

Lung Cancer

Lung cancer usually forms in the cells lining the air passages within the lungs. The two main types are small-cell lung cancer and non-small-cell lung cancer.

Your doctor may perform a physical exam, low-dose computed tomography (LDCT) or sputum cytology to help diagnose your condition. If cancer is detected, your doctor also may order a computed tomography (CT or CAT) scan of your chest, abdomen and pelvis, bronchoscopy (visual examination of the airway) or PET scan to determine the extent of the cancer. In more advanced stages, an MRI of the brain is performed. If you cannot tolerate an MRI of the brain, a CT scan of the head with contrast is performed. A needle biopsy of the lung may be performed to confirm the diagnosis of cancer. This biopsy can be done via a bronchoscope (a tube that goes down your throat) or a needle biopsy using CT to guide the needle. Sometimes an endobronchial ultrasound is performed to view and sample lymph nodes in the central chest (mediastinum). Treatment options depend on the extent of the disease and include surgery, radiation therapy and systemic therapy (which can be chemotherapy, targeted therapy, immunotherapy) or a combination thereof.



What is lung cancer?

Lung cancer forms in tissues of the lung, usually in the cells lining air passages.

Lung cancer is the leading cause of cancer deaths in the United States and worldwide. Approximately 85 percent of lung cancer tumors occur in current or former cigarette smokers. It is estimated that there are more than 94 million current and former smokers in the United States, many of whom are at high risk of developing the disease.

Besides cigarette smoking, other risk factors of lung cancer can include:

- Age
- Exposure to second hand smoke
- Exposure to asbestos or radon gas
- Genetics

Typical symptoms of lung cancer depend on the location and extent of the cancer but can include:

- Shortness of breath
- Chest pain
- Chronic coughing
- Coughing up blood
- Chronic shoulder pain
- Voice hoarseness
- Difficulty swallowing

- Unexplained weight loss
- Fatigue
- Unusual bone pain

In most cases of early lung cancer, there are no symptoms, and the cancer may be discovered on imaging tests performed for unrelated reasons. If the lung cancer has spread to the brain, you may also experience blurred vision, seizures, headaches and/or symptoms of stroke.

There are two main types of lung cancer, each of which has different microscopic appearances:

- Small-cell lung cancer (SCLC)—also referred to as oat-cell cancer—is usually found in active or former cigarette smokers. Although SCLC is a less common 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.

How is lung cancer diagnosed and evaluated?

Your primary doctor will begin by asking you about your medical history, risk factors and symptoms. You will also undergo a physical exam.

Before there are even symptoms of the disease, many patients undergo regular lung cancer screening in which one or more of the following imaging tests may be performed:

- Low-dose computed tomography (LDCT): CT scanning combines special x-ray equipment with sophisticated computers to produce multiple, cross-sectional images or pictures of the inside of the body. LDCT produces images of sufficient quality that may detect many lung diseases and abnormalities using up to 90 percent less ionizing radiation than a standard chest CT scan (<http://www.radiologyinfo.org/en/info/chestct>).
- Chest x-ray (<http://www.radiologyinfo.org/en/info/chestrad>): An x-ray exam will allow your doctor to see your lungs, heart and blood vessels and is often the first imaging test performed when there are symptoms of lung cancer. This noninvasive medical test provides views from the back to the front as well as from the side.
- Sputum Cytology: This diagnostic test examines a sample of sputum (coughed-up mucus) under a microscope to determine whether abnormal cells are present.

Other imaging tests that may be performed to evaluate the extent of lung cancer include:

- CT of the chest (<http://www.radiologyinfo.org/en/info/chestct>): A CT scan may be done to see finer details within the lungs and detect tumors that may be more difficult to see on a routine x-ray. It also is used to perform a detailed assessment of abnormalities that are detected but not fully evaluated with LDCT. CT is the main imaging test for the assessment of lung cancer. A CT scan of the abdomen and pelvis may also be performed.
- *PET/CT Scan*: (<http://www.radiologyinfo.org/en/info/pet>) This is a test that uses both PET and CT and a small amount of radioactive material (fluorodeoxyglucose or FDG) to help determine the extent of lung cancer after it has been diagnosed and to assess the lung cancer after treatment.
- Bronchoscopy: A visual inspection of the inside of the airways (trachea and the bronchial tree) of the lungs, using a rigid or flexible tube.
- Endobronchial ultrasound: An ultrasound probe is used during bronchoscopy to visualize and sample lymph nodes.
- MRI of the brain: In more advanced stages of lung cancer, an MRI of the brain is performed to evaluate for tumors spread to the brain.
- *MRI of the chest*: (<http://www.radiologyinfo.org/en/info/chestmr>) MRI of the chest is uncommonly used in lung cancer. It gives detailed pictures of the mediastinum, chest wall, pleura, heart and blood vessels. It can assess characteristics of tumors, including cancer of the lungs or other tissues, which are not fully assessed with other imaging modalities (typically

CT) or when there are contraindications to the use of standard imaging tests.

If an area of concern is suspected to be benign by these exams, no further steps may be needed. Your doctor may want to monitor the area at future visits to check if the tumor has changed, grown or dissolved.

If these tests suggest that the abnormal cells in question are lung cancer, a biopsy may be necessary. A lung biopsy is the removal of lung tissue in order to examine it for the presence of abnormal cells. Biopsies (<http://www.radiologyinfo.org/en/info/biopen>) are performed in several different ways. Some biopsies involve removing a small amount of tissue with a needle while others involve surgically removing an entire lump, or nodule, that is suspicious.

Often, the tissue is removed by placing a needle through the skin to the area of abnormality, a procedure called needle biopsy of the lung (<http://www.radiologyinfo.org/en/info/nlungbiop>). This procedure involves removing several small samples from your lung(s) and is extremely safe and effective.

How is lung cancer treated?

About one-third of lung cancer patients are diagnosed with localized disease that may be treated by either surgical resection or, if the patient is not a candidate for full surgical resection, with definitive radiotherapy. Very early stage disease can be treated with stereotactic body radiation therapy (SBRT) an alternative to surgery in elderly or frail people or people who refuse surgery. Another third of patients have disease that has already spread to the lymph nodes. In these cases, radiation therapy along with chemotherapy is used and occasionally surgery is performed. The remaining 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.

It is important to choose an overall treatment plan that is appropriate and customized for an individual patient. After diagnosis, treatment planning for lung cancer often involves consultations with doctors from different specialties including diagnostic radiology, surgery, radiation oncology, and medical oncology. The type of treatment chosen determines which of the doctors will treat the patient.

- **Surgery** consists of the removal of the tumor and a varying amount of surrounding lung tissue. It is the primary treatment for patients with early-stage cancer who are in good general health. The goal of surgery is to totally remove all the tumor cells and thereby provide a cure. Lung cancers tend to develop in some smokers more than 50 years of age, who very often have other lung disease or serious medical conditions that increase the risk of surgery. The extent of the operation is determined by the location and size of a lung tumor. Open thoracotomy or less invasive video-assisted thoracic surgery (VATS), or robotic assisted thoracic surgery (RATS) using smaller incisions, may be recommended for appropriately selected patients.
 - **Lobectomy**, the 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 less than three percent to four percent and tends to be highest in older patients. There are three lobes on the right (upper, middle and lower) and two on the left (upper and lower).
 - **Sublobar resection** may be referred to as either a "wedge resection" or a "segmentectomy." If lung function prohibits lobectomy, or a tumor is very small, sublobar resection may be performed in which a small cancer confined to a limited area may be removed with a small portion of surrounding lung tissue. Sublobar resection may carry a higher risk for recurrence than lobectomy. Sublobar resections are associated with less loss of lung function when compared to lobectomy, as a smaller portion of lung is removed. They carry an operative mortality risk of 1.4 percent. Not all small tumors can be removed by sublobar resections. Usually, these are deep in the middle of the lobe.
 - **Pneumonectomy**: If the entire lung must be taken out by "pneumonectomy", the expected mortality rate is higher (5–8 percent) with the oldest patients being at highest risk. This happens when tumors are very large or are very close to the large blood vessels (pulmonary artery or vein) of the chest or the mainstem bronchi.
 - **Mediastinoscopy**: A mediastinoscopy is performed through a small incision in the lower neck above the breast bone (sternum) and is used to sample the lymph nodes in the central chest (mediastinum). An alternative to

mediastinoscopy is an EBUS. In some cases, either the patient is not able to undergo a surgical resection because of other medical issues. These issues (also known as co-morbidities) include emphysema, chronic obstructive pulmonary disease (COPD), heart disease or general frailty. In other cases, it is not possible to remove the entire tumor because of its size or location. Lastly, in cases of advanced disease, surgery offers no benefit to the patient.

- **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 the tumor 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 localized lung cancer, but who are not candidates for surgery, are being treated with a radiation treatment technique known as stereotactic body radiation therapy (SBRT). Patients who are poor candidates for surgery include the elderly, patients with chronic heart failure, and patients receiving a blood thinning drug that puts them at risk of surgical bleeding. SBRT involves treatment with many small, focused radiation beams or an arc of radiation therapy delivered while tracking the lung tumor along with its movement during breathing, typically in three to five treatments. This treatment delivers very high doses of radiation therapy to the tumor in patients where surgery is not an option. SBRT is primarily used in the setting of early stage, localized disease. *See the Stereotactic Radiosurgery (SRS) and Stereotactic Body Radiotherapy (SBRT)* (<http://www.radiologyinfo.org/en/info/stereotactic>) page for more information on SBRT.

Radiation therapy is typically 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 to seven weeks for conventional treatments, and over one to five treatments for patients that can be treated with SBRT. *For more detailed information see the External Beam Therapy (EBT) page* (<http://www.radiologyinfo.org/en/info/ebt>). Three-dimensional conformal radiation therapy and intensity-modulated radiation therapy (IMRT) and SBRT are radiation techniques based on a 3-D image or 4-D image of the tumor taken with a chest CT scan. This image serves as the target for a high-energy radiation beam that can change in shape and size to match the tumor. These methods minimize radiation exposure of nearby normal lung tissue and other critical structures such as the heart and spinal cord. Because your lungs move (with breathing), your doctor may also use image-guided radiation therapy (IGRT) and four-dimensional computed tomography (4D CT), which allows the radiation oncologist to obtain information on how your tumor moves while you breathe, to improve the precision and accuracy of the delivery of treatment. *See the Intensity-Modulated Radiation Therapy (IMRT)*

page (<http://www.radiologyinfo.org/en/info/imrt>) and the Image-Guided Radiation Therapy (IGRT) page (<http://www.radiologyinfo.org/en/info/igrt>) for more information.

In brachytherapy (<http://www.radiologyinfo.org/en/info.cfm?pg=brachy>), radiation is delivered directly to the site of disease. This is usually achieved either through a surgical procedure where, after resection of the primary tumor, radioactive seeds are sutured to the edge of the surgical resection. Also, in the setting of an obstructive tumor within an airway, radiation is delivered to the site of obstruction through a plastic tube that is temporarily inserted into the airway. This may help to relieve severe symptoms but does not cure the cancer. Not all centers perform brachytherapy for lung cancers and not all cancers are appropriately treated with brachytherapy.

- **Systemic Therapy:** Systemic therapy is comprised of three categories of cancer fighting agents: chemotherapy, targeted agents that target a mutation in the cancer and immunotherapy.
 - **Chemotherapy** involves drugs that are toxic to cancer cells. The drugs are usually given by direct injection into an arm vein or through a catheter placed in a large central vein. *See the Vascular Access Procedures* (http://www.radiologyinfo.org/en/info/vasc_access) page for more information.

In non-small cell lung cancer, chemotherapy is often given after surgery to eliminate microscopic disease, 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. A combination of chemotherapy given during a course of radiotherapy is more effective than radiotherapy alone, but has more side effects.

If chemotherapy is used, it is often to increase the effectiveness of surgery or chemotherapy and the exact drugs may be different in NSCLC than in SCLC. Different types of chemotherapy may be used for different types of non-small cell lung cancer.

Chemotherapy may cause significant side effects, such as nausea or vomiting and damage to the white blood cells that are needed to combat infection, but there now are effective ways to at least partially counter and treat most of these effects. Every

chemotherapy drug is different and has a different set of side effects.

Chemotherapy is the mainstay of the treatment for small cell lung cancer (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 the tendency of SCLC to spread quickly beyond the local area. While surgery is seldom used to treat patients with SCLC, it is occasionally used to obtain tissue samples for microscopic study to determine the type of lung cancer present. For small cell lung cancer, after treatment directed to the disease in the chest, the 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. In SCLC that has spread beyond the chest, radiation therapy can be recommended after chemotherapy as "consolidation" to the bulky areas of tumor or to the brain (PCI). It can also be used in SCLC to alleviate symptoms caused by tumor.

- **Targeted agents:** Newer biologic agents, which may have fewer side effects than traditional chemotherapy and in some instances may be just as effective, are being used in appropriate people. Targeted therapies, newer drugs that work differently than regular chemotherapy, are designed to target mutations within NSCLC cells and inhibit growth. They may be used alone or in conjunction with regular chemotherapy
- **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.

It is extremely important to remember that "inoperable" does not mean "incurable" when it comes to lung cancer. In fact, an increasing number of patients are being treated with a non-surgical approach across all stages of this disease. The effectiveness of the treatment depends on the stage of disease. In early stage inoperable disease treated with radiotherapy alone, control of disease is the norm. In more advanced disease, a combination of chemotherapy and radiation is delivered with curative intent. Cure rates are lower but still possible even with disease spread to the lymph nodes within the chest. Your physicians will often propose a combination of surgery, systemic therapy and/or radiation therapy as appropriate.

See the *Lung Cancer Treatment* (<http://www.radiologyinfo.org/en/info/lung-cancer-therapy>) page for more information.

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