Infectious Agents and Cancer

Since the start of the 20th century, it's been known that certain infections play a role in cancer in animals. More recently, infections with certain viruses, bacteria, and parasites have been recognized as risk factors for several types of cancer in humans.

Worldwide, infections are linked to about 15% to 20% of cancers. In the United States and other developed countries, less than 10% of all cancers are thought to be linked to infectious agents. But in developing countries, infections can account for as many as 1 in 4 (25%) of all cancers.

Infections might raise a person's risk of cancer in different ways. Some infections can cause long-term inflammation, suppress a person's immune system, or directly affect a cell's DNA. Any of these changes might lead to a higher risk of cancer.

Even though the infections described here can raise a person's risk of certain types of cancer, most people with these infections never develop cancer. The risk of developing cancer is also influenced by other factors. For example, infection with *Helicobacter pylori* (*H pylori*) bacteria might increase your risk of stomach cancer, but what you eat, whether or not you smoke, and other factors also affect your risk.

The infections that influence cancer risk may be contagious, but cancer itself is not. A healthy person cannot "catch" cancer from someone who has it.

Viruses

Viruses are very small organisms; most can't even be seen with an ordinary microscope. They are made up of a small group of genes in the form of DNA or RNA surrounded by a protein coating. Viruses need to enter a living cell and "hijack" the cell's machinery to reproduce and make more viruses. Some viruses do this by inserting their own DNA (or RNA) into that of the host cell. When the DNA or RNA affects the host cell's genes, it may push the cell toward becoming cancer.

Several viruses are linked with cancer in humans. Our growing knowledge of the role of viruses as a cause of cancer has already led to the development of vaccines to prevent certain human cancers. But the vaccines can only help prevent the infections if they are given **before** the person is exposed to the cancer-promoting virus.

Human papilloma viruses (HPVs)

Human papilloma viruses (HPVs) are a group of more than 100 related viruses that can cause warts on the skin, mouth, genitals, and larynx. Some types of HPV only grow in skin, while others grow in mucous membranes such as the mouth, throat, or vagina.

All types of HPV are spread by contact (touch). More than 40 types of HPV can be passed on through sexual contact, and are very common in sexually active people. At least a dozen of these types are known to cause cancer.

There are no effective treatments for HPV other than removing or destroying cells that are known to be infected. But in most people, the body's immune system controls the HPV infection or gets rid of it over time.

HPV and cervical cancer

Just a few types of HPV are the main causes of cervical cancer, which is the second most common cancer among women worldwide. Cervical cancer has become much rarer in the United States because the Pap test has been widely available for many years. This test can show pre-cancerous changes in cells of the cervix that might be caused by HPV infection. These changed cells can then be treated or removed, if needed. Treatment can keep cancer from developing. Doctors may now also test for HPV, which can tell them if a woman might be at higher risk for cervical cancer.

Nearly all women with cervical cancer show signs of HPV infection on lab tests, but most women infected with HPV will **not** develop cervical cancer. Even though doctors can test women for HPV, there is no treatment directed at HPV itself. If the HPV causes abnormal cells to start growing, these cells can be removed or destroyed.

Women who are found to have HPV infection may be checked for abnormal cells more often than those who are not. Our document *Human Papilloma Virus (HPV), Cancer, HPV Testing, and HPV Vaccines – Frequently Asked Questions* has more information on this topic.

HPV and other cancers

HPVs also have a role in causing some cancers of the penis, anus, vagina, and vulva. They are linked to some cancers of the mouth and throat, too. Again, although HPVs have been linked to these cancers, most people infected with HPV never develop cancer.

Smoking, which is also linked with these cancers, may work with HPV to increase cancer risk. Other genital infections may also increase the risk that HPV will cause cancer.

Vaccines against HPV

Two vaccines are now being used against cancer-causing types of HPV. Gardasil® and Cervarix® have been shown to help protect against infection from the main cancer-

causing HPV types. The vaccines are approved for use in females aged 9 or 10 and into their mid-20's. Gardasil has also been approved for use in boys and young men.

Because the vaccines are still fairly new (first approved in 2006), and it often takes decades for cancer to develop, it's not yet known how well they will protect against it, or exactly which types of cancers it might help prevent. These vaccines and others like them are being studied further.

Epstein-Barr virus (EBV)

EBV is a type of herpes virus. It is probably best known for causing infectious mononucleosis, often called "mono" or the "kissing disease." In addition to kissing, EBV can be passed from person to person by coughing, sneezing, or sharing drinking or eating utensils. Most people in the United States are infected with EBV before the age of 20, although not everyone develops the symptoms of mono.

As with other human herpes viruses, EBV remains in the body throughout life even though most people have no symptoms after the first few weeks of infection. EBV infects and stays in certain white blood cells in the body called *B lymphocytes* (also called *B cells*).

EBV infection increases a person's risk of getting nasopharyngeal cancer (cancer of the area in the back of the nose) and certain types of fast-growing lymphomas such as Burkitt lymphoma. It may also be linked to Hodgkin lymphoma and some cases of stomach cancer. EBV-related cancers are more common in Africa and parts of Southeast Asia. Overall, very few people who have been infected with EBV will ever develop these cancers.

Hepatitis B virus (HBV) and hepatitis C virus (HCV)

Both HBV and HCV cause viral hepatitis, a type of liver infection. Other viruses can also cause hepatitis (hepatitis A virus, for example), but only HBV and HCV can cause the long-term infections that increase a person's chance of liver cancer. In the United States, about one-third of liver cancers are linked to HBV or HCV infection. This number is much higher in some other countries, where both viral hepatitis and liver cancer are much more common.

HBV and HCV are spread from person to person in much the same way as HIV (see the section on HIV below) — through sharing needles, unprotected sex, or childbirth. They can also be passed on through blood transfusions, but this is rare in the United States because donated blood is tested for these viruses.

Of the 2 viruses, infection with HBV is more likely to cause symptoms, such as a flu-like illness and jaundice (yellowing of the eyes and skin). Most people recover completely from HBV infection within a few months. Only a very small portion go on to become chronic HBV carriers. These people have a higher risk for liver cancer.

HCV is less likely to cause symptoms than HBV. About 75% of the estimated 3.2 million people in the United States who have chronic HCV infection don't even know they have it. To try and pinpoint some of these unknown infections, the Centers for Disease Control and Prevention recommend that all people born between 1945 and 1965 be tested once for HCV. Most people with HCV develop chronic infections, which are more likely to lead to liver damage or even cancer. Once the infection is found, treatment and preventive measures can be used to slow liver damage and reduce cancer risk.

Hepatitis B or C can be treated with drugs. Treating chronic hepatitis C infection for about 6 months to a year can get rid of HCV in many people. Although they do not cure the disease, a number of drugs can be used to treat chronic hepatitis B. They lower the risk of liver damage and might lower the risk of liver cancer as well.

There is a vaccine to prevent HBV infection, but none for HCV. In the United States, the HBV vaccine is recommended for all children. It's also recommended for adults who are at risk of exposure. This includes people who have sex with more than one partner, injection drug users, prisoners, people in certain group homes, and those with certain medical conditions and occupations (such as health care workers).

For more information, see our document *Liver Cancer*.

Human immunodeficiency virus (HIV)

HIV, the virus that causes acquired immune deficiency syndrome (AIDS), doesn't appear to cause cancers directly. But HIV infection increases a person's risk of getting several types of cancer, especially some linked to other viruses.

HIV is spread through semen, vaginal fluids, blood, and breast milk from an HIV-infected person. Known routes of spread include:

- Unprotected sex (oral, vaginal, or anal) with an HIV-infected person
- Injections with needles or injection equipment previously used by an HIV-infected person
- Prenatal and perinatal (during birth) exposure of infants from mothers with HIV
- Breastfeeding by mothers with HIV
- Transfusion of blood products containing HIV (blood has been tested since 1985)
- Organ transplants from an HIV-infected person (donors are now tested for HIV)
- Penetrating injuries or accidents (usually needlesticks) in health care workers while caring for HIV-infected patients or handling their blood

HIV is not spread by insects, through water, or by casual contact such as talking, shaking hands, hugging, coughing, sneezing, or from sharing dishes, bathrooms, kitchens, phones, or computers.

HIV infects and destroys white blood cells known as helper T-cells, which weakens the body's immune system. When the body is less able to fight off infections, other viruses such as HPV may be able to cause more damage to the cells. This damage may trigger cancer.

Many scientists believe that the immune system is also important in attacking and destroying newly formed cancer cells. So a weak immune system might let new cancer cells survive long enough to grow into a serious, life-threatening tumor.

HIV infection has been linked to a higher risk of developing Kaposi sarcoma and invasive cervical cancer. It's also linked to certain kinds of lymphoma, especially non-Hodgkin lymphoma and central nervous system lymphoma. Taking anti-HIV drugs may reduce the risk of getting these cancers.

Other types of cancer that may be more likely to develop in people with HIV infection include:

- Anal cancer
- Hodgkin lymphoma
- Lung cancer
- Cancers of the mouth and throat
- Skin cancers (basal cell, squamous cell, and Merkel cell)
- Liver cancer

For more information, see our document *HIV Infection, AIDS and Cancer.*

Human herpes virus 8 (HHV-8)

HHV-8, also known as *Kaposi sarcoma–associated herpes virus* (KSHV), has been found in nearly all tumors in patients with Kaposi sarcoma (KS). KS is a rare, slow-growing cancer that often appears as reddish-purple or blue-brown tumors just underneath the skin. In KS, the cells that line blood and lymph vessels are infected with HHV-8. The infection makes them divide too much and live longer than they should. These types of changes may eventually turn them into cancer cells.

KS has been known to exist in central Africa and the Middle East for some time, but was rare in the United States until it started appearing in people with AIDS in the early 1980s. The number of people with KS has dropped in the US since peaking in the early 1990s, most likely because of better treatment of HIV infection.

HHV-8 is transmitted through sex and appears to be spread other ways, such as through blood and saliva, as well. Studies have shown that fewer than 10% of people in the US are infected with this virus.

HHV-8 does not appear to cause disease in most healthy people. Because many more people are infected with HHV-8 than ever develop KS, it's likely that other factors are also needed for it to develop. Having a weakened immune system appears to be one such factor. In the US, almost all people who develop KS have other conditions that have affected their immune system, such as HIV infection or immune suppression after an organ transplant.

HHV-8 is related to other herpes viruses, such as the viruses that cause cold sores and genital herpes, Epstein-Barr virus (EBV), and cytomegalovirus (CMV). But these other viruses are not the same as HHV-8 and do not cause KS. Like other herpes virus infections, HHV-8 infections never go away, even when there are no signs of disease.

For more information on KS, see our document, *Kaposi Sarcoma.*

HHV-8 infection has also been linked to some rare blood cancers, such as primary effusion lymphoma. The virus has been found in many people with multicentric Castleman disease, an overgrowth of lymph nodes that acts very much like and often develops into cancer of the lymph nodes (lymphoma). (For more information, see our document *Castleman Disease*.) Further study is needed to better understand the role of HHV-8 in these diseases.

Human T-lymphotrophic virus-1 (HTLV-1)

HTLV-1 has been linked with a type of lymphocytic leukemia and non-Hodgkin lymphoma called *adult T-cell leukemia/lymphoma* (ATL). This cancer is found mostly in southern Japan, the Caribbean, central Africa, parts of South America, and in some immigrant groups in the southeastern United States.

In addition to ATL, this virus can cause other health problems, although many people with HTLV-1 don't have any of them.

HTLV-1 belongs to a class of viruses called *retroviruses*. These viruses use RNA (instead of DNA) for their genetic code. To reproduce, they must go through an extra step to change their RNA genes into DNA. Some of the new DNA genes can then become part of the chromosomes of the human cell infected by the virus. This can change how the cell grows and divides, which can sometimes lead to cancer. Retroviruses have long been known to cause leukemia in some animals.

HTLV-1 is something like HIV, which is another human retrovirus. But HTLV-1 cannot cause AIDS. In humans, HTLV-1 is spread in the same ways as HIV, such as unprotected sex with an HTLV-1-infected partner or injection with a needle or injection equipment after an infected person has used it. Mothers infected with HTLV-1 have about a 10% to 30% chance of passing on the virus to their children, although this risk can be reduced if the mother doesn't breastfeed.

People who are at low risk of blood-borne infections tend to show HTLV-1 infection rates below 1%, while those at high risk (such as injection users) can have much higher rates. Since 1988, all blood donated in the United States has been screened for HTLV-1.

This has greatly reduced the chance of infection through transfusion, and has also helped control the potential spread of HTLV-1 infection.

Once infected with HTLV-1, a person's chance of developing adult T-cell lymphoma can be up to about 5%, usually after a long time with no symptoms (20 or more years).

Merkel cell polyomavirus (MCV)

MCV was discovered in 2008. It was found in tissue samples from several cases of a rare and aggressive type of skin cancer called *Merkel cell cancer*. Many people are infected with MCV, which usually causes no symptoms. But in a few people with this infection, changes in the viral DNA can lead to Merkel cell cancer. About 8 out of 10 Merkel cell cancers are now thought to be linked to this infection.

It is not yet known how this virus is transmitted, but it has been found in a number of places in the body, including normal skin and saliva. Studies show that this common virus can be picked up in early childhood.

Viruses with uncertain or unproven links to cancer in humans

Simian virus 40 (SV40)

SV40 is a virus that usually infects monkeys. Some polio vaccines prepared between 1955 and 1963 were produced from monkey cells and were found to be contaminated with SV40.

Some older studies seemed to suggest that infection with SV40 might increase a person's risk of developing mesothelioma (a rare cancer of the lining of the lungs or abdomen), as well as some brain tumors, bone cancers, and lymphomas. The accuracy of these older tests for SV40 are now being questioned.

Scientists have found that some lab animals, such as hamsters developed mesotheliomas when they were intentionally infected with SV40. Researchers have also noticed that SV40 can make mouse cells grown in the lab become cancerous, and asbestos increases the cancer-causing effect of SV40 on these cells.

Other researchers have studied biopsy specimens of certain human cancers and found fragments that look like SV40 DNA. But not all researchers have found this, and fragments much like these can also be found in human tissues that show no signs of cancer.

So far, the largest studies looking at this issue have not found any increased risk for mesothelioma or other cancers among people who got the contaminated polio vaccines as children. For example, the recent increase in lung mesothelioma cases has been seen mainly in men aged 75 and older, most of whom would not have received the vaccine. Among the age groups who were known to have gotten the vaccine, mesothelioma rates have actually gone down. And even though women were just as likely to have had the vaccine, many more men continue to be diagnosed with mesothelioma.

The bottom line: even though SV40 causes cancer in some lab animals, the evidence so far suggests that it does not cause cancer in humans.

Bacteria

Helicobacter pylori

Stomach cancer is fairly rare in the United States, but it's the fourth most common cancer worldwide. Long-term infection of the stomach with *Helicobacter pylori (H pylori)* may cause ulcers. It can also inflame and damage the inner layer of the stomach. Some of these changes could lead to cancer over time, especially cancer in the lower part of the stomach. *H pylori* infection is also linked with some types of lymphoma of the stomach.

More than half of all cases of stomach cancer are thought to be linked to *H pylori* infection. Still, most people who have these bacteria in their stomachs never develop cancer. There is also some evidence that people with *H pylori* have a lower risk of other types of cancer, although it is unclear exactly what role the bacteria plays in this.

About 1 in 3 adults has evidence of infection with *H pylori*, and the rate of infection is higher in older age groups. It's likely spread in a couple of ways. One is the fecal-oral route, such as through contaminated food or water sources. In fact, contaminated well water has been linked to *H pylori* infection in the United States. It can also be transmitted from one person to another, mouth to mouth.

Other factors also play a role in whether or not someone develops stomach cancer. For example, nitrites are substances commonly found in cured meats, some drinking water, and certain vegetables. They can be converted by certain bacteria, such as *H pylori*, into compounds that have been found to cause stomach cancer in animals.

Antibiotics and other medicines can be used to treat *H pylori* infections. Doctors have given antibiotics to patients who have had superficial stomach cancers removed in order to get rid of *H pylori* infection. This seems to have helped prevent new stomach cancers in those patients. Patients with *H pylori* who have had ulcers or cancer in the lower part of the stomach should be treated to get rid of the bacteria, as should people at high risk for this type of stomach cancer.

Chlamydia trachomatis

Chlamydia trachomatis is a very common kind of bacteria that can infect the female reproductive system as well as other parts of the body in both men and women. It is spread through sex.

Although infection of the reproductive organs may cause symptoms in some people, most women have no symptoms. This means that women with chlamydia usually don't know they're infected unless samples are taken during a pelvic exam. These samples are then checked for this type of bacteria. It's a common infection in younger women who are sexually active, and can persist for years unless it's detected and treated.

Some studies have shown that women whose blood tests showed past or current chlamydia infection may be at greater risk for cervical cancer than women with negative blood test results.

Studies have not shown that chlamydia itself causes cancer, but it might work with HPV in a way that promotes cancer growth. For example, chlamydia may affect how long cancer-promoting HPV stays in the cervix. Researchers have found that women who had chlamydia along with HPV are more likely to still have HPV when they are re-tested later than women who have not had chlamydia. Although more studies are needed to confirm these findings, there are already good reasons to be checked for chlamydia infection and have it treated with antibiotics if it is found.

In women, long-term chlamydia infection is known to cause pelvic inflammation that can lead to infertility, mainly by building up scar tissue in the Fallopian tubes. Like other infections that inflame or cause ulcers in the genital area, chlamydia can also increase the risk of becoming infected with HIV during exposure to an HIV-infected sexual partner.

Parasites

Certain parasitic worms that can live inside the human body can also raise the risk of developing some kinds of cancer. These organisms are not found in the United States, but they can be a concern for people who live in or travel to other parts of the world.

Opisthorchis viverrini and *Clonorchis sinensis* are liver flukes (a type of flatworm) that have been linked to increased risk of developing cancer of the bile ducts. The bile ducts are tubes that connect the liver to the intestines. These infections come from eating raw or undercooked freshwater fish. This disease is found mostly in East Asia and is rare in other parts of the world.

Schistosoma haematobium is a parasite found in the water of developing countries of the Middle East, Africa, and Asia. Infection with this parasite (an illness called *schistosomiasis*) has been linked to bladder cancer. Possible links to other types of cancer are now being studied as well.

To learn more

More information 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 Web site, www.cancer.org.

Castleman Disease

HIV Infection and AIDS (also available in Spanish)

Kaposi Sarcoma

Liver Cancer (also available in Spanish)

Non-Hodgkin Lymphoma (also available in Spanish)

Stomach Cancer (also available in Spanish)

Thinking About Testing for HPV?

What Women Should Know About Cervix Cancer and the Human Papilloma Virus (also available in Spanish)

National organizations and Web sites*

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

Centers for Disease Control and Prevention (CDC)
Toll-free number: 1-800-311-3435
Web site: www.cdc.gov

Offers current information on infectious diseases and vaccines.

National Cancer Institute
Toll-free number: 1-800-4-CANCER (1-800-422-6237)
Web site: www.cancer.gov

Has information on cancer and viruses as well as vaccines and research.

**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 information and support. Call us at **1-800-227-2345** or visit www.cancer.org.

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