

Introduction

Definition & Overview

Lung diseases are caused by uncontrolled cell division in the lungs. The mutation in the cell division leads to the creation of masses (tumors) making the organs stop working. Lung cancer usually starts in the airways (bronchi or bronchioles) or small air sacs (alveoli).

Historical Context

In the mid-19th century, it was first described. At the beginning of the 20th century, it became rare. By the end of the century, it caused death among men in more than 25 developed countries. In the 21st century lung cancer emerged as the leading cause of cancer deaths worldwide. By 2012 it had passed breast cancer as the leading cause of cancer death among women.

Epidemiology

Lung cancer mainly occurs in older people. Most people diagnosed with lung cancer are 65 or older; a very small number of people diagnosed are younger than 45. The average age of people when diagnosed is about 70. Lung cancer is by far the leading cause of cancer death, accounting for about 1 in 5 of all cancer deaths. About 234,580 new cases of lung cancer (116,310 in men and 118,270 in women) About 125,070 deaths from lung cancer (65,790 in men and 59,280 in women)

Etiology

Causes & Risk Factors

The initiation of lung cancer is through an alteration of the DNA code in a lung cell gene. In many cases, it is inhaled carcinogenic substances, even if the exposure occurred years previously. It is often tobacco smoke but even ex-smokers have reduced risk. The second-leading cause is radon, which is a radioactive gas that occurs in soil. The risk of it increases in the presence of cigarette smoke. Hazardous chemicals including asbestos, uranium, arsenic, and some products

of petroleum increase the chance of acquiring lung cancer. It can also be at a potential risk if there is an inheritance of lung cancer from the family line.

Genetic & Environmental Influences

Genes control the formation, growth, division, and death of cells. Some lung cancers are linked to genes, segments of DNA that carry important instructions. Oncogenes encourage cells to grow and divide; tumor suppressor genes slow the division of cells or cause them to die when they are no longer needed. Mutations may interfere with the body's ability to rid itself of cancer-causing chemicals and to prevent DNA from repairing itself when it is damaged. Mutations of specific genes are present in about 60 percent of people with lung adenocarcinomas. If lung cancer runs in your family, shared environmental influences, in addition to genes, might contribute to the risk.

Clinical features

Signs & symptoms

Early symptoms of lung cancer include persistent or worsening cough, shortness of breath, chest pain, hoarseness, and unintended weight loss. Most of the time, symptoms of lung cancer mimic those of other diseases, hence easily dismissed until it is too late. These may include a cough that does not go away or worsens, shortness of breath or dyspnea, chest pain or discomfort, wheezing, coughing up blood or hoarseness, loss of appetite, unexplained weight loss, unexplained tiredness, shoulder pain, swelling in the face, neck, arms, or upper chest, and a small pupil and drooping eyelid in one eye with little sweating on that side of the face.

Stages & progression

Lung cancer has individual criteria for each of its stages, based on tumor size and its spread. Stage 0 is the in-situ kind of cancer, limited only to the top lining of the lung or bronchus; the process has not invaded the nearby tissues. On the other hand, Stage I cancer is contained only in the lung. Stage II cancer grows larger, reaches lymph nodes inside the lung or has multiple tumors in the same lobe.

Stage III is larger and has spread to the nearby lymph nodes or structures, or the tumor has developed in different lobes of the same lung. Stage IV has invaded the other lung, the fluid around the lung or the heart, or has spread to distant organs. In the case of small-cell lung cancer, the stages are limited or extensive. The limited stage SCLC remains confined to one lung or maybe to nearby lymph nodes, while the extensive SCLC is widespread throughout both the lungs, lymph nodes on the opposite side, or other parts of the body.

Complications

These may include facial swelling, superior vena cava obstruction, breathlessness due to tumors in the lungs, a resultant infection since their immune systems are weak. Others include blood clots, spitting up blood, cancer hypercalcemia, compression of the spinal cord, complications of the esophagus, and bony pain from metastases in bones. These would include keeping themselves hydrated, resting, consulting their doctor if they have trouble breathing, taking medications only as prescribed, following a healthy diet and exercise, and maintaining good hygiene to minimize the risk of infections.

Diagnosis

Diagnostic Criteria

Lung cancer diagnosis starts with an imaging test to look at the lungs. If you have symptoms. It starts with an X-ray. If you smoke or used to smoke, you might have an imaging test to look for signs of lung cancer before you develop symptoms. Testing healthy people for lung cancer: People with an increased risk of lung cancer may consider yearly lung cancer screening using low-dose CT scans. It is offered to people 50 and older who smoked heavily for many years and also offered to people who have quit smoking in the past 15 years.

Diagnostic tests & procedures

If your doctor thinks you may have lung cancer, there are many types of tests that can be done to identify the existence of cancerous cells. Imaging tests, such as x-rays, MRIs, CT scans, and positron emission tomography (PET) scans, all help in creating an image of your body in order to locate the tumor and its size. Your doctor may examine your sputum for the presence of cancer cells, a condition known as sputum cytology. A biopsy is the removal of a small sample of tissue for laboratory analysis. It may be performed in several ways. Bronchoscopy Bronchoscopy is performed by passing a small, lighted tube with a tiny camera down the throat into the airways to directly view the lungs and take tissue samples. Mediastinoscopy An incision is made at the base of the neck and the lymph nodes behind the breastbone are exposed for tissue collection. A needle biopsy uses X-ray or computed tomography images to guide a patient's needle into his lung tissue to remove cells from the suspected cancer. The extracted cancer cells will be forwarded to a laboratory to further analyze and classify the type of lung cancer.

Differential Diagnosis:

A number of conditions may be taken into account in the differential diagnosis when making a diagnosis of non-small cell lung cancer (NSCLC) highly suspected based upon intrathoracic symptoms and a pulmonary nodule on chest radiograph. These include a number of bronchogenic carcinoma such as adenocarcinoma, squamous cell carcinoma, and large cell carcinoma as well as small cell carcinoma. Metastatic diseases from such cancers as those of breast, melanoma, colon, kidney, or sarcoma would be taken into consideration. Nonmalignant considerations are smoking-related bronchial neoplasia, pulmonary carcinoid tumors, extranodal lymphoma, and benign growths like fibromas or lipomas. Other conditions that have to be excluded include such vascular phenomena, infectious granulomas, inflammatory conditions, and pseudotumors.

Pathophysiology:

Lung cancer Mechanism:

LC is the first cause of death due to cancer and is far linked to smoking, raising the risk by 20–40 times in over 85% of cases. Although the rate of smoking has

declined in the developed world since the mid-1960s, it remains a very prevalent habit with major effects on health. One reason that only about one in six to seven smokers develops LC is due to genetic predisposition. Yet, these individuals are not protected from developing the full range of smoking-related diseases. All lung tumors acquire several defining characteristics during their development, including the capabilities for self-sufficiency in growth signals, insensitivity to inhibitory signals, evasion of apoptosis, limitless replicative potential, sustained angiogenesis, and tissue invasion and metastasis. Targeted therapies, in particular EGFR inhibitors, have enjoyed some good initial responses, though overall efficacy has been modest. Public awareness and legislation are one thing, but the insights into the genetic and biochemical determinants of nicotine addiction are of equal order to develop effective interventions concerning smoking-related harm.

Cellular & Molecular changes In Lung cancer

Some cellular and molecular changes of this nature in cancerous cells lead to progression and spread. Uncontrolled growth occurs because the malignant cell fails to respond to normal regulatory signals, over-dividing because of it. They bypass apoptosis, the process that makes damaged or unneeded cells undergo programmed cell death. Cancerous cells increase angiogenesis, which means the formation of new blood vessels, ensuring there is a constant blood supply. They invade other organs and metastasize. At the molecular level, it is the driver mutations in genes like EGFR and KRAS that promote over-activity, hence driving cell growth, or the inactivation of a gene similar to TP53, which normally stops cell proliferation. Activation of telomerase allows cancer cells to bypass normal cellular aging processes and divide indefinitely. Further, the cancer cells may steer clear of the surveillance methods applied by the immune system by expressing proteins like PD-L1 that will let them slip from the attacks of the host's immune system.

Impacts on body systems

The influence of lung cancer can be very strong not only on the lungs but also on other body systems. In the respiratory system, cell division goes out of control and forms a tumor within the lungs, the lining of the lungs, and airways. It often goes without early symptoms or visible changes on X-rays. The cancer cells that enter the blood will travel to other organs through the blood vessels and probably cause

bleeding in the airways with a high risk for blood clots. In the course of such development, cancer can infiltrate the lymph nodes of the immune and excretory systems, leading to swellings in the areas like the collarbone, neck, or armpits and paraneoplastic syndromes that change the normal metabolic activity. Neurologically, brain metastases may cause headaches, memory problems, visual disturbances, and motor symptoms like weakness and difficulties in balancing. It may also lead to bone pain, thinning, and breaking, and, additionally, Lambert-Eaton syndrome, a disorder of muscle weakness if the cancer spreads to the bones.

Management & Treatment

Medical & Surgical treatment

Treatments for lung cancer are primarily based on surgery, whereby the tumorous portion of the lung and surrounding tissue are excised. These include wedge resection, segmental resection, lobectomy, and pneumonectomy. This occurs after evaluating the extent and size of the tumor. If surgery is impossible, then chemotherapy or radiation therapy might be administered in trying to shrink the tumor or kill the remaining cancer cells. Radiation therapy: This is the killing of cancer cells with high-energy beams; it is at times given together with chemotherapy. Chemotherapy uses strong drugs that cyclically kill the cancerous cells. Stereotactic radiotherapy is given for small tumors or metastases and provides strong, very accurate radiation. Targeted therapy attacks certain chemicals in cancerous cells. In immunotherapy, the person's immune system is helped to recognize and kill the tumor cells. Palliative care is support to lessen symptoms and thereby enhance quality of life; it comes to complement other modalities of treatment.

Lifestyle& Dietary Modification

The management of lung cancer involves lifestyle changes, dietary adjustments, and palliative care. Protect your lungs: Avoid smoking and bad air quality. Other measures of health maintenance, such as stress management, good nutrition, and regular exercise, are supportive during therapy. Do not hesitate to ask for help and support from the resources and the people around you; they can give

emotional and practical support, which proves quite helpful. Diet changes can help in weight control, provide enough energy, and give support during recovery. Eating small frequent meals with proteins, whole grains, and healthy fats contributes to wellness when combined with hydration and food safety. The potential for exercise training and counseling which can be integrated into the pulmonary rehabilitation program can contribute for managing fatigue and shortness of breath. Palliative care is available for all stages of lung cancer. Such care offers physical and emotional support, namely by focusing on pain management, nutritional support, and emotional counseling, at any cancer stage. This embodies the best service in care and support along the entire journey of treatment.

Prevention & control

Prevention strategies

Although there is no guaranteed way to prevent lung cancer, several strategies can significantly lower your risk. Not smoking or being exposed to smoke minimizes the chance of developing lung cancer; quitting smoking, even after years, lowers the risk. Limiting, at work, exposure to agents that cause cancer with the use of protective equipment is a must. Also, limiting your intake of food and maintaining a balanced diet with an abundance of fruits, vegetables, and regular exercise will further support lung health. Interventions targeted toward public health, such as reducing minors' access to tobacco, assisting persons in quitting smoking, decreasing secondhand smoke exposure, and increasing radon testing, are some of the ways to prevent lung cancer. Agencies like CDC, Community Preventive Services Task Force, and National Cancer Institute provide many tools and resources for these efforts.

Lung cancer Vaccination & screening program

CIMAvax-EGF is the very first kind of immunotherapy drug against lung cancer to be developed in Cuba. The new drug acts on the epidermal growth factor that needs to be bound for the growth of the cell that contains lung cancer. Well, it doesn't kill the cell but starves them of EGFs by not letting them bind to its receptor. It is under investigation today in combination with other therapies, like nivolumab, and has shown promise in improving tumor stabilization and overall survival. It's approved in several countries but

is available in the U.S. only through clinical trials at Roswell Park. Therefore, low-dose CT scans are recommendable for screening lung cancer in high-risk patients, mostly based on their smoking history and age, so that these cancers could be detected early, though associated with some hazards like false positives, overdiagnosis, and radiation exposure.

Prognosis

Outcomes & Survival Rates

The survival rates of lung cancer vary profoundly between the stages. In stage 1, the five-year survival for a person diagnosed with the disease is approximately 65%, which suggests that there is a fairly good long-term possibility of survival. In contrast, the survival rate decreases to about 40% of those who have been diagnosed with stage 2 lung cancer. Only about 15% of patients if the disease had progressed to stage 3 would have survived for five years or longer. The worst outlook of patients is those with stage 4 lung cancer, where only about 5 percent will live 5 years or longer after an initial diagnosis. These figures are for people diagnosed with lung cancer in England between 2016 and 2020, and they are non-age-standardised—they, therefore, don't allow for the different ages of the patients.

Factors Affect Lung Cancer Prognosis

Several factors influence lung cancer prognosis. A weight loss of more than 5% of the body weight before treatment is a predictor of poor prognosis. Performance status refers to the patient's daily activity capabilities, which have a bearing on prognosis; higher score cases tend to have better outcomes. Gender is another factor, with women having a slightly better prognosis than men. A general factor is overall health, where one in good health is better placed to go through treatments and surgeries, thus improving their survival. Patients with pre-existing conditions, like lung or heart disease, do not have a good prognosis at all. Gene mutations in the cancer cells would dictate how a certain cancer would turn out after treatment; some do much better with targeted therapies.

Quality of life

In the past, the overall five-year survival rate of lung cancer, when diagnosed at an early stage and confined to a primary site, has increased to 56%, and patients are living longer

with the disease, but satisfaction levels with their oncologists vary widely among patients. A survey of 117 members of MyLungCancerTeam revealed that 55% are "very satisfied" with their physician care team, while another 22% are "somewhat satisfied." Central among these differences is a sense of being heard and understood by doctors: 85 percent of very satisfied patients agreed with the statement "The doctor cares about his or her preferences," compared with only 22 percent of those less satisfied. Also, it was found that 83% of the very satisfied patients responded that the doctor listens to and understands what they need, whereas only 19% among the less satisfied ones replied similarly. Also, only 29% have either undergone or are scheduled for biomarker testing, thus showing a need for further education on the matter for these patients. It affects mental health: high levels of anxiety, depression, and isolation are noted among patients; as problems in performing daily activities, exercise, social life, and work/education.

Current research & future directions

Recent advances

NCI-funded researchers are working on the prevention, early detection, and treatment of lung cancer. They are studying ways to detect lung cancer early by refining blood and sputum tests to find the disease before symptoms appear. Some meaningful research in that direction is ongoing using machine learning, through computer programs, to better diagnose lung cancer. Actually, researchers have used these programs to identify types of lung cancer and related genetic mutations with an accuracy of 97 percent. Treatment modalities for lung cancer include surgical intervention, radiation therapy, chemotherapy, targeted therapy, and immune-modulating therapy, with continued research into new options for all stages.

Ongoing clinical trials

"Adjuvant Lung Cancer Enrichment Marker Identification and Sequencing Trials (ALCHEMIST)." This trial is focused on early-stage non-small cell lung cancer (NSCLC) patients who have had their tumors surgically removed. The ALCHEMIST study aims to identify genetic changes in tumors and evaluate the effectiveness of targeted therapies based on these genetic markers. Specifically, it investigates whether adding targeted treatments or immunotherapy after surgery can improve survival rates. This trial is crucial in advancing personalized medicine for lung cancer patients.

Future research needed

In future research, they need to focus on understanding and reducing medicines overcoming by the lungs. This research could lead to the development of new drugs or combination therapies that maintain their effectiveness over longer periods, significantly improving patient outcomes and survival rates.

Cause Study:

A 71-year-old man with stage IV lung adenocarcinoma survived 11 years. The first stage, sequential treatments with carboplatin and docetaxel, resulted in partial regression of the mass, but relapses occurred. Re-challenge chemotherapeutic sequences were given over six years. Chemotherapies were switched to erlotinib, but the treatment was administered discontinuously because the disease progressed. Further EGFR mutation analysis revealed a T790M mutation that became sensitive to treatment with osimertinib. This is the case in point for which the beckoning light of hope stands out for long-term survival in advanced lung cancer treated with cytotoxic chemotherapy, intermittent EGFR-TKI therapy, and targeted treatment for specific mutations.