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#Reference From NCCN Guidelines

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MDS basics

Myelodysplastic syndromes (MDS) are a rare group of bone marrow disorders. In MDS, the bone marrow does not make enough healthy blood cells. MDS is considered a form of blood cancer. Learn how MDS starts in adults. This will help you plan for treatment.

Blood

Blood is made up of plasma (watery liquid) and cells that float in it. Plasma is the liquid part of the blood, comprised mostly of water. Plasma also contains proteins, hormones, vitamins, and minerals. Blood takes oxygen and nutrients to the tissues, and carries away wastes.

Blood cells

There are 3 types of blood cells:

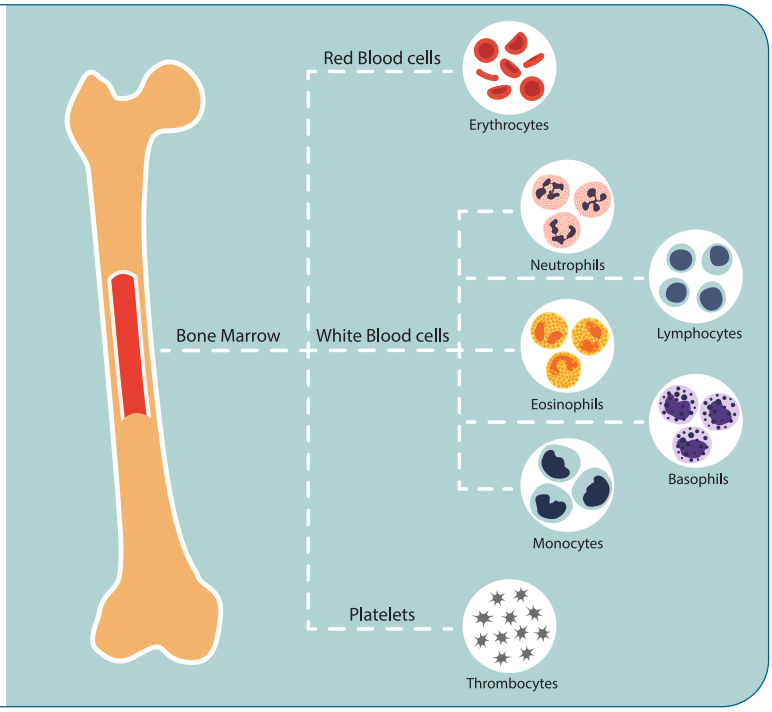
- Red blood cells (erythrocytes)
- White blood cells (leukocytes)
- Platelets (thrombocytes)

Blood cells have important jobs. Red blood cells carry oxygen throughout the body. White blood cells fight infection. Platelets help control bleeding. Normal stem cells grow and divide to make new red blood cells, white blood cells, and platelets.

Blood cells don't live forever. Normal red blood cells live for 3 months. Normal white blood cells live for 8 to 14 days. Normal platelets live for about a week (7 days). After cells reach these ages, they die off and are replaced by new cells. Your blood cells are being replaced in your body all the time.

Blood cell formation

Bone marrow contains stem cells. A blood stem cell is an immature cell that can develop into a red blood cell, white blood cell, or platelet.



Myelodysplastic syndromes

Myelodysplastic syndromes (MDS) are a rare group of bone marrow disorders. In MDS, the body does not make enough healthy blood cells for the bone marrow. Bone marrow is a spongy substance found in the center of the bones. Bone marrow contains parent cells called stem cells. Stem cells can rapidly divide and clone themselves to form new cells.

In MDS, some stem cells are abnormal. Abnormal cells may not develop into normal cells. Instead, abnormal, immature cells crowd out normal cells in the bone marrow.

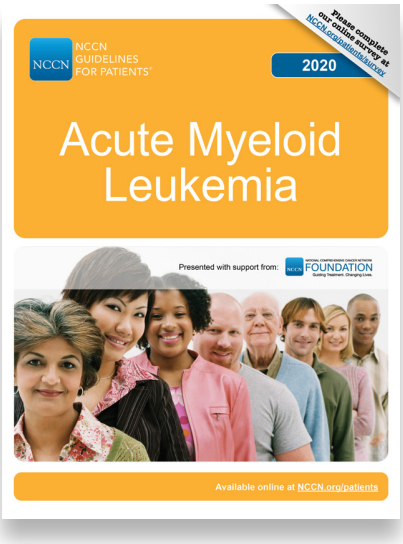
The abnormal cells are different from normal blood cells in a few ways:

- The cells have an abnormal size, shape, or look. This is called dysplasia.
- The cells do not grow into normal, mature blood cells and do not leave the bone marrow, as they should.
- The cells may die too early within the bone marrow or soon after they enter the bloodstream.

This abnormal cell development does not allow the bone marrow to make the healthy cells needed for the body. The abnormal cells can build up and overcrowd the bone marrow. As a result, your body may not make enough red blood cells, white blood cells, or platelets.

MDS may get worse over time. In some cases, it may develop to a fast-growing cancer called acute myeloid leukemia (AML). This occurs when more and more abnormal cells fill up the bone marrow. About 1 out of 3 with MDS, who have other risk factors, may develop AML.

For more information, read the *NCCN Guidelines for Patients: Acute Myeloid Leukemia*, available at NCCN.org/patientguidelines.



Symptoms of MDS

MDS causes low levels of one or more types of blood cells. This is called cytopenia. MDS is often slow-growing, and people may have no early symptoms of the disease. Symptoms of MDS differ depending on the cell type affected.

Anemia

Anemia describes a low number of healthy red blood cells. Red blood cells carry oxygen through the body. Anemia is often the first symptom recognized in a person with MDS. Early on, a person may have mild symptoms or none at all. As the red cell count drops, and the anemia worsens, more symptoms may develop.

You may experience the following if you have a low red blood cell count:

- Feel sleepy or tired
- Loss of appetite
- Pale skin
- Chest pain
- Shortness of breath
- Irregular or rapid heartbeats
- Cold hands and feet

Leukopenia

Leukopenia is caused by a drop in any white blood cells. A low number of white blood cells means there are fewer disease-fighting cells (leukocytes) in your blood.

You may experience the following if you have a low white blood cell count:

- Fever
- Inflammation in and around the mouth
- Frequent infections or infections that don't go away

Neutropenia

Neutropenia (a type of leukopenia) refers to a decrease in neutrophils, the most common type of white blood cell. A low number of white blood cells can lead to frequent or severe infections.

A person with neutropenia may experience:

- Frequent fevers or infections
- Bladder infections that are painful or make you urinate more often
- Lung infections that cause coughing and difficulty breathing
- Mouth sores
- Sinus infections
- Skin infections

Thrombocytopenia

Thrombocytopenia occurs when you have a low number of healthy platelets. Platelets help control bleeding (form clots) and heal wounds. This condition can range from mild to severe. In rare cases, the number of platelets drops so low that internal bleeding occurs. Bleeding that will not stop is considered a medical emergency.

If you have a low platelet count, you may experience:

- Unexplained bruising or bleeding
- Nose bleeds
- Bleeding gums, especially after brushing your teeth
- Tiny, flat red spots under your skin (petechiae)
- Heavier than normal menstrual periods (for women)

Types of MDS

MDS is broken up into groups based on features of the bone marrow and blood cells. These groups are called subtypes. The World Health Organization (WHO) separates MDS into groups based on how the cells within the bone marrow look under a microscope. These include:

- How many red blood cells, white blood cells, or platelets in the bone marrow look abnormal under the microscope (known as dysplasia)
- How many types of low blood cell counts are found (known as cytopenia)
- How many red blood cells contain rings of iron deposits around the center (known as sideroblasts)
- How many very early forms of blood cells are in the bone marrow or blood
- Certain chromosome changes in the bone marrow cells

Based on these factors, the WHO system recognizes 6 main types of MDS. They are described next.

MDS with single lineage dysplasia

Someone with MDS with single lineage dysplasia (MDS-SLD) has low numbers of 1 or 2 types of blood cells, but normal numbers of the other types.

MDS with ring sideroblasts

MDS with ring sideroblasts (MDS-RS) is described as when a person has many red blood cells containing rings of iron deposits (ring sideroblasts). It most often affects older people or people of late middle age. There is an increased risk of developing leukemia with this type of MDS.

This condition is further divided into 2 types (MDS-RS-SLD or MDS-RS-MLD), based on how many of the cell types in the bone marrow are affected by dysplasia. Dysplasia describes abnormal appearance of cells within a tissue or organ.

MDS with multilineage dysplasia

An individual with MDS with multilineage dysplasia (MDS-MLD) has 1 or more cytopenias (one or more blood cell types are lower than they should be) and dysplastic changes in 2 or more of the myeloid lineage (erythroid, granulocytic, and megakaryocytic). Blood and bone marrow are always involved. At least 2 types of blood counts are low and have an abnormal appearance under a microscope (dysplasia). This type of MDS includes childhood MDS, though it is very rare.

MDS with excess blasts

A person with MDS with excess blasts (immature blood cells) has more blasts than normal in the bone marrow, and at least 1 cell type with lower than normal numbers. There may or may not be severe dysplasia in the bone marrow.

This type of MDS is broken up into two types based on the number of excess blasts (MDS-EB 1 and 2). It accounts for about 1 in 4 cases. It is one of the types of MDS most likely to turn into acute myeloid leukemia (AML), with the risk being higher for MDS-EB2 than for MDS-EB1.

MDS, unclassifiable

MDS, unclassifiable (MDS-U) is rare. It most often occurs in older women. You may be classified as having this type if blood and bone marrow test results do not fit any other type of MDS. People diagnosed with this MDS-U have decreased numbers of white blood cells, red blood cells, or platelets.

MDS with isolated del(5q)

Someone with MDS with isolated del(5q) has one abnormal chromosome change in their cells in the bone marrow. This change is called del(5q), which means that part of chromosome 5 is missing (deleted). In some circumstances, one additional abnormal chromosome may be present. Less than 5 percent of cells in the bone marrow are blast cells. This type of MDS is most often found among middle-aged or older women.

For more information on types of MDS, see Guide 1.

Guide 1
Classifications for MDS

MDS	• MDS with single lineage dysplasia (MDS-SLD) • MDS with ring sideroblasts (MDS-RS) • MDS with multilineage dysplasia (MDS-MLD) • MDS with excess blasts-1 (MDS-EB-1) • MDS with excess blasts-2 (MDS-EB-2) • MDS, unclassifiable (MDS-U) • MDS with isolated del(5q) • Refractory cytopenia of childhood (provisional WHO category)
MDS/MPN overlap syndromes	• Chronic myelomonocytic leukemia (CMML)-0 • CMML-1 • CMML-2 • Atypical chronic myeloid leukemia (aCML), *BCR-ABL* negative • Juvenile myelomonocytic leukemia (JMML) • MDS/MPN, unclassifiable (“Overlap syndrome”) • MDS/MPN with ring sideroblasts and thrombocytosis (MDS/MPN-RS-T)
Acute myeloid leukemia (AML)	• See *NCCN Guidelines for Patients: Acute Myeloid Leukemia*
If negative for MDS/AML	• Somatic mutation • Clonal karyotypic abnormality • Marrow dysplasia • Cytopenia

Review

- Blood cells are made in the soft tissue in the center of most bones called bone marrow.
- A blood stem cell is a cell from which all other types of blood cells are made.
- MDS is a group of cancers that affect blood cells in the bone marrow and bloodstream.
- In MDS, the bone marrow makes abnormal blood cells and doesn't make enough healthy, mature blood cells for the body.
- MDS is divided into smaller groups based on the features of the bone marrow and blood cells. These smaller groups are called subtypes.

2
Testing for MDS

Testing is needed to diagnose and treat myelodysplastic syndromes (MDS). This chapter presents an overview of required tests and those you might receive.

General health tests

Medical history

A medical history is a record of all health issues and treatments you have had in your life. Be prepared to list any illness or injury and when it happened. Bring a list of any medicines you take, including over-the-counter medicines, herbals, or supplements. A medical history will help determine which treatment option is best.

Family history

Some cancers and other diseases can run in families. Your doctor will ask about the health history of family members who are blood relatives. This information is called a family history. Before your visit with your doctor, you may want to ask your family members about their health issues like heart disease, cancer, and diabetes and what age they were diagnosed.

Documentation of transfusion

Bring any information you may have on previous transfusions. This will be helpful for your doctor in developing your treatment plan.

Bring a list of any medications, vitamins, over-the-counter drugs, herbals, or supplements you are taking.

Physical exam

A physical exam checks the body for signs of disease.

A health care provider may:

- Check your temperature, blood pressure, pulse, and breathing rate
- Weigh you
- Listen to your lungs and heart
- Look in your eyes, ears, nose, and throat
- Feel and apply pressure to parts of your body to see if organs are of normal size, are soft or hard, or cause pain when touched. Tell your doctor if you feel pain.

A list of necessary and optional testing can be found in Guide 2.

Guide 2 Tests for MDS	
Needed	Medical history and physical exam
	Blood tests • Complete blood count (CBC), platelets, differential, reticulocyte count • Examination of peripheral smear • Serum erythropoietin (prior to red blood cell transfusion) • RBC folate, serum B12 • Serum ferritin, iron, total iron-binding capacity (TIBC) • Thyroid-stimulating hormone (TSH) • Lactate dehydrogenase (LDH)
	Documentation of transfusion history
	Bone marrow aspiration with iron stain and biopsy and cytogenetics by standard karyotyping
Additional testing (may be needed)	Bone marrow sample for fibrosis
	Genetic testing for somatic mutations (acquired mutations)
	Molecular and genetic testing for hereditary hematologic malignancy predisposition
	HIV testing
	Evaluation of copper deficiency
	Distinction from congenital sideroblastic anemia (CSA)

Blood tests

Blood tests check for signs of disease and how well organs are working. They require a sample of blood, which is removed through a needle placed into your vein. The blood sample will then be sent to a lab for testing. At the lab, a pathologist will examine the blood sample with a microscope and perform other tests.

Complete blood count

A complete blood count (CBC) measures the levels of red blood cells, white blood cells, and platelets in your blood. Red blood cells carry oxygen throughout your body, white blood cells fight infection, and platelets control bleeding. A CBC looks for many illnesses including anemia, infections, and leukemia.

Differential

There are 5 types of white blood cells: neutrophils, lymphocytes, monocytes, eosinophils, and basophils. A differential counts the number of each type of white blood cell (WBC). It also checks if the counts are in balance with each other. Your doctor may be able to determine the cause of an abnormal white blood count from this test.

Reticulocyte count

A reticulocyte count is a test to measure the level of reticulocytes in your blood. Reticulocytes are immature red blood cells (RBCs). A reticulocyte count can help your doctor learn if your bone marrow is able to produce red blood cells in response to the development of anemia. The test may also help your doctor find out the cause of anemia.

Anemia is a low number of healthy red blood cells in the bloodstream. The body's normal response to anemia is for the bone marrow to make more reticulocytes. A low reticulocyte count is a sign that the bone marrow isn't working to produce more red blood cells.

Blood smear

In a blood smear test, a drop of blood is placed on a slide so it can be viewed with a microscope. A pathologist will look at cell size, shape, type, and maturity. This test is also used to count the different types of blood cells, which helps to define blood cells that are abnormal in shape or size (dysplasia).

A blood smear test may also be used to check for blast cells in the bloodstream. Although blast cells are normally found in the bone marrow, in some cases of MDS, blast cells may be found in the bloodstream.

Serum erythropoietin

Erythropoietin (EPO) helps to stimulate bone marrow to make more red blood cells. The body makes EPO when it detects a low level of oxygen in red blood cells. By measuring the amount of EPO in the blood, your doctor can help to find out the cause of anemia. People with anemia from MDS typically have an EPO level that is higher than normal.

Iron, ferritin, folate, and vitamin B12

Red blood cells have an important role in carrying oxygen from the lungs to all parts of your body. There are 4 minerals and proteins that help make red blood cells: iron, ferritin, folate, and vitamin B12.

Iron is a mineral found in your cells. Iron is considered essential because it is needed to make hemoglobin. Hemoglobin is the protein in red blood cells that carries oxygen. Ferritin is a protein in your blood that contains iron. A ferritin test will help your provider understand how much iron is in your body. If the blood ferritin test is lower than normal, it indicates an iron deficiency. As a result, you could be anemic. If the ferritin test is higher than normal, it could indicate you are storing too much iron.

Folate and vitamin B12 are nutrients in the body that are needed to make red blood cells. A shortage of folate or B12 can cause anemia.

Assess for thyroid problems

Your thyroid makes hormones to control how fast your body uses energy. Your doctor will test the amount of thyroid-stimulating hormone (TSH) in your blood. A high level of TSH in your blood is a sign that your thyroid is not making enough hormones. If your thyroid does not make enough hormones, it can lead to anemia.

Copper level

Copper is a mineral that helps with many processes in the body. A low level of copper can cause the number of red blood cells and white blood cells to be low. It can also cause blood cells to have an abnormal size, shape, or look. While not a standard test for MDS, it may be done in certain cases to rule out other causes of the abnormal appearance or number of blood cells.

HIV testing

Human immunodeficiency virus (HIV) can cause low blood cell counts. It can also cause blood cells to have an abnormal size, shape, or look. In certain cases, tests may be done to rule out HIV as the cause of these symptoms.

HLA typing

A human leukocyte antigen (HLA) is a protein found on the surface of most cells. It plays an important role in your body's immune response. HLAs are unique to each person. They mark your body's cells. Your body detects these markers to tell which cells are yours. In other words, all your cells have the same set of HLAs. Each person's set of HLAs is called the HLA type or tissue type.

HLA typing is a test that detects a person's HLA type. This test is done before a donor blood stem cell transplant. Your proteins will be compared to the donor's white blood cells to see how many proteins are the same in order to find the best match. A 5 out of 10 or better match is needed for a transplant to be a treatment option. Otherwise, your body will reject the donor cells or the donor cells will react against your body. Blood samples from you and your blood relatives will be tested first.

Flow cytometry

Flow cytometry involves adding a light-sensitive dye to cells. The dyed cells are passed through a beam of light in a machine. The machine measures the number of cells, size and shape of the cells, and proteins on the surface of thousands of cells. In some cases of MDS, this test may be used to identify the specific type of cells present.

Bone marrow tests

Bone marrow will be tested to diagnose and classify the type of MDS. This test may also be repeated to tell if the MDS is responding to treatment or is transforming into acute myeloid leukemia (AML).

There are 2 types of bone marrow tests that are often done at the same time:

- Bone marrow aspiration
- Bone marrow biopsy

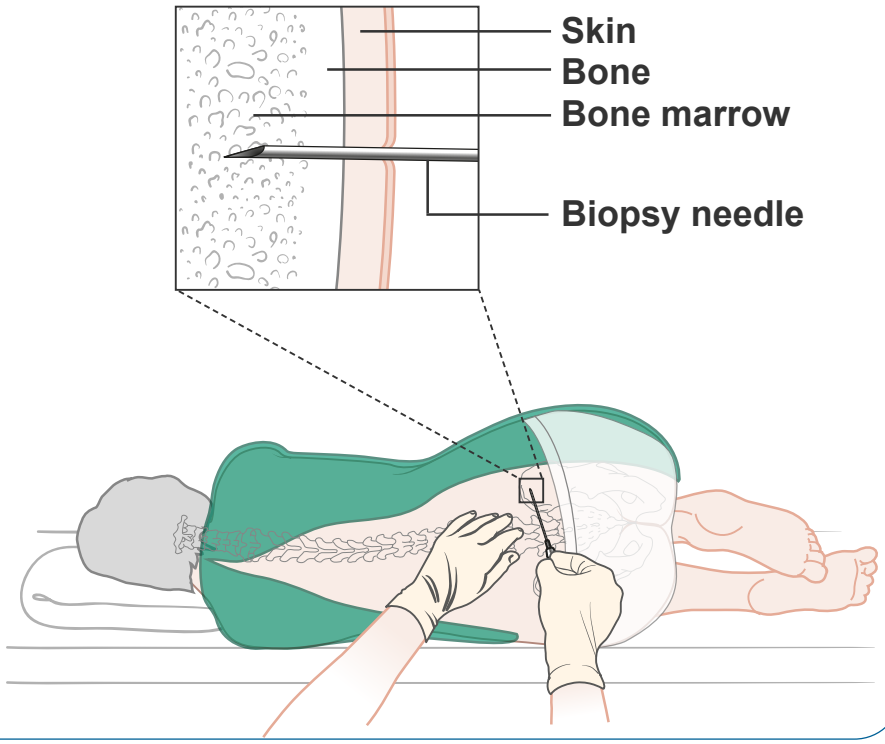
The samples are usually taken from the back of the hip bone (pelvis). Ask your provider about the type of bone marrow test you might have, where the sample will be taken, and if you will be given something to help relax.

Aspiration and biopsy

Bone marrow is like a sponge holding liquid. A bone marrow aspiration takes some of the liquid out of the sponge; a biopsy takes a piece of the sponge. For aspiration, a hollow needle will be pushed through your skin and into the bone. Liquid bone marrow will then be drawn into a syringe. For the biopsy, a needle will be used to remove a core sample. The samples will be sent to a lab for testing. You may feel bone pain at your hip for a few days. Your skin may bruise.

Bone marrow biopsy

Samples of bone and marrow are removed in a biopsy.



https://commons.wikimedia.org/wiki/Category:SVG_bone_marrow_biopsy#/media/File:Diagram_showing_a_bone_marrow_biopsy_CRUK_051.svg Attribution: Cancer Research UK [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)]

Genetic tests

If you are suspected of having MDS, you may receive tests to look for predisposition syndromes. Predisposition syndromes are cell mutations that can lead to other cancers. These tests use samples obtained from the bone marrow aspiration or biopsy.

Inside our cells are deoxyribonucleic acid (DNA) molecules. These molecules are tightly packaged into what is called a chromosome. Chromosomes contain most of the genetic information in a cell. Normal human cells contain 23 pairs of chromosomes for a total of 46 chromosomes. Each chromosome contains thousands of genes. Genes tell cells what to do and what to become.

The following are tests that may be done.

Cytogenetic testing

Cytogenetic testing is the study of chromosomes. Chromosomes are long strands of deoxyribonucleic acid (DNA) and protein that contain most of the genetic information in a cell. Samples of tissue, blood, or bone marrow are tested to look for changes in chromosomes, including broken, missing, rearranged, or extra chromosomes. Cytogenetics may be used to help diagnose a disease or condition, plan treatment, or find out how well treatment is working.

There are many types of chromosome defects. Part of a chromosome, or a whole chromosome, may be missing. Or, there may be an extra copy of a chromosome. Doctors use symbols and shortened terms to describe the different types of chromosome changes. A missing chromosome or missing part of a chromosome is noted by a minus sign (-) or the word “del” for deletion. An extra copy of a chromosome is noted by a plus sign (+).

Examples for MDS include:

- del(5q) and 5q- both mean that the “q” part (long arm) of chromosome 5 is missing
- -7 and del(7) both mean that a copy of chromosome 7 is missing
- +7 means that there is an extra copy of chromosome 7

Half of people with MDS have abnormal chromosomes. The most common abnormal chromosomes are found in chromosomes 5, 7, 8, and 20. Identifying the type and number of chromosome changes helps doctors assess the likely outcome (prognosis) for your MDS. This information can also help guide treatment options.

FISH

Fluorescence in situ hybridization (FISH) is a test that identifies the genetic material in a person’s cells. FISH testing can be done on samples of blood or bone marrow. This test detects specific gene or chromosome changes that are common and known to affect patients with MDS.

Karyotype

A karyotype is a genetic test that produces an image of a person's chromosomes. The test is used to look for abnormal numbers or structures of chromosomes.

Molecular testing

Molecular testing is used to find small changes in genes. It is more sensitive than either karyotype or FISH. Molecular testing can be done on a sample of blood or bone marrow removed from your body.

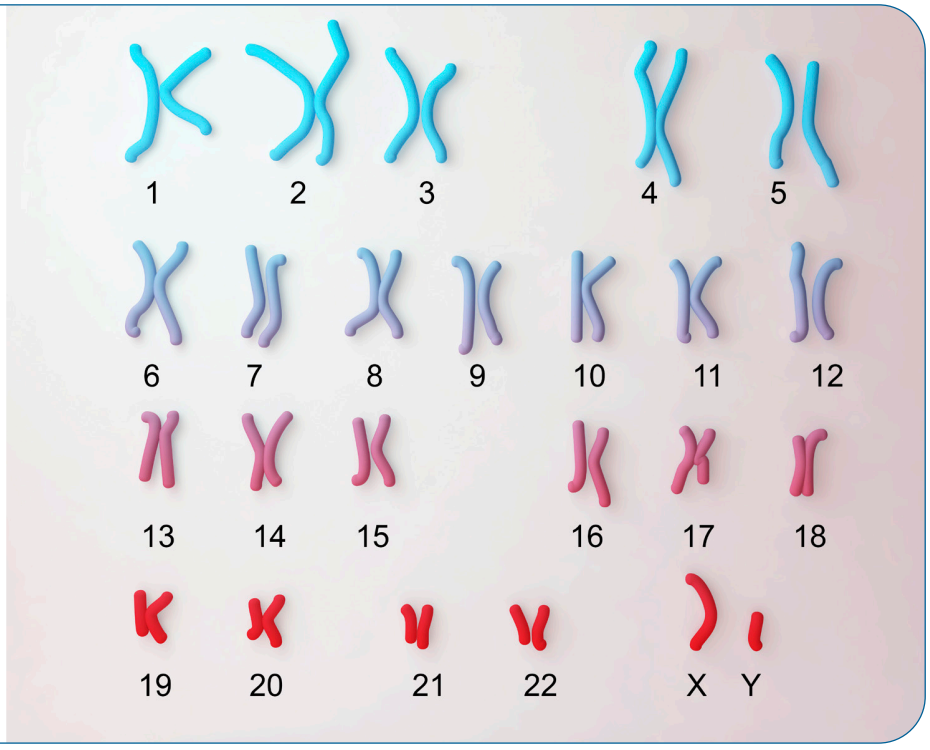
Molecular testing may be done to look for gene mutations (changes).

Recurrent gene mutations

More than 50 different gene mutations have been repeatedly found in people with MDS. These are called recurrent gene mutations. DNA sequencing is a test that can identify mistakes within genes. Doctors use this test to find out which recurrent gene mutations are present in MDS cells. Certain mutations are linked with a better or worse prognosis or can help predict response to different treatments. Thus, doctors may test for these common mutations to help plan treatment.

Karyotype sheet

A karyotype test looks at the size, shape, and number of your chromosomes.



Review

- A medical history, physical exam, and blood tests can reveal signs of cancer.
- A variety of blood tests are done to assess the extent and cause of low blood cell counts.
- A bone marrow biopsy removes a piece of bone and marrow to test for cancer cells. A bone marrow aspiration removes liquid marrow. Bone marrow tests are used to assess the prognosis of MDS.
- Genetic tests check for abnormal changes in the genes and chromosomes of MDS cells. It is common for MDS cells to have genetic mutations (changes).

Create a medical binder

A medical binder or notebook is a great way to organize all of your records in one place.

- Make copies of blood tests, imaging results, and reports about your specific type of cancer. It will be helpful when getting a second opinion.
- Choose a binder that meets your needs. Consider a zipper pocket to include a pen, small calendar, and insurance cards.
- Create folders for insurance forms, medical records, and tests results. You can do the same on your computer.
- Use online patient portals to view your test results and other records. Download or print the records to add to your binder.
- Organize your binder in a way that works for you. Add a section for questions and to take notes.
- Bring your medical binder to appointments. You never know when you might need it!

3
Treating MDS

There is more than one treatment for MDS. This chapter presents an overview of the types of treatment and what to expect. Not everyone will receive the same treatment. Work with your provider to determine the best treatment option for your type of MDS.

Chemotherapy

Chemotherapy (chemo) is a type of drug therapy used to treat cancer. It works by killing fast-growing cells in the body. Chemotherapy is used to destroy cancer cells, but it can also affect normal cells. There are a variety of chemotherapy drugs. Some chemotherapy drugs kill abnormal cells; others stop new ones from being made.

Chemotherapy drugs are liquids that are injected into a vein with a needle, or a pill that is swallowed. In most cases, chemotherapy is given in cycles of treatment days followed by days of rest. This allows the body to recover before the next cycle. Cycles vary in length depending on which chemotherapy is used. You will have tests to see how well treatment is working. You might spend time in the hospital during treatment.

Below are some examples of chemotherapies used to treat MDS:

- Azacitidine (Vidaza®)
- Decitabine (Dacogen®)
- Decitabine-cedazuridine (Inqovi®)

These drugs are a type of chemotherapy called hypomethylating agents. They work by blocking deoxyribonucleic acid (DNA) that helps abnormal cells grow. This helps to “turn on” genes that promote the growth of normal, healthy cells in the bone marrow.

Immunosuppressive therapy

Immunosuppressive therapy (IST) supports the body’s natural defenses to fight MDS. It uses materials made either by the body or in a laboratory to improve, target, or restore immune system function. IST is a type of drug therapy that lowers the body’s immune response to allow bone marrow stem cells to grow and make new blood cells.

Three drug therapies are used to treat MDS:

- Antithymocyte globulin (Atgam®)
- Cyclosporine (Sandimmune®, Neoral®)
- Eltrombopag (Promacta®)

Antithymocyte globulin

Antithymocyte globulin (ATG) is a drug used to treat MDS and aplastic anemia or reduce rejection after a bone marrow transplant. ATG works by decreasing your body’s natural defense (immune system). This allows bone marrow to rebuild its supply of bone marrow stem cells, causing blood counts to go up.

Cyclosporine

Cyclosporine is a drug typically used in combination with ATG to treat acquired aplastic anemia. It is also used to prevent rejection after an organ transplant and to reduce immune response after a bone marrow transplant.

Eltrombopag

Eltrombopag (Promacta®) is a drug used to treat adults with low blood platelet counts due to chronic immune thrombocytopenia (ITP) when other medicines have not worked. The drug increases the growth and development of bone marrow stem cells. It is used for people with low platelet levels who also have aplastic anemia, chronic immune thrombocytopenia, or chronic hepatitis C-associated thrombocytopenia.

Immunomodulators

Lenalidomide

Lenalidomide (Revlimid®) is a drug used to increase hemoglobin levels (the protein in red blood cells that carry oxygen). Lenalidomide is used to treat MDS with cells that are missing part of chromosome 5. This is referred to as "del(5q)." Lenalidomide may reduce or prolong the need for a transfusion for people with MDS with del(5q), as well as those with lower-risk MDS types.

Erythroid maturation agent

An erythroid maturation agent (EMA) is used to treat anemia. Luspatercept-aamt is an erythroid (red blood cell) maturation agent used when erythropoiesis-stimulating agents (ESAs) such as epoetin alfa and darbepoetin alfa are not effective in increasing red blood cell production. Luspatercept-aamt is specifically used in adults with very low- to intermediate-risk myelodysplastic syndromes with ring sideroblasts (MDS-RS) or with myelodysplastic/myeloproliferative neoplasm with ring sideroblasts and thrombocytosis (MDS/MPN-RS-T).

Before starting lenalidomide, be sure to tell your doctor about any other medications you are taking (prescription, over-the-counter, vitamins, herbal remedies, etc.).

Hematopoietic cell transplant

Hematopoietic cell transplant (HCT), also called bone marrow transplant or stem cell transplant, is a type of treatment that destroys cells in the bone marrow then replaces them with new, healthy blood-forming cells from another person. These blood-forming cells are called blood stem cells or hematopoietic stem cells.

Bone marrow is the soft, spongy area in the center of some of the larger bones in your body. The marrow produces all of the different cells that make up the blood, such as red blood cells, white blood cells (of many different types), and platelets. All of the cells of the immune system are also made in the bone marrow. All of these cells develop from a type of cell found in the bone marrow, called a “hematopoietic stem cell.”

The goal of an HCT is to cure cancer by replacing unhealthy blood stem cells with healthy ones. The transplanted healthy cells may also recognize and attack cancer cells. This is done by first suppressing the normal stem cells and cancer cells with chemotherapy. Then, healthy stem cells from another person are infused. The healthy stem cells will expand to form new cells, and potentially attack any remaining cancer cells.

For the treatment of MDS, blood stem cells from a donor are used for the transplant. This is called an allogeneic HCT. Before the transplant, special testing must be done to make sure the donor is a good match for you. Human leukocyte antigen (HLA) typing is used to find a person’s tissue type, called an HLA type.

Treatment steps for allogeneic HCT are described next.

Conditioning treatment

Before the transplant, you will receive either a high-intensity or reduced-intensity chemotherapy. This chemotherapy is referred to as conditioning treatment since it prepares (conditions) your body to receive the donated blood stem cells. The chemotherapy is used to destroy normal cells and cancer cells in your bone marrow. Without this conditioning, your immune system would immediately kill the transplanted blood stem cells.

There are two main types of conditioning treatment that can be used before the HCT. High-dose conditioning consists of high doses of strong (high-intensity) chemotherapy drugs. Reduced-intensity conditioning consists of lower doses of strong chemotherapy drugs or low-intensity drugs. Radiation therapy may also be given as part of the conditioning treatment.

Transplanting stem cells

After the conditioning treatment, the blood stem cells will be put into your body with a transfusion. A transfusion is a slow injection of blood products into a large vein. This process can take several hours to complete.

The transplanted blood stem cells will naturally travel to your bone marrow where they may expand and grow. The transplanted cells will make new, healthy blood cells. This process is called engraftment. It usually takes about 2 to 4 weeks for the transplanted stem cells to establish in the bone marrow and begin to make mature blood cells. During this period, you will be in the hospital. You will also be at higher risk for infection and bleeding. It may take weeks or months for blood cells to fully recover and your immune system to go back to normal.

Clinical trials

Clinical trials study how safe and helpful tests and treatments are for people. Clinical trials find out how to prevent, diagnose, and treat a disease. Clinical trials have allowed doctors to find safe and effective ways to improve your care and treatment of cancer.

Clinical trials have 4 phases.

- **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.
- **Phase II trials** assess if a drug works for a specific type of cancer.
- **Phase III trials** compare a new drug to a standard treatment.
- **Phase IV trials** study the long-term safety and benefit of a treatment after it is approved.

To join a clinical trial, you must meet the conditions of the study. Patients in a clinical trial often are alike in terms of their cancer and general health. This helps to ensure that any change is from the treatment and not because of differences between patients.

If you decide to join a clinical trial, you will need to review and sign a paper called an informed consent form. This form describes the study in detail, including the risks and benefits. Even after you sign a consent form, you can stop taking part in a clinical trial at any time.

Finding a clinical trial

In the United States

NCCN Cancer Centers
NCCN.org/cancercenters

The National Cancer Institute (NCI)
cancer.gov/about-cancer/treatment/clinical-trials/search

Worldwide

The U.S. National Library of Medicine (NLM)
clinicaltrials.gov/

Need help finding a clinical trial?
NCI's Cancer Information Service (CIS)
1.800.4.CANCER (1.800.422.6237)
cancer.gov/contact

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. Discuss the risks and benefits of joining a clinical trial with your care team. Together, decide if a clinical trial is right for you.

Supportive care

Supportive care is the cornerstone of all MDS treatments. Supportive care aims to improve your quality of life by reducing symptoms from low blood counts. It includes care for health issues caused by cancer or cancer treatment. It is sometimes called palliative care.

Supportive care options for MDS are described next and listed in Guide 3.

General health monitoring

All cancer treatments can cause unwanted health issues. Such health issues are called side effects. Side effects depend on many factors. These factors include the drug type and dose, length of treatment, and the person. Some side effects may be harmful to your health. Others may just be unpleasant.

Ask your treatment team for a complete list of side effects of your treatments. Also, tell your treatment team about any new or worsening symptoms. There may be ways to help you feel better and to prevent some side effects.

Quality-of-life assessment

A quality-of-life assessment is used to identify concerns early on such as pain or other problems that may be physical, psychosocial, and spiritual. The assessment has a specific MDS section (QOL-E v.2) that focuses on general well-being and addressing physical, functional, social, sexual, fatigue, and disease-specific factors.

Guide 3
Supportive care options

Monitoring for changes in general health
Psychosocial support
Quality-of-life assessment
Transfusions
Antibiotics for bacterial infections
Aminocaproic acid or other antifibrinolytic agents for bleeding
Iron chelation
Cytokines
G-CSF

Red blood cell transfusion

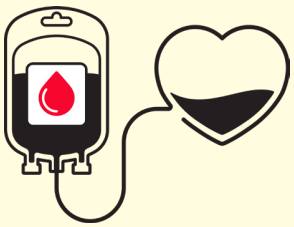
Symptoms of anemia and MDS result in low red blood cell counts causing severe fatigue and shortness of breath, among others. A red blood cell transfusion may be used to increase hemoglobin and iron levels, as well as improving the amount of oxygen in the body. A red blood cell transfusion is a slow injection of red blood cells into a vein. It is used to treat anemia and increase oxygen to tissues.

Platelet transfusion

Platelets help control bleeding by forming clots and healing wounds. Low platelet counts are a common side effect of chemotherapy treatments. Platelet transfusions help increase the number of platelets in your body. A platelet transfusion is a slow injection of platelets into a vein. Since platelets only survive for a few days, platelet transfusions are needed often.

Antibiotics for bacterial infections

Recurrent infections are one of the most common issues with MDS, after anemia. A low level of white blood cells increases your risk of infection. You should speak to your doctor if there are any signs of infection, such as fever, signs of pneumonia (cough, shortness of breath), or urinary tract infection (burning when urinating). You will likely be treated with antibiotics if you have bacterial infections.



Transfusions

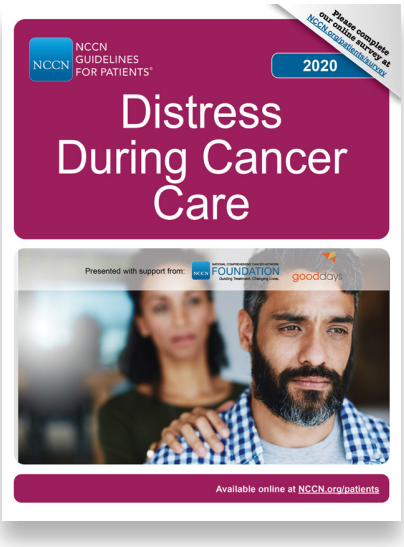
A transfusion is a common procedure to replace blood or blood components (red blood cells or platelets). It is given to you through an intravenous line (IV), a tiny tube that is inserted into a vein with a small needle.

- The whole process can take about 1 to 4 hours, depending on how much blood is needed.
- Most transfusions use blood from a donor. Some choose a family member or friend to donate blood.
- Blood transfusions are usually very safe. Donated blood is carefully tested, handled, and stored.
- Most people's bodies handle blood transfusions very well. But, like any medical procedure, there are some risks. Speak with your doctor for specific information about your risks.
- Chemotherapy can affect how bone marrow makes new blood cells. Some people getting treatment for cancer might need a transfusion of red blood cells or platelets.

Psychosocial support

Distress is normal, common, and expected. Common symptoms include sadness, fear, and helplessness. Distress ranges from mild to extreme levels. Everyone with cancer has some level of distress at some point in time. Some people are more likely to be distressed than others. Those with uncontrolled symptoms, money problems, lack of support, or a history of mental illness are likely to be distressed. People with psychosocial concerns are often helped by social work, counseling, or mental health services.

For more information, read the *NCCN Guidelines for Patients: Distress During Cancer Care*, available at NCCN.org/patientguidelines.



Aminocaproic acid

If bleeding is not helped by transfusions or growth factors (such as darbepoetin alfa), another option might be treatment with an oral drug called an antifibrinolytic agent, such as aminocaproic acid (Amicar).

Iron chelation

While transfusions are helpful in relieving symptoms of MDS or anemia, too many transfusions (usually 20 or more) may cause iron to build up, which can cause organ damage (iron overload). An overload of iron requires a special treatment to remove the excess iron. This is called iron chelation. In iron chelation, drugs called chelating agents are used to bind with the iron so the body can get rid of it.

Consider seeking support from a local support group. There is a list of resources in the Websites section.

Cytokines

Cytokines exist naturally in your body as part of your immune system. They can also be made in a laboratory and used as cancer treatments. Cytokines used to treat MDS include erythropoiesis-stimulating agents (ESAs; darbepoetin alfa and erythropoietin alpha) and colony-stimulating factors (G-CSF or GM-CSF). ESAs are copies of the erythropoietin hormone made by the human kidney. These drugs are used to treat anemia in patients with MDS.

G-CSF

Granulocyte-colony stimulating factors (G-CSF) drive the bone marrow to make additional neutrophils or granulocytes and decrease the risk for infection. This drug can be used with chemotherapy, or before or after stem cell transplant.

Erythropoiesis-stimulating agents

Erythropoiesis-stimulating agents (ESAs) help stimulate the bone marrow to make red blood cells. ESAs are used to treat anemia caused by chemotherapy. They help to decrease the need for blood transfusions. Examples include epoetin alfa (Epogen®, Procrit®) and darbepoetin alfa (Aranesp®). Both are used to treat symptomatic anemia.

Supportive care

Support can come from anywhere. Talk to your care team about any supportive care needs you may have.

Treatment team

Treating cancer takes a team approach. Some members of your care team will be with you throughout cancer treatment, while others will only be there for certain parts of it. Get to know your care team and let them get to know you.

Depending on your diagnosis, your team might include the following specialists:

- **Your primary care doctor** handles medical care not related to cancer. This person can help you express your feelings about treatments to your cancer care team.
- **A pathologist** interprets the cells, tissues, and organs removed during a biopsy or surgery.
- **A diagnostic radiologist** reads the results of x-rays and other imaging tests.
- **An interventional radiologist** performs needle biopsies, ablations, and arterially directed therapies, and places ports for treatment.
- **A surgical oncologist** performs operations to remove cancer.
- **A medical oncologist** treats cancer in adults using systemic therapy. Often, this person will lead the overall treatment team and keep track of tests and exams done by other specialists.
- **A radiation oncologist** prescribes and plans radiation therapy to treat cancer.
- **An anesthesiologist** gives anesthesia, a medicine so you do not feel pain during surgery or procedures.
- **A palliative care specialist** is an expert in the treatment of symptoms caused by the cancer with the goal of improving a patient's quality of life and easing suffering.
- **Advanced practice providers** are registered nurse practitioners and physician assistants who monitor your health and provide care.
- **Oncology nurses** provide hands-on care, like giving systemic therapy, managing your care, answering questions, and helping you cope with side effects.
- **Nutritionists** can provide guidance on what foods or diet are most suitable for your particular condition.
- **Psychologists and psychiatrists** are mental health experts who can help manage issues such as depression, anxiety, or other mental health conditions that can affect how you feel.

Review

- Chemotherapy is used to destroy cancer cells, but it can also affect normal cells.
- Immunotherapy supports the body's natural defenses to fight MDS.
- The goal of a hematopoietic cell transplant (HCT) is to cure cancer by replacing unhealthy blood stem cells with healthy ones that will attack cancer cells.
- Supportive care is the cornerstone of all MDS treatments. Supportive care aims to improve your quality of life by reducing symptoms.
- Distress is normal, common, and expected.
- Get to know your care team and let them get to know you.

4
MDS outlook

There are several known risk factors for myelodysplastic syndromes (MDS), including age, sex, genetics, and smoking among others. This chapter goes into more detail about risk factors and scoring for MDS.

Risk factors

A risk factor is something that increases your chance of developing a disease. If you have been diagnosed with myelodysplastic syndrome (MDS), your provider will consider a number of risk factors when determining the best course of treatment.

Risk factors associated with MDS include:

- Age
- Sex
- Prior treatment(s)
- Genetic syndromes
- Smoking
- Environmental exposures

Risk factors are explained in more detail next.

Age

Age is one of the most important risk factors for MDS. In most cases, MDS is found in people in their 70s or 80s. It is uncommon in people younger than 50 years of age.

Sex

MDS is more common in men than in women. While there is no clear reason for this, it might have something to do with exposure to smoke or chemicals in the past.

Prior treatment(s)

A person treated with certain chemotherapy drugs in the past is more likely to develop MDS later on. This is referred to as secondary MDS or treatment-related MDS. The risk of secondary MDS will vary based on the type and dose of chemotherapy drugs you have received. However, a small percentage of people who are treated with these medicines will develop MDS.

Some of the drugs that can lead to MDS include:

- Mechlorethamine (nitrogen mustard)
- Procarbazine
- Chlorambucil
- Cyclophosphamide
- Ifosfamide
- Etoposide
- Teniposide
- Doxorubicin

Genetic syndromes

Certain inherited syndromes are more likely to develop into MDS. These syndromes are caused by abnormal (mutated) genes that have been passed on from one or both parents (inherited).

Examples of genetic syndromes associated with MDS include:

- Fanconi anemia
- Shwachman-Diamond syndrome
- Diamond Blackfan anemia
- Familial platelet disorder with a propensity to myeloid malignancy
- Severe congenital neutropenia
- Dyskeratosis congenita

Smoking

While most people know smoking can cause lung cancer, it can also cause cancer in other parts of the body. For instance, smoking increases the risk of MDS. Substances found in tobacco smoke are absorbed into the blood as it passes through the lungs. Once in the bloodstream, these substances spread to many parts of the body.

Environmental exposures

High-dose radiation exposure (such as surviving an atomic bomb blast or nuclear reactor accident) increases the risk of developing MDS.

Long-term workplace exposure to benzene and certain chemicals used in the petroleum and rubber industries can also increase the risk of developing MDS.

Severity of the disease

Your provider will use your test results to determine the severity of MDS. The score will be used to develop a treatment plan that is right for you.

Talk to your doctor about your risk score and treatment options.

Hematopoietic stem cell transplant candidate

If you are under 75 years of age and are considered otherwise healthy, you may be able to receive a stem cell transplant (also known as bone marrow transplant). You must have a matched stem cell donor in order to receive a transplant. This person can be a family member or an unrelated volunteer donor.

Scoring and risk groups

Myelodysplastic syndrome (MDS) severity is rated through a scoring system. The score is used to determine the likely outcome (prognosis) of MDS and to help develop a treatment plan. A rating, called a risk score, is used to classify MDS into risk groups. A number of factors are used to classify MDS, including the number and depth of low blood counts, the percent of immature marrow cells (blasts), and type of cytogenetic (chromosome) abnormalities. This section describes the key factors and scoring systems that are used to determine MDS severity.

Prognostic factors

Prognosis is a prediction of the pattern and outcome of a disease. MDS treatment planning includes an assessment of the prognosis for your MDS. A key aspect of the prognosis of MDS is the chance that it will progress to acute myeloid leukemia (AML). There are certain factors related to your blood counts, bone marrow assessment, and karyotype/molecular profile that affect the prognosis of MDS. These are called prognostic factors. These factors will be used to help decide if cancer treatment is needed right away and how intensive treatment needs to be.

Such factors include:

- The MDS subtype
- The number and severity of low blood cell counts (cytopenias)
- The percent of blast cells in the bone marrow
- The type and number of chromosome changes

Some factors are linked with better outcomes or a lower chance that MDS will turn into AML. Other factors are linked with poorer outcomes or a higher chance that MDS will turn into AML. Some factors help to predict the response to treatment. Based on these prognostic factors, a scoring system is used to rate and classify the severity of MDS.

There are three main prognostic scoring systems for MDS:

- IPSS (International Prognostic Scoring System)
- IPSS-R (Revised International Prognostic Scoring System)
- WPSS (WHO classification-based Prognostic Scoring System)

Each scoring system is described next.

IPSS

The IPSS was the first prognostic scoring system to be widely accepted for MDS. It was created almost 20 years ago. Although it is still the most commonly used scoring system, many MDS specialists are moving away from the IPSS and towards the IPSS-R. As a result of these changes, the IPSS-R is better at predicting prognosis than the IPSS.

IPSS-R

The IPSS-R was developed in 2012. It is an updated (revised) version of the original IPSS. A key way the IPSS-R differs is that it scores the types and severity of low blood cell counts. It also scores a wider range of chromosome changes.

IPSS-R classifies MDS into 5 risk groups:

- Very low risk
- Low risk
- Intermediate risk
- High risk
- Very high risk

The low-risk MDS group includes anyone with a risk of very low, low, or intermediate disease. High risk includes those with intermediate risk, high, or very high risk of disease.

WPSS

The WPSS is also a newer scoring system. But, it is not used as often as the IPSS or IPSS-R. A key way the WPSS differs from the other two systems is that it includes the MDS subtype as a prognostic factor. As for low blood cell counts, the WPSS gives a score based on the presence or absence of severe anemia. Like the IPSS-R, this system also has 5 risk groups.

A key point to remember is that these scoring systems and risk groups do not predict how MDS will respond to treatment. They only help predict how MDS may behave over time without treatment.

Review

- MDS is classified into risk groups based on the risk score.
- Doctors use scoring systems to rate the severity of MDS to help plan your treatment.
- A risk score is a rating of the severity of MDS. It describes how slow or fast MDS will likely progress without treatment.
- When planning treatment, doctors look at the risk groups in terms of “lower-risk” MDS and “higher-risk” MDS.

5
Anemia

If you have anemia, your body's cells may not be receiving enough oxygen. There are many forms of anemia, each with its own cause and symptoms. This chapter will provide more information on anemia and potential treatment options.

Overview

Anemia is a condition where your body does not make enough healthy blood cells, resulting in less oxygen being carried to your cells. There are many types and causes of anemia. Mild anemia is a common and treatable condition that can occur in anyone. Anemia may also be a sign of a more serious condition. It may result from chronic bleeding in the stomach, chronic inflammation from an infection, kidney disease, cancer, or an autoimmune disease.

There are different types of anemia, including:

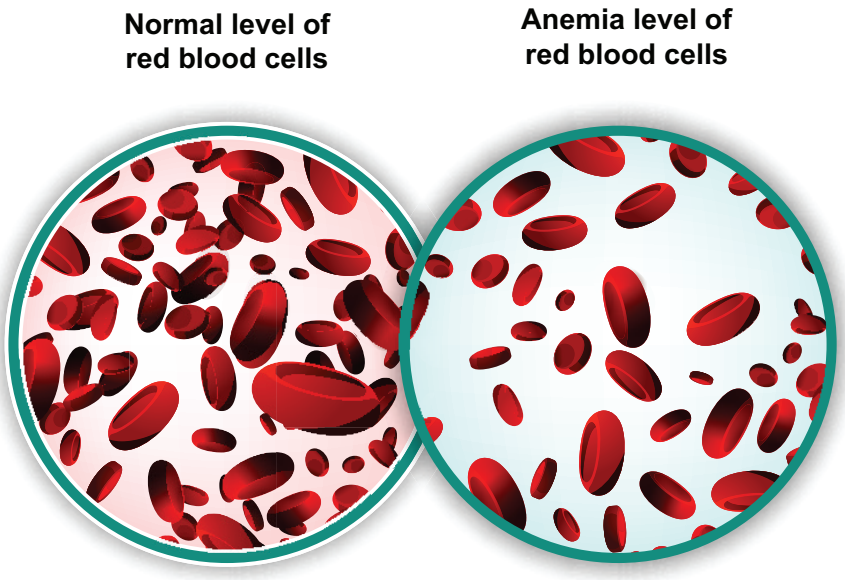
- Anemia associated with bone marrow disease
- Aplastic anemia
- Hemolytic anemia
- Iron deficiency anemia
- Sickle cell anemia
- Vitamin deficiency anemia

Anemia associated with bone marrow disease

Anemia associated with bone marrow disease affects the blood produced in your bone marrow. This anemia includes a variety of diseases, such as leukemia and myelofibrosis.

Anemia

Anemia is a condition where the blood does not have enough healthy red blood cells.



Aplastic anemia
In aplastic anemia normal blood cell production slows or stops. This occurs because bone marrow stem cells are damaged. The number of stem cells also goes down because they are unable to replicate themselves or are being destroyed by a part of the immune system.

Hemolytic anemia
Hemolytic anemia occurs when red blood cells are destroyed faster than bone marrow can replace them. Hemolytic anemia can be acquired in two ways: either you can inherit it, or you can develop it later in life.

Sickle cell anemia
Sickle cell anemia is an inherited and serious condition. It is caused by a defective form of hemoglobin that forces red blood cells to assume an abnormal crescent (moon) shape. The irregular blood cells die too soon, resulting in an ongoing shortage of red blood cells.

Iron deficiency anemia
Iron deficiency anemia is the most common type of anemia. It is caused by a lack of iron in your body. Your bone marrow needs iron to make hemoglobin. Without enough iron, your body can't produce enough hemoglobin for red blood cells.

Vitamin deficiency anemia
Similar to iron, vitamins (folate, vitamin B12, vitamin C) are essential to making healthy red blood cells. Vitamin deficiency anemia can occur if you do not eat enough foods that have folate, vitamin B12, or vitamin C. It can also occur if your body has trouble absorbing or processing these vitamins.

Anemia

Anemia occurs when the body cannot produce enough red blood cells to move oxygen towards tissues and organs.

- Anemia can cause breathing difficulties, cold fingers and toes, pale skin, and frequent headaches.
- Anemia can affect people of all ages, races, and ethnicities. Some types of anemia are very common, and some are very rare.
- Causes of anemia may include blood loss or too few red blood cells. Factors that may cause too few red blood cells include diet, medical conditions, or genetic disorders.
- If the anemia is due to a poor diet, eating more dark leafy green vegetables, nuts, dried fruit and red meat, grains, citrus fruits, and beans may help.
- Anemia symptoms can also be risk factors for other diseases and disorders. This means the anemia could possibly be overlooked or misdiagnosed.
- Work with your doctor to determine the cause of anemia. You are more likely to stay healthy and avoid other serious health conditions in the long run.

Symptoms and testing

Symptoms depend on your specific type of anemia. Mild symptoms can be so mild that they go unnoticed. However, as your body loses more iron and the anemia gets worse, symptoms also increase.

Anemia signs and symptoms may include:

- Fatigue
- Weakness
- Pale skin
- Chest pain, fast heartbeat, or shortness of breath
- Headache, dizziness, or lightheadedness
- Cold hands and feet
- Loss of appetite

If you have symptoms of anemia, your doctor will perform a series of tests to identify the type and severity. For a full list of tests, see Guide 4.

Guide 4
Testing for anemia

Physical exam
Complete blood count (CBC), platelets, differential, reticulocyte count
Examination of peripheral blood smear
Bone marrow aspiration with iron stain, biopsy, and cytogenetics
Serum EPO level
Rule out coexisting causes

Treatment

Your medical history, physical exam, and test results will be used when diagnosing and treating anemia. A blood test will be used to confirm that you have low amounts of red blood cells or hemoglobin. Recommended treatment options can be found in Guide 5.

Healthy eating changes may be suggested to prevent anemia in the future. If you have severe anemia, red blood cell transfusions may be recommended.

del(5q)

MDS that has del(5q) with symptomatic anemia is treated with lenalidomide. Lenalidomide (Revlimid®) is an oral cancer drug used to support immune system function.

If your cancer does not respond to lenalidomide, it will be treated with one of the following:

- Azacitidine (Vidaza®)
- Decitabine (Dacogen®)
- Clinical trial

Guide 5
Symptomatic anemia

No del(5q) with ring sideroblasts less than 15%	If serum EPO is 500 mU/mL or less, options are: • rHu-EPO • Darbepoetin alfa	→	If response, the options are: • Continue EPO • Continue darbepoetin
			If no response, the options are: • Continue EPO or darbepoetin • Consider adding lenalidomide or G-CSF
	If serum EPO is more than 500 mU/mL, then see Guide 6		
No del(5q) with ring sideroblasts 15% or more	If serum EPO is 500 mU/mL or less, options are: • rHu-EPO with G-CSF • Darbepoetin alfa with G-CSF	→	If no response, then treat with luspatercept-aamt
	If serum EPO is more than 500 mU/mL, then treat with: • Luspatercept-aamt	→	If no response, then consider lenalidomide

No del(5q) with ring sideroblasts of less than 15 percent

MDS without del(5q) and ring sideroblasts of less than 15 percent (15%) is treated with recombinant human erythropoietin (rHu-EPO) or darbepoetin alfa. rHu-EPO is used to increase red blood cell production. Darbepoetin alfa is used to treat anemia. You will remain on this treatment if you respond well to it.

If there is no response, your doctor may add lenalidomide or granulocyte colony-stimulating factor (G-CSF). Lenalidomide (Revlimid®) is a chemotherapy drug used to increase hemoglobin levels. G-CSF, known as a colony-stimulating factor, is a glycoprotein that stimulates the bone marrow to produce granulocytes (white blood cells that help the immune system fight off infection) and stem cells.

No del(5q) with ring sideroblasts of 15 percent or more

MDS without del(5q) and ring sideroblasts of 15 percent (15%) or more is treated based on your serum EPO level.

If your serum EPO is 500 mU/mL or less then the treatment options are recombinant human erythropoietin (rHu-EPO) and granulocyte colony-stimulating factor (G-CSF), or darbepoetin alfa and G-CSF. rHu-EPO is used to increase red blood cell production. Darbepoetin alfa is also used to treat anemia by increasing red blood cell production. G-CSF stimulates the bone marrow to produce granulocytes (white blood cells that help the immune system fight off infection) and stem cells. If no response, then you will be treated with luspatercept-aamt.

If your serum EPO is more than 500 mU/mL then you will be treated with luspatercept-aamt (Reblozyl®). Luspatercept-aamt is an erythroid (red blood cell) maturation agent used when erythropoiesis-stimulating agents (ESAs) such as epoetin alfa and darbepoetin alfa are not effective in increasing red blood cell production. Luspatercept-aamt is specifically used in adults with very-low- to intermediate-risk myelodysplastic syndromes with ring sideroblasts (MDS-RS) or with myelodysplastic/myeloproliferative neoplasm with ring sideroblasts and thrombocytosis (MDS/MPN-RS-T).

If there is no response to treatment, then your doctor may consider lenalidomide. Lenalidomide (Revlimid®) is used to support immune system function.

Review

- Anemia is a condition where your body does not make enough healthy blood cells, resulting in less oxygen in your body's cells.
- There are many types and causes of anemia.
- Mild anemia is a common and treatable condition that can occur in anyone.
- Symptomatic anemia in MDS is treated based on the presence of del(5q) or if no del(5q), the number of sideroblasts.

6
Low-risk MDS

There is more than one treatment for low-risk MDS. This chapter presents treatment options based on the type of low-risk MDS.

Overview

Low-risk MDS is slow growing and may not progress to acute myeloid leukemia (AML) for a long time. The goals in treating low-risk MDS are to improve blood cell counts, lessen the need for blood transfusions, and improve quality of life.

If you have very-low-risk, low-risk, or intermediate-risk MDS without symptoms, you may not need treatment right away. Instead, you will have regular check-ups and your blood counts will be monitored. This is referred to as active monitoring or watch and wait.

Low-risk MDS includes the following risk groups:

- IPSS low and intermediate-1
- IPSS-R very low, low, and intermediate
- WPSS very low, low, and intermediate

If you have low-risk MDS, you may not need treatment right away. Speak to your doctor about treatment options.

Treatment

There are multiple treatment options for MDS. Treatment options are based on factors such as the MDS subtype, risk score, as well as your age and health status. The timing, intensity, and goal of treatment differs depending on the risk group.

The best treatment will depend on your:

- Risk group
- Subtype of MDS
- Overall health
- Preferences

Talk to your provider about treatment options based on your type of MDS and its possible risks and benefits.

Low-risk MDS with anemia

If you are diagnosed with cytopenia(s) or with no increase in bone marrow blasts, you will receive supportive care. Supportive care is in addition to your cancer treatment. Supportive care is health care that relieves symptoms caused by cancer or its treatment and improves quality of life. A list of some supportive care options can be found in Guide 3.

Symptomatic anemia with del(5q)

If you are experiencing symptoms with anemia and are found to have MDS with del(5q), treatment will be based on any chromosome changes in the blood cells and the level of erythropoietin (EPO) in the blood. EPO is a hormone produced mainly by the kidneys. It plays a key role in the production of red blood cells (RBCs).

One key chromosome change is when MDS cells are missing part of chromosome 5. This change is called del(5q). If you have del(5q) by itself or with another abnormal chromosome (except chromosome 7), you will be given lenalidomide. Lenalidomide (Revlimid®) is an oral cancer drug used to support immune system function.

Symptomatic anemia with no del(5q)

If no del(5q) chromosome change is found, you will receive serum erythropoietin (EPO). Serum EPO is a hormone that helps to control the creation of red blood cells. For more information on treatment for MDS without del(5q), see Guide 6.

Serum EPO 500 mU/mL or less

MDS with serum EPO of 500 mU/mL or less is treated with recombinant human erythropoietin (rHu-EPO) or darbepoetin alfa. rHu-EPO is used to increase red blood cell production. Darbepoetin alfa is a synthetic form of erythropoietin that is used to treat anemia by increasing red blood cell production. If there is no response to treatment, your doctor may add lenalidomide or granulocyte colony-stimulating factor (G-CSF). Lenalidomide (Revlimid®) is a chemotherapy drug used to increase hemoglobin levels. G-CSF, known as a colony-stimulating factor, is a glycoprotein that stimulates the bone marrow to produce granulocytes (white blood cells that help the immune system fight off infection) and stem cells.

Serum EPO more than 500 mU/mL

MDS with serum EPO more than 500 mU/mL is treated based on the probability of responding to immunosuppressive therapy (IST). IST is used to treat people 60 years of age or under with 5 percent (5%) or less marrow blasts. If there is a good chance for a response to the IST, treatment will include an antithymocyte globulin (ATG) with or without cyclosporin A. ATG is a drug used to treat MDS or reduce rejection after a bone marrow transplant. ATG works by decreasing your body's natural defense (immune system). This allows bone marrow to rebuild its supply of bone marrow stem cells, causing blood counts to go up.

Cyclosporin A is used prevent organ rejection after transplant.

If there is a poor chance of responding to IST, treatment options include:

- Azacitidine (Vidaza®)
- Decitabine (Dacogen®)
- Decitabine-cedazuridine (Inqovi®)
- Lenalidomide (if needed)
- Clinical trial

If there is no response to these treatments, options include a clinical trial, or allo-HCT in some cases. An allogeneic stem cell transplant (allo-HCT) is typically used in treating MDS. In this procedure, a person receives blood-forming stem cells from a donor.

Guide 6
Symptomatic anemia with no del(5q)

Serum EPO 500 mU/mL or less	Treatment options: • Epoetin alfa (rHu-EPO) • Darbepoetin alfa	→ If no response or loss of response, the options are: • rHu-EPO with or without G-CSF or lenalidomide • Darbepoetin alfa with or without G-CSF or lenalidomide	→ If no response after 4 months follow serum EPO 500 mU/mL or more
Serum EPO more than 500 mU/mL	Good probability to respond to IST	→ Treat with ATG with or without cyclosporin A	→ If no response or intolerance, see row below
	Poor probability to respond to IST	→ Treatment options: • Azacitidine • Decitabine • Consider lenalidomide • Clinical trial	→ If no response with 6 cycles of azacitidine or 4 cycles of decitabine or intolerance, the options are: • Clinical trial • Consider allo-HCT in some cases

Low-risk MDS without anemia

If you have thrombocytopenia, neutropenia, or increased marrow blasts you will be treated by azacitidine (Vidaza®), decitabine (Dacogen®), immunosuppressive therapy (IST) in certain cases, or clinical trial. IST is used to treat people aged 60 or under with 5 percent (5%) or less marrow blasts. If there is no response or your disease worsens, your doctor will consider hypomethylating agents (decitabine, azacitidine) if not previously received, a clinical trial, or bone marrow transplant. Hypomethylating agents are a type of chemotherapy that blocks methyl groups from binding to deoxyribonucleic acid (DNA). They turn silenced genes back on, which allow leukemia blasts to mature.

For more information, see Guide 7.

Review

- The goals in treating low-risk MDS are to improve blood cell counts, lessen the need for blood transfusions, and improve quality of life.
- Treatment options are based on factors such as the MDS subtype, risk score, as well as your age and health status.
- Talk to your provider about treatment options based on your type of MDS and the possible risks and benefits.
- If you have symptomatic anemia, treatment options will be based on the presence of del(5q).

Guide 7
Thrombocytopenia, neutropenia, or increased marrow blasts

Treatment options include:
- Azacitidine (preferred)
- Decitabine
- IST
- Clinical trial

→

If disease progression or no response, then:
- Consider hypomethylating agents
- Clinical trial
- Consider HCT

7
High-risk MDS

Overview

People with high-risk MDS are more likely to have problems from the disease and progress to acute myeloid leukemia (AML) in a shorter period of time. The goals of treatment for high-risk MDS are to slow or stop MDS from turning into AML and to help people live longer.

In high-risk MDS, immature cells called blast cells often make up more than 5 percent (5%) of the cells in the bone marrow. People with high-risk disease are more likely to have multiple types of low blood counts (cytopenias), with anemia (low hemoglobin), neutropenia (low white blood cell counts), and/or thrombocytopenia (low platelets). In high-risk MDS, people are more likely to require blood or platelet transfusions and treatment for infections.

High-risk MDS includes the following risk groups:

- IPSS intermediate-2, high
- IPSS-R intermediate, high, and very high
- WPSS high, very high

Treatment

Treatment options for high-risk MDS depend on treatment goals. Treatment goals include potential cure or disease control. If the goal is cure, then an allogeneic hematopoietic cell transplant (allo-HCT) will be recommended. Depending on a person's age and the stage or status of MDS, there may or may not be additional treatment before qualifying for allo-HCT. Treatment options are shown further in Guide 8.

Guide 8
Transplant candidate

If transplant candidate	Treatment options include: • Allo-HCT • Azacitidine followed by allo-HCT • Decitabine followed by allo-HCT • High-intensity chemotherapy followed by allo-HCT	→	If relapse after allo-HCT or no response, then: • Consider allo-HCT or donor lymphocyte infusion • Azacitidine • Decitabine • Clinical trial
If not transplant candidate	Treatment options include: • Azacitidine (preferred) • Decitabine • Decitabine-cedazuridine • Clinical trial	→	If response, treatment will continue If no response or relapse, then: • Clinical trial • Supportive care

Not everyone is a candidate for a stem cell transplant. Treatment options differ based on transplant candidacy.

Transplant candidate

If you are a transplant candidate, treatment options will include:

- Allo-HCT
- Azacitidine followed by allo-HCT
- Decitabine followed by allo-HCT
- Decitabine-cedazuridine (Inqovi®) followed by allo-HCT
- High-intensity chemotherapy followed by allo-HCT

Allogeneic hematopoietic cell transplant

An allogeneic hematopoietic cell transplant (allo-HCT) is used in treating MDS. In this procedure, a person receives blood-forming stem cells from a donor. For best results, the donor's cell type (also known as the HLA type) is matched to the person receiving the transplant. Donors may include a person's brother or sister, parent, or child. Less often, the donor is not related.

When treatment is needed in addition to allo-HCT, azacitidine (Vidaza®) decitabine (Dacogen®), decitabine-cedazuridine (Inqovi®), or high-intensity chemotherapy is used. Azacitidine and decitabine are hypomethylating agents. Hypomethylating agents are a type of chemotherapy that block methyl groups from binding to deoxyribonucleic acid (DNA). They turn silenced genes back on, which allow leukemia blasts to mature.

High-intensity therapy includes intensive induction chemotherapy or allo-HCT. High-intensity chemotherapy refers to the delivery of chemotherapy before definitive surgery or radiation therapy.

Not a transplant candidate

If you are not a candidate for a stem cell transplant, treatment options include:

- Azacitidine (Vidaza®)
- Decitabine (Dacogen®)
- Clinical trial

If there is a response to treatment, the treatment will continue. If there is no response or a relapse, options include a clinical trial or supportive care. A relapse occurs when MDS comes back after treatment. This can happen at any point (weeks, months, or even years) after the first cancer was treated.

Review

- High-risk MDS is more likely to grow faster and progress to acute myeloid leukemia (AML) in a shorter period of time.
- In high-risk MDS, immature cells called blast cells often make up more than 5 percent (5%) of the cells in the bone marrow.
- Treatment options for high-risk MDS depend on treatment goals. Treatment goals include potential cure or disease control.
- An allogeneic hematopoietic cell transplant (allo-HCT) is typically used in treating MDS.

8
MDS/MPN overlap

Overview

Myelodysplastic syndromes (MDS) are a group of diseases where the bone marrow does not make enough healthy mature blood cells (red blood cells, white blood cells, and platelets). In myeloproliferative neoplasms (MPN), the body makes too many of one or more types of blood cells. MDS can overlap with MPN. These are called myeloid disorders. Myeloid disorders have dysplastic (abnormal cells) and proliferative (increase numbers) features. These disorders are not considered as either MDS or MPN, because they have some features of both MDS and MPN.

The following are subtypes of MDS/MPN:

- Chronic myelomonocytic leukemia
- Atypical chronic myelogenous leukemia
- Juvenile myelomonocytic leukemia
- MDS/MPN, unclassifiable
- MDS/MPN with ring sideroblasts and thrombocytosis

CMML

Chronic myelomonocytic leukemia (CMML) is a disease in which too many monocytes (a type of white blood cell) develop in the bone marrow. Some of the cells do not develop into mature white blood cells. The monocytes and immature blood cells (called blasts) crowd out the other cells in the bone marrow so there are not enough red blood cells and platelets.

The World Health Organization (WHO) categorizes CMML into 2 subtypes based on the number of blasts in the blood and bone marrow:

- CMML-1 means that less than 5 percent (5%) of the cells in the blood and less than 10 percent (10%) of the cells in the bone marrow are blasts.
- CMML-2 means that 5 to 19 percent (5% to 19%) of the cells in the blood and 10 to 19 percent (10% to 19%) of the cells in the bone marrow are blasts.

aCML

Atypical chronic myelogenous leukemia (aCML) is a rare disorder where too many blood stem cells in the bone marrow develop into granulocytes (a type of white blood cell). Some of the granulocytes do not mature. The immature cells are called blasts. Gradually the blasts and granulocytes crowd out healthy red blood cells and platelets in the bone marrow.

JMML

Juvenile myelomonocytic leukemia (JMML) is a rare and serious form of childhood leukemia (blood cancer). JMML occurs when too many blood stem cells become white blood cells called monocytes and myelocytes.

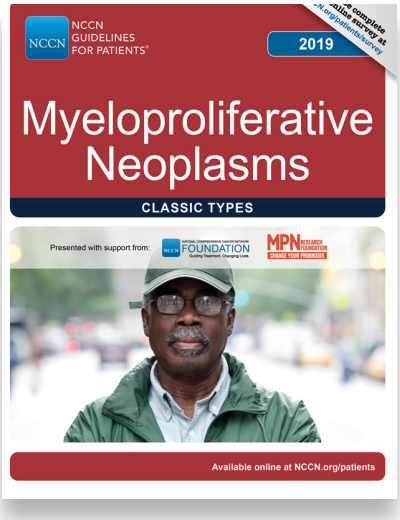
MDS/MPN, unclassifiable

MDS/MPN, unclassifiable (MDS/MPN-UC) is a very rare disorder where too many stem cells in the bone marrow develop into blood cells (red blood cells, white blood cells, or platelets). Some of the blood cells do not mature. The immature blood cells are called blasts. Gradually the blasts and abnormal cells (called MDS/MPN-UC cells) crowd out the healthy blood cells in the bone marrow.

MDS/MPN with ring sideroblasts and thrombocytosis

MDS/MPN with ring sideroblasts and thrombocytosis (MDS/MPN-RS-T) is a disorder where there is a high level of one or more types of blood cells in the blood and bone marrow. In this subtype, at least 15 percent (15%) of immature blood cells in the bone marrow are ring sideroblasts with a platelet count.

For more information on MPN, read the *NCCN Guidelines for Patients: Myeloproliferative Neoplasms*, available at NCCN.org/patientguidelines.



MDS/MPN overlap syndromes

In recent years, it has been recognized that people may show signs of both MDS and MPN. These are referred to as MDS/MPN overlap syndromes.

- MDS represents a group of bone marrow disorders where bone marrow does not produce enough healthy blood cells (often referred to as dysplasia).
- MPN are a group of diseases described as an overproduction of blood cells (often referred to as cell proliferation).
- MDS/MPN overlap describes a specific category of myeloid disorders where cells have both dysplastic and proliferative features.
- The MDS/MPN subtype includes 3 disorders: chronic myelomonocytic leukemia (CMML), juvenile myelomonocytic leukemia (JMML), and atypical chronic myeloid leukemia (aCML).
- Goals of therapy in MDS/MPN overlap syndrome include cure, reduction of symptoms, improvement of blood counts, and limiting the disease from getting worse.

Treatment

Treatment options vary based on the subtype of MDS/MPN disorder. Options range from observation, to hypomethylating agents (HMAs) such as azacitidine and decitabine, and allogeneic hematopoietic cell transplant (allo-HCT).

For information on specific subtypes and their treatment options, see Guide 9.

Guide 9
MDS/MPN overlap management

Subtype	Common mutations	Treatment
CMML-0	*TET2, SRSF2, ASXL1, RUNX1, NRAS, CBL*	→ Observation
CMML-1	*TET2, SRSF2, ASXL1, RUNX1, NRAS, CBL*	→ Consider HMA
CMML-2	*TET2, SRSF2, ASXL1, RUNX1, NRAS, CBL*	→ HMA with or without ruxolitinib and/or allogeneic HCT
aCML	*SETBP1, ETNK1*	→ Consider HMA and/or ruxolitinib and/or allogeneic HCT
JMML	*PTPN11, NF1, N/KRAS, CBL, SETBP1, JAK*	→ Allogeneic HCT
MDS/MPN, unclassifiable	*TET2, NRAS, RUNX1, CBL, SETBP1, ASXL1*	→ Consider HMA and/or allogeneic HCT
MDS/MPN with ring sideroblasts and thrombocytosis	*SF3B1, JAK2, MPL, CALR*	→ Consider HMA and/or lenalidomide or luspatercept-aamt

Review

- MDS is a group of diseases in which bone marrow does not make enough healthy mature blood cells (red blood cells, white blood cells, and platelets).
- MDS can overlap with MPN. These are called myeloid disorders.
- In MPN, the body makes too many of one or more types of blood cells.
- Treatment options vary based on the subtype of MDS/MPN disorder. Speak with your doctor to determine the best treatment option for you.

9
Making treatment decisions

It's important to be comfortable with the cancer treatment you choose. This starts with having an open and honest conversation with your doctor.

It's your choice

In shared decision-making, you and your doctors share information, discuss the options, and agree on a treatment plan. Treatment decisions are very personal. What is important to you may not be important to someone else.

Some things that may play a role in your decision-making:

- What you want and how that might differ from what others want
- Your feelings about certain treatments like surgery or chemotherapy
- Your feelings about pain or side effects such as nausea and vomiting
- Cost of treatment, travel to treatment centers, and time away from school or work
- Quality of life and length of life
- How active you are and the activities that are important to you

Think about what you want from treatment. Discuss openly the risks and benefits of specific treatments and procedures. Weigh options and share concerns with your provider. If you take the time to build a relationship with your doctor, it will help you feel supported when considering options and making treatment decisions.

Second opinion

It is normal to want to start treatment as soon as possible. While cancer can't be ignored, there is time to have another doctor review your test results and suggest a treatment plan. This is called getting a second opinion, and it's a normal part of cancer care. Even doctors get second opinions!

Things you can do to prepare:

- Check with your insurance company about its rules on second opinions. There may be out-of-pocket costs to see doctors who are not part of your insurance plan.
- Make plans to have copies of all your records sent to the doctor you will see for your second opinion.

Support groups

Many people diagnosed with cancer find support groups to be helpful. Support groups often include people at different stages of treatment. Some people may be newly diagnosed, while others may be finished with treatment. If your hospital or community doesn't have support groups for people with cancer, check out the websites listed in this book.

Questions to ask your doctors

Possible questions to ask your doctors are on the following pages. Feel free to use these questions or come up with your own. Be clear about your goals for treatment and find out what to expect from treatment. It starts with an open and honest conversation between you and your doctor.

Questions to ask about diagnosis and testing

1. What type of MDS do I have? What does this mean in terms of my prognosis and treatment options?
2. What tests do I need? What tests are recommended?
3. How soon will I know the results and who will explain them to me?
4. Where will the tests take place? How long will the tests take?
5. Is there a cancer center or hospital nearby that specializes in my type and subtype of cancer?
6. What will you do to make me comfortable during testing?
7. How do I prepare for testing?
8. Would you give me a copy of the pathology report and other test results?
9. Who will talk with me about the next steps? When?
10. Will I start treatment before the test results are in?

Questions to ask about options

1. What will happen if I do nothing?
2. How do my age, health, and other factors affect my options?
3. Am I a candidate for a blood stem cell transplant?
4. Am I a candidate for a clinical trial?
5. 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?
6. How do you know if treatment is working? How will I know if treatment is working?
7. What are my options if my treatment stops working?
8. Are there any life-threatening side effects of this treatment? How will I be monitored?
9. What should I expect from this treatment?
10. Can I stop treatment at any time? What will happen if I stop treatment?

Questions to ask about treatment

1. What are my treatment choices? What are the benefits and risks?
2. Which treatment do you recommend and why? What are the expected outcomes of the treatment?
3. How long do I have to decide?
4. Will I have to go to the hospital or elsewhere for treatment? How often? How long is each visit? Will I have to stay overnight in the hospital or make travel plans?
5. Do I have a choice of when to begin treatment? Can I choose the days and times of treatment? Should I bring someone with me?
6. How much will the treatment hurt? What will you do to make me comfortable?
7. What type of home care will I need? What kind of treatment will I need to do at home?
8. What can I do to prevent or relieve side effects? What will you do?
9. Which treatment will give me the best quality of life? Which treatment option will extend my life? By how long?

Questions to ask about blood stem cell transplants

1. What do I need to do to prepare?
2. What will you do to prepare?
3. What are the risks to myself and/or the donor?
4. How will the transplant affect my prognosis?
5. How will a transplant affect the quality and length of my life?
6. What should I expect from a blood stem cell transplant?
7. How long should I expect to be in the hospital?
8. How will I feel before, during, and after the transplant?
9. How many blood stem cell transplants has this center done for my type of MDS?

Questions to ask your doctors about their experience

1. What is your experience treating my type of MDS?
2. What is the experience of those on your team?
3. Do you only treat MDS? What else do you treat?
4. I would like to get a second opinion. Is there someone you can recommend?
5. I would like another pathologist or hematopathologist to review my blood samples. Is there someone you recommend?
6. How many patients like me (of my age, gender, race) have you treated?
7. Will you be consulting with MDS experts to discuss my health care? Who will you consult?
8. How many procedures like the one you're suggesting have you done?
9. Is this treatment a major part of your practice?
10. How many of your patients have had complications? What were the complications?

Websites

Aplastic Anemia and MDS International Foundation (AAMDSIF)
aamds.org/about/MDS

American Cancer Society®
cancer.org/cancer/myelodysplastic-syndrome

American Society of Hematology
hematology.org/education/patients

Be The Match®
bethematch.org

Blood & Marrow Transplant Information Network
bmtinfonet.org

The Leukemia and Lymphoma Society
lls.org/disease-information/myelodysplastic-syndromes

MDS Foundation, Inc.
mds-foundation.org

National Bone Marrow Transplant Link
nbmtlink.org

National Cancer Institute
Cancer.gov/types/myeloproliferative/patient/myelodysplastic-treatment-pdq

National Coalition for Cancer Survivorship
Canceradvocacy.org/toolbox

National Hospice and Palliative Care Organization
nhpco.org/patients-and-caregivers

U.S. Department of Health & Human Services
bloodstemcell.hrsa.gov

Words to know

acute myeloid leukemia (AML)
A fast-growing cancer that starts in the bone marrow and causes too many immature white blood cells to be made.

allogeneic hematopoietic cell transplant (allo-HCT)
A treatment in which the patient receives healthy, immature blood-forming cells from another person to replace damaged or diseased cells in the bone marrow.

anemia
A condition in which the number of red blood cells is low.

biopsy
Removal of small amounts of tissue from the body to be tested for disease.

blast cell
An immature blood cell.

blood cell growth factors
Substances that cause new blood cells to grow in the bone marrow.

blood smear
A test in which a drop of blood is placed on a slide and viewed with a microscope to assess the size, shape, type, and maturity of the blood cells.

blood stem cell
An immature blood-forming cell from which all other types of blood cells are made. Also called hematopoietic stem cell.

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

bone marrow aspiration
The removal of a small amount of liquid bone marrow to test for disease.

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

chemotherapy
Treatment with drugs that kill abnormal cells or stop new ones from being made.

chromosomes
Long strands that contain bundles of coded instructions in cells for making and controlling cells.

chronic myeloid leukemia (CML)
A slow-growing cancer that starts in the bone marrow and causes too many white blood cells called granulocytes to form.

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

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

conditioning treatment
Treatment that is used to destroy cells in the bone marrow to prepare (condition) the body for a hematopoietic cell transplant.

cytogenetic testing
A test that uses a microscope to examine a cell's chromosomes—long strands of coded instructions in cells for making and controlling cells.

cytopenia
A condition in which the number of blood cells is low.

del(5q)
An abnormal chromosome change in which the "q" part of chromosome 5 is missing (deleted).

Words to know

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

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

donor
A person who gives their organs, tissues, or cells to another person.

dysplasia
Cells have an abnormal size, shape, or look (appearance) when viewed with a microscope.

erythropoiesis-stimulating agent (ESA)
A drug that tells (stimulates) the bone marrow to make more red blood cells.

erythropoietin (EPO)
A natural substance in the body that tells (stimulates) the bone marrow to make more red blood cells.

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

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 changes in a cell's genes and chromosomes.

folate
A nutrient in the body that is needed to make red blood cells.

gene
A set of coded instructions in cells for making and controlling cells.

gene mutation
An abnormal change in the coded instructions in cells for making and controlling cells.

genetic tests
Tests of the coded instructions in cells that are needed to make and control cells. These instructions are called genes and they are grouped into long strands called chromosomes.

granulocyte colony-stimulating factor (G-CSF)
A substance that helps (stimulates) the bone marrow to make more white blood cells called neutrophils. It is made naturally in the body but can also be made in a lab.

hematopoietic cell transplant (HCT)
A treatment that replaces damaged or diseased cells in the bone marrow—sponge-like tissue in the center of bones where blood cells are made—with healthy blood-forming cells. Also called stem cell transplant.

hematopoietic stem cell or hematopoietic cell
An immature blood-forming cell from which all other types of blood cells are made. Also called blood stem cell.

hemoglobin
A protein in red blood cells that carries oxygen.

high-intensity chemotherapy
Treatment with high doses of strong cancer drugs that are more likely to cause severe side effects.

high-intensity treatment
Treatment that is more likely to cause severe side effects and often requires a hospital stay.

high-risk MDS
MDS that is more likely to progress faster or turn into acute myeloid leukemia (AML) quickly if not treated.

Words to know

hormone
A chemical in the body that activates cells or organs.

human leukocyte antigen (HLA)
Special proteins on the surface of cells that help the body to tell its own cells apart from foreign cells.

human leukocyte antigen (HLA) type
The unique set of proteins on the surface of cells that helps the body to tell its own cells apart from foreign cells.

human leukocyte antigen (HLA) typing
A blood test that finds a person's HLA type—the unique set of proteins on the surface of cells that help the body to tell its own cells apart from foreign cells.

hypocellular bone marrow
The number of cells in the bone marrow is lower than normal.

immune response
The action of the body's natural defense against infections and disease in response to foreign substances.

immune system
The body's natural defense against infection and disease.

immunomodulators
Drugs that change (modify) different parts of the immune system.

immunosuppressive therapy (IST)
Treatment with drugs that weaken (suppress) the body's immune system.

immunotherapy
Treatment with drugs that modify the immune system to help the body fight cancer.

International Prognostic Scoring System (IPSS)
A system that doctors use to rate the severity of MDS and classify it into groups based on the likely outcome (prognosis).

iron
A mineral that is found in red blood cells and that the body needs to make new red blood cells.

iron chelation therapy
Treatment that is used to remove excess iron from the body.

low-intensity chemotherapy
Treatment with cancer drugs that are less likely to cause severe side effects.

low-intensity treatment
Treatment that is less likely to cause severe side effects and usually does not require a hospital stay.

lower-risk MDS
MDS that is more likely to grow and progress slowly and may not cause many or severe symptoms for a long time.

lymphocyte
A type of white blood cell that helps protect the body from infection and disease.

molecular test
Tests that look for abnormal changes in genes known to have an effect on cancer treatment or outcomes.

monocyte
A type of white blood cell.

mutation
An abnormal change.

myeloproliferative neoplasm (MPN)
A cancer in which the bone marrow makes too many red blood cells, white blood cells, or platelets.

Words to know

neutropenia
A condition in which the number of white blood cells called neutrophils is low.

neutrophil
A type of white blood cell that helps fight infections and has small particles (granules).

platelet
A type of blood cell that helps control bleeding.

platelet transfusion
A slow injection of platelets—blood cells that help control bleeding—into a vein.

prognosis
The likely or expected course, pattern, and outcome of a disease based on tests.

prognostic factor
Something that affects and helps predict the likely pattern and outcome of a disease.

prognostic scoring system
A system that doctors use to rate the severity of MDS and classify it into groups based on the likely outcome (prognosis).

recurrent gene mutation
Mutations that occur repeatedly, generally at some frequency.

red blood cell
A type of blood cell that carries oxygen from the lungs to the rest of the body.

red blood cell growth factor
A substance that causes new red blood cells to grow in the bone marrow. It is made naturally in the body but can also be made in a lab to use as treatment.

red blood cell transfusion
A slow injection of red blood cells into a vein.

regimen
A treatment plan that specifies the dose, schedule, and duration of treatment.

relapse
The return or worsening of cancer after a period of improvement.

reticulocyte
Younger (precursor) cells that become mature red blood cells.

Revised International Prognostic Scoring System (IPSS-R)
A newer system that doctors use to rate the severity of MDS and classify it into groups based on the likely outcome (prognosis).

ring sideroblasts
Young red blood cells that have too much iron and show up as a circle (ring) around the center of the cells.

risk group
Classification of MDS based on its severity and the chance (risk) that it will progress to AML (acute myeloid leukemia).

risk score
A rating of the severity of MDS that describes how fast or slow it will likely grow and progress.

serum EPO
The amount of natural erythropoietin—a substance made in the body that causes red blood cells to grow—that is found in the blood.

side effect
An unhealthy or unpleasant physical or emotional condition caused by treatment.

subtype
Smaller groups that a type of cancer is divided into based on certain features of the cancer cells.

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

Words to know

thrombocytopenia
A condition in which there is a low number of platelets—blood cells that help control bleeding.

transfusion
A slow injection of whole blood or parts of blood into a vein.

treatment response
An outcome or improvement in disease that is caused by treatment.

white blood cell
A type of blood cell that helps fight infections in the body.

white blood cell growth factor
A substance that causes new white blood cells to grow in the bone marrow. It is made naturally in the body but can also be made in a lab to use as treatment.

WHO classification-based Prognostic Scoring System (WPSS)
A system that doctors use to rate the severity of MDS and classify it into groups based on the likely outcome (prognosis).

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* Reviewed this patient guide. For disclosures, visit NCCN.org/about/disclosure.aspx.

NCCN Cancer Centers

Abramson Cancer Center
at the University of Pennsylvania
Philadelphia, Pennsylvania
800.789.7366 • *pennmedicine.org/cancer*

Fred & Pamela Buffett Cancer Center
Omaha, Nebraska
402.559.5600 • *unmc.edu/cancercenter*

Case Comprehensive Cancer Center/
University Hospitals Seidman Cancer
Center and Cleveland Clinic Taussig
Cancer Institute
Cleveland, Ohio
800.641.2422 • UH Seidman Cancer Center
uhhospitals.org/services/cancer-services
866.223.8100 • CC Taussig Cancer Institute
my.clevelandclinic.org/departments/cancer
216.844.8797 • Case CCC
case.edu/cancer

City of Hope National Medical Center
Los Angeles, California
800.826.4673 • *cityofhope.org*

Dana-Farber/Brigham and
Women's Cancer Center
Boston, Massachusetts
617.732.5500
youhaveus.org

Massachusetts General Hospital
Cancer Center
617.726.5130
massgeneral.org/cancer-center

Duke Cancer Institute
Durham, North Carolina
888.275.3853 • *dukecancerinstitute.org*

Fox Chase Cancer Center
Philadelphia, Pennsylvania
888.369.2427 • *foxchase.org*

Huntsman Cancer Institute
at the University of Utah
Salt Lake City, Utah
800.824.2073
huntsmancancer.org

Fred Hutchinson Cancer
Research Center/Seattle
Cancer Care Alliance
Seattle, Washington
206.606.7222 • *seattlecca.org*
206.667.5000 • *fredhutch.org*

The Sidney Kimmel Comprehensive
Cancer Center at Johns Hopkins
Baltimore, Maryland
410.955.8964
www.hopkinskimmelcancercenter.org

Robert H. Lurie Comprehensive
Cancer Center of Northwestern
University
Chicago, Illinois
866.587.4322 • *cancer.northwestern.edu*

Mayo Clinic Cancer Center
Phoenix/Scottsdale, Arizona
Jacksonville, Florida
Rochester, Minnesota
480.301.8000 • Arizona
904.953.0853 • Florida
507.538.3270 • Minnesota
mayoclinic.org/cancercenter

Memorial Sloan Kettering
Cancer Center
New York, New York
800.525.2225 • *mskcc.org*

Moffitt Cancer Center
Tampa, Florida
888.663.3488 • *moffitt.org*

The Ohio State University
Comprehensive Cancer Center -
James Cancer Hospital and
Solove Research Institute
Columbus, Ohio
800.293.5066 • *cancer.osu.edu*

O'Neal Comprehensive
Cancer Center at UAB
Birmingham, Alabama
800.822.0933 • *uab.edu/onealcancercenter*

Roswell Park Comprehensive
Cancer Center
Buffalo, New York
877.275.7724 • *roswellpark.org*

Siteman Cancer Center at Barnes-
Jewish Hospital and Washington
University School of Medicine
St. Louis, Missouri
800.600.3606 • *siteman.wustl.edu*

St. Jude Children's Research Hospital
The University of Tennessee
Health Science Center
Memphis, Tennessee
866.278.5833 • *stjude.org*
901.448.5500 • *uthsc.edu*

Stanford Cancer Institute
Stanford, California
877.668.7535 • *cancer.stanford.edu*

UC San Diego Moores Cancer Center
La Jolla, California
858.822.6100• *cancer.ucsd.edu*

UCLA Jonsson
Comprehensive Cancer Center
Los Angeles, California
310.825.5268 • *cancer.ucla.edu*

UCSF Helen Diller Family
Comprehensive Cancer Center
San Francisco, California
800.689.8273 • *cancer.ucsf.edu*

University of Colorado Cancer Center
Aurora, Colorado
720.848.0300 • *coloradocancercenter.org*

University of Michigan
Rogel Cancer Center
Ann Arbor, Michigan
800.865.1125 • *rogelcancercenter.org*

The University of Texas
MD Anderson Cancer Center
Houston, Texas
844.269.5922 • *mdanderson.org*

University of Wisconsin
Carbone Cancer Center
Madison, Wisconsin
608.265.1700 • *uwhealth.org/cancer*

UT Southwestern Simmons
Comprehensive Cancer Center
Dallas, Texas
214.648.3111 • *utsouthwestern.edu/simmons*

Vanderbilt-Ingram Cancer Center
Nashville, Tennessee
877.936.8422 • *vicc.org*

Yale Cancer Center/
Smilow Cancer Hospital
New Haven, Connecticut
855.4.SMILOW • *yalecancercenter.org*

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DR SHIVAM SHINGLA

BSES MG Hospital (Andheri):
9 am to 10 am (Monday to Friday)
Nanavati Max Hospital (Vile Parle):
10 am to 12 pm (Monday to Saturday)
S. L. Raheja Hospital (Mahim):
12 pm to 4 pm (Monday to Saturday)
Suvarna Hospital (Borivali):
5 pm to 6 pm (Monday and Friday)
Sushrut Hospital (Chembur):
By appointment
Hinduja Hospital (Khar): By appointment
Galaxy Healthcare (Borivali): By appointment

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#Reference From NCCN Guidelines