# Aplastic Anemia and Myelodysplastic Syndromes

*National Hematologic Diseases Information Service*

U.S. Department of Health and Human Services

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## What are aplastic anemia and MDS?

Aplastic anemia and myelodysplastic syndromes (MDS) are rare and serious disorders that affect the bone marrow and blood.

In both disorders, bone marrow doesn't produce enough healthy red or white blood cells or platelets. Red blood cells contain hemoglobin, an iron-rich protein that gives blood its red color and carries oxygen from the lungs to the tissues of the body. White blood cells help fight infection. Too few functioning red and white blood cells can lead to fatigue and infection. Platelets are cells that help blood clot. Too few platelets can lead to spontaneous or uncontrolled bleeding.

Anemia most often describes a condition in which a person has too few red blood cells or cells that do not carry enough hemoglobin. In aplastic anemia, however, normal production of all blood cells—red cells, white cells, and platelets—slows or stops. Blood cell production declines because bone marrow stem cells—the cells that give rise to all three types of mature blood cells—are damaged. The number of stem cells also declines because they are unable to replicate themselves. Although production of mature blood cells is seriously impaired in aplastic anemia, the few blood cells that mature and enter the bloodstream are normal.

Aplastic anemia most often affects children and young adults. Between 500 and 1,000 people in the United States develop aplastic anemia each year.[1]

[1]National Heart, Lung, and Blood Institute. Aplastic anemia. Available at: www.nhlbi.nih.gov/health/dci/Diseases/aplastic/aplastic_whoisatrisk.html. May 2006.

### Blood Cell Production

All three types of blood cells begin as unspecialized stem cells. Stem cells divide and produce more stem cells or can evolve through a series of stages into mature, specialized blood cells of any type. Early in the maturation process, "progenitor" cells emerge from stem cells. Unlike stem cells, progenitor cells are committed to develop into only one blood cell type and evolve into mature red or white blood cells or platelets.

In MDS, a shortage of bone marrow stem cells usually doesn't occur, as it does in aplastic anemia. But the stem cells are defective and do not mature normally. Progenitor cells and immature blood cells are deformed and fail to develop into healthy, mature red or white blood cells or platelets. These cells often die in the bone marrow. Many of the blood cells that do enter the bloodstream don't survive or function normally.

Some forms of MDS are prone to develop into leukemia, an aggressive blood cancer. Between 7,000 and 12,000 people, mostly older adults, develop MDS each year.[2]

[2]U.S. Food and Drug Administration. FDA approves new treatment for myelodysplastic syndrome (MDS). Available at: www.fda.gov/bbs/topics/news/2005/NEW01289.html. Posted December 28, 2005. Accessed June 26, 2008.

## What causes aplastic anemia and MDS?

Although the cause of aplastic anemia or MDS usually can't be determined, the diseases may be triggered by exposure to

- chemotherapy
- radiation therapy
- high levels of ionizing radiation—the type produced by high power x-ray machines and in nuclear power plants
- benzene, a chemical used in some manufacturing processes
- toxic chemicals found in some pesticides
- certain viral infections

In most cases of aplastic anemia, these or other unknown triggers provoke the body's own immune system to destroy the bone marrow stem cells. Certain rare inherited disorders can also lead to aplastic anemia and uncommon forms of MDS seen in children.

## What are the symptoms of aplastic anemia and MDS?

Symptoms vary depending on the individual and the severity and type of disease. Symptoms may include

- tiredness, or fatigue
- weakness
- excessive bleeding
- pinpoint red spots on the skin caused by bleeding from small blood vessels
- easy bruising
- frequent infections
- fevers
- pale skin
- shortness of breath

Because many of these symptoms resemble those of other illnesses, a professional evaluation from a specialist is important. MDS often does not cause symptoms at first and may be discovered through a routine blood test.

## How are aplastic anemia and MDS diagnosed?

In addition to a medical history and physical exam, doctors use blood tests and a bone marrow biopsy to diagnose aplastic anemia or MDS.

- **Blood tests.** A complete blood count is usually the first test a doctor uses to detect aplastic anemia or MDS. This test measures the number of red blood cells, white blood cells, and platelets in the blood. It also looks at the amount of hemoglobin in the red blood cells. Lower-than-normal quantities of one or more blood cell types may suggest aplastic anemia or MDS.

  In another test called a peripheral blood smear, the doctor examines a sample of blood for unusual changes in the size, shape, and appearance of the blood cells. These cells usually appear normal in aplastic anemia but may be abnormal in MDS.

- **Biopsy.** A bone marrow biopsy is needed to confirm the diagnosis of aplastic anemia or MDS. This test usually involves removing a small sample of bone marrow by inserting a needle into the hip bone. A doctor then examines the bone marrow for the number and type of blood progenitor cells and for the presence of abnormal cells.

## How are aplastic anemia and MDS treated?

### Aplastic Anemia Treatment

People with mild or moderate aplastic anemia may not need treatment at first. However, people with severe aplastic anemia need immediate medical treatment to prevent or reverse complications from very low blood cell levels.

- **Blood transfusions.** Transfusions of red blood cells or platelets, in which healthy cells from a donor with the same blood type are injected into a patient's vein, can raise blood cell counts and relieve symptoms. But transfusions are not a cure.

  Most people with aplastic anemia require repeated transfusions, which can lead to complications. Over time, the body may develop antibodies that damage or destroy donor blood cells. And iron from transfused red blood cells can build up in the body and damage organs unless the excess iron is removed with drugs called iron chelators.

- **Stem cell transplant.** Stem cell transplants, which replace damaged stem cells in bone marrow with healthy stem cells from a donor's blood or bone marrow, can cure aplastic anemia. However, this form of treatment is usually limited to people younger than 40 to 50 with an available donor—usually a brother or sister—whose bone marrow cells are tested and found to "match" those of the patient.

  Before the transplant, the patient's own bone marrow cells are eliminated by chemotherapy and sometimes radiation. Doctors remove stem cells from the donor's blood or bone marrow and freeze them for storage. After chemotherapy, the doctor gives the patient the thawed stem cells through a blood infusion. The stem cells then travel to the bone marrow where they re-establish and maintain normal blood cell production.

  Stem cell transplants are usually reserved for people with severe aplastic anemia and are most successful in children and young adults with matched donors. Older adults are less able to tolerate the treatments used to prepare the body for transplant and are more likely to develop severe post-transplant complications.

- **Medications.** Doctors often prescribe one or more medications that suppress the immune system and reduce damage to bone marrow cells. These drugs may allow the marrow to start making blood cells again and reduce or eliminate the need for transfusions. In some people, blood counts return to normal. These "immunosuppressive" drugs are the preferred form of treatment for older adults and for young patients who don't have a matched stem cell donor.

  Adjunct drug therapy may include erythropoietin (EPO), a man-made version of a natural hormone that stimulates the production of red blood cells, or granulocyte-colony stimulating factor (G-CSF), which stimulates white blood cell production. Antibiotics are often used if infections occur.

## MDS Treatment

Stem cell transplants are not routinely performed for MDS because most people with MDS are older adults and thus ineligible for this form of treatment. For younger people with a matched sibling donor, however, a transplant may offer a cure. No other potential cures for MDS currently exist. Treatment options, which may be used alone or in combination, include the following:

- **Supportive care.** Traditionally the first line of treatment, supportive care aims to manage the symptoms of the disease. This approach may include blood transfusions and drug therapy with EPO, G-CSF, and antibiotics.
- **Medications.** Three recently developed drugs—azacitidine (Vidaza), lenalidomide (Revlimid), and decitabine (Dacogen)—may help the bone marrow function more normally, reducing the need for transfusions. Azacitidine and decitabine are used to treat all forms of MDS, while lenalidomide is used to treat only one specific type of MDS. Some people may also benefit from immunosuppressive drugs.
- **Chemotherapy.** Chemotherapy is sometimes used in an effort to destroy defective blood progenitor cells in severe MDS and allow the few remaining normal blood stem cells to re-establish normal blood cell production. This approach is often not effective over the long term.
- **Experimental stem cell transplants.** New techniques that use a less toxic pretransplant regimen are being developed. Since the regimen may be better tolerated by older adults, it may allow stem cell transplants to be more widely used as a treatment for MDS.

## Points to Remember

- Aplastic anemia and myelodysplastic syndromes (MDS) are rare and serious disorders in which bone marrow doesn't produce enough healthy red or white blood cells or platelets.
- Symptoms of aplastic anemia and MDS include fatigue, excessive bleeding, easy bruising, frequent infections, and shortness of breath.
- Both diseases are diagnosed through blood tests and a bone marrow biopsy.
- Aplastic anemia is treated with blood transfusions, immunosuppressive drugs, or stem cell transplants. Immunosuppressive medications improve blood counts in most people. Stem cell transplants can cure aplastic anemia but require a matched bone marrow donor and are usually limited to people younger than 40 to 50.
- MDS is usually treated with blood transfusions and medication. Stem cell transplants are not often used, but new techniques may allow this form of treatment to be more widely used.

## Hope through Research

The National Institutes of Health has clinical trials under way to test many new treatments for aplastic anemia and MDS.

For aplastic anemia, several trials are studying the ability of certain drugs to increase blood counts, reduce anemia symptoms, and lower dependence on transfusions. Other trials are evaluating viral agents that might cause the disease and studying the effectiveness of various immunosuppressive drug regimens.

For MDS, studies are testing drugs that help increase red blood cell counts, evaluating certain stem cell transplant procedures, and examining whether the immune system, through a vaccine, could control the abnormal growth of cells causing MDS.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit *www.ClinicalTrials.gov*.

## For More Information

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This fact sheet is also available at *www.hematologic.niddk.nih.gov*.

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