Lung Cancer Prevention and Early Detection

Lung cancer is the second most common cancer in both men and women (not counting skin cancer), and is by far the leading cause of cancer death among both men and women. Each year, more people die of lung cancer than of colon, breast, and prostate cancers combined.

Most lung cancers could be prevented, because they are related to smoking (or secondhand smoke), or less often to exposure to radon or other environmental factors. But some lung cancers occur in people without any known risk factors for the disease. It is not yet clear if these cancers can be prevented.

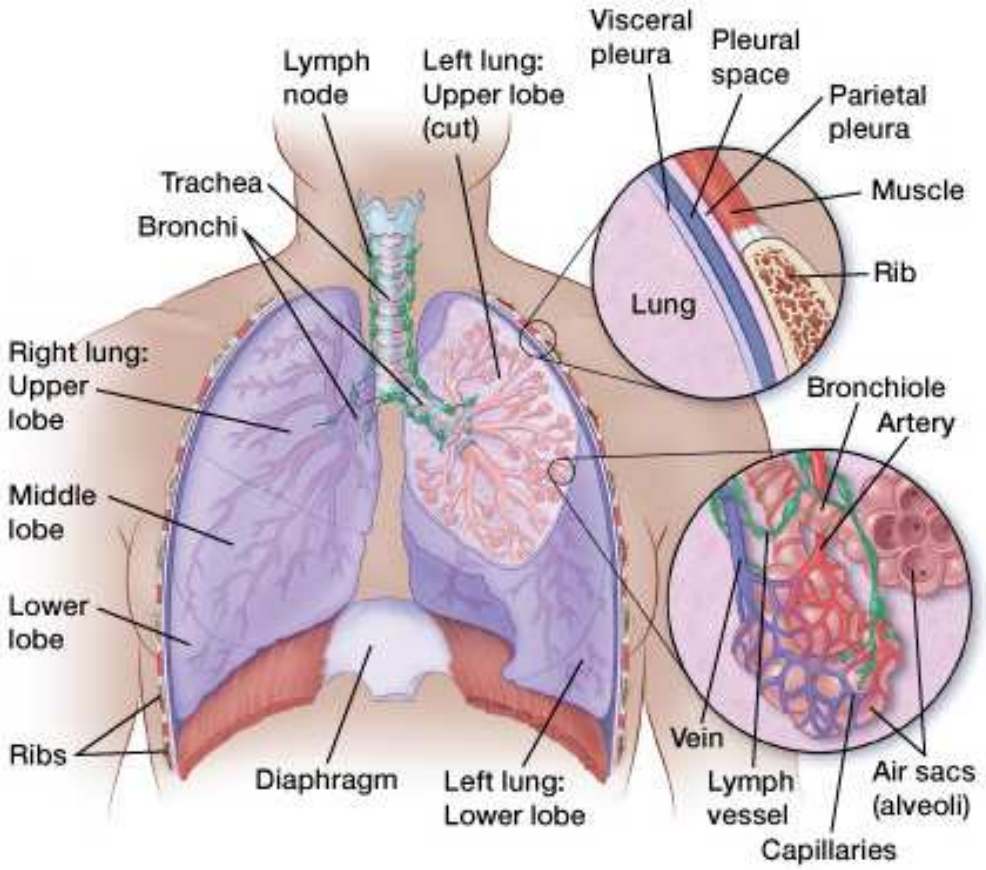
Most lung cancers have already spread widely and are at an advanced stage when they are first found. These cancers are very hard to cure. But in recent years, doctors have found a test that can be used to screen for lung cancer in people at high risk of the disease. This test can help find some of these cancers early, which can lower the risk of dying from this disease.

What is lung cancer?

Lung cancer is a cancer that starts in the lungs. To understand lung cancer, it helps to know about the normal structure and function of the lungs.

The lungs

Your lungs are 2 sponge-like organs found in your chest. Your right lung is divided into 3 sections, called *lobes*. Your left lung has 2 lobes. The left lung is smaller because the heart takes up more room on that side of the body.



When you breathe in, air enters through your mouth or nose and goes into your lungs through the *trachea* (windpipe). The trachea divides into tubes called the *bronchi* (singular, *bronchus*), which enter the lungs and divide into smaller bronchi. These divide to form smaller branches called *bronchioles*. At the end of the bronchioles are tiny air sacs known as *alveoli*.

Many tiny blood vessels run through the alveoli. They absorb oxygen from the inhaled air into your bloodstream and pass carbon dioxide from the body into the alveoli. This is expelled from the body when you exhale. Taking in oxygen and getting rid of carbon dioxide are your lungs' main functions.

A thin lining layer called the *pleura* surrounds the lungs. The pleura protects your lungs and helps them slide back and forth against the chest wall as they expand and contract during breathing.

Below the lungs, a thin, dome-shaped muscle called the *diaphragm* separates the chest from the abdomen. When you breathe, the diaphragm moves up and down, forcing air in and out of the lungs.

Start and spread of lung cancer

Lung cancers can start in the cells lining the bronchi and parts of the lung such as the bronchioles or alveoli.

Lung cancers are thought to start as areas of pre-cancerous changes in the lung. The first changes in the genes (DNA) inside the lung cells may cause the cells to grow faster. These cells may look a bit abnormal if seen under a microscope, but at this point they do not form a mass or tumor. They cannot be seen on an x-ray and they do not cause symptoms.

Over time, the abnormal cells may acquire other gene changes, which cause them to progress to true cancer. As a cancer develops, the cancer cells may make chemicals that cause new blood vessels to form nearby. These blood vessels nourish the cancer cells, which can continue to grow and form a tumor large enough to be seen on imaging tests such as x-rays.

At some point, cells from the cancer may break away from the original tumor and spread (metastasize) to other parts of the body. Lung cancer is often a life-threatening disease because it tends to spread in this way even before it can be detected on an imaging test such as a chest x-ray.

Types of lung cancer

There are 2 main types of lung cancer:

- Small cell lung cancer (SCLC)
- Non-small cell lung cancer (NSCLC)

Small cell lung cancer

About 10% to 15% of all lung cancers are small cell lung cancer (SCLC), named for the size of the cancer cells when seen under a microscope. Other names for SCLC are *oat cell cancer*, *oat cell carcinoma*, and *small cell undifferentiated carcinoma*. It is very rare for someone who has never smoked to have small cell lung cancer.

SCLC often starts in the bronchi near the center of the chest, and it tends to spread widely through the body early in the course of the disease. This cancer is discussed in our document *Lung Cancer (Small Cell).*

Non-small cell lung cancer

About 85% to 90% of lung cancers are non-small cell lung cancer (NSCLC). There are 3 main subtypes of NSCLC. The cells in these subtypes differ in size, shape, and chemical

make-up. But they are grouped together because the approach to treatment and prognosis (outlook) are often very similar.

Squamous cell (epidermoid) carcinoma: About 25% to 30% of all lung cancers are squamous cell carcinomas. These cancers start in early versions of squamous cells, which are flat cells that line the inside of the airways in the lungs. They are often linked to a history of smoking and tend to be found in the middle of the lungs, near a bronchus.

Adenocarcinoma: About 40% of lung cancers are adenocarcinomas. These cancers start in early versions of the cells that would normally secrete substances such as mucus. This type of lung cancer occurs mainly in current or former smokers, but it is also the most common type of lung cancer in non-smokers. It is more common in women than in men, and it is more likely to occur in younger people than other types of lung cancer.

Adenocarcinoma is usually found in the outer parts of the lung. It tends to grow slower than other types of lung cancer, and is more likely to be found before it has spread outside of the lung.

People with a type of adenocarcinoma called *adenocarcinoma in situ* (previously called *bronchioloalveolar carcinoma*) tend to have a better outlook (prognosis) than those with other types of lung cancer.

Large cell (undifferentiated) carcinoma: This type of cancer accounts for about 10% to 15% of lung cancers. It can appear in any part of the lung. It tends to grow and spread quickly, which can make it harder to treat. A subtype of large cell carcinoma, known as *large cell neuroendocrine carcinoma*, is a fast-growing cancer that is very similar to small cell lung cancer.

Other subtypes: There are also a few other subtypes of non-small cell lung cancer, such as adenosquamous carcinoma and sarcomatoid carcinoma. These are much less common.

For more information about non-small cell lung cancer, see our document *Lung Cancer (Non-Small Cell)*.

Other types of lung cancer

Along with the 2 main types of lung cancer, other tumors can occur in the lungs.

Lung carcinoid tumors: Carcinoid tumors of the lung account for fewer than 5% of lung tumors. Most are slow-growing tumors that are called *typical carcinoid tumors*. They are generally cured by surgery. Some typical carcinoid tumors can spread, but they usually have a better prognosis than small cell or non-small cell lung cancer. Less common are *atypical carcinoid tumors*. The outlook for these tumors is somewhere in between typical carcinoids and small cell lung cancer. For more information about typical and atypical carcinoid tumors, see our document *Lung Carcinoid Tumor*.

Other lung tumors: Other types of lung cancer such as adenoid cystic carcinomas, lymphomas, and sarcomas, as well as benign lung tumors such as hamartomas are rare. These have different risk factors from the more common lung cancers. They are not discussed in this document.

Cancers that spread to the lungs: Cancers that start in other organs (such as the breast, pancreas, kidney, or skin) can sometimes spread (metastasize) to the lungs, but these are not lung cancers. For example, cancer that starts in the breast and spreads to the lungs is still breast cancer, not lung cancer. Treatment for cancer that has spread to the lungs is based on which type of cancer it is.

What are the risk factors for lung cancer?

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

But risk factors don't tell us everything. Having a risk factor, or even several risk factors, does not mean that you will get the disease. And some people who get the disease may not have had any known risk factors. Even if a person with lung cancer has a risk factor, it is often very hard to know how much that risk factor may have contributed to the cancer.

Several risk factors can make you more likely to develop lung cancer.

Tobacco smoke

Smoking is by far the leading risk factor for lung cancer. In the early 20th century, lung cancer was much less common than some other types of cancer. But this changed once manufactured cigarettes became readily available and more people began smoking.

At least 80% of lung cancer deaths are thought to result from smoking. The risk for lung cancer among smokers is many times higher than among non-smokers. The longer you smoke and the more packs a day you smoke, the greater your risk.

Cigar smoking and pipe smoking are almost as likely to cause lung cancer as cigarette smoking. Smoking low-tar or "light" cigarettes increases lung cancer risk as much as regular cigarettes. There is concern that menthol cigarettes may increase the risk even more since the menthol allows smokers to inhale more deeply.

Secondhand smoke: If you don't smoke, breathing in the smoke of others (called secondhand smoke or environmental tobacco smoke) can increase your risk of developing lung cancer by about 30%. Secondhand smoke is thought to cause more than 7,000 deaths from lung cancer each year.

Some evidence suggests that certain people are more susceptible to the cancer-causing effect of tobacco smoke than others.

If you or someone you care about needs help in quitting, see our document *Guide to Quitting Smoking* or call the American Cancer Society at 1-800-227-2345.

Radon

Radon is a naturally occurring radioactive gas that results from the breakdown of uranium in soil and rocks. It cannot be seen, tasted, or smelled. According to the US Environmental Protection Agency (EPA), radon is the second leading cause of lung cancer in this country, and is the leading cause among non-smokers.

Outdoors, there is so little radon that it is not likely to be dangerous. But indoors, radon can be more concentrated. When it is breathed in, it enters the lungs, exposing them to small amounts of radiation. This may increase a person's risk of lung cancer.

The lung cancer risk from radon is much lower than that from tobacco smoke. However, the risk from radon is much higher in people who smoke than in those who don't.

Radon levels in the soil vary across the country, but they can be high almost anywhere. Homes in some parts of the United States built on soil with natural uranium deposits can have high indoor radon levels (especially in basements). Studies from these areas have found that the risk of lung cancer is higher in those who have lived for many years in a radon-contaminated house.

If you are concerned about radon exposure, you can use a radon detection kit to test the levels in your home. State and local offices of the EPA can also give you the names of reliable companies that can test your home (or other buildings) for radon and help you fix the problem, if needed. For more information, see our document called *Radon.*

Asbestos

Workplace exposure to asbestos fibers is an important risk factor for lung cancer. Studies have found that people who work with asbestos (in some mines, mills, textile plants, places where insulation is used, shipyards, etc.) are several times more likely to die of lung cancer. In workers exposed to asbestos who also smoke, the lung cancer risk is much greater than even adding the risks from these exposures separately. It's not clear to what extent low-level or short-term exposure to asbestos might raise lung cancer risk.

Both smokers and non-smokers exposed to asbestos also have a greater risk of developing mesothelioma, a type of cancer that starts in the pleura (the lining surrounding the lungs). Because it is not usually considered a type of lung cancer, mesothelioma is discussed in our document called *Malignant Mesothelioma*.

In recent years, government regulations have greatly reduced the use of asbestos in commercial and industrial products. It is still present in many homes and other older buildings, but it is not usually considered harmful as long as it is not released into the air by deterioration, demolition, or renovation. For more information, see our document called *Asbestos*.

Other cancer-causing agents in the workplace

Other carcinogens (cancer-causing agents) found in some workplaces that can increase lung cancer risk include:

- Radioactive ores such as uranium
- Inhaled chemicals or minerals such as arsenic, beryllium, cadmium, silica, vinyl chloride, nickel compounds, chromium compounds, coal products, mustard gas, and chloromethyl ethers
- Diesel exhaust

The government and industry have taken steps in recent years to help protect workers from many of these exposures. But the dangers are still present, so if you work around these agents, you should be careful to limit your exposure whenever possible.

Air pollution

In cities, air pollution (especially near heavily trafficked roads) appears to raise the risk of lung cancer slightly. This risk is far less than the risk caused by smoking, but some researchers estimate that worldwide about 5% of all deaths from lung cancer may be due to outdoor air pollution.

Radiation therapy to the lungs

People who have had radiation therapy to the chest for other cancers are at higher risk for lung cancer, particularly if they smoke. Typical patients are those treated for Hodgkin disease or women who get radiation after a mastectomy for breast cancer. Women who receive radiation therapy to the breast after a lumpectomy do not appear to have a higher than expected risk of lung cancer.

Arsenic in drinking water

Studies of people in parts of Southeast Asia and South America with high levels of arsenic in their drinking water have found a higher risk of lung cancer. In most of these studies, the levels of arsenic in the water were many times higher than those typically seen in the United States, even in areas where arsenic levels are above normal. For most

Americans who are on public water systems, drinking water is not a major source of arsenic.

Personal or family history of lung cancer

If you have had lung cancer, you have a higher risk of developing another lung cancer.

Brothers, sisters, and children of those who have had lung cancer may have a slightly higher risk of lung cancer themselves, especially if the relative was diagnosed at a younger age. It is not clear how much of this risk might be due to inherited genes and how much might be from shared household exposures (such as tobacco smoke or radon).

Researchers have found that genetics does seem to play a role in some families with a strong history of lung cancer. For example, people who inherit certain DNA changes in a particular chromosome (chromosome 6) are more likely to develop lung cancer, even if they don't smoke or only smoke a little. At this time these DNA changes cannot be routinely tested for. Research is ongoing in this area.

Certain dietary supplements

Studies looking at the possible role of vitamin supplements in reducing lung cancer risk have not been promising so far. In fact, 2 large studies found that smokers who took beta carotene supplements actually had an increased risk of lung cancer. The results of these studies suggest that smokers should avoid taking beta carotene supplements.

Factors with uncertain or unproven effects on lung cancer risk

Marijuana smoking

There are some reasons to think that marijuana smoking might increase lung cancer risk. Marijuana smoke contains tar and many of the same cancer-causing substances that are in tobacco smoke. (Tar is the sticky, solid material that remains after burning, and is thought to contain most of the harmful substances in smoke.) Marijuana cigarettes (joints) are typically smoked all the way to the end, where tar content is the highest. Marijuana is also inhaled very deeply and the smoke is held in the lungs for a long time, which gives any cancer causing substances more opportunity to deposit in the lungs. And because marijuana is often an illegal substance, it may not be possible to control what other substances it might contain.

But those who use marijuana tend to smoke less marijuana in a day or week than the amount of tobacco consumed by cigarette smokers. For example, a light smoker may smoke half of a pack (10 cigarettes) a day, but 10 marijuana cigarettes in a day would be very heavy use of marijuana. In one study, most people who smoked marijuana did so 2

to 3 times per month. The lesser amount smoked would make it harder to see an impact on lung cancer risk.

It has been hard to study whether there is a link between marijuana and lung cancer because marijuana was illegal in many countries for so long, and it is not easy to gather information about the use of illegal drugs. Also, in the studies that looked at past marijuana use in people who had lung cancer, most of the marijuana smokers also smoked cigarettes. This can make it hard to know how much of the risk is from tobacco and how much might be from marijuana. More research is needed to know the cancer risks from smoking marijuana.

Talc and talcum powder

Talc is a mineral that in its natural form may contain asbestos. Some studies have suggested that talc miners and millers might have a higher risk of lung cancer and other respiratory diseases because of their exposure to industrial grade talc. But other studies have not found an increase in lung cancer rate.

Talcum powder is made from talc. By law since 1973, all home-use talcum products (baby, body, and facial powders) in the United States have been asbestos-free. The use of cosmetic talcum powder has not been found to increase the risk of lung cancer.

Do we know what causes lung cancer?

We don’t know what causes each case of lung cancer. But we do know many of the risk factors for these cancers and how some of them cause cells to become cancerous.

Smoking

Tobacco smoking is by far the leading cause of lung cancer. At least 80% of lung cancer deaths are caused by smoking, and many others are caused by exposure to secondhand smoke.

Smoking is clearly the strongest risk factor for lung cancer, but it often interacts with other factors. Smokers exposed to other known risk factors such as radon and asbestos are at even higher risk. Not everyone who smokes gets lung cancer, so other factors like genetics likely play a role as well (see below).

Lung cancer in non-smokers

Not all people who get lung cancer are smokers. Many people with lung cancer are former smokers, but many others never smoked at all.

Lung cancer in non-smokers can be caused by exposure to radon, secondhand smoke, air pollution, or other factors. Workplace exposures to asbestos, diesel exhaust, or certain other chemicals can also cause lung cancers in some people who do not smoke.

A small portion of lung cancers occur in people with no known risk factors for the disease. Some of these might just be random events that don't have an outside cause, but others might be due to factors that we don't yet know about.

Lung cancers in non-smokers are often different in some ways from those that occur in smokers. They tend to occur at younger ages. Lung cancers in non-smokers often have certain gene changes that are different from those in tumors from smokers.

Gene changes that may lead to lung cancer

Scientists now know how some of the risk factors for lung cancer can cause certain changes in the DNA of lung cells. These changes can lead to abnormal cell growth and, sometimes, cancer. DNA is the chemical in each of our cells that makes up our genes – the instructions for how our cells function. We usually look like our parents because they are the source of our DNA. But DNA affects more than how we look. It also can influence our risk for developing certain diseases, including some kinds of cancer.

Some genes contain instructions for controlling when cells grow, divide to make new cells, and die. Genes that help cells grow and divide are called *oncogenes*. Genes that slow down cell division or cause cells to die at the right time are called *tumor suppressor genes*. Cancers can be caused by DNA changes that turn on oncogenes or turn off tumor suppressor genes.

Inherited gene changes

Some people inherit DNA mutations (changes) from their parents that greatly increase their risk for developing certain cancers. But inherited mutations alone are not thought to cause very many lung cancers.

Still, genes do seem to play a role in some families with a history of lung cancer. For example, some people seem to inherit a reduced ability to break down or get rid of certain types of cancer-causing chemicals in the body, such as those found in tobacco smoke. This could put them at higher risk for lung cancer.

Other people may inherit faulty DNA repair mechanisms that make it more likely they will end up with DNA changes. Every time a cell divides into 2 new cells, it must make a new copy of its DNA. This process is not perfect, and copying errors sometimes occur. Cells normally have repair enzymes that proofread the DNA to help prevent this. People with repair enzymes that don't work as well might be especially vulnerable to cancer-causing chemicals and radiation.

Researchers are developing tests that may help identify such people, but these tests are not yet used routinely. For now, doctors recommend that all people avoid tobacco smoke and other exposures that might increase their cancer risk.

Acquired gene changes

Gene changes related to lung cancer are usually acquired during life rather than inherited. Acquired mutations in lung cells often result from exposure to factors in the environment, such as cancer-causing chemicals in tobacco smoke. But some gene changes may just be random events that sometimes happen inside a cell, without having an outside cause.

Acquired changes in certain genes are thought to be important in the development of lung cancer. Changes in some genes may also make some lung cancers more likely to grow and spread than others. Not all lung cancers share the same gene changes, so there are undoubtedly changes in other genes that have not yet been found.

Can lung cancer be prevented?

Not all lung cancers can be prevented, but there are some ways you can reduce your risk of getting lung cancer.

The best way to reduce your risk of lung cancer is not to smoke and to avoid breathing in other people's smoke.

If you stop smoking before a cancer develops, your damaged lung tissue gradually starts to repair itself. No matter what your age or how long you've smoked, quitting may lower your risk of lung cancer and help you live longer. People who stop smoking before age 50 cut their risk of dying in the next 15 years in half compared with those who continue to smoke. If you would like help quitting smoking, see our document *Guide to Quitting Smoking* or call the American Cancer Society at 1-800-227-2345.

Limiting your exposure to secondhand smoke might also help lower your risk of lung cancer, as well as some other cancers. For more information, see our document *Secondhand Smoke*.

Radon is an important cause of lung cancer. You can reduce your exposure to radon by having your home tested and treated, if needed. For more information, see our document *Radon*.

Avoiding exposure to known cancer-causing chemicals, in the workplace and elsewhere, may also be helpful (see "What are the risk factors for lung cancer?"). When people work where these exposures are common, they should be kept to a minimum. Be sure to follow proper safety procedures, such as wearing a respirator, if this applies at your workplace.

A healthy diet with lots of fruits and vegetables may also help reduce your risk of lung cancer. Some evidence suggests that a diet high in fruits and vegetables may help protect

against lung cancer in both smokers and non-smokers. But any positive effect of fruits and vegetables on lung cancer risk would be much less than the increased risk from smoking.

Attempts to reduce the risk of lung cancer in current or former smokers by giving them high doses of vitamins or vitamin-like drugs have not been successful so far. In fact, some studies have found that beta-carotene, a nutrient related to vitamin A, appears to increase the rate of lung cancer in these people.

Some people who get lung cancer do not have any clear risk factors. Although we know how to prevent most lung cancers, at this time we don't know how to prevent all of them.

Can lung cancer be found early?

Usually symptoms of lung cancer do not appear until the disease is already in an advanced, non-curable stage. Even when symptoms of lung cancer do appear, many people may mistake them for other problems, such as an infection or long-term effects from smoking. This may delay the diagnosis.

Some lung cancers are diagnosed early because they are found by accident as a result of tests for other medical conditions. For example, lung cancer may be found by imaging tests (such as a chest x-ray or chest CT scan), bronchoscopy (viewing the inside of lung airways through a flexible lighted tube), or sputum exam (microscopic examination of cells in coughed up phlegm) done for other reasons in patients with heart disease, pneumonia, or other lung conditions. A small portion of these patients do very well and may be cured of lung cancer.

Screening is the use of tests or exams to detect a disease in people without symptoms of that disease. Doctors have looked for many years for a test to find lung cancer early and help people live longer, but only in recent years has a study shown that a lung cancer screening test can help lower the risk of dying from this disease.

The National Lung Screening Trial

The National Lung Screening Trial (NLST) was a large clinical trial that looked at using a type of CT scan known as low-dose CT (sometimes called low-dose spiral or helical CT) to screen for lung cancer. CT scans of the chest provide more detailed pictures than chest x-rays and are better at finding small abnormalities in the lungs. (Both of these tests are discussed in more detail in the section "Exams and tests to look for lung cancer.") Low-dose CT (LDCT) of the chest uses lower amounts of radiation than a standard chest CT and does not require the use of intravenous (IV) contrast dye.

The NLST compared LDCT of the chest to chest x-rays in people at high risk of lung cancer to see if these scans could help lower the risk of dying from lung cancer. The study included more than 50,000 people aged 55 to 74 who were current or former

smokers and were in fairly good health. To be in the study, they had to have at least a 30 pack-year history of smoking. A pack-year is the number of cigarette packs smoked each day multiplied by the number of years a person has smoked. Someone who smoked a pack of cigarettes per day for 30 years has a 30 pack-year smoking history, as does someone who smoked 2 packs a day for 10 years and then a pack a day for another 10 years. Former smokers could enter the study if they had quit within the past 15 years. The study did not include people if they had a prior history of lung cancer or lung cancer symptoms, if they had part of a lung removed, if they needed to be on oxygen at home to help them breathe, or if they had other serious medical problems.

People in the study got either 3 LDCT scans or 3 chest x-rays, each a year apart, to look for abnormal areas in the lungs that might be cancer. After several years, the study found that people who got LDCT had a 16% lower chance of dying from lung cancer than those who got chest x-rays. They were also 7% less likely to die overall (from any cause) than those who got chest x-rays.

Screening with LDCT was also shown to have some downsides that need to be considered. One drawback of this test is that it also finds a lot of abnormalities that have to be checked out with more tests, but turn out not to be cancer. (About 1 out of 4 CT scans in the NLST showed such a finding.) This may lead to additional tests such as other CT scans or more invasive tests such as needle biopsies or even surgery to remove a portion of lung in some people. These tests can sometimes lead to complications (like a collapsed lung) or rarely, death, even in people who do not have cancer (or who have very early stage cancer).

LDCTs also expose people to a small amount of radiation with each test. It is less than the dose from a standard CT, but it is more than the dose from a chest x-ray. Some people who are screened may end up needing further CT scans, which means more radiation exposure. When done in tens of thousands of people, this radiation may cause a few people to develop breast, lung, or thyroid cancers later on.

The NLST was a large study, but it left some questions that still need to be answered. For example, it’s not clear if screening with LDCT scans would have the same effect on people different from those allowed in the study, such as those who smoke less (or not at all), or people younger than age 55 or older than 74. Also, in the NLST, patients got a total of 3 scans over 2 years. It’s not yet clear what the effect would be if people were screened for longer than 2 years.

These factors, and others, need to be taken into account by people and their doctors who are considering whether or not screening with LDCT scans is right for them.

American Cancer Society guidelines for lung cancer screening

The American Cancer Society has thoroughly reviewed the subject of lung cancer screening and issued guidelines that are aimed at doctors and other health care providers:

Patients should be asked about their smoking history. Patients who meet ALL of the following criteria may be candidates for lung cancer screening:

- 55 to 74 years old
- In fairly good health (discussed further down)
- Have at least a 30 pack-year smoking history (this was discussed above)
- Are either still smoking or have quit smoking within the last 15 years

These criteria were based on what was used in the NLST.

Doctors should talk to these patients about the benefits, limitations, and potential harms of lung cancer screening. Screening should only be done at facilities that have the right type of CT scan and that have a great deal of experience in LDCT scans for lung cancer screening. The facility should also have a team of specialists that can provide the appropriate care and follow-up of patients with abnormal results on the scans.

For patients

If you fit all of the criteria for lung cancer screening listed above, you and your doctor (or other health care provider) should talk about starting screening. He or she will talk to you about what you can expect from screening, including possible benefits and harms, as well as the limitations of screening.

The main benefit is a lower chance of dying of lung cancer, which accounts for many deaths in current and former smokers. Still, it is important to be aware that, like with any type of screening, not everyone who gets screened will benefit. Screening with LDCT will not find all lung cancers, and not all of the cancers that are found will be found early. Even if a cancer is found by screening, you may still die from lung cancer. Also, LDCT often finds things that turn out not to be cancer, but have to be checked out with more tests to know what they are. This can mean more CT scans, or even invasive tests such as a lung biopsy, in which a piece of lung tissue is removed with a needle or in surgery. These tests have risks of their own (see above).

Screening should only be done at facilities that have the right type of CT scanner and that have a great deal of experience in LDCT scans for lung cancer screening. The facility should also have a team of specialists that can provide the appropriate care and follow-up

of patients with abnormal results on the scans. You might not have the right kind of facility nearby, so you may need to travel some distance to be screened.

If you and your doctor decide that you should be screened, you should get a LDCT every year until you reach the age of 74, as long as you remain in good health.

If you are a current smoker, you should receive counseling about stopping. You should be told about your risk of lung cancer and referred to a smoking cessation program. Screening is not a good alternative to stopping smoking. For help quitting smoking, see our document *Guide to Quitting Smoking* or call the American Cancer Society at 1-800-227-2345.

What does “in fairly good health” mean?

Screening is meant to find cancer in people who do not have symptoms of the disease. People who already have symptoms that might be caused by lung cancer may need tests such as CT scans to find the underlying cause, which in some cases may be cancer. Still, this kind of testing is for diagnosis and is not the same as screening. Some of the possible symptoms of lung cancer that kept people out of the NLST were coughing up blood and weight loss without trying.

To get the most potential benefit from screening, patients need to be in good health. For example, they need to be able to have surgery and other treatments to try to cure lung cancer if it is found. Patients who require home oxygen therapy most likely could not withstand having part of a lung removed, and so are not candidates for screening. Patients with other serious medical problems that would shorten their lives or keep them from having surgery may also not be able to benefit enough from screening for it to be worth the risks, and so should also not be screened.

Metal implants in the chest (like pacemakers) or back (like rods in the spine) can interfere with x-rays and lead to poor quality CT images of the lungs. People with these types of implants were also kept out of the NLST, and so should not be screened with CT scans for lung cancer according to the ACS guidelines.

People who have been treated for lung cancer often have follow-up tests, including CT scans to see if the cancer has come back or spread. This is called surveillance and is not the same as screening. (People with a prior history of lung cancer were not eligible for the NLST.)

Costs of screening and insurance coverage

The cost for a low-dose CT scan as a screening test for lung cancer is generally about $300 for each test, but prices vary widely at different centers.

At this time, some private insurers are covering the cost of lung cancer screening, but many others are not. Medicare does not over the cost of lung cancer screening at this time. More insurers (including Medicare) may cover the tests in the near future as more expert groups issue their screening guidelines. In fact, some states have introduced legislation that would require insurance coverage of the tests for some people.

Because insurance coverage (and laws related to it) might change quickly in the next few years, it is important to check with your health insurance provider, as well as the center performing the test, so that you have an idea about what you might have to pay. If something abnormal is found during screening, further tests are likely to be covered by insurance, but again it is best to check with your provider.

If something abnormal is found during screening

About 1 out of 4 screening tests will show something abnormal in the lungs or nearby areas that might be cancer. Most of these abnormal findings will turn out not to be cancer, but additional CT scans or other tests will be needed to be sure. Some of these tests are described in the section “Exams and tests to look for lung cancer.”

CT scans of the lungs can also sometimes show problems in other organs that just happen to be in the field of view of the scans. Your doctor will discuss any such findings with you if they are found.

Signs and symptoms of lung cancer

Most lung cancers do not cause any symptoms until they have spread too far to be cured, but symptoms do occur in some people with early lung cancer. If you go to your doctor when you first notice symptoms, your cancer might be diagnosed at an earlier stage, when treatment is more likely to be effective. The most common symptoms of lung cancer are:

- A cough that does not go away or gets worse
- Chest pain that is often worse with deep breathing, coughing, or laughing
- Hoarseness
- Weight loss and loss of appetite
- Coughing up blood or rust-colored sputum (spit or phlegm)
- Shortness of breath
- Feeling tired or weak
- Infections such as bronchitis and pneumonia that don’t go away or keep coming back

- New onset of wheezing

If lung cancer spreads to distant organs, it may cause:

- Bone pain (like pain in the back or hips)
- Nervous system changes (such as headache, weakness or numbness of an arm or leg, dizziness, balance problems, or seizures), from cancer spread to the brain or spinal cord
- Yellowing of the skin and eyes (jaundice), from cancer spread to the liver
- Lumps near the surface of the body, due to cancer spreading to the skin or to lymph nodes (collections of immune system cells), such as those in the neck or above the collarbone

Most of the symptoms listed above are more likely to be caused by conditions other than lung cancer. Still, if you have any of these problems, it's important to see your doctor right away so the cause can be found and treated, if needed.

Some lung cancers can cause a group of very specific symptoms. These are often described as *syndromes.*

Horner syndrome

Cancers of the top part of the lungs (sometimes called *Pancoast tumors*) may damage a nerve that passes from the upper chest into your neck. This can cause severe shoulder pain. Sometimes these tumors can affect certain nerves to the eye and part of the face, causing a group of symptoms called *Horner syndrome*:

- Drooping or weakness of one eyelid
- Having a smaller pupil (dark part in the center of the eye) in the same eye
- Reduced or absent sweating on the same side of the face

Conditions other than lung cancer can also cause Horner syndrome.

Superior vena cava syndrome

The superior vena cava (SVC) is a large vein that carries blood from the head and arms back to the heart. It passes next to the upper part of the right lung and the lymph nodes inside the chest. Tumors in this area may push on the SVC, which can cause the blood to back up in the veins. This can cause swelling in the face, neck, arms, and upper chest (sometimes with a bluish-red skin color). It can also cause headaches, dizziness, and a change in consciousness if it affects the brain. While SVC syndrome can develop

gradually over time, in some cases it can become life-threatening, and needs to be treated right away.

Paraneoplastic syndromes

Some lung cancers can make hormone-like substances that enter the bloodstream and cause problems with distant tissues and organs, even though the cancer has not spread to those tissues or organs. These problems are called *paraneoplastic syndromes*. Sometimes these syndromes may be the first symptoms of lung cancer. Because the symptoms affect organs besides the lungs, patients and their doctors may suspect at first that a disease other than lung cancer is causing them.

Some of the more common paraneoplastic syndromes associated with small cell lung cancer (SCLC) are:

- **SIADH (syndrome of inappropriate anti-diuretic hormone):** In this condition, the cancer cells make a hormone (ADH) that causes the kidneys to retain water. This causes salt levels in the blood to become very low. Symptoms of SIADH can include fatigue, loss of appetite, muscle weakness or cramps, nausea, vomiting, restlessness, and confusion. Without treatment, severe cases may lead to seizures and coma.

- **Cushing syndrome:** In some cases, lung cancer cells may make ACTH, a hormone that causes the adrenal glands to secrete cortisol. This can lead to symptoms such as weight gain, easy bruising, weakness, drowsiness, and fluid retention. Cushing syndrome can also cause high blood pressure and high blood sugar levels (or even diabetes).

- **Neurologic problems:** Small cell lung cancer can sometimes cause the body's immune system to attack parts of the nervous system, which can lead to problems. One example is a muscle disorder called the *Lambert-Eaton syndrome*. In this syndrome, muscles around the hips become weak. One of the first signs may be trouble getting up from a sitting position. Later, muscles around the shoulder may become weak. A rarer problem is *paraneoplastic cerebellar degeneration*, which can cause loss of balance and unsteadiness in arm and leg movement, as well as trouble speaking or swallowing. SCLC can also cause other nervous system problems, such as muscle weakness, sensation changes, vision problems, or even changes in behavior.

Some of the more common paraneoplastic syndromes that can be caused by non-small cell lung cancer (NSCLC) include:

- High blood calcium levels (*hypercalcemia*), which can cause frequent urination, thirst, constipation, nausea, vomiting, belly pain, weakness, fatigue, dizziness, confusion, and other nervous system problems

- Excess growth of certain bones, especially those in the finger tips, which is often painful
- Blood clots
- Excess breast growth in men (*gynecomastia*)

Again, many of the symptoms listed above are more likely to be caused by conditions other than lung cancer. Still, if you have any of these problems, it's important to see your doctor right away so the cause can be found and treated, if needed.

Exams and tests to look for lung cancer

If your doctor thinks you might have lung cancer based on the results of a screening test or because of symptoms you are having, he or she will do exams and tests to find out for sure.

Medical history and physical exam

Your doctor will want to take a medical history to check for any risk factors and to learn more about any symptoms you are having. Your doctor will also examine you for signs of lung cancer or other health problems.

If the results of the history and physical exam suggest you might have lung cancer, more involved tests will be done (see below).

Tests that might be used to look for lung cancer

Sputum cytology

For this test, a sample of sputum (mucus you cough up from the lungs) is looked at under a microscope to see if it contains cancer cells. The best way to do this is to get early morning samples from you 3 days in a row. This test is more likely to help find cancers that start in the major airways of the lung, such as most small cell lung cancers and squamous cell lung cancers. It may not be as helpful for finding other types of non-small cell lung cancer.

Chest x-ray

If you have symptoms that might be due to lung cancer, this is often the first test your doctor will do to look for any masses or spots on the lungs. Plain x-rays of your chest can be done at imaging centers, hospitals, and even in some doctors' offices. If the x-ray is

normal, you probably don't have lung cancer (although some lung cancers may not show up on an x-ray). If something suspicious is seen, your doctor may order more tests.

Computed tomography (CT) scan

A CT (or CAT) scan is more likely to show lung tumors than routine chest x-rays. A CT scan can also provide precise information about the size, shape, and position of any lung tumors and can help find enlarged lymph nodes that might contain cancer that has spread from the lung.

The CT scan uses x-rays to produce detailed cross-sectional images of your body. Instead of taking one picture, like a regular x-ray, a CT scanner takes many pictures as it rotates around you while you lie on a table. A computer then combines these pictures into images of slices of the part of your body being studied. Unlike a regular x-ray, a CT scan creates detailed images of the soft tissues in the body.

Before the CT scan, you may be asked to drink a contrast solution or you may get an injection of a contrast solution through an IV (intravenous) line. This helps better outline structures in your body. The contrast may cause some flushing (a feeling of warmth, especially in the face). Some people are allergic and get hives. Rarely, more serious reactions like trouble breathing or low blood pressure can occur. Be sure to tell the doctor if you have any allergies or if you ever had a reaction to any contrast material used for x-rays.

A CT scanner has been described as a large donut, with a narrow table that slides in and out of the middle opening. You will need to lie still on the table while the scan is being done. CT scans take longer than regular x-rays, and you might feel a bit confined by the ring while the pictures are being taken.

Further tests if you have an abnormal screening test result

It is common for a low-dose CT scan of the lungs to show small, abnormal areas (called *nodules* or *masses*) in the lungs, especially in current or former smokers. Most lung nodules seen on CT scans are not cancer. They are more often the result of old infections, scar tissue, or other causes. But tests are often needed to be sure a nodule is not cancer.

Most often the next step is to get a repeat CT scan to see if the nodule is growing over time. The time between scans might range anywhere from about a month to a year, depending on how likely your doctor thinks it is that the nodule could be cancer. This is based on the size, shape, and location of the nodule, as well as whether it appears to be solid or filled with fluid. If the nodule is larger, your doctor might also want to get another type of imaging test called a positron emission tomography (PET) scan, which can often help tell if it is cancer.

If the second scan shows that the nodule has grown, or if the nodule has other concerning features, your doctor will want to get a sample of it to check it for cancer cells (called a *biopsy*). This can be done in different ways:

- The doctor might pass a long, thin tube (called a *bronchoscope*) down your throat and into the airways of your lung to reach the nodule. A small, hollow needle on the end of the bronchoscope can be used to get a sample of the nodule.
- If the nodule is in the outer part of the lung, the doctor might pass a thin, hollow needle through the skin of the chest wall and into the nodule to get a biopsy sample.
- If there is a higher chance that the nodule is cancer (or if the nodule can't be biopsied with a needle), surgery might be done to remove the nodule and some surrounding lung tissue. Sometimes larger parts of the lung might be removed at the same time as well.

These types of tests, biopsies, and surgeries are described in more detail in our documents *Lung Cancer (Non-Small Cell)* and *Lung Cancer (Small Cell)* as are the options for treatment if lung cancer is found.

Further tests if you have possible signs or symptoms of lung cancer

If your doctor is concerned you might have lung cancer because of signs or symptoms you are having, a chest x-ray or chest CT scan to look for tumors in the lung is likely to be the next step. Other tests that might be done include having you cough up sputum (phlegm) to have it looked at for cancer cells, or having a bronchoscopy, where the doctor puts a long, thin tube down your throat and into your lungs to look for anything abnormal.

If any of these tests are suspicious for cancer, further tests such as a biopsy or even surgery will likely be needed to get samples from any tumors.

These tests and procedures are described in more detail in our documents *Lung Cancer (Non-Small Cell)* and *Lung Cancer (Small Cell)*, along with the options for treatment if lung cancer is found.

Additional resources for lung cancer prevention and early detection

More information from your American Cancer Society

The following related information may also be helpful to you. These materials may be ordered from our toll-free number, 1-800-227-2345.

Lung cancer

Lung Cancer (Non-Small Cell) (also in Spanish)

Lung Cancer (Small Cell) (also in Spanish)

Tobacco

Guide to Quitting Smoking (also in Spanish)

Questions About Smoking, Tobacco, and Health (also in Spanish)

Secondhand Smoke (also in Spanish)

Other possible causes

Arsenic

Asbestos (also in Spanish)

Diesel Exhaust

Radon (also in Spanish)

Talcum Powder and Cancer

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

National organizations and websites*

In addition to the American Cancer Society, other sources of patient information and support include:

American Lung Association
Toll-free number: 1-800-586-4872 (1-800-LUNGUSA)
Website: www.lungusa.org

Lungcancer.org
Toll-free number: 1-800-813-4673 (1-800-813-HOPE)
Website: www.lungcancer.org

Lung Cancer Alliance
Toll-free number: 1-800-298-2436
Web site: www.lungcanceralliance.org

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

**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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Last Medical Review: 8/22/2014
Last Revised: 11/10/2014

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