



Infections in People With Cancer

What are infections and who is at risk?

Infections are caused by germs (also called *microbes* or *microorganisms*) that enter the body, multiply, and cause harm or illness. The main types of germs are bacteria, viruses, protozoa (some of which act as parasites), and fungal organisms (also called *fungi*).

Cancer can increase your risk of getting a life-threatening infection. So can certain types of cancer treatment. Once the cancer is gone and treatment is over, the risk of infection usually goes back to a normal level.

Infections that develop in people who have cancer or are getting cancer treatment can be more serious than those in people who are otherwise healthy. They can also be harder to treat. If you have cancer, it's important to find and treat infections early, before they get worse and spread.

By learning more about problems that infections can cause, you and your family may be able to help prevent them. You can:

- Take steps to avoid being exposed to dangerous germs.
- Take certain drugs and do things to help prevent some infections even after you have been exposed to the germs.

If you do get an infection, the information here will help you know what to look for and what you should do to get treatment quickly. For most people with cancer, the highest risk for serious infection only lasts for a limited time. And most people with cancer are not at a high risk of getting the kinds of infections described here. Your risk of infection depends on the type of cancer you have and the treatment you get. For example, surgery does not weaken a person's resistance to infection nearly as much as a bone marrow transplant. And some chemotherapy drugs are less likely than others to affect a person's ability to resist infection.

It's important to weigh the risk of infection and other side effects against the benefits of cancer treatment. Talk with your doctors before or during chemotherapy or radiation therapy to see how this information applies to you. Here are some questions you can ask your doctor or cancer care team before and during cancer treatment:

- Will this cancer treatment make me more likely to get infections?
- Will you do anything special to help keep me from getting infections during treatment?
- What can I do to lower my risk of infection?

- How will I know if I have an infection?
- What kinds of infections are most common for someone in my situation?
- What should I do if I think I have an infection?
- If I get a fever, does that mean I have an infection?
- How will you decide how to treat my infection?
- What will you do if the treatment doesn't get rid of my infection?
- What are the likely side effects of the proposed treatments for infection?

What can people with cancer do to prevent infections?

Infection is one of the most common life-threatening complications of cancer. To reduce your risk of infection while being treated for cancer, be sure to:

- Get the right vaccines
- Take precautions
- Use medicines if prescribed

Vaccines during cancer treatment

People with weak immune systems can get some vaccines, but they should **not** get vaccines that contain live virus. Fatal infections have been caused by giving live-virus polio, measles, and smallpox vaccines to people with weak immune function.

It's generally recommended that vaccines not be given during chemo or radiation treatments — the only exception to this is the flu shot. This is because vaccines need an immune system response to work, and you may not get an adequate response during cancer treatment.

In many cases, live-virus vaccines can be given at least 3 months after all immune-suppressing treatment has stopped. But this time varies and you should talk to your doctor before you or anyone you live with or spend a lot of time with gets vaccinated with a live virus.

Even when your immune system is weak, some preventive immunizations can be very helpful. Your doctor should tell you about any vaccines that might help you, such as certain ones that may be recommended after bone marrow or stem cell transplant. But it's important to know which vaccines are safe for people with weak immune systems. We will talk about the most common vaccines here.

Be sure to talk to your cancer doctor before you or anyone you spend a lot of time with gets any vaccines.

Flu shots

The flu shot is given to reduce your risk of getting influenza (the flu). Since the flu raises your risk of pneumonia (lung infection), avoiding the flu lowers that risk. The flu shot may be given at least 2 weeks before chemo or between chemo cycles. It can be given 6 months after a bone marrow or stem cell transplant, and every year after that.

Flu-mist[®], the nasal mist version of the flu vaccine, contains a weakened version of the live virus. People with cancer should NOT use the nasal mist flu vaccine. Family members of a person with cancer can safely get the nasal spray unless the patient is being cared for in a germ-protected area. For example, household members should not get the nasal mist vaccine if a family member has recently had a stem cell or bone marrow transplant.

For more information on this, see our document called *Should I Get a Flu Shot?*

Polio and smallpox

Polio vaccine: Children who have weak immune systems, as well as their siblings and others who live with them, only should get *inactivated* polio virus vaccines. Most doctors in the United States use only the inactivated polio vaccine, but you can ask to be sure. The older oral polio virus vaccine (which is taken by mouth) contains a live virus. People who get the live virus vaccine can pass the poliovirus on to people with weak immune systems.

Smallpox vaccine: In general, people with weakened immune systems should not get the smallpox vaccine. Household members of those with weak immune systems should not get it either. There are many other restrictions and exceptions on how this vaccine is used. To learn more about smallpox vaccination, see our document called *Smallpox Vaccine and Cancer*.

Measles-mumps-rubella

People who have very weak immune systems should not get the measles-mumps-rubella (MMR) vaccine because it contains live virus. But unlike the smallpox vaccine, it's safe for other household members to get it.

After exposure to measles: If the person being treated for cancer is exposed to someone with measles, let the doctor know right away. Sometimes, measles immune globulin (a blood product that contains antibodies to the measles virus) can be given to help fight the measles infection before it starts.

Pneumococcus (pneumococcal pneumonia)

Your doctor may recommend one or more doses of the pneumococcal vaccine, depending on your age and health history. If you are to have your spleen removed, the vaccine will be given before surgery. Most adults with long-term health problems get the Pneumovax[®] (or PPV-23) vaccine. The vaccine can help people with weak immune systems fight off serious infections, such as pneumonia, caused by certain bacteria. Children and those with recent bone marrow transplants may get a different vaccine (called PCV or *Prevnar 13*) to help them fight this germ, although some may need the PPV-23 vaccine later.

Pneumococcus can cause serious infections that can invade the lungs, blood, or brain (meningitis). These infections can be life-threatening. People with chronic illness, including a weak immune system, can reduce their risk of this infection by getting the pneumococcal vaccine.

Varicella (chickenpox)

This is another live virus vaccine that's given only to people with blood tests that do not show immunity to the varicella zoster virus (VZV). Varivax[®] is intended to prevent chickenpox in people who have never had it. But this vaccine should not be given to people while their immune systems are weak. It's OK for household members of the person with weakened immunity to get the varicella vaccine.

After exposure to chickenpox: A person with weak immunity who has been exposed to someone with chickenpox should call the doctor right away. The patient may need *VZV immune globulin* (a blood product that contains antibodies to the VZV virus) to help fight the virus. It must be given within 72 hours of exposure. Cancer treatment may be stopped and restarted after the end of the VZV incubation period (the time it takes to see if you get sick, usually about 21 days). If a person with cancer has signs of VZV infection, the doctor may hold off on cancer treatment that causes immune suppression until scabs have formed.

Varicella zoster (shingles)

Zostavax[®] is a live virus vaccine that is given to prevent shingles (or make symptoms of shingles less severe). It's used in adults age 60 and older who have had chickenpox. It's not used in people whose immune systems are weak, including people being treated for cancer.

People who have had stem cell transplants must wait at least 2 years after the transplant to take this vaccine. And if you are on any drug that suppresses the immune system or you're getting chemo or radiation treatments, you should not get Zostavax. Talk to your doctor before you or anyone in your household gets this vaccine.

See "Varicella zoster virus" under "Viruses" in the section called "What kinds of germs cause infections in people with cancer?" for more information about shingles.

Precautions to help prevent infection during cancer treatment

You are more likely to get a serious infection when your absolute neutrophil count (ANC) is low. You can ask your doctor or nurse what your ANC is, so that you know when it is low. Here are some things you can do that might help prevent illness during that time:

- Be aware of and watch for signs and symptoms of infection. Report any to your doctor or nurse right away. (See the section "Signs of infection people with cancer should watch for.")
- After bathing, look for redness, swelling, and soreness where any tubes or catheters go into your body.
- Get your flu shot every fall. Encourage other members of your household to get it, too.
DO NOT get the nasal mist flu vaccine if your immune system is weak.

To help avoid being exposed to infection while your ANC or white blood cell count is low (see the section "Immunosuppression and neutropenia"), you can:

- Wash your hands often with soap and warm water. Be sure to wash your hands before eating and before touching your face or mucous membranes (eyes, nose, mouth, etc.).
- Wash your hands after using the bathroom, blowing your nose, coughing, or sneezing.
- Wash your hands after touching animals, collecting trash, or taking out garbage.
- Use moist cleaning wipes to clean surfaces and things that you touch, such as door handles, ATM or credit card keypads, and any items that are used by other people.
- Avoid large crowds of people such as school, travel, shopping, social events, and public gatherings. Wash your hands after visiting a public place or touching items used by others.
- Stay away from anyone with a fever, the flu, or other infection.
- Keep yourself clean by bathing each day. Be sure to wash your feet, groin, armpits, and other moist, sweaty areas.
- Wear gloves for gardening and wash up afterward.
- Keep your mouth clean by brushing your teeth twice each day. Ask your doctor or nurse if it's OK to gently floss your teeth. Tell them if your gums bleed. Your doctor or nurse may give you a special mouthwash to help clean your mouth. Do not use alcohol-based mouthwash.
- Keep your groin area and anal area clean — use soft moist tissues such as disposable baby wipes or bathroom towelettes after bowel movements. Tell your doctor about any bleeding.
- Do not get manicures or pedicures at salons or spas (you can use your own personal and well-cleaned tools at home). Do not use false nails or nail tips.
- Do not wade, play, or swim in ponds, lakes, rivers, or water parks.
- Do not get into hot tubs.
- Wear shoes all the time — in the hospital, outdoors, and at home. This helps you avoid injury and keep germs off your feet.
- Use an electric shaver instead of a razor to avoid cuts and nicks. Do not share shavers.
- If you cut or scrape your skin, clean the area right away with soap and warm water. Cover the area with a clean bandage to protect it. If the bandage gets wet or dirty, clean the area and put on a new bandage. Tell your doctor if you notice redness, swelling, pain, or tenderness.
- Prevent constipation and straining to have a bowel movement by drinking 2 quarts of fluid each day. Exercising each day can help, too. Let your doctor or nurse know if you are having bowel problems. If needed, your doctor may give you medicine that softens your stool. Do not put anything in your rectum, including enemas, thermometers, and suppositories.
- Women should not use tampons, vaginal suppositories, or douche.
- Use water-based lubricants during sex to avoid injury or abrasion of the skin and mucous membranes. Use latex or plastic condoms to reduce the risk of sexually transmitted infections.
- Do not keep fresh flowers or live plants in your bedroom.

- Do not clean up droppings from your pets. Do not clean bird cages or fish or turtle tanks. Let someone else do this for you.
- Place cat litter boxes away from kitchens and food areas. Litter boxes should be cleaned every day by someone else.
- Do not touch soil that may contain feces (stool) of animals or people.
- Do not change diapers, but if you do, wash your hands very well afterward.
- If you use disposable gloves to avoid touching things like soil or waste, wash your hands after you take off the gloves. (Gloves can have tiny holes that you can't see.)
- Stay away from all standing water, for example, in vases, denture cups, and soap dishes. If you have dentures that you store in a cup, wash the cup and change the water with each use.
- Use hot water to clean your dishes.
- Do not share bath towels or drinking glasses with others, including family members.
- Stay away from chicken coops, caves, and any place where dust from the ground is being blown into the air, such as construction sites.
- Talk with your doctor or nurse if you are planning any travel during this time.

Food safety for the person with cancer

Food safety is very important when your white blood cell count, especially neutrophils, are low (see the section "Immunosuppression and neutropenia"). Infections can be picked up from food and drinks. These actions may help you reduce infection risk from foods:

- Do not eat or drink any raw milk or raw milk products, or any milk or milk product that has not been pasteurized, including cheese and yogurt made from unpasteurized milk.
- Do not eat Mexican-style soft cheese such as queso fresco or queso blanco.
- Do not eat cheese containing chili peppers or other uncooked vegetables.
- Do not eat raw or undercooked meat, fish, chicken, or tofu.
- Do not eat hot dogs, deli meats, or processed meats unless they have been cooked or thoroughly re-heated just before eating.
- Do not eat any food that contains mold (for example, brie, feta, or blue cheese, including that in salad dressings).
- Do not eat any unwashed fresh vegetables and fruits.
- Do not eat unwashed salad greens.
- Do not eat uncooked vegetable sprouts (alfalfa, bean, and others).
- Do not drink fruit or vegetable juices that have not been pasteurized.
- Do not eat raw honey (honey that has not been pasteurized).

- Do not eat foods containing raw or undercooked eggs, including homemade Caesar salad dressing, raw cookie dough, and eggnog
- Do not drink unboiled well water.
- Do not eat any outdated food.
- Do not eat any cooked food that has been left at room temperature for 2 hours or more. If the food is left where the air temperature is 90° F or above, the limit is 1 hour.
- Do not eat any food that has been handled or prepared with unwashed hands.

Some of these precautions are just good food safety, while others are part of a low-microbe diet (low-germ or *neutropenic diet*).

Some additional precautions are recommended for people recovering from a stem cell transplant:

- Do not eat raw nuts or nuts roasted in their shells.
- Do not drink wine or beer that has not been pasteurized (this is most often home brewed and some microbrewery beers).
- Do not drink “sun tea” or cold-brewed tea made with warm or cold water.
- Do not drink maté tea.
- Do not eat cold smoked fish, including lox, jerky, kippered, or nova-style fish.
- Do not eat miso or tempeh products.
- Do not eat uncooked grain products.
- Do not eat brewer’s yeast.

About eating fresh fruits and vegetables: Fresh fruits and vegetables can have germs on the outside which can cause illness. Some doctors tell their patients who have suppressed immune systems not to eat any fresh fruits or vegetables to help lower the risk of infection. Others allow their patients to consume fresh fruits and vegetables if they are washed thoroughly first. It’s important to know that even when the outer part of a fruit (such as the peel or rind) isn’t eaten, it still needs to be washed. If it isn’t, germs can get on the part that is eaten when the peel or rind is cut. It may also be a good idea to avoid certain foods that have been linked to outbreaks before, such as raw vegetable sprouts, fresh salsa, and berries.

Talk with your doctor about any dietary questions or concerns you may have, or ask to talk with a registered dietitian.

For more food safety information, visit the US Department of Agriculture website at www.fsis.usda.gov and search “cancer.” Or you can call them at 202-512-1800 for a copy of their booklet *Food Safety for People With Cancer*.

Medicines to prevent infections during cancer treatment

Sometimes, doctors prescribe medicines when a person's absolute neutrophil count (ANC) is very low — even though there's no sign of infection. The drugs are given to help keep you from getting an infection.

Preventive antibiotics

Anti-bacterial, anti-viral, and/or anti-fungal drugs may be used to help prevent infection. You may hear this called *prophylactic antibiotic* use, or just *prophylaxis*. Prophylaxis is only used when there's a very high risk of getting infections, for example, if you are expected to have a very low neutrophil count for a week or longer. Antibiotics may also be given if you are taking other medicines that can make your immune system weak, such as a long course of steroids or certain immunotherapy or chemotherapy drugs.

The prophylactic antibiotics are stopped when your ANC improves or your immune system is no longer so weak (often some time after the immune-weakening drugs are stopped). Using antibiotics in this way does not prevent all infections, so it's still important to use the same precautions as when you are not taking preventive antibiotics.

Growth factors

Growth factors are proteins your body makes to help your blood cells grow. They are also known as *colony-stimulating factors (CSFs)*.

You can be given man-made CSFs as injections (shots). They are most often used after chemo to keep your white blood cell (WBC) count up and help prevent infection. You may be given a CSF before a cycle of chemo to help your WBCs grow and keep your absolute neutrophil count (ANC) from getting too low. Or, you might get it when your ANC is low to help build it back up. Your doctor also may give you a CSF if your ANC is low and you have a serious infection that is getting worse even though you are getting treatment.

CSF drugs used today include filgrastim (Neupogen[®]) and pegfilgrastim (Neulasta[®]), which affect the neutrophils. Sargramostim (Leukine[®]) is a CSF that affects neutrophils, monocytes, and macrophages. All of these medicines shorten the length of time a person is neutropenic (low on neutrophils) and make the shortage of WBCs and neutrophils less severe.

Growth factors can have serious side effects in some people, but they can reduce the risk of infection in the patients who need them. You can call us (1-800-227-2345) to get more information on each of these drugs.

What are signs of infection in people with cancer?

It's important to watch for early signs of infection and tell your health care team about them right away. This way treatment can be started as early as possible. This is most important for people who have a low white blood cell count. Signs and symptoms of an infection might include:

- Body temperature of more than 100.5° F or higher taken by mouth
- Shaking chills or sweats (often goes along with fever)

- Sore throat
- Cough or shortness of breath
- Nasal congestion
- Burning or pain when passing urine; bloody or cloudy urine
- Redness, swelling, drainage, or warmth at the site of an injury, surgical wound, or vascular access device (VAD), or anywhere on the skin including the genital and rectal areas
- Pain or tenderness in the stomach or abdomen (the belly)
- Stiff neck
- Sinus pain or headache

Fever is especially important because it's often the first sign of an infection in people with cancer. You should have a thermometer to check your temperature – you can't rely on how you feel to know when you have a fever. Patients may be told to call their doctor or nurse if they have a temperature of 100.5° F or higher, or if they have other signs and symptoms of infection. **Don't take medicines to reduce your fever (such as Tylenol®, Advil®, Motrin®, or aspirin) without checking with your doctor first.** Ask your doctor what you should do and when you should call. Be sure you know how to reach your health care team after hours, including nights and weekends.

It's important for people with cancer and their families and friends to know these things:

- Your risk for infection
- How long your white blood cell count (WBC) or absolute neutrophil count (ANC) is likely be low after treatment
- The importance of taking your temperature, how to take it the right way, when to check it, and how often to check it
- When to report a fever or other signs and symptoms of infection to the doctor or nurse
- The importance of basic hand washing and hygiene for the patient and the people they come in contact with
- The importance of cleaning around the anus after each bowel movement
- How to take good care of your mouth and check for sores and fungal infections
- How to clean cuts, scrapes, or other breaks in the skin and keep them clean to prevent infection
- Good care of IVs and vascular access devices (VADs)
- Where to look for signs of infection (skin, mouth, and VAD sites)
- The importance of good nutrition, a balanced diet, and drinking plenty of fluids
- The importance of sleep and exercise, and how to pace yourself to save energy

- The need to take medicines as prescribed and being sure the doctor knows about all medicines you are taking (prescription, over-the-counter, vitamins, herbs, and supplements); keep a list and update it at each doctor visit
- Ways to prevent dryness of the skin and mucous membranes
- The need to talk with your health care team or doctor before getting vaccinated (immunized) and before getting close to children or adults who have recently had vaccinations.

Review these points with your doctor or nurse before and during treatment to get the information that is most important to you. Double check with them about how you would expect to handle these things and find out if there are ways that would work better during your cancer treatment.

How does the body normally resist infections?

Your body has many ways to protect itself from infections. It helps to understand the normal ways your body does this, and how cancer and cancer treatment change this process. This may help you better understand why infections can develop so easily and be so serious in people with cancer.

Skin and mucous membranes

The skin is your body's largest organ and its most important barrier against infections. It's your first line of defense in protecting internal tissues from harmful germs. It also keeps body tissues from drying out (dehydrating). When there's a break in your skin, it's easier for germs to enter your body and cause infection.

Mucous membranes, which form the moist, pink lining layer of the mouth, throat, nose, eyelids, urethra, vagina, and digestive (gastrointestinal) system, also act as a partial barrier against infection. These membranes normally help protect us from germs in the air we breathe, our environment, and in our food and drink.

Cancer treatments (such as chemotherapy, radiation therapy, or surgery) and certain procedures (like putting in catheters or IVs, or getting shots) can damage the skin or mucous membranes. This makes it easier for germs to get in.

The immune system and blood cells

If germs get through the skin or mucous membranes, the job of protecting the body shifts to your immune system. Your immune system is a complex network of cells, signals, and organs that work together to help kill germs that cause infections. Many of these are special blood cells that travel in the blood until they find germs to attack. Others spend part of their time in the blood and the rest of their time in immune system organs.

Blood cells and how they're made

Blood cells are made when cells in the bone marrow, called *stem cells*, grow into different kinds of mature cells. These mature cells are released into the blood to do their work. There are 3 major kinds of blood cells.

- Red blood cells (RBCs or *erythrocytes*) carry oxygen to cells throughout the body.

- Platelets (*thrombocytes*) help make clots to plug up holes that form in blood vessels from injuries such as cuts, scrapes, or bruises.
- White blood cells (WBCs or *leukocytes*) help fight germs that get into the body.

White blood cells help fight infection

White blood cells are part of the immune system. (Red cells and platelets are not.) There are different types of white blood cells, and they each have a key role in the body's defense against germs:

- *Neutrophils*
- *Lymphocytes* (which include T-lymphocytes and B-lymphocytes)
- *Monocytes*
- *Macrophages*

Neutrophils are key infection-fighters

Normally, most of our white blood cells are *neutrophils*. Neutrophils form a very important defense against most types of infection. For most people with cancer, having a low neutrophil count is the biggest risk factor for getting a serious infection. Ask your doctor if your cancer treatment will cause your neutrophils to drop.

Lymphocytes can make antibodies, mark, signal, and destroy germs

Some treatments, most often those given during bone marrow transplant, can cause a shortage of lymphocytes. B and T lymphocytes help fight viruses, but have different jobs:

- B-lymphocytes make special proteins called *antibodies* that recognize and kill certain germs. They also can mark germs to be destroyed by other cells.
- T-lymphocytes make signaling substances called *cytokines* that tell other cells what to do. They also destroy cells infected by viruses.

Monocytes and macrophages help recognize invaders, kill fungi and parasites

- They help lymphocytes recognize germs.
- They can surround and digest germs that have been coated by antibodies (the proteins made by B-lymphocytes).
- They help fight bacteria, fungi, and parasites.

Why are people with cancer more likely to get infections?

Some types of cancer can damage the immune and blood systems or change the way they work. For instance, lymphomas (Hodgkin and non-Hodgkin) and certain types of leukemia start in immune system cells. They change the immune system cells so that cells that once protected your

body begin to interfere with the normal way your immune system works. Many other types of cancer can also affect the immune system.

In most cases it's not the cancer itself, but the cancer treatment that changes the immune system. Treatments can cause short- or long-term damage. For example, long-term damage happens when immune system organs such as the spleen are removed. A *splenectomy* (surgery to remove the spleen) is sometimes done to remove cancer or learn how much it has spread. On the other hand, chemotherapy, radiation therapy, immunotherapy, either alone or in combination can lead to short-term immune system damage. Bone marrow or stem cell transplant uses very strong treatments to kill cancer cells. This treatment also kills immune system cells, which can worsen and prolong the risk of infection. Sometimes this damage can last for months after treatment ends.

Some people with cancer have a higher risk of infection because of the changes in their body's defense systems. Cancer and cancer treatments can affect these systems in different ways. People with cancer might be more likely to get infections because of:

- Problems caused by the cancer itself
- Problems caused by certain types of cancer treatment
- Poor nutrition

All of these (discussed in later sections sections) can increase your risk of infection by causing immunosuppression and neutropenia.

Immunosuppression and neutropenia

Chemotherapy, radiation therapy, surgery, stem cell or bone marrow transplant, steroids, or the cancer itself can suppress or weaken the immune system. These treatments can lower the number of white blood cells (WBCs) and other immune system cells. This is called *immunosuppression*.

You may get an infection when there aren't enough WBCs, especially neutrophils, to destroy germs. Treatment can also cause these cells to not work as well as they should.

When looking at your risk of getting an infection, doctors look at the number of neutrophils you have. A low neutrophil count is called *neutropenia*. The doctor may say you are *neutropenic*.

It's possible for your total WBC count to be in the normal range while you are neutropenic. But because neutrophils normally make up the largest part of the total white blood cell count, the WBC count is usually low when the neutrophil count is low.

Absolute neutrophil count

You may hear your doctor or nurse talk about your *absolute neutrophil count* or *ANC*. This is the number of neutrophils you have in a certain amount of blood. Some labs will put this number on the report of your complete blood count, but it isn't always labeled "ANC," so you may need to ask your doctor or nurse to help find it. Sometimes the lab will only report different types of neutrophils as a percentage of white blood cells, and then your health care team will calculate your ANC. You can also calculate it yourself. Your health care team will use this number to get an idea of how well your immune system might work during treatment. You might want to keep track of your ANC so you'll know when you have a higher risk of getting infections.

Figuring out your ANC: The numbers for your ANC are taken from the results of a blood test called the *differential white blood cell (WBC) count*. You can find out the results of these blood tests or get copies of the test results from your doctor.

Normally, neutrophils make up 50% to 70% of WBCs. To find out your ANC, multiply the percentage of neutrophils by the total number of WBCs. (Neutrophils are sometimes called *segs* or *polys*, and young neutrophils may be called *bands* on your lab report. If bands are listed as a percentage of WBCs, add them to the neutrophils before multiplying.)

You can figure out your ANC using this formula:

$$[(\% \text{ of neutrophils} + \% \text{ of bands}) \div 100] \times \text{WBC count} = \text{ANC}$$

So, for example, if a patient's WBC count is 1,000 and the percentage of neutrophils is 70%, and there are no bands, then the ANC is 700, which is calculated like this:

$$[(70 + 0) \div 100] \times 1,000$$

$$(70 \div 100) \times 1,000$$

$$0.7 \times 1,000 = 700$$

Another example is if the patient's WBC is 1,300, with 60% neutrophils and 5% bands. The bands are added with the neutrophils (60 + 5), and the ANC is 845:

$$[(60 + 5) \div 100] \times 1,300$$

$$(65 \div 100) \times 1,300$$

$$0.65 \times 1300 = 845$$

What the absolute neutrophil count means: An ANC less than 1,500 or 1,000 means that you have a low number of neutrophils and your immune system is weak.

The lower the ANC drops and the longer it stays low, the higher your risk of getting a serious infection. If the ANC drops below 500 for a few days, you are at a high risk of getting an infection. If your ANC is 100 or less for more than a week, your risk of serious infection is extremely high.

In a person with a healthy immune system, the usual signs of infection are fever, pus, pain, swelling, and redness. As the ANC gets lower, many of these signs may not show up when an infection starts. This is because these signs are caused by neutrophils fighting off germs. But if you're neutropenic, you might not have enough neutrophils to show signs the body is fighting back, even though the germs are there. This can make it hard to know if you have an infection. The good thing is that another WBC, called the monocyte, can still cause fever in the person who has neutropenia. In people with severe neutropenia, a fever may be the only sign of an infection.

If your ANC is 1,000 to 1,500 or lower and you have a fever of 100.5° F (38° C) or higher when taken by mouth, your doctor will likely assume that the fever is caused by an infection. Treatment with antibiotics is usually started right away, often before the cause of the infection can even be found. When a person has neutropenia, infections must be treated as quickly as possible. But doctors still look for the exact cause so that they can choose the treatment that's most likely to work.

How cancer can increase risk of infection

Cancer cells can get into the bone marrow where blood cells are made. The cancer cells then compete with the normal bone marrow cells for space and nutrients. If too many normal marrow cells are destroyed or pushed out of the bone marrow, the few cells that are left will not be able to make enough white blood cells (WBCs) to fight infection.

Cancer can also damage other parts of the immune system. A tumor can grow through the skin or mucous membranes, breaking natural barriers and allowing germs to get in. Tumors may also reduce blood flow to the normal tissues by pressing on them or their blood supply. Tumors in the lungs may block normal mucus drainage, which can lead to infections. And tissues that have been damaged by cancer are more prone to infections.

Cancer cells can also release chemicals that change normal immune cells. This is a well-known effect of many cancers that start in immune system cells, such as lymphomas, leukemias, and multiple myeloma. It can happen with other cancers, too.

How cancer treatment can increase the risk of infection

Most cancer treatments used today can increase the risk of infection.

Surgery

For reasons that aren't very clear, any type of major surgery can suppress the immune system. Researchers have seen decreases in immune function within hours of surgery. Anesthesia (the drugs used to make the patient sleep) may play a role. It may take from 10 days to many months for an immune system to recover completely.

Surgery also breaks the skin and mucous membranes and can expose internal tissues to germs. The wound caused by surgery (the *incision*) is a common place for infection.

Because surgery is often used to diagnose, stage, or treat people with cancer, it's important to know that surgery can increase the risk of certain infections. Things that raise the risk of infection after surgery include:

- How long the person is in the hospital
- The extent of the surgery (how much cutting was done)
- How long the operation took
- The amount of bleeding during surgery
- The person's nutritional status
- Prior cancer treatment, such as chemotherapy or radiation or medical problems such as diabetes, or heart or lung problems

People with cancer may get antibiotics before and for a short time after having surgery to help protect them from infection.

Chemotherapy

Chemotherapy (often called chemo) is the most common cause of a weakened immune system in people getting cancer treatment. The effects on the immune system depend on many things, including:

- Which chemo drugs are used
- Chemo dose (how much of each drug is given at once)
- How often chemo is given
- Past cancer treatments
- The person's age (older people are more likely to get infections, with or without cancer)
- The person's nutritional status
- The type of cancer
- The stage of the cancer (how much cancer there is)

Some drugs affect the bone marrow and immune system more than others. But chemo drugs can have different effects on how well the body makes white blood cells, red blood cells, and platelets. In most cases, white blood cells are the ones most affected by chemo.

The chemo's effect on your blood cells doesn't last. After treatment ends, your blood cell counts usually go back to normal over time.

Radiation therapy

Radiation therapy's effects on bone marrow cells can be much like the effects of chemo. It also can cause low white blood cell counts (including neutropenia), which increases the risk for infections.

Many things affect the degree of neutropenia from radiation therapy. These include:

- The total radiation dose
- The radiation schedule
- The part of the body being treated with radiation
- How much of the body is treated with radiation

Total body irradiation or TBI (where a person's entire body is treated with radiation) is the only type of radiation likely to cause very low blood counts. Radiation is most often given to just one part of the body, so the whole immune system is not damaged by it. Still, depending on the dose and the part of the body being treated with radiation, the skin or mucous membranes may be damaged, so you're less able to keep germs out.

Today, radiation treatments are most often given over many sessions rather than in one large dose. This helps decrease the amount of skin and tissue damage, immune suppression, and the risk of infections.

Immunotherapy or biotherapy

Immunotherapy is also known as *biotherapy* or *biologic therapy*. It's given to make your immune system better able to recognize and attack cancer cells. This can be done by helping your own immune system work harder or smarter, or by giving you things like man-made immune system proteins. Immunotherapy is sometimes used by itself to treat cancer, but it's often used along with or after another type of treatment to add to its effects.

These treatments promote immune reactions against cancer cells, but sometimes they change the way the immune system works. Because of this, people who get biologic therapies may be at risk for immune suppression and neutropenia. In fact, some immunotherapy drugs lower the levels of all white blood cells (not just neutrophils), and some only lower the levels of lymphocytes.

When lymphocyte levels are low, the chance of getting certain serious viral and fungal infections becomes very high. Absolute neutrophil counts may also drop. Most of the time the neutrophil counts return to normal soon after the treatment is stopped, but the lymphocyte counts can stay low for months. (For more information see our document called *Immunotherapy*.)

Hematopoietic stem cell transplant (bone marrow transplant)

Hematopoietic stem cell transplant (HSCT) is the term now used to include *bone marrow transplant* (BMT), *peripheral blood stem cell transplant* (PBSCT), and *umbilical cord blood stem cell transplant* (UCBSCT). These transplants allow doctors to use very high doses of chemo and/or total body irradiation (TBI) to try to kill all the cancer cells in the body.

In the process of killing the cancer cells, the blood-forming stem cells of the patient's normal bone marrow are also killed. Because of this, stem cells (either from the blood or bone marrow) are removed from the patient and saved before the high-dose chemo is given. Or, stem cells may be taken from a donor or banked umbilical cord blood. Once the cancer cells are killed, the saved or donated stem cells are given to the patient so that blood cells can be made and the immune system rebuilt.

High-dose chemo is sometimes used with TBI for transplants. This causes more severe neutropenia that lasts for a longer time. It can also damage the skin and mucous membranes and make them less able to keep germs out of the body.

For these reasons, very strict precautions are taken to try to protect transplant patients from getting infections. These usually include:

- Keeping the transplant patient in a special area of the hospital until their WBC counts begin to reach normal (this often takes weeks)
- Limiting their exposure to other people or other sources of germs
- Watching the patient closely for signs of infection for weeks afterward, and for much longer if they have signs of graft-versus-host disease.
- Treating quickly if infection is suspected.

Patients who get stem cells from other people may also need medicine to keep them from rejecting the stem cells. These medicines further suppress the immune system. For more information on

transplants, see our document called *Stem Cell Transplant (Peripheral Blood, Bone Marrow, and Cord Blood Transplants)*.

How nutrition affects risk of infection in people with cancer

All cells need nutrients to grow and work. Lack of vitamins, minerals, calories, and protein can weaken your immune system and make it less able to find and destroy germs. This means people who are poorly nourished (*malnourished*) are more likely to develop infections. People who are malnourished either do not take in enough calories and nutrients, or the body can't use the food it takes in. Either way, it can weaken your immune system.

People with cancer often need extra calories and protein to support their immune system cells and other tissues. For example, recovery from surgery increases the body's need for nutrients. People with cancer might be poorly nourished for many reasons:

- The cancer itself can make it hard to eat or digest food. This is common in people with cancers of the digestive system, mouth, or throat.
- Cancer treatments, like radiation therapy and chemotherapy, can cause nausea and a loss of appetite.
- Cancer cells use up nutrients, leaving less to meet the needs of normal, healthy tissues.

People with cancer often need help from dietitians or doctors to get enough calories and nutrients. Dietary supplements, tube feedings, or even intravenous (IV, through a vein) feedings may help in some cases.

Good nutrition, stress management, and good self-care might help improve the immune function of people with cancer, which may help prevent some infections. Your doctor might have you meet with a dietitian to plan what you should eat and for help managing eating problems. Nutrition counseling should include the importance of getting enough calories, protein, and vitamins. This is tailored to each person's food intake and nutrition problems. Other therapies such as biofeedback, humor, music therapy, guided imagery, counseling, and meditation may help manage stress and make it easier to eat. Learn more about what to eat during cancer treatment in our document *Nutrition for the Person With Cancer*.

What are the risk factors that mean infections could be serious?

When your cancer treatment causes low white blood cell counts, you have a higher risk of getting an infection. When your absolute neutrophil count (ANC) is low (neutropenia), there are other risk factors that can make any infection you get more likely to become a serious one. For instance, fever is more likely to mean a serious infection if your ANC is low and you:

- Are in the hospital when your fever starts
- Have other serious illnesses
- Have cancer that is not controlled or is getting worse
- Have an ANC of 100 or less for a week or more

- Are age 60 or older
- Do not have normal liver and/or kidney function
- Have lung disease, like emphysema or chronic obstructive pulmonary disease (COPD)
- Can't eat because of severe mouth sores
- Are dehydrated
- Have low blood pressure
- Are taking alemtuzumab (Campath[®])
- Have signs that suggest pneumonia or another complex infection

If you have more than one of these risk factors, the risk of serious infection is even higher. Serious infections will probably need to be treated in the hospital because they can be life-threatening. A person with neutropenia and a serious infection must be treated aggressively and followed up carefully.

Factors that might work in your favor

When your ANC is low, an infection is less likely to be serious if you:

- Have none of the high-risk factors listed above
- Are expected to be neutropenic for less than a week
- Are still able to do most of your daily activities for yourself

How does the doctor know what kind of infection a person with cancer has?

People with cancer can get many different types of infections. These infections differ in their risk factors, the symptoms they cause, how they are treated, and the chance for curing the infection. If you have an infection, it's important for the doctor to know:

- The part of the body affected
- The type of germ causing the infection

Parts of the body most likely to get infections

Your signs and symptoms (for example, where you have pain, redness, or swelling) help your doctor know what tests are needed to find the cause of the infection. The results of certain tests (such as x-rays, CT scans, or lab tests done on body fluids) help pinpoint where the infection is.

Common sites of infection in people with cancer include:

- The skin and mucous membranes

- The digestive system (mouth, esophagus [swallowing tube], stomach, intestines, and rectum)
- The lungs and breathing passages (sinuses, throat, and lungs)
- The urinary system (bladder and kidneys)
- The nervous system (brain and spinal cord)
- The skin and tissue around a vascular access device (VAD). A VAD is a tube or catheter put in a vein that is used to draw blood and give IV drugs or fluids (like a PICC line or port-a-cath).

Finding the germs that cause infections in people with cancer

Infections are grouped by the type of germs that cause them. Bacteria, viruses, protozoa (some of which act as parasites), or fungi may cause infections in people with cancer.

Most of the infections in people with cancer are caused by germs that normally live on the skin, in the intestines, or in the environment. These germs usually do not cause infections in people with normal defenses and immune systems. But if the normal barriers and immune system are weak, the germs can get in the body, grow, and cause damage. These infections are often called *opportunistic infections*, because the germs use the opportunity of a patient's weakened defenses to cause illness.

Naming germs

Like all other living things, germs are given scientific names from the genus (first names) and species (last names). These names tell biologists and health care workers which living things are related and may be like each other. For example, the biological names *Felis domesticus* (house cats) and *Felis leo* (lions) tell biologists the animals are related. (Note that scientific names are usually written in italics, except for viruses.)

In the same way, *Staphylococcus epidermidis* and *Staphylococcus aureus* are related bacteria. But, like house cats and lions, they differ in important details. *Staphylococcus epidermidis* lives on our skin and rarely causes infections in healthy people. But it can cause infections in people with cancer who have an IV (intravenous) or vascular access device (VAD) and a low white blood cell count. *Staphylococcus aureus* can cause very serious infections even in those with healthy immune systems. It's often resistant to certain antibiotics and can be very hard to treat.

Although most germs have first and last names, those that are very well known are often called by their first names only. Germs like this include *Pneumococcus*, *Candida*, and *Aspergillus*. And like some people, germs with long names are sometimes more commonly known by their initials or nicknames. These include *E. coli* (*Escherichia coli*), *Staph* (*Staphylococcus aureus*), and CMV (cytomegalovirus).

Lab tests to identify germs

Knowing the exact type of germ that is causing an infection helps doctors choose the best treatment. Different drugs are used to treat each of the main types of germs — bacteria, viruses, fungi, and parasites. And even among the main types of germs, different types are treated with different drugs. This means an antibiotic that can kill one type of bacteria might have no effect on another type of bacteria. Your health care team will do all they can to find out exactly what germ is causing your infection. Here are some of the tests they may use.

Gram stain: Samples from the suspected site of infection can be put on a microscope slide and stained with a series of dyes. This test is called a *Gram stain*. It changes the colors of the germs and makes them easier to see. It takes only a few minutes to stain the sample and look at it. The colors and shapes of the stained germs often give doctors an idea of which germ is causing the infection. This can help narrow the choice of antibiotics until more precise test results come in. Gram stains are most useful for bacteria; fungi and parasites usually need different stains.

Tests for viruses: Viruses are too small to be seen with most microscopes. Instead, viruses are sometimes identified by lab tests that look for the viral proteins or viral genes. Others are detected by finding their antibodies.

Genetic tests: New medical lab tests can quickly identify some germs by testing their DNA, RNA, or other substances. These tests often help doctors choose the best treatment more quickly than older tests. This means the right treatment can be started before the infection causes serious harm.

Culture*: Samples from the suspected site of infection are put in a nutrient broth or gel and kept warm until the germs grow. Bacteria and fungi often take at least a few days to grow in the lab before they can be seen. After enough germs have grown, they are tested so they can be identified. Viruses may also be identified by taking samples and growing them in the lab, but it can take a few weeks to get results.

Sensitivity tests*: Once bacteria (or fungi) have been cultured, an extra test called a *sensitivity test* may be done. This is often needed because some germs resist certain antibiotics that kill others of that same type. This test also takes time, but it shows the best antibiotic to kill the germ causing a certain infection.

**Because infections in people with cancer can quickly get worse, treatment is usually started before culture and sensitivity results are back. These antibiotics may be changed after the lab tests have identified the exact germ and which drug will work best to treat it.*

How can doctors treat the infection while they wait for lab test results?

Doctors know which germs tend to infect which organs of people with cancer. So they can often make an educated guess at which germs are most likely causing a patient's infection. Sometimes they are able to use tests that can be done quickly, like the Gram stain, to narrow down the type of germ. Educated guesses are very important because it can take many days to get the results of the tests that show the exact type of germ causing an infection and which drug will best stop or kill it.

Test samples or specimens

All of the tests listed above are done on samples or specimens from the patient. Common types of samples include:

- Blood
- Urine
- Spinal fluid
- Wound drainage or pus
- Phlegm (sputum)

If you have symptoms that point to a certain organ, samples will be taken to check for germs in that area. For example, sputum samples may be taken if you have a cough or are short of breath. Urine samples may be taken if you have blood in your urine or feel pain while urinating. Sometimes, if a person has a very low white blood cell count and a fever, samples will be taken before these types of symptoms start.

What kinds of germs cause infections in people with cancer?

Bacteria

Bacteria are the smallest forms of life. Biologists believe that bacteria are a separate life form — they are different from plants and animals. Bacteria cause most of the infections in people with cancer. Some bacteria that commonly cause infections in people with cancer include:

- *Pseudomonas aeruginosa*
- *Klebsiella pneumonia*
- *Escherichia coli* (*E. coli*)
- *Salmonella*
- *Clostridium difficile* (*C. diff*)
- *Staphylococcus aureus* (*Staph aureus*)
- *Staphylococcus epidermidis* (*Staph epi*)
- *Streptococcus viridans*
- *Pneumococcus*
- *Enterococcus*

Viruses

Viruses are the smallest known germs. Unlike bacteria, they are not really alive because they cannot grow on their own. Viruses can only make new viruses when they are inside living cells, such as human, animal, or plant cells. Most viral infections in people with very low white blood cell counts are caused by

- Varicella zoster virus (VZV), the virus that causes chickenpox and shingles
- Herpes simplex virus (HSV), the virus that causes cold sores and genital herpes
- Cytomegalovirus (CMV)

Other viruses, such as respiratory and hepatitis viruses, may cause problems, too.

Varicella zoster virus

Varicella zoster virus (VZV) can cause serious infections in people with cancer, especially children. Unlike many other infections, a VZV infection never completely goes away even in a healthy person. This means when a person recovers from chickenpox, some of the virus stays in their nerve cells. If the person's immune system is weakened, even many years later, the virus can become active again and cause a problem known as *shingles*. People with shingles have groups of tiny, painful blisters on their skin. The blisters form along the paths of nerves. The pain from shingles can last long after the blisters go away.

These skin blisters hurt, but the most serious part of VZV infection in people with a weak immune system is that the virus may spread to other organs. This can lead to pneumonia (lung infection) or encephalitis (infection of the brain). There's a high risk of serious damage from VZV in people with low white blood cell counts and weak immune systems. Unlike chickenpox infections in healthy people, VZV infections can be deadly in people with cancer.

Herpes simplex virus

Herpes simplex virus (HSV) is from the same family of viruses as varicella zoster. Like varicella zoster, HSV causes mild infections in people with healthy immune systems, but it also stays in their nerve cells. It can become active again years later, especially if the immune system changes. And like varicella zoster, HSV can also cause pneumonia and encephalitis.

Cytomegalovirus

Cytomegalovirus (CMV) infection is common in healthy people and it's usually not serious. Many people have the virus in their bodies for years without even knowing it. But when the immune system is weakened, CMV can cause things like serious pneumonia, enteritis (intestinal infection), hepatitis (liver infection), and retinitis (a serious eye infection that can lead to blindness if not treated).

CMV infection can be very hard to treat in people with low white blood cell (WBC) counts, because the drugs that work against the virus also lower the number of WBCs. This makes it hard for the body to fight the infection. Often, the best thing to do for patients with weak immune systems is to try to prevent the infection from flaring up. This is done by giving patients certain anti-viral drugs before their symptoms begin.

Respiratory viruses

Respiratory viruses are those like influenza (the flu), respiratory syncytial virus (RSV), and other seasonal viruses. They can cause illnesses in people with normal immune systems, but these illnesses may become more severe in those with weak immunity. Respiratory viruses can affect the nose, throat, sinuses, breathing passages, and lungs. Pneumonia, which affects the lungs, is the most serious problem that can be caused by respiratory viruses. Pneumonia is more likely when one of these viruses infects a person whose immune system isn't working well.

The best way to prevent the flu is to get a flu shot every fall and have other household members vaccinated, too. Wash your hands often when viral infections are going around to help decrease the chances of infection. People with low white blood cell counts should try to stay away from crowds

and people with these kinds of infections. (See the section called “What can people with cancer do to prevent infections?”)

Protozoa

Protozoa are one-celled creatures thought to be the smallest and simplest form of animals. Some protozoa can infect people who have healthy immune systems. But these infections are more common in less-developed countries than in the United States. In the US, protozoa mostly cause disease in people with weak immune systems. People who have organ transplants, cancer, AIDS, or other diseases can get life-threatening infections with protozoa. Common protozoa that can cause serious illness in people with cancer include

- *Toxoplasma gondii*
- *Cryptosporidium*

Toxoplasma gondii

Toxoplasma gondii is found in soil, cat waste, water contaminated with cat waste, and undercooked meats. It can cause fever and lymph node swelling or no symptoms at all in adults with normal immune systems. It usually stays inactive in healthy people, but when the immune system is weak the infection may become active and damage the brain or heart. People with cancer can have old infections become active again, or they can get infected for the first time while their immune system is weak.

Cryptosporidium

Cryptosporidium is a common cause of diarrhea and stomach pain in people with weak immune systems. It's spread by infected people and animals, often through drinking water or produce contaminated with stool. It can cause very severe diarrhea, leading to malnutrition, weight loss, imbalances in blood chemistry, and dehydration (severe fluid loss).

Fungi

In humans, fungi can live in balance with other germs that normally live on or in the body without causing symptoms or damage. But fungal infections can happen when there are changes in this balanced environment. Things that can change the normal balance include:

- Damage to the skin or mucous membranes
- Low white blood cell counts
- A weak immune system
- Fewer bacteria than normal on the body's surfaces or mucous membranes (such as the intestines or vagina — this often happens with antibiotic treatment)

Fungal infections can be serious and even deadly. Fungi that commonly infect people with cancer include:

- *Pneumocystis jirovecii* (formerly known as *P. carinii*)

- *Candida* (yeast)
- *Aspergillus*
- *Cryptococcus*
- *Histoplasma*
- *Coccidioides*

Pneumocystis jirovecii

Pneumocystis jirovecii is an atypical fungus that can cause illness in those with weak immune systems. It causes pneumonia and rarely spreads to other organs, but the pneumonia can make it very hard to breathe. *Pneumocystis* infections are common enough in patients with weak immune systems that sometimes doctors will give an antibiotic to help prevent this illness.

Candida

This is the most common fungal infection. *Candida* can live in a healthy person without causing any problems. Sometimes it may cause a mild skin rash or vaginal discharge (called a *yeast infection*). In babies, it can cause a mouth infection called *thrush*. But a person with a weak immune system is at risk for a more serious version of thrush. It can affect the mouth and esophagus (swallowing tube) and may spread to other organs. *Candida* can also cause bloodstream infections in people with weak immune systems.

Aspergillus

Aspergillus is a fungus that's often found in the air and in our environment. It's rarely a problem in healthy people, but it can cause a mild lung infection in people with allergies or asthma. In people with cancer, though, it can cause serious infections of the sinuses, lungs, kidneys, brain, and heart valves in people. This is especially true for those with very low white blood cell counts or those getting cancer treatments that suppress the immune system. This type of infection is often hard to diagnose. Quick, aggressive treatment is needed as soon as it's suspected.

Cryptococcus

Cryptococcus is found in the soil and in bird droppings, especially pigeon waste. It's thought to be spread by breathing in the germ after it's dried out and gets stirred up into the air. In people with healthy immune systems it may cause a lung infection that goes away without symptoms. But the fungus can remain inactive in the lungs for years. And if the person's immune system becomes weak, *Cryptococcus* can begin to grow and spread to other parts of the body. One of the most serious outcomes of this infection is meningitis, an infection of the membranes that cover the brain and spinal cord.

Histoplasma

Histoplasma is another fungus that often infects the lungs of healthy people without causing symptoms or tissue damage. Infection with *Histoplasma* is quite common in the Mississippi and Ohio River Valleys in the United States, although it is seen outside of these regions. It's also found

in many other parts of the world. People become infected through contact with soil or breathing the dust from soil that contains bird or bat waste. Like *Cryptococcus*, the fungus may remain inactive for years in the lungs of healthy people. But it can become active if their immune system is weakened. In people with cancer, *Histoplasma* may cause a serious illness and may spread to the lymph system, liver, spleen, and other organs.

Anyone who has lived in any part of Arkansas, Kentucky, Missouri, Tennessee, and West Virginia is likely to be infected. People from certain parts of Alabama, Illinois, Indiana, Iowa, Kansas, Louisiana, Maryland, Mississippi, Nebraska, Ohio, Oklahoma, Texas, and Virginia are also likely to be infected with *Histoplasma*.

Coccidioides

Coccidioides causes a fungal disease called *coccidioidomycosis* or Valley Fever. The fungus lives in the soil in the southwestern United States, parts of Mexico, and Central and South America. People breathe in this fungus when dust containing it is stirred up. Most people with healthy immune systems don't know they have the disease and it goes away on its own. But *Coccidioides* can cause serious illness in people with weak immune systems. It can spread outside the lungs to the skin, nerves, brain, bones, and joints.

How is infection treated in people with cancer?

Fever and other signs of infection in a person with a weak immune system are treated as medical emergencies. Antibiotics should be started right away. After a complete physical exam, lab tests and sometimes even imaging studies or special procedures will be done. This will help the doctor find out exactly where the infection is and help narrow down which germ may be causing it. Then antibiotics (which can be anti-bacterial, anti-viral, anti-fungal, or anti-protozoal drugs) are started quickly after cultures or test samples are taken (see "Lab tests to identify germs" in the section "How does the doctor know what kind of infection a person with cancer has?"). After the exact germ is identified, the antibiotics may be continued, or new medicines may be started if the cultures or tests show others would work better.

Where treatment is given

In the past, patients were almost always put in the hospital to treat these infections, and many still are. But some patients can take their antibiotics in pill or liquid form. And some patients who need intravenous (IV) antibiotics may be able to get them in clinics, doctor's offices, or at home.

Home care is only used with infections that are not likely to become more serious. The patient must have an adequate home environment that's safe for home care. They must have a responsible adult at home with them at all times, and be able to handle treatment at home. The patient must have a phone, and be able to quickly get to a hospital with 24-hour medical emergency support. Patients who have nausea and vomiting, or who have recently taken certain drugs, can't be treated at home.

The doctor or cancer care team must be able to see the patient every day for the first few days, do needed tests, and follow up by phone. If all goes well, they still will need to stay in close contact during treatment. Otherwise, the patient may need to be put in the hospital.

What treatment may be like

At first, the patient is watched closely and lab results are checked often. The white blood cell (WBC) count and absolute neutrophil count (ANC) are checked daily. Antibiotics may be changed when the final culture or other results come in. (The culture tells which germ is causing the infection; see “Lab tests to identify germs” in the section “How does the doctor know what kind of infection a person with cancer has?”)

If the infection doesn't get better, an infectious disease specialist may be called in. These are doctors who specialize in treating infections. This doctor may recommend extra testing and different treatments. In some cases, CSFs (colony-stimulating factors) may be given to boost the WBCs so the body can better fight the infection.

Each type of infection (bacterial, viral, protozoal, and fungal) is treated with different drugs. If you have any questions about drugs you are given or why you're taking them, talk with your doctor or nurse.

Bacterial infections

When treating bacterial infections in people with weak immune systems, samples are taken for lab testing and antibiotics are started before these test results have identified the germ. Doctors think about the site of infection and the germ most likely causing it when choosing antibiotics to use at this point. Most often, antibiotics that will treat many different bacteria are chosen. These are called *broad-spectrum antibiotics*. Many times, 2 or 3 antibiotics are used at the same time.

Drug-resistant germs: Even in serious situations, overuse of antibiotics must be avoided because this can cause some bacteria to become resistant to these drugs. Such germs are called *drug resistant* because they no longer respond to the antibiotics that killed them in the past. Germs change and adapt all the time. For example, some strains of *Staphylococcus* (staph) have become resistant to most antibiotics. Staph can be resistant to methicillin and other antibacterial drugs. Staph that is resistant in this way is called *methicillin-resistant staph aureus*, or *multi-drug-resistant staph aureus*. This is often shortened to the initials *MRSA* and may be pronounced **mer-suh** rather than being spelled out.

Some staph has now become resistant to intravenous (IV) vancomycin, which was once used to treat resistant infections. This is called *vancomycin-resistant staph aureus* or *VRSA* (may be pronounced **ver-suh**).

Some strains of enterococcus, which normally live in the human intestine, have now become resistant to vancomycin as well. These strains are called *VRE*, for *vancomycin-resistant enterococcus*.

The good thing is that there's a handful of newer drugs that can still work against some of these hard-to-kill germs. To avoid spreading drug-resistant bacteria to other patients, health care workers often wear disposable gowns and gloves when caring for people known to have these infections.

Viral infections

While anti-bacterial antibiotics have been available for around 70 years, anti-viral drugs are somewhat newer. Herpes simplex virus (HSV) and varicella zoster are most often treated with anti-viral drugs. These same kinds of drugs are used to treat cytomegalovirus (CMV).

If you have chronic hepatitis B, certain cancer treatment drugs can cause it to become active. There are drugs to fight hepatitis B. Your doctor may give you one of these drugs to keep your hepatitis B infection under control during cancer treatment.

Influenza that cannot be prevented by vaccination may be treated with an anti-viral drug. Other viruses are less common, but if they become a problem, they can be treated with anti-viral drugs, too.

Protozoal infections

Protozoa seldom cause problems for healthy people, but they can be hard to treat in people with weak immune systems.

Toxoplasma can be treated with a variety of drugs. But there's no one treatment for *Cryptosporidium* infection, which causes severe diarrhea. In this case, treatment is aimed at building up the immune system, treating the diarrhea, and avoiding dehydration.

Fungal infections

People with *Candida* infections in the mouth, throat, and esophagus might be prescribed anti-fungal drugs to be taken by mouth. For more serious *Candida* infections (such as infections in the blood), anti-fungal drugs may be given in the vein (IV).

There are drugs to treat *Aspergillus*, *Cryptococcus*, *Histoplasma*, and *Pneumocystis* infections.

Some of these drugs are also used to try to prevent fungal infections when the ANC is very low. (For more on this, see "Preventive antibiotics" in the section called "Medicines to prevent infections during cancer treatment")

To learn more

From your American Cancer Society

Here is more information you might find helpful. You also can order free copies of our documents from our toll-free number, 1-800-227-2345, or read them on our website, www.cancer.org.

More on cancer treatment

A Guide to Chemotherapy (also in Spanish)

Understanding Radiation Therapy: A Guide for Patients and Families (also in Spanish)

Understanding Cancer Surgery: A Guide for Patients and Families (also in Spanish)

Stem Cell Transplant (Peripheral Blood, Bone Marrow, and Cord Blood Transplants) (also in Spanish)

Understanding Your Lab Test Results

Nutrition for the Person With Cancer During Treatment: A Guide For Patients and Families (also in Spanish)

Vaccinations and cancer

Should I Get a Flu Shot?

Smallpox Vaccine and Cancer

For caregivers and family members

Caring for the Patient With Cancer At Home: A Guide for Patients and Families (also in Spanish)

What It Takes to Be a Caregiver

Helping Children When a Family Member Has Cancer: Dealing With Treatment (also in Spanish)

Books

Your American Cancer Society also has books that you might find helpful. Call us at 1-800-227-2345 or visit our bookstore online at cancer.org/bookstore to find out about costs or to place an order.

National organizations and Websites*

Along with the American Cancer Society, other sources of information and support include:

Centers for Disease Control and Prevention (CDC)

Toll-free number: 1-800-232-4636 (1-800-CDC-INFO)

TTY: 1-888-232-6348

Website: www.cdc.gov

Offers reliable information on infections, prevention, and vaccines as well as chronic diseases and other health information (also offered in Spanish)

National Cancer Institute

Toll-free number: 1-800-422-6237 (1-800-4-CANCER)

TTY: 1-800-332-8615

Website: www.cancer.gov

Offers information on cancer and its treatment, a drug dictionary of common medicines used in cancer treatment, and coping with cancer (also offered in Spanish)

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are, we can help. Contact us anytime, day or night, for cancer-related information and support. Call us at **1-800-227-2345** or visit www.cancer.org.

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