensional computed tomography

BTK
Bruton's tyrosine kinase

CAM
complementary and alternative medicine

CBC
complete blood count

CNS
central nervous system

CT
computed tomography

DNA
deoxyribonucleic acid

EBRT
external beam radiation therapy

FDA
Food and Drug Administration

FISH
fluorescence in situ hybridization

FNA
fine-needle aspiration

GI
gastrointestinal

GVHD
graft-versus-host disease

GVT
graft-versus-tumor

HDT/ASCR
high-dose therapy with autologous stem cell rescue

HLA
human leukocyte antigen

IFRT
involved-field radiation therapy

IGHV
immunoglobulin heavy-chain variable

IGRT
image-guided radiation therapy

IHC
immunohistochemistry

IMRT
intensity-modulated radiation therapy

ISRT
involved-site radiation therapy

LDH
lactate dehydrogenase

LINAC
linear accelerator

MRI
magnetic resonance imaging

MUGA
multi-gated acquisition

NCCN®
National Comprehensive Cancer Network®

NK cell
natural killer cell

PET
positron emission tomography

TLS
tumor lysis syndrome
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Mantle Cell Lymphoma, 2017

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