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# Acute Myeloid Leukemia Causes, Risk Factors, and Prevention

## Risk Factors

A risk factor is anything that affects your chance of getting a disease such as cancer. Learn more about the risk factors for acute myeloid leukemia.

- [Risk Factors for Acute Myeloid Leukemia \(AML\)](#)
- [What Causes Acute Myeloid Leukemia \(AML\)?](#)

## Prevention

There is no way to completely prevent cancer. But there are things you can do that might lower your risk. Learn more.

- [Can Acute Myeloid Leukemia \(AML\) Be Prevented?](#)

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# Risk Factors for Acute Myeloid Leukemia (AML)

A risk factor is something that affects your chance of getting a disease, such as cancer. Different cancers have different risk factors. Some risk factors, like smoking, can be changed. Others, like a person's age or family history, can't be changed.

But having a risk factor, or even several risk factors, does not always mean that a person will get the disease, and many people get cancer without having any known risk factors.

There are some known risk factors for acute myeloid leukemia (AML).

## Getting older

AML can occur at any age, but it becomes more common as people get older.

## Being male

AML is more common in males than in females. The reason for this is not clear.

## Smoking

The only proven lifestyle-related risk factor for AML is [smoking](#)<sup>1</sup>. Many people know that smoking is linked to cancers of the lungs, mouth, and throat, but few realize that it can also affect cells that don't come into direct contact with tobacco smoke. Cancer-causing substances in tobacco smoke are absorbed by the lungs and spread through the bloodstream to many parts of the body.

## Being exposed to certain chemicals

The risk of AML is increased if you have been exposed to certain chemicals.

For example, long-term exposure to [benzene](#)<sup>2</sup> is a risk factor for AML. Benzene is a solvent used in the rubber industry, oil refineries, chemical plants, shoe manufacturing, and gasoline-related industries, and is also found in cigarette smoke, gasoline and motor vehicle exhaust, and some glues, cleaning products, detergents, art supplies, and paints.

Some studies have linked AML risk to heavy workplace exposure to [formaldehyde](#)<sup>3</sup>, but this link has not been seen in some other studies.

## Being treated with certain chemotherapy drugs

Patients with cancer who are treated with certain chemotherapy (chemo) drugs are more likely to develop AML in the years following treatment.

Drugs called alkylating agents are linked to an increased risk of AML. Often a patient will get a disease called a [myelodysplastic syndrome](#)<sup>4</sup> before the AML. Examples of alkylating drugs include cyclophosphamide, mechlorethamine, procarbazine, chlorambucil, melphalan, busulfan, carmustine, cisplatin, and carboplatin.

Chemo drugs known as topoisomerase II inhibitors are also linked to AML. AML linked to these drugs tends to occur without myelodysplastic syndrome developing first. Examples of topoisomerase II inhibitors include etoposide, teniposide, mitoxantrone, epirubicin, and doxorubicin.

## Being exposed to radiation

High-dose [radiation exposure](#)<sup>5</sup> (such as being a survivor of an atomic bomb blast or nuclear reactor accident) increases the risk of developing AML. Japanese atomic bomb survivors had a greatly increased risk of developing acute leukemia.

Radiation treatment for cancer has also been linked to an increased risk of AML. The risk varies based on the amount of radiation given and what area is treated.

The possible risks of leukemia from exposure to lower levels of radiation, such as from [imaging tests](#)<sup>6</sup> like x-rays or CT scans, are not well-defined. Exposure to such radiation, especially very early in life, might carry an increased risk of leukemia, but how much of a risk is not clear. If there is an increased risk it is likely to be small, but to be safe, most doctors try to limit radiation exposure from tests as much as possible, especially in children and pregnant women.

For more information, see [X-rays, Gamma Rays and Cancer Risk](#)<sup>7</sup>.

## Having certain blood disorders

People with certain blood disorders seem to be at increased risk for getting AML. These include chronic myeloproliferative disorders such as polycythemia vera, essential thrombocythemia, and idiopathic myelofibrosis. The risk of AML increases if these disorders are treated with some types of chemotherapy or radiation.

Some people who have a [myelodysplastic syndrome \(MDS\)](#)<sup>8</sup> may develop AML. Patients with MDS have low blood cell counts and abnormal cells in the blood and bone marrow. MDS can evolve over time into AML. AML that develops after MDS is often hard to treat.

## Having a genetic syndrome

Some syndromes that are caused by genetic mutations (abnormal changes) present at birth seem to raise the risk of AML. These include:

- Fanconi anemia
- Bloom syndrome
- Ataxia-telangiectasia
- Diamond-Blackfan anemia
- Shwachman-Diamond syndrome
- Li-Fraumeni syndrome
- Neurofibromatosis type 1
- Severe congenital neutropenia (also called Kostmann syndrome)

Chromosomes are long strands of DNA (genes) inside our cells. Some chromosome problems present at birth are also linked to a higher risk of AML, including:

- Down syndrome (being born with an extra copy of chromosome 21)
- Trisomy 8 (being born with an extra copy of chromosome 8)

## Having a family history

Although most cases of AML are not thought to have a strong genetic link, having a close relative (such as a parent, brother, or sister) with AML increases your risk of getting the disease.

Someone who has an identical twin who got AML before they were a year old has a very high risk of also getting AML.

## Uncertain, unproven or controversial risk factors

Other factors that have been studied for a possible link to AML include:

- Exposure to [electromagnetic fields](#)<sup>9</sup> (such as living near power lines)
- Workplace exposure to diesel, gasoline, and certain other chemicals and solvents
- Exposure to herbicides or pesticides

So far, none of these factors has been linked conclusively to AML. Research is being done in these areas.

## Hyperlinks

1. [www.cancer.org/cancer/cancer-causes/tobacco-and-cancer.html](http://www.cancer.org/cancer/cancer-causes/tobacco-and-cancer.html)
2. [www.cancer.org/cancer/cancer-causes/benzene.html](http://www.cancer.org/cancer/cancer-causes/benzene.html)
3. [www.cancer.org/cancer/cancer-causes/formaldehyde.html](http://www.cancer.org/cancer/cancer-causes/formaldehyde.html)
4. [www.cancer.org/cancer/myelodysplastic-syndrome.html](http://www.cancer.org/cancer/myelodysplastic-syndrome.html)
5. [www.cancer.org/cancer/cancer-causes/radiation-exposure/x-rays-gamma-rays.html](http://www.cancer.org/cancer/cancer-causes/radiation-exposure/x-rays-gamma-rays.html)
6. [www.cancer.org/treatment/understanding-your-diagnosis/tests/understanding-radiation-risk-from-imaging-tests.html](http://www.cancer.org/treatment/understanding-your-diagnosis/tests/understanding-radiation-risk-from-imaging-tests.html)
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8. [www.cancer.org/cancer/myelodysplastic-syndrome.html](http://www.cancer.org/cancer/myelodysplastic-syndrome.html)
9. [www.cancer.org/cancer/cancer-causes/radiation-exposure/extremely-low-frequency-radiation.html](http://www.cancer.org/cancer/cancer-causes/radiation-exposure/extremely-low-frequency-radiation.html)

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# What Causes Acute Myeloid Leukemia (AML)?

Some people with acute myeloid leukemia (AML) have one or more known risk factors, but many do not. Even when a person has one or more risk factors, it's very hard to know if it actually caused the cancer.

Certain changes in the DNA in normal bone marrow cells can cause them to become leukemia cells. The DNA inside our cells makes up our **genes**, which control how our cells function. We tend to look like our parents because they are the source of our DNA. But our genes affect more than how we look.

Some genes control when our cells grow, divide to make new cells, and die at the right time:

- Genes that help cells grow, divide, or stay alive are called **oncogenes**.
- Genes that help keep cell division under control or make cells die at the right time are called **tumor suppressor genes**.

The DNA inside each cell is in long strands called **chromosomes**. Each time a cell divides into 2 new cells, it must make a new copy of its chromosomes. This process isn't perfect, and errors can occur that affect genes within the chromosomes. Cancers (including AML) can be caused by mutations (changes) that turn on oncogenes or turn off tumor suppressor genes. For instance, changes in certain genes such as *FLT3*, *c-KIT*, and *RAS* are common in AML cells. These types of changes can stop bone marrow cells from maturing the way they normally would, or help the cells grow out of control.

Mutations in many different genes can be found in AML, but larger changes in one or more chromosomes are also common. Even though these changes involve larger pieces of DNA, their effects are still likely to be due to changes in just one or a few genes that are on that part of the chromosome. Several types of chromosome changes may be found in AML cells:

- **Translocations** are the most common type of chromosome change. A translocation means that a part of one chromosome breaks off and becomes attached to a different chromosome. The point at which the break occurs can affect nearby genes – for example, it can turn on oncogenes or turn off genes like *RUNX1* and *RARa*, which would normally help blood cells to mature.

- **Deletions** occur when part of a chromosome is lost. This can result in the cell losing a gene that helped keep its growth in check (a tumor suppressor gene).
- **Inversions** occur when part of a chromosome gets turned around, so it's now in reverse order. This can result in the loss of a gene (or genes) because the cell can no longer read its instructions (much like trying to read a book backward).
- **Addition or duplication** means that there is an extra chromosome or part of a chromosome. This can lead to too many copies of certain genes within the cell. This can be a problem if one or more of these genes are oncogenes.

There are many types of AML, and different cases of AML can have different gene and chromosome changes, some of which are more common than others. Doctors are trying to figure out why these changes occur and how each of them might lead to leukemia. For example, some are more common in leukemia that occurs after chemotherapy for another cancer.

Some changes seem to have more of an effect on a person's prognosis (outlook) than others. For instance, some changes might affect how quickly the leukemia cells grow, or how likely they are to respond to treatment. This is discussed in more detail in [Acute Myeloid Leukemia \(AML\) Subtypes and Prognostic Factors](#)<sup>1</sup>.

## Inherited versus acquired gene changes

Some people with certain types of cancer have inherited DNA mutations from a parent that increase their risk for the disease. Although this can happen sometimes with AML, such as with the genetic syndromes discussed in [Risk Factors for Acute Myeloid Leukemia \(AML\)](#), inherited mutations are not a common cause of AML.

Most DNA changes related to AML occur during a person's lifetime, rather than having been inherited before birth. Some of these acquired changes may have outside causes like radiation or cancer-causing chemicals, but in most cases the reason they occur isn't clear. Many of these gene changes are probably just random events that sometimes happen inside a cell, without having an outside cause. They seem to happen more often as we age, which might help explain why AML usually occurs in older people.

## Hyperlinks

1. [www.cancer.org/cancer/acute-myeloid-leukemia/detection-diagnosis-staging/how-classified.html](http://www.cancer.org/cancer/acute-myeloid-leukemia/detection-diagnosis-staging/how-classified.html)

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# Can Acute Myeloid Leukemia (AML) Be Prevented?

It's not clear what causes most cases of acute myeloid leukemia (AML). Since most people with AML don't have risk factors that can be changed, at the present time there is no known way to prevent most cases of AML.

**Smoking** is by far the most significant controllable risk factor for AML, and [quitting](#)<sup>1</sup> offers the greatest chance to reduce a person's risk of AML. Non-smokers are also much less likely than smokers to develop many other cancers, as well as heart disease, stroke, and some other diseases.

Treating some other cancers with [chemotherapy](#)<sup>2</sup> or [radiation](#)<sup>3</sup> may cause secondary (treatment-related) leukemias in some people. Doctors are trying to figure out how to treat these cancers without raising the risk of secondary leukemia. But for now, the obvious benefits of treating life-threatening cancers with chemotherapy and radiation must be balanced against the small chance of getting leukemia years later.

Avoiding known **cancer-causing chemicals**, such as [benzene](#)<sup>4</sup>, might lower the risk of

getting AML. But most experts agree that exposure to workplace and environmental chemicals seems to account for only a small portion of leukemias.

## Hyperlinks

1. [www.cancer.org/healthy/stay-away-from-tobacco/guide-quit-smoking.html](http://www.cancer.org/healthy/stay-away-from-tobacco/guide-quit-smoking.html)
2. [www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/treatment-risks.html](http://www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/treatment-risks.html)
3. [www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/treatment-risks.html](http://www.cancer.org/treatment/treatments-and-side-effects/physical-side-effects/second-cancers-in-adults/treatment-risks.html)
4. [www.cancer.org/cancer/cancer-causes/benzene.html](http://www.cancer.org/cancer/cancer-causes/benzene.html)

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