Lung Lesions: Causal Factors, Treatment Options, and Prognosis

Mickie Steck, CST

Lung cancer—the most deadly form of cancer—results in nearly 200,000 fatalities annually. Because symptoms are not apparent immediately, victims of this disease may not suspect they are ill until lesions are revealed during a routine medical examination. Causal factors, symptoms, diagnosis, treatment options, and prognosis are all addressed in the following article.

CAUSAL FACTORS
Eighty-five percent of lung cancers develop in adults aged 45 to 70 who smoke. Other sources of carcinogenic exposure include radon, industrial pollutants, and asbestos. Additionally, breast, colon, prostate, testis, kidney, thyroid, or bone cancer may metastasize to the lungs. Ten-year survivors of endometrial cancer and women taking estrogen replacements are at a higher risk as well. High estrogen levels appear to contribute to the development of adenocarcinoma (malignant adenomas that develop from the epithelium of glandular organs) but have not been associated with squamous cell carcinoma. Diet plays a role also: Diets high in animal fat and cholesterol have been shown to correlate with development of the disease while consumption of vegetables—particularly dark greens and tomatoes—appear to act as a deterrent.

SYMPTOMS
Lesions in the central airways (trachea, right and left main-stem bronchi, and major segmental bronchi) are more likely to cause symptoms than peripheral lesions. Lung tumor symptoms include a cough that produces hemoptysis (blood-tinged sputum), shortness of breath, loss of appetite and accompanying weight loss, chest pain, and hoarseness. A lesion in the left hilar area of the chest may compress structures against the left recurrent laryngeal nerve causing left vocal cord paralysis (right vocal cord paralysis is rare).

DIAGNOSIS
Diagnosis begins with a thorough medical examination—including a chest x-ray film. Such films reveal 5% to 10% of lesions before symptoms develop. Once a lesion is detected, scanning the chest in slices of 1 cm to 3 cm using computed tomography (CT) or obtaining a magnetic resonance image (MRI) will aid in determining the lesion’s size and position in relationship to other structures. When possible, comparing current and previous x-ray films and CT or MRI scans may also help to dictate a future course of action.

To determine the most appropriate therapeutic approach—surgery or another treatment mode—lesions must first be identified by cell type. To date, research has resulted in the identification of 20 lung lesion cell types—some malignant and some benign. The four major malignant cell types include: adenocarcinoma (Figure 1 on page 22), squamous cell carcinomas (Figure 2 on page 22), large cell carcinomas, and small (oat) cells. In a small number of cases, bronchoaveolar cell carcinomas affect the alveoli. Benign lesions include carcinoids (Figure 3 on page...
The most commonly used diagnostic tool for lung lesions—the bronchoscope—enables the physician to determine visually if the vocal cords are functioning normally and to check the major airways for endobronchial components. The bronchoscope is also used to suction and collect sputum in an attached trap. A flexible bronchoscope, used more often than a rigid scope, has a working channel that allows passage of sampling brushes, biopsy forceps, and aspiration needles. This procedure represents minimal risk for the patient.

Distal lesions, which the bronchoscope cannot access, may be sampled with a fluoroscope to determine the lesion’s location. However, lesions that develop in the central airway, while considered distal, will not require fluoroscopy because they can be seen readily.

Peripheral lesions that are less than 2 cm in size cannot be diagnosed reliably through bronchoscopy. Video thorascopy, an open lung biopsy, or percutaneous thoracic needle aspiration (PTNA) provide good diagnostic alternatives. PTNA involves inserting a needle through the chest and attaching an aspiration gun that has a syringe. Under fluoroscopic guidance, the needle aspirates material for cytology studies.

Diagnostic Procedures and Tools
Before undergoing any diagnostic procedures, the patient’s clotting factors should be measured to assess bleeding potential. Regardless of the results, topical vasoconstrictors (topical ephrine, topical thrombin, or cold saline) should be available during the procedure. If bleeding occurs during fluoroscopy for a peripheral lesion, cold saline instillation may prove more helpful than topical vasoconstrictors. Unexpected excessive bleeding during a diagnostic procedure can also be controlled by tilting the patient laterally with the bleeding side down, which will prevent blood from spilling into the noninvolved lung.

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A safety concern exists when sampling the lung's periphery with a bronchoscope. If the biopsy forceps cause a pinching sensation, the parietal pleura has likely been closed in the forceps, which can cause pneumothorax—gas or air collection in the pleural cavity—during the biopsy procedure. The patient should therefore be queried regarding pain after each forceps closing, and the biopsy should proceed only if no pain is felt. Incidence of pneumothorax during a bronchoscopy is less than 4%.4

In addition to the lung lesion(s), the lymph nodes outside the airway—particularly in the hilar region—may be enlarged, indicating infection or advanced malignancy. The nodes can be sampled through mediastinoscopy or bronchoscopy, which involves passing an 18- or 21-gauge aspiration needle through the scope’s working channel (Figure 6 on page 24). The needle punctures the airway wall into the lymph nodes, and a syringe—attached to the proximal end of the needle sheath—aspirates the material, which is then placed on a glass slide and sent for cytologic examination. If cancer is present, this test will help determine staging (extent of spread) of the cancer.

**STAGING OF THE CANCER**

If the lesion is malignant, staging of the cancer in order to determine the best treatment approach is based on three factors: tumor size (T), regional lymph node involvement (N), and extent of metastasis (M).

**Tumor Size Scale**

Tumor size is identified as follows:

- **TX**—no visible lesions on imaging or bronchoscopy
- **T1**—tumors less than 3 cm
- **T2**—tumors greater than 3 cm
- **T3**—tumor is invading the chest wall, heart, great vessels, trachea, esophagus, main carina, vertebral body
- **T4**—tumor involves mediastinum, diaphragm, mediastinal pleura, or a tumor in main-stem bronchus is 2 cm distal to the main carina

**Lymph Node Involvement**

Lymph node involvement—indicated when nodes have enlarged to greater than 1 cm—requires sampling for signs of
metastasis. Node sites are numbered 1 through 9 in the mediastinum and 10 through 13 in the hilum. The staging system for nodes follows:

- **N0**—no involvement of regional nodes
- **N1**—metastasis to ipsilateral peribronchial or hilar nodes
- **N2**—metastasis to ipsilateral mediastinal or cranial nodes
- **N3**—metastasis to contralateral mediastinal or hilar nodes or to any scalene or supraclavicular nodes.

### Extent of Metastasis

The component in the TNM staging system that relates to metastasis is defined as follows:

- **M0**—no metastasis
- **M1**—distant metastasis exists

### Tumor Staging Scale

To develop the following tumor staging scale, various staging calculations from all three categories—T, N, and M—were combined:

- Occult: TX N0 M0
- **Stage I**
  - T1-2 N0 M0
- **Stage II**
  - T1-2 N1 M0
- **Stage IIIA**
  - T3 N0-1 M0
  - T1-3 N2 M0
- **Stage IIIB**
  - T4 N0-2 M0
  - T1-4 N3 M0
- **Stage IV**
  - any T any N M1

### Treatment

#### The Surgical Option

Before surgery, the patient's pulmonary and cardiac status must be evaluated through pulmonary function tests, an electrocardiogram (ECG), and measurement of blood gases. The lesion's size and location must also be considered, as well as the patient's lung capacity, which may not allow for surgical reduction of lung volume. Ultimately, determining the appropriate approach to surgical resection—wedge resection, segmentectomy, lobectomy, or pneumonectomy—hinges on the need to ensure that all of the cancer is removed (providing the lesion is malignant) and the need to preserve the maximum amount of viable lung tissue.

A thoracotomy is performed to resect lung lesions while a lymph node dissection reduces the incidence of metastasis. Benign (endobronchial)
lesions, which have a low rate of recurrence, may be surgically resected using a bronchoscope and the Neodinium Yttrium-Aluminum-Garnett (NdYAG) laser. When resecting a T3 lesion from the parietal pleura, a chest wall resection improves the survival rate. Bronchoplastic procedures can be performed on major airway lesions, thereby preserving the lung parenchyma. Non-small-cell carcinomas—adenocarcinomas, squamous cell carcinomas, and large cell carcinomas—(Stages I and II) also respond well when resected. However, small cell carcinomas, generally considered too aggressive for surgical treatment, respond best to radiation and chemotherapy.

**The Radiation Option**

Patients with an unresectable tumor and those who represent a poor surgical risk are often given external ionizing radiation. Smaller tumors—less than 5 cm—respond to 5,000 rads given in daily doses of 180 to 280 rads. Tumors larger than 5 cm may require as much as 10,000 rads. Side effects of external radiation include esophagitis, bronchitis, and erythema of the skin.

Internal radiation (brachytherapy) can be used on lesions that cannot be resected totally. During surgery, iodine 125 pellets are implanted in the lesion. They radiate a low gamma emission and are therefore considered safe for use in the operating room. Following the resection, another radiation option involves placing catheters in the chest—close to the thoracotomy—and then loading the catheters 1 week later with iridium 192 to be administered in doses of 8,000 to 20,000 rads. Endobronchial lesions can be internally irradiated via a catheter placed bronchoscopically under fluoroscopic guidance. The catheter, which may be removed later through the nose, should be loaded with iridium 192 fo 10 to 15 minutes, thereby generating 1,000 rads. Brachytherapy can be repeated in 2 weeks. Internal radiation may be supplemented with external beam radiation.

**The Chemotherapy Option**

Preoperative chemotherapy has been used experimentally to reduce large (Stage IIIA) non-small-cell tumors to resectable size. Chemotherapeutic agents—usually given in low-dose combinations to reduce toxic side-effects include cisplatin, vindesine, mitomycin C, etoposide, and ifosfamide.

**The Bronchoscopic Laser Option**

Bronchoscopic laser treatment represents another nonsurgical approach for dealing with airway-obstructing tumors. Opening a major airway via laser relieves shortness of breath, allows access for a radiation catheter, and reduces the occurrence of obstructive infection behind the lesion. To accomplish this, an endobronchial stent may be placed to maintain an adequate lumen (Figure 7 on page 25).

Treatment for central-airway occult squamous cell carcinomas involves combining hematoporphyrin derivative (HpD) with an argon-dye laser (630 nm). HpD (2 mg/kg of body weight) is administered intravenously 40 to 50 hours preoperatively. When concentrated in abnormal cells, HpD responds to laser energy—delivered via a fiber passed through a flexible bronchoscope—by destroying cancer cells. Laser power is set at 200 mW for a direct beam and 400 mW for a diffusing fiber. Exposure time is based on the power setting, surface area to be treated, and the total amount of joules to be delivered. Two precautions must be considered when administering laser treatment: Excessive treatment may lead to severe edema in the airway, and laser-treatment patients should be cautioned to avoid sun exposure because their skin may retain sensitivity for 4 to 6 weeks.1 Successful response to laser treatment has been found in 65% to 75% of patients with superficial cancers.

**SURVIVAL RATES**

Long-term survival rates are unfavorable for those diagnosed with metastatic
tumors. However, surgery, radiation, and chemotherapy used in combination can prolong life. Survival rates increased from 12 months in a nonsurgical group to 19 months when treatments, including surgery, were used in combination. Examples of combined therapies include surgical resection to “debulk” a tumor followed by radiation or chemotherapy to control metastasis. Another option is preoperative radiation. However, while radiation may reduce the tumor’s size, it can increase surgical complications. Survival rates by percentage can be found in the box on this page.

**CONCLUSION**

Early detection of lung cancers—long before symptoms appear—optimizes long-term survival. The trend toward noninvasive diagnosis and treatment should reduce morbidity and mortality. Noninvasive devices used to localize cancer at its earliest stage include bronchoscopy, systems that use fluorescence during bronchoscopy, and ultrasound. Mickie Stelck, CST, has 15 years of experience working for the Mayo Clinic in Rochester, Minnesota, at St Mary’s Hospital. She specializes in bronchoscopy and urology. This article received the 2nd-place award in the 1997 AST Writer’s Award contest.

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**REFERENCES**


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