

Lung Cancer

This information is reviewed by a physician with expertise in the area presented and is further reviewed by committees from the American College of Radiology (ACR) and the Radiological Society of North America (RSNA), comprising physicians with expertise in several radiologic areas.

Lung cancer overview

More than one in four of all diagnosed cancers involve the lung, and lung cancer remains the most common cancer-related cause of death among American men and women. In 2008, more than 161,000 lung cancer deaths are expected, outnumbering deaths from breast, prostate and colon cancers combined.

At the same time, it may well be that a great many lung cancers are preventable. Inhaling cancer-causing substances such as tobacco smoke may lead to changes in the lung tissue shortly after exposure — so-called precancerous changes. Nevertheless, cancer itself typically develops over a period of many years, and if detected at an early enough stage can be eliminated by a variety of treatments.

What are my treatment options?

- Treatment options overview
- Does the treatment method depend on the type of lung cancer?
- How does the stage of disease guide lung cancer treatment?
- How effective is treatment for inoperable lung cancer?

Treatment options overview

- About one-third of lung cancer patients are diagnosed with localized disease that may be treated by surgical resection. Another third of patients have disease that has already spread to the lymph nodes. In these cases, radiation therapy along with chemotherapy and occasionally surgery is used.

The last third of patients may have tumors that have already spread to other parts of the body via the blood stream and are typically treated with chemotherapy and sometimes with radiation therapy for the relief of symptoms.

- **Surgery** is the primary treatment for patients with early-stage cancer who are in good general health. The goal of surgery is to totally eliminate all the tumor cells and thereby provide a cure. Even if a tumor recurs after an attempt to remove it, the recurrent tumor often can be removed in a second operation. Surgery is a possibility even if there are multiple tumors, or metastases, provided they are all close together at a site that the surgeon can reach. Unfortunately, lung cancers tend to develop in smokers more than 50 years of age, who very often have other lung disease or serious medical conditions that magnify the risk of surgery.

The location and size of a lung tumor dictate how extensive the operation must be. Lobectomy — removal of an entire lobe of the lung — is an accepted procedure for removing lung cancer when the lungs are functioning well. The mortality risk is 3 percent to 4 percent, and tends to be highest in older patients. If lung function prohibits lobectomy, a small cancer confined to a limited area can be removed with a small portion of surrounding lung tissue. This is called segmental resection, or wedge resection.

Patients lose less of the lung function as a smaller portion of lung is removed. This segmental resection is suitable for only small early stage cancers that are at the edge of the lung and carries a mortality risk of 1.4 percent. If the entire lung must be taken out by pneumonectomy, the expected mortality rate is 5 percent to 8 percent. The oldest patients are at highest risk and recurrent cancer is very common.

In a majority of cases, either the patient is not fit for surgery or it is not possible to remove the entire tumor because of its size or location. But a number of other treatments are available that can shrink a tumor so that it may be more easily resected or in some cases completely destroy a lung cancer.

- **Radiation therapy**, or radiotherapy, delivers high-energy x-rays that can destroy rapidly dividing cancer cells. It has many uses in lung cancer:
 - As primary treatment
 - Before surgery to shrink the tumor
 - After surgery to eliminate any cancer cells that remain in the treated area
 - To treat lung cancer that has spread to the brain or other areas of the body

Besides attacking the tumor, radiotherapy can help to relieve some of the symptoms it causes such as shortness of breath. When used as an initial treatment instead of surgery, radiotherapy may be given alone or combined with chemotherapy.

Today, many patients who have a small lung cancer that can be easily reached by an x-ray beam, but who are not candidates for surgery, are receiving curative doses of radiotherapy. These patients may include the elderly, those with chronic heart failure, and those receiving a blood-thinning drug that puts them at risk of surgical bleeding. More recently, a newer technique called Stereotactic Body Radio Therapy (SBRT) is being increasingly used. It involves a multitude of small, focused radiation beams tracking the lung tumor along with its respiratory movement, in typically three to five treatments. This treatment delivers very high doses of radiation therapy to the lung cancer in patients where surgery is not an option.

Most often, radiation therapy is delivered by the external beam technique, which aims a beam of x-rays directly at the tumor. Treatment is given in a series of sessions, or fractions, usually over six weeks.

Some studies have obtained good results with fewer side effects when the total radiation dose is given in more fractions over a shorter time. Three-dimensional conformal radiation therapy is a fairly new technique based on a 3-D image of the tumor taken with CT scanning.

This image serves as the target for a high-dose radiation beam that automatically changes its shape and size to match the tumor. This method minimizes radiation exposure of nearby normal lung tissue.

In brachytherapy, radioactive seeds are implanted through a thin plastic tube directly into the site of cancer. This may help to relieve severe symptoms but does not cure the cancer.

- **Chemotherapy** involves drugs that are toxic to cancer cells. The drugs are usually given by direct injection into a vein or through a catheter placed in a large vein. Often given after surgery to get rid of small groups of cancer cells that may remain, chemotherapy also may slow tumor growth and relieve symptoms in patients who cannot have surgery. This treatment is used in all stages of lung cancer and can prolong life even in elderly persons as long as they are in good general health. Some chemotherapy drugs increase damage done to tumors by the radiation treatment of cancer cells. Others keep the tumor cells at a stage where they are most susceptible to radiation treatment, or impair the ability of cancer cells to repair themselves after a course of radiation therapy. Evidence is mounting that a combination of these drugs integrated with radiotherapy is more effective than radiotherapy alone, but there is a substantial risk of serious side effects.

Chemotherapy causes many distressing side effects, such as severe nausea with vomiting and damage to the white blood cells needed to combat infection, but there now are ways to counter some of these effects. Some lung cancer patients will have to decide whether it is worth suffering side effects and having a poorer quality of life in order to remain alive for a somewhat longer time.

Does the treatment method depend on the type of lung cancer?

There are two main types of lung cancer that have different microscopic appearances:

- **Small-cell lung cancer (SCLC)**—also referred to as oat-cell cancer—usually is found in active or former cigarette smokers. Although SCLC is less common than the other type of lung cancer, it is a more aggressive tumor that is more likely to spread to other body sites.

- **Non-small-cell lung cancer (NSCLC)** tends to grow more slowly and takes longer to spread beyond the lung.

Small-cell lung cancer: Chemotherapy is the mainstay of the treatment for SCLC. Radiation therapy is often used along with chemotherapy to treat lung tumors that have not spread beyond the chest or other organs. Surgery is not commonly used in SCLC due to its tendency to spread quickly. While surgery is seldom used to treat patients with SCLC, occasionally it is done to obtain tissue samples for microscopic study to determine for certain which type of lung cancer is present. Lymph nodes will be removed at the same time to see whether they contain cancer.

SCLC is more often treated by chemotherapy in an attempt to slow or halt its spread beyond the lungs. In addition, patients may receive radiotherapy aimed either at the original lung tumor or metastases in other parts of the body—especially the brain. The physician caring for you, probably a radiation oncologist, may suggest radiation therapy directed at the brain even though no cancer has been found there. This is called prophylactic cranial irradiation and is given to prevent lung cancer metastases from forming at this vital site. However, because radiation may affect brain function, the doctor and patient should consult together to make this decision.

Besides the brain, radiotherapy may be delivered to other body sites where cancer has spread, such as the spine and other bones. Even if the cancer cannot be removed completely, radiation therapy or chemotherapy may succeed in making the patient more comfortable.

Non-small-cell lung cancer: Patients diagnosed as having NSCLC in its earliest stages are candidates for surgical resection with a realistic hope of curing the disease. More recently, chemotherapy is added after surgery to treat patients with any tumor spread to the lymph nodes or to treat large tumors that remain after surgery.

Radiation therapy and chemotherapy also may be used to slow tumor growth and relieve symptoms.

Radiation therapy may prove helpful:

- In treating patients with NSCLC who cannot undergo surgery because of other serious medical problems.
- For patients whose lung cancer has spread to lymph nodes or nearby tissues.
- When the cancer has spread to distant parts of the body. Radiotherapy sometimes will shrink the tumors and relieve the pain they are causing.

Pain relief is a very important part of treating lung cancer.

Although many effective painkillers are available and there are devices for delivering medication on demand without overdosing, many cancer patients still do not receive adequate pain relief. Such relief should be possible in 95 percent of all patients. Patients need to be clear and assertive about their pain without concern about appearing weak or troublesome.

How does the stage of disease guide lung cancer treatment?

Small-cell lung cancer: For extensive SCLC there are two basic choices, chemotherapy—with or without radiotherapy to the brain—or radiotherapy delivered to body sites where the cancer has spread. If lung cancer recurs after initial treatment, either radiotherapy or chemotherapy may help to reduce discomfort and pain. Radiotherapy or laser treatment can keep the airways open, allowing the patient to breathe more freely.

Non-small-cell lung cancer: The earliest NSCLCs are very small tumors diagnosed after cancer cells are found in a sputum sample. Special tests may be needed to locate the main tumor. Whatever the initial treatment, the radiation oncologist may suggest that the patient take part in a clinical trial of chemotherapy in the hope of preventing recurrent cancer.

Combined treatment is the rule when cancer has spread to structures near the lung, such as the chest wall, diaphragm or distant lymph nodes. Depending on the exact location of cancer, radiation therapy may be given alone or combined with surgery and/or chemotherapy. Surgery may be futile when cancer has spread to distant parts of the body. Chemotherapy or radiation therapy, alone or in combination, are usually relied upon to control symptoms in these patients. Laser treatment or brachytherapy may also be tried. The same measures are available to treat patients whose NSCLC has recurred, with one exception: surgery may be done to remove a very small amount of tumor that has spread to the brain.

Any patient with lung cancer may want to consider taking part in one of the many clinical trials that are under way at any given time with the goal to find more effective treatments.

Besides studies of new chemotherapy drugs, these trials are evaluating photodynamic therapy, laser treatment and novel experimental measures.

How effective is treatment for inoperable lung cancer?

In some patients with NSCLC, it is not possible to remove all of the tumor surgically. They commonly receive regular cycles of chemotherapy over several months as outpatients. Generally, more than one drug is given and if there is no response after several months, a different drug—possibly an experimental one—may be tried. Another approach to advanced lung cancer is to deliver small doses of radiotherapy each day for several weeks, or in some cases several times a day. As with chemotherapy, hospital admission is not necessary. Reports indicate that some patients with locally-advanced but not widespread lung cancer have done well when given larger-than-usual doses of radiotherapy.

The medical or radiation oncologist may propose a combination of chemotherapy and radiation therapy for a patient who is normally active. The two treatments may be given at the same time or chemotherapy may be started before radiotherapy or after it is completed. Chemotherapy followed by radiation therapy has extended life and increased survival rates for patients with inoperable lung cancer, compared with radiotherapy alone. Combined treatment also has helped some patients with locally advanced and inoperable SCLC, but at the price of severe side effects. There is evidence that using both chemotherapy and radiotherapy during the same period lowers the risk of cancer recurring; this applies to both SCLC and NSCLC.

When cure is not a possibility, palliative treatment often is recommended. This is the use of medications, chemotherapy, radiation therapy or other measures to relieve symptoms of lung cancer without actually eliminating the tumor. It is important that radiotherapy be given in small doses so that side effects do not develop. Even though non-surgical treatment is not often curative, it can prolong survival. At some point, if you and your oncologist or primary care physician agree that treatment no longer is advisable, hospice care can provide comfort.

What happens during radiation therapy?

Radiation therapy is the delivery of focused high-energy x-rays, gamma rays or atomic particles. It affects cells that are rapidly dividing—such as cancer cells—much more than those that are not. Most cancers, including lung tumors, are made of cells that divide more rapidly than those in normal lung tissue, holding out the hope that the tumor can be eliminated without damaging surrounding normal tissues. Radiotherapy acts by attacking the genetic material—or DNA—within tumor cells, making it impossible for them to grow and create more cancer cells.

Normal body cells may also be damaged—though less markedly—but they are able to repair themselves and function properly once again. The key strategy is to give daily doses of radiation large enough to kill a high percentage of the rapidly dividing cancer cells, while at the same time minimizing damage to the more slowly dividing normal tissue cells in the same area.

What are possible side effects of radiation therapy?

- Most patients tire easily after receiving their first radiation treatments. This fatigue gradually increases as treatment continues and may become severe, seriously limiting the ability to engage in normal daily activities. Typically, fatigue lessens one to two months after radiotherapy is completed. If you experience fatigue it is important to get enough rest, but at the same time your physician may suggest that you stay as active as possible.
- Some patients experience hair loss in the area of the chest wall included in the radiation field. Depending on how much radiation is delivered, this may be temporary or permanent.
- Skin irritation is the rule after a few weeks of radiation therapy. The affected area may be reddened, dry, tender and itchy. This reaction can become quite severe during a long course of treatment. It helps to keep the skin clean with gentle soap and warm water, to dry it well and to avoid very hot water while bathing. A sunscreen should be used when skin in the treated area is exposed to sunlight. Perfumes, cosmetics and deodorants should not be used in the area of treatment. After daily treatments you may apply an unscented cream or lotion.
- Temporary loss of appetite is a possibility.
- Esophagitis, inflammation of the tube that conveys food from the mouth to the stomach, is common after radiotherapy for lung cancer and can be severe. The esophagus is very sensitive to radiation, and worse damage occurs in patients who also receive chemotherapy. Esophagitis makes it difficult to swallow and some patients have lost 10 percent or more of their body weight as a result. Nevertheless the inflammation settles within three weeks of completing treatment in most patients and shortly thereafter they begin to regain their lost weight.
- An inflammation of the lungs called radiation pneumonitis may develop three to nine months after radiotherapy is over. It causes coughing and shortness of breath as well as fever but in most cases calls for no specific treatment and gets better within two to four weeks. Radiation pneumonitis leaves no lasting effects on breathing.

What kind of treatment follow-up should I expect?

Once a course of radiotherapy comes to an end your physician usually will want to see you after six weeks and then every three months for the first two years. After this you may be seen every six months for three years and then once a year. Often your medical or radiation oncologist will recommend that you have a computed tomography (CT) scan, a magnetic resonance imaging (MRI) study or a positron emission tomography (PET) scan at the end of treatment. These images will make it possible to do comparisons with images obtained in the course of follow-up. In this way treatment-related complications can be found at an early stage and it will be possible to tell the difference between recurrent cancer and lung scars produced by high-dose radiation treatment. Many patients will be spared a period of needless anxiety. By obtaining chest x-rays at each follow-up visit any recurrent cancer hopefully will be discovered in time to be treated again and eliminated.

In addition to x-rays, other tests such as blood cell counts and bronchoscopy may be a routine part of the follow-up exam, depending on whether symptoms are present. If new symptoms develop at another part of the body, tests may be done to detect any potential problem. Typical sites where cancers spread are checked by doing an MRI study of the brain, a bone scan, and a CT scan of the chest and upper abdomen.

Apart from recurrent tumor, a small amount of cancer may remain after treatment and begin to grow many months later. Or the finding of cancer during follow-up may mean a second primary lung tumor rather than a recurrence. Patients whose early-stage lung cancers are cured develop second cancers at a rate of at least 3 percent of patients per year. Here, too, frequent follow-up visits and chest x-rays provide the best chance of finding disease at an early, more treatable stage. A new method called fluorescent bronchoscopy uses a special light that is taken up by lung cancer cells and is able to detect very early cancers.

Are there any new developments in treating my disease?

- Less invasive surgical methods are under study. They require a much smaller incision and allow the patient to be up within hours after surgery ends.

- Immunotherapy uses drugs that boost the patient's immune system to help control cancer. Some studies, but not all, have shown better survival rates when these drugs are given after surgery.
- Gene therapy may kill cancer cells or slow their growth when healthy genes are delivered directly into a lung tumor.
- Angiogenesis inhibitors are agents that prevent new blood vessels from forming in growing cancers and may actually turn off the tumor's blood supply. This remains an experimental approach but is promising in part because it seems to cause very few side effects.

Clinical Trials

To learn about current clinical trials being conducted, see the Clinical Trials page of the National Cancer Institute's Web site.

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