LUNG CANCER

Abstract:

Lung cancer is a common malignant disease and has surpassed other forms of cancer. Although there are common risk factors associated with lung cancer, such as smoking, age, and race, people who do not smoke or who are exposed to environmental toxins can still be diagnosed with lung cancer. There are several ways to diagnose cancer and the hope is that it will be diagnosed early in the disease process. Treatment can improve the patient's survival rate and quality of life, and may include chemotherapy, radiation therapy, or a combination of both amongst other treatment options. Lung cancer that is diagnosed late has a poor prognosis. For end-stage lung cancer, palliative care measures are generally added to the patient's treatment plan and involve the complete health team. The burden of lung cancer is enormous in the United States. Prevention such as smoking cessation is an important step to reduce the incidence of lung cancer.

Learning Objectives:

1. Describe the causes of lung cancer.
2. Identify treatment options for lung cancer.
3. Explain the importance of smoking cessation to the prevention of lung cancer.

Introduction

Lung cancer is the leading cause of cancer-related deaths in the United States. The most common and frequent cause of lung cancer is due to tobacco smoking, although other causative factors that contribute to its development. Lung cancer is often suspected through patient risk factors and symptom recognition and it is identified through chest imaging. The type and staging of cancer are determined through various tests, and a late diagnosis is deadly. Delaying the diagnosis of lung cancer and the subsequent treatment will lead to an advanced or metastatic disease state with a poor prognosis. Despite improved treatments, the diagnosis of lung cancer is typically associated with a poor outcome and death, although treatments are available to improve a patient's quality of life, including at later stages of disease progression.

Incidence and Prevalence Rates

Lung cancer is the second-most common cancer in men and women in the United States. Each year approximately 200,000 new cases of lung cancer are diagnosed and approximately 150,000 people who have lung cancer will die. Although the mortality rates for lung cancer have declined in recent years, this is still a very serious disease. Each year more people die from lung cancer than from breast cancer, colon cancer, and prostate cancer combined. Lung cancer affects men more than women. The incidence of lung cancer in white and African American women is essentially the same, but African American men are much more likely than white men to develop the disease, even after smoking patterns are taken into account. Lung cancer primarily affects people over the age of forty.

Although there are different types of lung cancer, the majority of cases (about 85%) are a type called non-small cell lung cancer. For discussion in the following sections, the term *lung cancer* will be used here to refer to all cancers of the lungs.

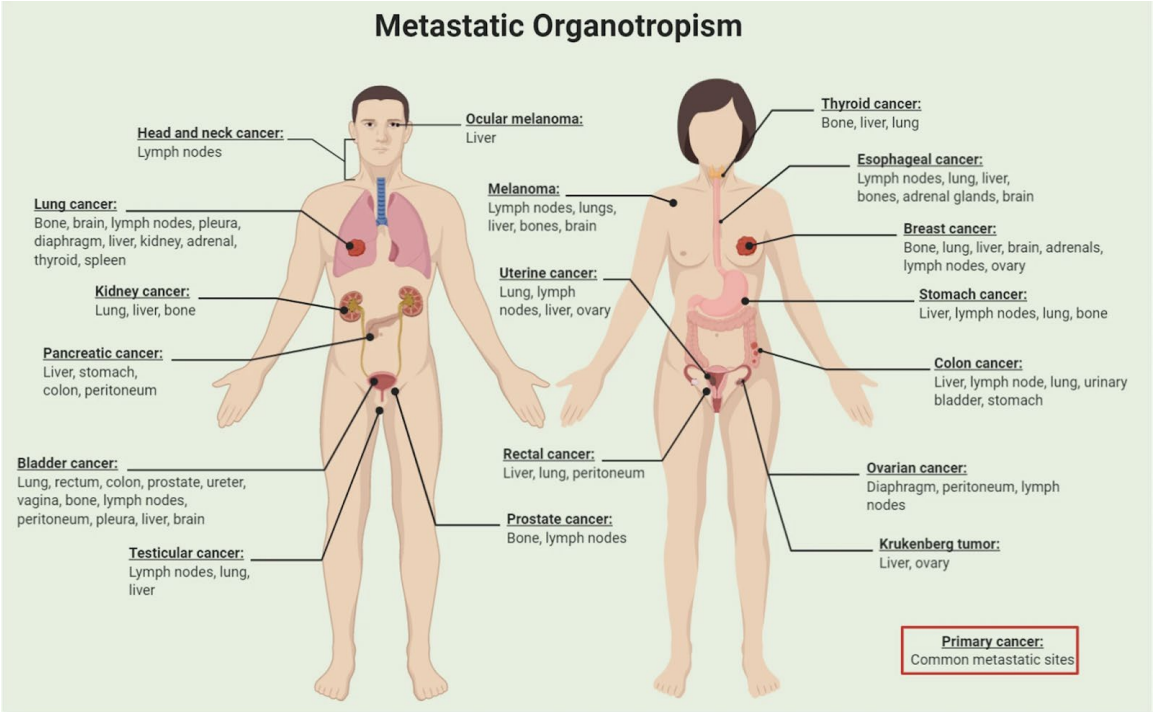
The number one cause of lung cancer is cigarette smoking, and the risk of developing lung cancer is directly associated with how much and how long someone has smoked. Smoking rates in the United States are decreasing and in 2014 the percentage of adults in the country who smoked reached an all-time low of 17.8%. This in part explains why mortality rates for lung cancer have been decreasing, but this good news is tempered by the fact that the prognosis for patients who have lung cancer is very poor. Five years after diagnosis only 15% of all patients who have lung cancer will be alive.

The five-year survival rate is a term that is commonly used when discussing cancer. The five-year survival rate indicates the percentage of people who have a specific cancer who will be alive five years, measured from the time the cancer was diagnosed. For example, five years after lung cancer has been diagnosed only 15 out of 100 patients will be alive. This assumes that the patient has been treated, and it does not mean that the cancer will never come back. The five-year survival rate is also an average and it cannot accurately predict the survival rate for everyone.

Cancer Staging and Disease Progression

Cancer is a neoplastic disease. The term *neoplasm* means new and abnormal growth of tissues and most cancers are characterized by the formation of abnormal collections of tissue called *tumors.* Tumors caused by cancers are *malignant* and they are potentially dangerous for two reasons. Malignant tumors replace normal, functioning tissues and they also cause damage to the surrounding healthy tissues and organs. Cancers can also spread from the primary site to other areas of the body; this process is called *metastasis.* Each type of cancer affects the body in a particular way and each type of cancer (but not all cancers) will metastasize to a specific area or other areas of the body. Most people associate the word tumor with cancer, but some tumors are caused by non-cancerous conditions and these tumors are almost always harmless, or *benign*.

The image below shows the common areas that cancers will metastasize in other parts of the body.



Benign tumors are tumors that stay in their primary location without invading other areas of the body. They do not spread to local structures or distant parts of the body. In other words, they do not metastasize. Benign tumors tend to grow slowly and have distinct borders when visualized through imaging. The exact cause of a benign tumor is often unknown. Benign tumors develop when cells in the body divide and grow at an excessive rate. Typically, the body is able to balance cell growth and division by preventing this rapid division of cells. When old or damaged cells die, they are automatically replaced with new, healthy cells succinctly and do not form tumors.

Carcinogens and Cancer

The development of cancer is usually a lengthy and complex process and it involves two factors: exposure to a carcinogen and genetic susceptibility. A *carcinogen* is a substance that can initiate the process of cancer. Carcinogens occur naturally in the environment, and

people are exposed to carcinogens at home, at work, or as a result of personal health habits. Table 1 lists carcinogens causing lung cancer.

TABLE 1: CARCINOGENS

1. **Air pollution**
2. **Arsenic**
3. **Asbestos**
4. **Beryllium**
5. **Chromium**
6. **Copper**
7. **HIV infection**
8. **Nickel**
9. **Radon**
10. **Tobacco smoke**

Exposure to a carcinogen could be considered the first step in the process of developing cancer. But in most cases, exposure to a carcinogen alone and by itself will not necessarily cause cancer. The exposure must be a certain amount and over a certain period of time for cancer to occur. Some carcinogens such as certain types of radiation are so powerful that even brief exposure can cause cancer. People exposed to radiation from the atomic bombs dropped on Japan during World War II were exposed only briefly. But, the level of exposure was so great and the radiation was such a powerful carcinogen that many of them developed cancer.

Most carcinogens cause cancer only after continual exposure for months or years. For example, occupational asbestos exposure is a well-known cause of a rare type of lung cancer called mesothelioma. But, for asbestos to cause mesothelioma workers must be exposed for many years to high levels of asbestos in the air.

Genetic Susceptibility and Cancer

Exposure to a carcinogen is necessary for cancer to develop, however some degree of genetic susceptibility generally exists for

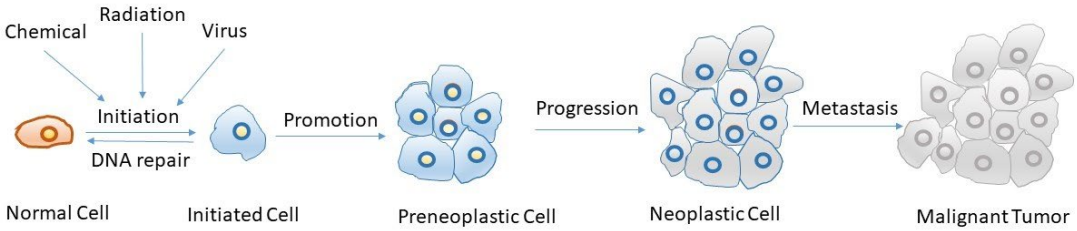
cancer to develop. Genetic susceptibility is defined as "the increased likelihood of developing a particular disease due to the presence of gene mutations, or a family history of the disease." Genetic susceptibilities are not completely understood. Some people are at risk for specific cancers because of their genetic makeup, yet family history and genetic mutations do not always predict who develops cancer. Genetic susceptibility is more proven for some types of cancers, and for others the evidence for the contribution of genetic susceptibility in cancer development is theoretical.

Carcinogens, Genetic Susceptibility, and Cancer

Cancer, as mentioned previously, is characterized by abnormal growths called tumors and cancers happen because of exposure to a carcinogen in someone who is genetically susceptible. This process of cancer onset and development is outlined below.

1. Normal growth and multiplication of the cells and tissues of the body are controlled processes.
2. The potential for *abnormal* cell and tissue growth is always present, but this potential is also controlled and prevented.
3. These processes of growth and multiplication can be disrupted by exposure to a carcinogen in a genetically susceptible person.
4. Mutations of genes that control normal cell and tissue growth can be inherited, caused by exposure to a carcinogen, or by both.
5. Mutations of the genes that control and prevent abnormal cell and tissue growth can be inherited, caused by exposure to a carcinogen, or by both.
6. The genetic mutation and the carcinogen exposure together adversely affect how the body controls cell and tissue growth and prevents abnormal cell and tissue growth.

Multistep Carcinogenesis



Environmental Causes of Lung Cancer

The number one cause of lung cancer is cigarette smoking. Tobacco smoke contains several very strong carcinogens and approximately 90% of all cases of lung cancer are directly attributed to cigarette smoking. There is a definite and strong relationship between how many cigarettes are smoked, the number of years of smoking, and the tar and nicotine content of the cigarettes. The more a person smokes, the longer time spent smoking, and the stronger the cigarettes then the higher the chances are that someone will develop lung cancer. Not everyone who smokes will get lung cancer, but people who smoke have a risk of developing lung cancer that is 10 to 30 times higher than the risk of nonsmokers. There is no safe number of cigarettes but smoking more than 20 cigarettes a day seems to be the amount that drastically increases the chances of lung cancer.

Unfortunately, cigarette smoke is also harmful to people who do not smoke but are exposed to secondhand smoke. The risk of developing lung cancer is increased by 20%-30% with exposure to secondhand cigarette smoke, and it has been estimated that each year there are approximately 3000 new cases of lung cancer that are caused by secondhand cigarette smoke.

Cigar or pipe smoking and chewing tobacco are not safe alternatives to cigarette smoking. All of these increase the risk of

developing lung cancer and other cancers as well, and the harmful effects of tobacco products on overall health have been documented. At this time, the health risks of e-cigarettes are not well understood.

Smoking cessation does significantly decrease someone's risk of lung cancer but the effect is not immediate and it is not absolute, and during the first year or two after stopping smoking the risk for lung cancer increases. Once a person has stopped smoking for five to ten years the risk for lung cancer then begins to decrease, but a former smoker is still much more likely to get lung cancer than someone who never smoked.

Other Causes and Risk Factors for Lung Cancer

Although cigarette smoking and exposure to secondhand cigarette smoke are the most important specific causes of lung cancer, many cases of lung cancer occur in people who have never smoked or who are former smokers. These cases of lung cancer can be caused, or partially caused by the following factors.

Age

Age is not by itself a risk factor for lung cancer except when it contributes to the number of years a person has smoked. Lung cancer primarily affects people over the age of 40 and the risk for lung cancer increases for each year past forty.

Asbestos

Asbestos is a naturally occurring mineral that was once widely used for insulation, in the construction of automobile brakes, as a component of floor tiles, and for many other products. Long-term inhalation of high levels of asbestos can cause lung cancer. The combination of cigarette smoking and exposure to asbestos is especially dangerous.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) can increase the risk for lung cancer independent of someone's smoking habits. Research has shown that long-term inflammation within the lungs is linked to both COPD and lung cancer. Inflammation causes lung cells to divide rapidly in an attempt to repair the damage that has occurred due to COPD, smoking, or other environmental irritants. This raises the risk that the cells within the lungs will mutate and turn into cancerous cells.

Chronic obstructive pulmonary disease (COPD) is a common comorbid disease in lung cancer and is estimated to affect 40–70% of lung cancer patients. Smoking exposure is found in 85–90% of those diagnosed with either COPD or lung cancer, coexisting disease could merely reflect a shared smoking exposure.

Environmental and Industrial Exposures

Radon

Radon is a radioactive gas produced by the natural decay of uranium in the soil. It is found throughout the world and can enter homes through cracks in the foundation, via sump pumps and drains, and through gaps around pipes and wires.

Secondhand smoke

According to the Centers for Disease Control and Prevention (CDC), tobacco smoke contains around 7,000 toxic chemicals, 70 of which are known or suspected to be cancer-causing carcinogens.

Secondhand exposure to these chemicals increases a non-smoker's risk of lung cancer no less than two to three-fold. Secondhand smoke is responsible for around 2% of lung cancer deaths in the United States, or approximately 7,300 deaths per year.

Asbestos

Asbestos is a mineral-based substance long used for insulation. It has been banned in the United States for several decades due to its link to different cancers, including mesothelioma.

Air Pollution

In the United States, air pollution is believed to contribute to around 5% of lung cancers in men and 3% in women.

In parts of Europe, as many as 10% of cases are directly associated with atmospheric pollutants. In China and parts of East Asia, the rate may be as high as 50%.

Among some of the carcinogens commonly found in air pollution are:

1. Benzene
2. Sulfur Dioxide
3. Diesel Engine Exhaust
4. Formaldehyde
5. Coal Ash

Wood Smoke

Exposure to wood smoke may increase the risk of lung cancer. The risk tends to be highest in people exposed to smoke from wood-burning stoves and fireplaces for many years.

Many of those at risk rely on solid fuels like wood, coal, and charcoal for cooking and heat. Those responsible for cooking in such environments frequently women are at higher risk.

Genetic Lung Cancer

Tobacco smoke is a powerful cause of lung cancer but not everyone who smokes gets lung cancer. Research has clearly shown that

certain people are predisposed, or genetically susceptible, to developing lung cancer. It is not clear why this happens, but it may be that some people neutralize tobacco carcinogens less effectively. Anyone who has a first-degree relative (parent or sibling) that has lung cancer has a higher risk for the disease.

Human Immunodeficiency Virus

Infection with the human immunodeficiency virus (HIV) increases the risk of developing lung cancer, even in people who do not smoke.

Signs and Symptoms of Lung Cancer

The signs and symptoms of lung cancer vary depending on the site of the primary tumor, how advanced the disease is, and whether or not cancer has metastasized. Many patients who have lung cancer will have some of the signs and symptoms that are listed in Table 3. The presence and intensity of these signs and symptoms will be different for each patient.

TABLE 2: SIGNS AND SYMPTOMS OF LUNG CANCER

1. **Anorexia**
2. **Chest pain**
3. **Chest**
4. **Dyspnea**
5. **Fatigue**
6. **Hemoptysis (coughing up blood)**
7. **Hoarseness**
8. **Nausea**
9. **Pain**
10. **Shortness of breath**
11. **Vomiting**
12. **Weakness**
13. **Weight loss**
14. **Wheezing**

Lung cancer often metastasizes and the primary sites lung cancer can spread to are:

1. adrenal glands
2. brain
3. bones
4. lymph nodes
5. liver
6. skin

Because of the primary location of lung cancer, most of the patient's complaints will be respiratory. However, once cancer has metastasized the patient may have many non-respiratory signs and symptoms. Metastases to the adrenal gland and the liver usually do not cause signs or symptoms. Metastases to the brain may cause neurological problems. Metastases to the bones cause pain, usually in the spine, ribs, and femur.

Diagnosis of Lung Cancer

Unfortunately, the majority of people who have lung cancer do not have signs and symptoms until the disease is well advanced or the signs and symptoms are mild or non-specific. Many cases of lung cancer are found when a chest X-ray is done as part of a routine check-up or for the evaluation of an ongoing illness. A mass is seen on the X-ray, the patient is usually a smoker, so lung cancer is highly probable. The majority of people who have lung cancer have lymph node involvement and metastases at the time of the diagnosis

If a mass is seen on the chest X-ray, the diagnosis of lung cancer must be confirmed by other studies because there are other cancers and benign illnesses that may appear on an X-ray. There are several ways to determine if a mass in the lungs is cancer, such as bronchoscopy, sputum samples, tissue biopsy, and various radiology tests.

Bronchoscopy

A bronchoscope is a thin, flexible, lighted tube that is inserted into the lungs through the throat. Using a bronchoscope the provider can directly examine the lungs and can also take tissue samples.

Sputum Samples

Cancer cells can be shed into the lungs and they may be detected in the sputum.

Tissue Biopsy

A computed tomography (CT) scan can be used to guide a biopsy needle into the lungs to obtain a tissue sample, and a CT scan and other tests are useful to determine whether cancer has metastasized. These other tests might include blood samples, CT scans of the abdomen, chest, and head, magnetic resonance imaging (MRI) scan of the spine, a bone scan, and pulmonary function testing to evaluate the patient's respiratory status. Blood tests alone cannot confirm a diagnosis of lung cancer but may be useful for determining the seriousness of the case.

Lung Cancer Staging

Once the diagnosis of lung cancer is certain the next step is staging. Staging determines the size of the primary tumor, whether cancer has affected the lymph nodes, any areas of metastasis, and the seriousness of the metastases or patient prognosis. This approach to staging can be remembered by the letters:

1. **T** (**t**umor)
2. **N** (**n**odes)
3. **M** (**m**etastases)

The numbers after the letters indicate how big the tumor is and how far it has spread. The combination of letters and numbers describes the type of cancer, its size, characteristics, and extent. Doctors often use this classification as a basis for making a prognosis and proposing an individual treatment plan.

TABLE 3: STAGING AND CHARACTERISTICS

Characteristic	Abbreviation	Meaning
Primary tumor	T0	No tumor has been found, or the original tumor cannot be detected (anymore).
	T1 to T4	The numbers 1 to 4 indicate increasing tumor size and extent: T1 describes a small tumor, and T3 describes a bigger tumor, for example.
Lymph nodes	N0	There are no tumors in the lymph nodes.
	N1 to N3	The numbers 1 to 3 stand for location and number of affected regional lymph nodes. Tumors found in lymph nodes that are not in the drainage area of the affected organ are regarded as distant metastases.
Metastases	M0	No distant metastases have been found.
	M1	There are distant metastases.

Staging provides valuable information about the level of lung cancer severity, how long the patient is expected to live, and what treatments are appropriate. For example, if the primary tumor is determined to be stage T2, it is > 5 cm but ≤ 7 cm. If the lymph node involvement is determined to be stage N3, lymph nodes throughout the chest have evidence of cancer. Metastatic involvement that is stage M1 indicates that cancer has spread to many distant sites. The stages of the primary tumor, the lymph nodes, and the metastases would be combined to provide an overall score of stage IV. This would represent a very serious, advanced case of lung cancer. The patient would be treated with chemotherapy and possibly a lung resection but treatment would not be expected to be successful.

A lymph node is a small structure (usually three-fourths of an inch or smaller that is part of the lymphatic system. The lymphatic system and the lymph nodes are an important part of the body's immune

system. They are also a very common route by which cancers metastasize.

Prognosis of Lung Cancer

Lung cancer is a serious disease and in most cases the prognosis is poor. The majority of cases of lung cancer are discovered after the disease has become advanced and there are metastases. The overall five-year survival rate for patients who have lung cancer is 15%, but this figure represents all patients who have the disease. However, there are seven stages of lung cancer, IA, IB, IIA, IIB, IIIA, IIIB, and IV. Once cancer has progressed to stage IIIB or IV the five-year survival rate is less than 5% and as low as 2%. If cancer has progressed to a stage where surgery is not possible, most patients will only live for 8 to 14 months.

TABLE 4: STAGE DESCRIPTORS

Stage	Descriptors
I	Complete encapsulation of tumor
IIa	Microscopic tumor invasion through capsule
IIb	Macroscopic tumor invasion into surrounding fat
III	Invasion of pericardium, great vessels, or lung
IVa	Pleural or pericardial dissemination
IVb	Lymphatic/hematogenous metastasis

Lung cancer is likely incurable if the disease is in an advanced stage and since smoking is the number one cause of lung cancer, patients who smoke *should* be screened for lung cancer often. Early detection is important so the disease may be treated before it has progressed too far. Unfortunately, research has not shown that screening makes a significant difference and it is not currently

recommended. If a patient is a smoker and is 55 years of age or older some providers will order a yearly CT screen of the chest. Screening chest X-rays for the general population are not recommended.

Treatment of Lung Cancer

Treatment of lung cancer has three goals; cure the disease, slow the progression of the disease, and lessen the intensity of the signs and symptoms so that the patient feels better. The specific treatment approach that is used will depend on the stage of lung cancer. There are several options and each of these will be discussed separately.

TABLE 5: TREATMENT OPTIONS FOR LUNG CANCER BY STAGE

Stage I:	**Surgical resection; radiation therapy if resection is not possible**
Stage II:	**Surgical resection; radiation therapy if resection is not possible**
Stage III	**a: Chemoradiotherapy and surgical resection in certain patients** **b: Chemoradiotherapy**
Stage IV:	**Chemotherapy, surgical resection in selected cases**

Surgical Resection

Surgical resection of the lung is one of the recommended treatments for stage I through stage IIIa lung cancer. In stages I through stages IIIa cancer has remained localized to the lung; it has not metastasized and the lymph nodes are not affected. Surgical resection is seldom used for patients who have stage IIIb or stage IV lung cancer.

Several different types of lung resections can be done. If the tumor is relatively small and localized a small section of the lung can be removed. This is called a *wedge resection* and is the least extensive and complicated procedure. If the cancer is more extensive, the entire lobe that contains cancer may be removed and is called a *lobectomy.* A more advanced stage of lung cancer would result in the entire lung possibly needing to be removed in a procedure called a *pneumonectomy*.

Chemoradiotherapy

Chemoradiotherapy is a combination of chemotherapy and radiation therapy. This treatment is the recommended approach for patients who have stage IIIa or stage IIIb lung cancer, and it can dramatically improve survival rates. Combining the two is much more successful than using either chemotherapy or radiation therapy alone. Chemotherapy by itself is not used because as a single treatment it is not effective and by itself cannot cure lung cancer. Radiation therapy alone is typically only used for patients who have stage I or stage II disease and cannot tolerate surgery.

Chemotherapy for lung cancer uses intravenous (IV) infusions of a platinum-based drug combined with other chemotherapy drugs. This includes either cisplatin or carboplatin, which are the platinum-based drugs that are typically used. These drugs along with the other chemotherapeutic agents kill cancer cells and they also stop cancer cells from growing. The doses and the duration of therapy are individualized for each patient, but a typical treatment plan is one to three days a week of IV chemotherapy for three weeks. This is called a cycle of therapy.

After each cycle, a rest period is prescribed so that the drugs can work, and then another cycle is started. Most patients require four to six cycles and at the end of that time, the progress or lack of progress is determined.

Radiation Therapy

Radiation therapy uses high-energy radiation that is directed at the tumor. Lung cancer is treated with external beam radiation delivered by a machine called a linear accelerator; this looks somewhat like a CT scan machine. The patient lies down on a treatment table and the linear accelerator delivers high-energy radiation to the tumor, destroying malignant tissue and shrinking the tumor. Before the treatment, the size, shape, and location of the tumor are determined and the current methods of delivering external beam radiation precisely aim the radiation directly at the tumor, thus sparing non-cancerous tissue. Radiation can be given after or before chemotherapy or concurrently. The treatment sessions are usually about 15 minutes long and are painless at the time they are delivered.
Most people feel no pain when each treatment is being delivered but effects of treatment slowly build up over time and may include discomfort, skin changes, or other side effects, depending on where on the body treatment is being delivered.

The treatment approaches described here are the basic and standard ones that are used. New treatments and new combinations of therapy are being designed all the time and not all cancer treatment centers offer every type of therapy. In addition, each patient has different needs so the treatment plans patients undergo may look different than what has been outlined here.

Lung Cancer Laser and Other Therapies

Surgery, chemotherapy, radiation therapy, and chemoradiation therapy are the primary treatments for lung cancer but there are other options. These are used less frequently and are beyond the scope of this discussion.

Cryosurgery

Cryosurgery is the application of intense cold. It has long been used to remove warts and certain types of skin cancer and it can be used to treat lung cancer.

Electrocautery

Electrocautery involves the use of a heated needle or probe to destroy tumors.

Laser

A laser is an intensely focused beam of light that produces heat and can be used to destroy lung tumors. Laser therapy can also be used in combination with injected drugs that accumulate in the cancer cells, making them easier to visualize during laser therapy.

Targeted therapy

Targeted therapy involves the use of drugs that are designed to find and attack cancer cells that have a specific genetic weakness.

Side Effects of Therapy

The side effects of surgical resection are essentially the same as for any other surgical procedure. Side effects include post-operative pain, the risk for infection, the possibility of blood clots, and post-operative pneumonia. These patients may also need pulmonary rehabilitation to help them adjust to the changes in lung volume.

The side effects of chemotherapy, radiation therapy, and chemoradiation therapy are numerous and they are listed below in Table 7. These side effects can be mild and temporary or very disabling and each patient will have a different experience with the treatments. Some of these side effects can be managed with supportive care. For example, most patients have nausea and vomiting and an anti-emetic such as

Zofran® will be prescribed. Some patients will have side effects that are dangerous or intolerable and therapy may need to be stopped for a while. When chemotherapy and radiation therapy are used together, they are more effective than either one used alone, but the number and intensity of the side effects are correspondingly worse.

For the sake of convenience, the side effects of chemotherapy and radiation therapy have been combined in Table 6 and they are described as side effects of chemoradiation therapy.

TABLE 6: SIDE EFFECTS OF CHEMORADIATION THERAPY

1. **Anemia**
2. **Anorexia**
3. **Cough**
4. **Diarrhea**
5. **Fatigue**
6. **Hearing problems**
7. **Infections**
8. **Mouth ulcers**
9. **Nausea**
10. **Peripheral neuropathy**
11. **Skin irritation**
12. **Throat irritation**
13. **Weight loss**
14. **Vomiting**

Some of these side effects are common to many types of medications, but some are specific to radiation therapy and chemotherapy. Because the radiation energy is delivered to the chest, the esophagus, which has sensitive mucous membranes that can be easily irritated, may be damaged by a thermal burn. Skin irritation and burns on the surface of the chest are also common.

Chemotherapy drugs are designed to target and destroy cells that are rapidly growing and multiplying because that is what cancer cells do. However, other cells and tissues in the body also are very active in this respect and chemotherapy drugs damage healthy cells and tissues

such as the bone marrow and the immune system. Because of this effect patients receiving chemotherapy become anemic and they cannot fight off infections, making them prone to fatigue and illnesses.

Unfortunately, the side effects listed in Table 6 are primarily the immediate ones the patient can experience. Chemotherapy, radiation therapy, and chemoradiotherapy also have long-term side effects such as kidney damage, heart damage, and various types of lung problems such as radiation pneumonitis, and inflammation of the lungs.

Efficacy of Treatment

Surgical resection is effective only for a very small number of patients who have lung cancer and only if the disease is localized and diagnosed quickly. Surgery and chemotherapy and/or radiation therapy can be combined and this approach increases survival rates and cure rates. Without treatment, most patients with lung cancer will die very quickly, usually within weeks from the time of diagnosis. If the disease is in an early stage approximately 20%-25% of patients can be cured. Those who are not cured may have a remission but the cancer will reoccur in one to two years. These re-occurrences are more resistant to treatment than the original tumor and metastases.

If the patient is considered to have been cured or remission has occurred, careful long-term follow-up care is still needed. The patient should have periodic evaluations by the provider, scheduled CT scans of the chest, yearly influenza and pneumonia vaccinations, herpes zoster (shingles) vaccination if needed, and lifestyle and nutrition counseling.

Patients who have stopped smoking should be started on a smoking cessation program. The term *remission* means that a cancerous tumor has substantially decreased in size or is gone but there are still cancer cells in the body and cancer will probably re-occur. A remission is a positive sign but remission is not the same as a cure.

Smoking Cessation and Prevention of Lung Cancer

Smoking cessation is a vital part of the prevention and treatment of lung cancer. Nicotine is the active ingredient in tobacco and it is an addictive substance. Many people find that stopping smoking is extremely difficult, and it may take several attempts before smoking cessation is successful. The most successful smoking cessation programs combine education, individual counseling, and the medications Chantix® and Zyban®.

Palliative Care for End-Stage Lung Cancer Patients

If a patient has lung cancer that has not responded to treatment or if the lung cancer is very advanced and treatment will not be helpful then *palliative care* will be started. Palliative care is a term for therapies that relieve the pain and symptoms of a disease but are not intended to cure the disease. The patient is made comfortable but there is no expectation that the patient will survive.

Since the cure rate for lung cancer is so small, most patients will eventually need palliative care. Commonly used palliative care therapies are listed in Table 7.

TABLE 7: PALLIATIVE CARE THERAPIES FOR LUNG CANCER

1. **Analgesics for pain relief**
2. **Anti-anxiety medications such as diazepam (Valium)**
3. **Antidepressants**
4. **Antitussives for cough relief**
5. **Bronchodilators**
6. **Intravenous hydration**
7. **Nutritional support**
8. **Oxygen therapy**
9. **Psychotherapy**
10. **Social services**
11. **Soporifics such as zolpidem (Ambien) for sleep**

Case Study: Lung Cancer

The following case study was obtained from a PubMed search and discusses physical complications arising from a diagnosis of lung cancer.

The authors reported on a 36-year-old female who was referred by her primary care provider to the hospital because of three weeks of progressive mental status changes, weakness, and loss of desire to eat. Her husband reported the patient had been diagnosed with a large cell lung cancer 8 months earlier and had been treated with a combination of chemotherapy and radiation therapy that was completed 4 months before she was admitted with the current symptoms. She had been in her usual state of health before the onset of these new symptoms, including significant mental status changes. The patient showed difficulty with the use of words to express herself and appeared confused. She was found putting food in a coffee maker. After approximately 1 week, however, the confusion resolved but she rapidly developed slurred speech and made nonsensical statements. The patient's speech deficit worsened, she had difficulty walking, impaired balance, and had an episode of incontinence. Her husband reported noticing that her "eyes were beating back and forth and the left side of her face was twitching." Her husband stated that she was "not interacting with her environment." The patient's symptoms progressed until she stopped walking and talking 2 days before arriving at the hospital.

The patient's medical history included rheumatoid arthritis. There was no prior use of tobacco, alcohol, or drugs, and she was sexually active only with her husband. Home medications included pain medication (narcotics), and other medication to reduce inflammation and improve appetite. Her family history listed her mother had "seizures."

An admission was arranged to an inpatient medical oncology unit and the patient was evaluated to be nonverbal except for moaning in response to painful stimuli and her sister's voice. The vital signs were

normal. She reportedly appeared ill, however well-nourished. The skin was mildly sweaty. There were neurological abnormalities such as sluggish pupil reaction to light. In addition to difficulty opening her mouth, the patient had increased general muscle tone and intermittent, inconsistent resistance to passive movement. She could move all four extremities spontaneously but not in response to being instructed to do so.

Examination of other body systems showed dry, peeling skin on her lips, mucous membranes were moist and free of swelling or lesions. The lungs were clear with the use of a stethoscope. The heart rate and sounds were normal and she had good circulation to her extremities. The patient's abdomen was nondistended with normal bowel sounds and the abdomen was soft, nontender, and without evidence of masses. Her skin appeared normal in color.

Laboratory studies included normal blood tests. There were blood and urine tests done to rule out a source of infection. Cerebrospinal fluid (CSF) was obtained through a lumbar puncture and the results were normal. Computed tomography (CT) of the head was also normal. Other radiology testing included an ultrasound of the abdomen which showed a nonspecific liver lesion. Other CT scans of the chest, abdomen, and pelvis showed the primary malignancy in the left lung, as well as possible metastatic disease to the lungs and liver, as well as widespread cancer, spread to the bone. Finally, magnetic resonance imaging (MRI) of the brain after admission demonstrated the patient's brain was also affected by cancer spread, and she had developed swelling of the brain leading to her current symptoms.

Discussion

The patient's general brain dysfunction led to her altered mental status. Clinicians must consider other causes of confusion, such as medication and even a psychiatric illness in the setting of a devastating cancer diagnosis in a relatively young person. The patient could have

had an infection so blood and urine cultures, as well as cerebrospinal fluid, were obtained. Seizures needed to be ruled out, especially since the condition existed in her family history. Finally, the brain MRI was reviewed by the patient's cancer care and neurology team who felt that the abnormal lesions seen were suspicious for metastatic disease. While the patient had cancer spread to the brain, not all altered levels of consciousness that are so profound meant cancer spread. Sometimes it may be an inflammatory response to treatment that is seen in patients with cancer.

Summary

Lung cancer is the second-most common cancer in the United States and it is one of the most dangerous with a five-year survival rate of approximately 15% for lung cancer victims. A late diagnosis of lung cancer is considered untreatable, and most patients will die within months.

Each year more people die of lung cancer than from breast cancer, colon cancer, and colon cancer combined. Most lung cancer victims are 40 years of age or older and affect some populations more than others. The cause of lung cancer is believed to be genetic susceptibility and environmental. People diagnosed with COPD are more vulnerable to developing lung cancer. Carcinogens known to cause lung cancer are multifactorial and the most common culprit is tobacco smoking, as well as second-hand smoke. Not everyone who smokes will be diagnosed with lung cancer, and non-smokers are not immune.

The case study presented above illustrates that lung cancer can occur in people who do not smoke or have significant risk factors. The treatment, side effects, and steps to determine the patient's progress are not always straightforward and other complicating factors may occur.

Smoking cessation is a recommended prevention strategy, however former smokers remain at higher risk of developing lung cancer than non-smokers. The common signs and symptoms of lung cancer have been discussed, including how to identify an advanced disease stage. Diagnostic testing to determine whether the lung cancer stage of I through IV is important to deciding treatment. Surgery, chemotherapy, radiation therapy, or a combination of chemotherapy and radiotherapy, as well as other types of cancer treatment, will need to be discussed with patients. The decision of whether to start palliative care for end-stage lung cancer will involve the patient and family, and will eventually include all members of the health team.