

**Question V.1:** A 54-year-old moderately obese man has been complaining of persistent cough and shortness of breath for the past year. He used to smoke, and has been in excellent health except for occasional esophageal reflux. Eight months ago, pulmonary function tests revealed mild ventilatory obstruction. An unsatisfactory response to inhaled bronchodilators, inhaled corticosteroids, and weight loss program prompted pulmonary consultation. His chest radiograph is normal but suggests a poor inspiratory effort. The patient gags after meals, and his voice has become hoarse. Flexible bronchoscopy reveals the abnormality shown below. Which of the following is the most likely diagnosis?

- A. Tracheal amyloidosis
- B. Tracheal Sarcoidosis
- C. Tracheal lymphoma
- D. Chronic aspiration and gastroesophageal reflux



**Answer V.1:** A

Tracheobronchial amyloidosis is most frequently due to Immunoglobulin or light chain derived amyloid submucosal deposition in and around bronchial glands, connective tissue and blood vessels. Occasionally ossification occurs, simulating tracheopathica osteochondroplastica. The bronchoscopic appearance is usually that of raised, shiny yellowish or pale multifocal submucosal plaques with scattered focal stenoses. Diagnosis is made on deep endobronchial or tracheal biopsies that bleed easily.

Histologic appearance is that of a pale waxy extracellular material deposited in a uniform longitudinal fashion. Specimens have an apple-green birefringence with polarized microscopy when stained with Congo red. Up to 30 percent of patients die as a direct result of their airway disease.

Amyloid deposition is progressive and relentless, involving the trachea, the bronchi, and the larynx. Laser resection is difficult, providing only temporary relief. Stents are of little value over the long term because thickened and inflamed amyloid-infiltrated mucosa continues to grow through or around the stents, as well as distally within segmental airways causing segmental stenosis.

If abnormal serum proteins are noted, systemic amyloidosis should be suspected. Localized tracheobronchial amyloidosis should not be confused with diffuse pulmonary amyloidosis in which patients have diffuse reticulonodular infiltrates on chest radiographs and restrictive ventilatory impairment.

Endobronchial sarcoidosis can appear as hypertrophied pale yellowish raised lesions on the nasal septum or oral pharynx, and in the tracheobronchial tree can cause engorged bronchial mucosal blood vessels with possible lymph node enlargement. Other endoscopic findings include mucosal nodularity, hypervascularity, mucosal edema, and bronchial stenosis. Lymphoma is usually a more focal process that can also cause mucosal hypertrophy. Chronic aspiration and reflux can be suspected when cobblestoning, unilateral mucosal inflammation, and focal bronchial mucosal thickening, erythema and inflammation are noted, but these findings are nonspecific.



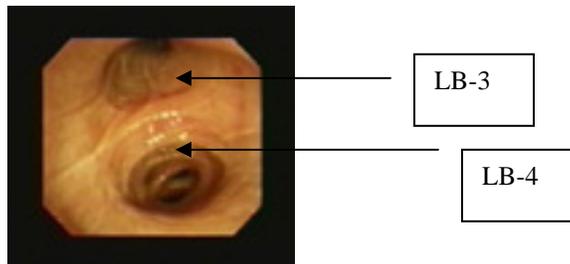
**Question V.2:** A non-English speaking colleague has referred a patient with an obstructing lesion in LB 4. The lesion is in

- A. The anterior basal segment of the right lower lobe.
- B. The superior segment of the left lower lobe.
- C. The anterior segment of the left upper lobe.
- D. The superior segment of the lingula.
- E. The inferior segment of the lingula.

**Answer V.2:** D

LB-4 is the superior segment of the lingual. A secondary carina separates LB-4 from LB-3, which is the anterior segmental bronchus of the left upper lobe upper division bronchus. Numerous nomenclatures have been proposed for bronchial lobar and segmental anatomy. These include those of Jackson and Huber, Boyden, Shinoi, Nagaiishi and Ikeda.

There are small differences in these nomenclatures, particularly for distal anatomy and naming of subsegmental bronchi and beyond. Left is (L), and right is (R). Carinal, lobar, and proximal segmental anatomy nomenclature is relatively constant. Bronchi are classified from 1-10 (1-3 upper lobe, 4-5 middle lobe or lingula, 6-10 lower lobe). A Carina is classified as C-1 or C-2. An airway nomenclature helps bronchoscopists describe extent of neoplastic involvement and sites of early lung cancer, and delineate limits for surgical resection.



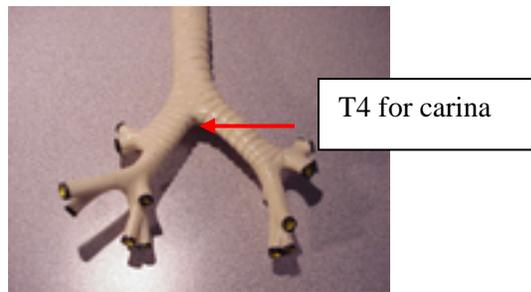
**Question V.3:** Which of the following should be classified as nonsmall cell lung cancer stage T4

- A. A tumor involving the carina and proximal 1 cm of the medial wall of the right main bronchus
- B. A tumor in the main bronchus within 2 cm of the carina, but not involving the carina
- C. A tumor involving the main bronchus 2 cm or more distal to the carina
- D. A tumor less than 3 cm in size within the right upper lobe bronchus but not extending into the main bronchus.

**Answer V.3:** A

A tumor of any size involving the carina is classified as T4. In addition, any tumors involving the pericardium, great blood vessels, and vertebrae are also T4. All T4 lung tumors, regardless of nodal status are automatically classified as stage III B lung cancers. In the absence of distant metastases (M 0). Stage III B also includes tumors that are T1N3, T2N3, and T3N3.

The current recommended treatment of unresectable stage III B nonsmall cell lung cancer is combination chemotherapy and radiation. With combined modality therapy, five-year survival is ten to twenty percent.

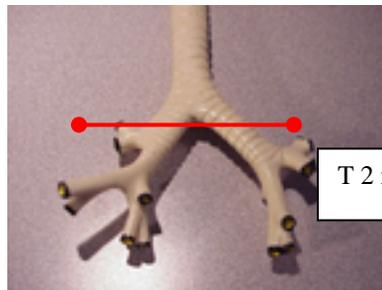


**Question V.4:** Which of the following should be classified as nonsmall cell lung cancer stage T2

- A. A tumor involving the carina and proximal 1 cm of the medial wall of the right main bronchus
- B. A tumor in the main bronchus within 2 cm of the carina, but not involving the carina
- C. A tumor involving the main bronchus 2 or more cm distal to the carina
- D. A tumor less than 3 cm inside the right upper lobe bronchus but not extending into the main bronchus.

**Answer V.4:** C

T2 disease includes tumors that involve the main bronchus 2 cm or more distal to the carina, as well as tumors that are more than 3 cm in dimension, invade the visceral pleura, or are associated with atelectasis or postobstructive pneumonitis that do not involve the entire lung. T2 lesions with N 1 (positive hilar, interlobar, or subsegmental nodes), N 2 (ipsilateral mediastinal paratracheal, aortopulmonary, or subcarinal nodes), or N3 (contralateral hilar, mediastinal, scalene, supraclavicular nodes, or ipsilateral scalene or supraclavicular nodes) are classified as stage as II B, III A and III B respectively.



T 2 more than 2 cm beyond carina)

**Question V.5:** Flexible bronchoscopy reveals obstruction of 90 percent of the cross-sectional area of the right main bronchus by a large, wide-based tumor. The patient is dyspneic. Chest radiographs show a right lower lobe infiltrate. Which of the following bronchoscopic procedures is warranted to restore airway patency and provide immediate symptomatic relief.

- A. Nd:YAG laser resection
- B. Photodynamic therapy
- C. Brachytherapy
- D. Electrocautery
- E. Argon plasma coagulation

**Answer V.5:** A

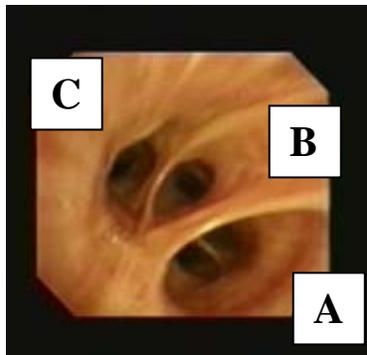
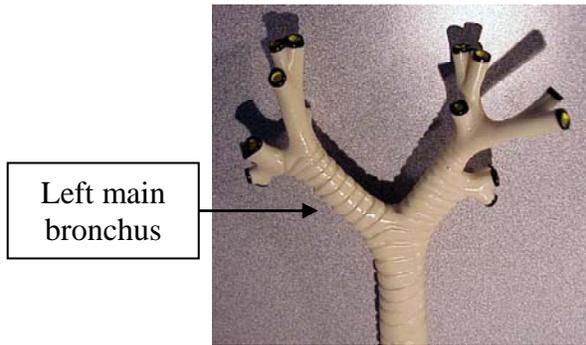
Nd:YAG laser resection can be performed under general anesthesia or using topical anesthetic and conscious sedation. Laser energy is delivered as a 1,064 nm wavelength derived from a Neodymium yttrium-aluminum garnet crystal (Nd:YAG). Tissue effects include photocoagulation and necrosis. Survival benefits have been shown for patients undergoing emergency treatment compared to those receiving external beam radiation alone. Like all bronchoscopic therapies, laser resection does not preclude chemotherapy and external beam radiation therapy.

Symptomatic relief is usually immediate, with improvement in ventilatory flow, symptoms, and quality of life. Nd:YAG laser resection can also be done in addition to other bronchoscopic therapies, including airway stent insertion. In regards to the other modalities listed above, the effect of cryotherapy is not immediate, and usually requires additional intervention in order to remove tissues that became necrotic as a result of freezing.

Brachytherapy does not provide immediate relief. This intraluminal delivery of radiation is usually reserved for patients who have already received maximum doses of external beam radiation. Electrocautery and argon plasma coagulation both can effectively and immediately restore airway patency. In fact, indications are similar to those of Nd:YAG laser resection. However, most experts prefer using Nd:YAG in large bulky tumors because deep coagulation and treatment of bleeding is enhanced. Photodynamic therapy does not provide immediate restoration of airway patency.

**Question V.6** In the Figure below, the letters A, B, and C correspond to which of the following basal segments of the left lower lobe bronchus

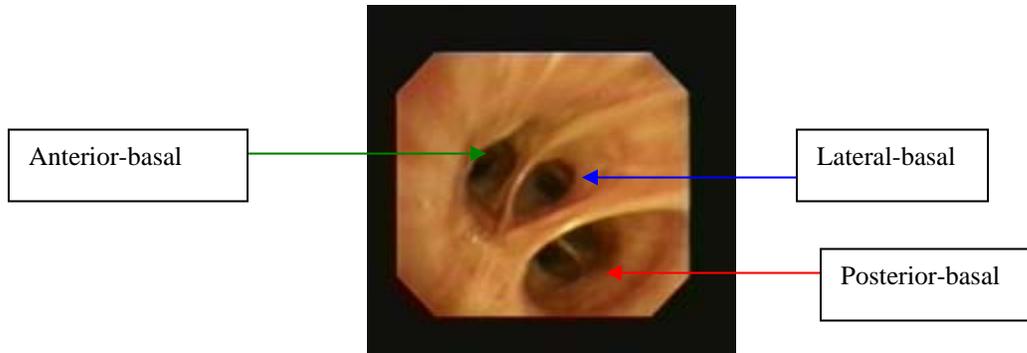
- A. The posterior-basal, lateral-basal, and anterior-basal segments (LB 10, LB 9- LB 8)
- B. The lateral-basal, posterior-basal, and anterior-basal segments (LB 8, LB 10- LB9)
- C. The anterior-basal, lateral-basal, posterior-basal segments (LB 8, LB 9- LB 10)
- D. The lateral-basal, posterior-basal, and anterior-basal segments (LB 9, LB10- LB 8)



**Answer V.6**

**A**

Imagining the interior of the airway as a clock face and using the carina as the central reference point, orientation is possible by identifying the membranous posterior membrane located between 12 o'clock and 3 o'clock. The posterior-basal segment is usually the most medial of all the segments of the left lower lobe. It is therefore located at the 5 o'clock position in this view. The lateral-basal segment (LB 9) lies between the posterior-basal and the anterior-basal segments of the left lower lobe bronchus. Some bronchoscopists call these three basal segments the "basal pyramid". Others refer to them as the "three musketeers".



**Question V.7:** After taking an endobronchial biopsy, the forceps do not close. You try moving the forceps back and forth inside the airway but they still do not close. Your assistant straightens the forceps between the insertion site at the bronchoscope and the forceps handle, but they still do not close. Your next step is to

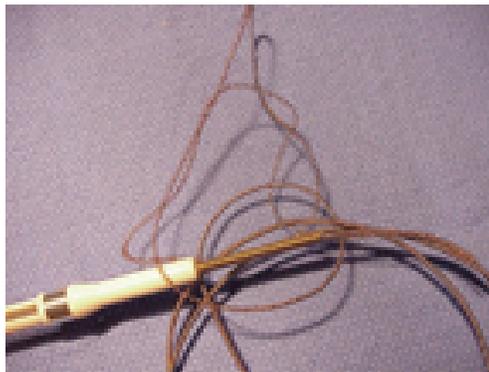
- A. Pull the open forceps back firmly into the working channel to force the cups to close.
- B. Straighten the bronchoscope. Pull the open forceps back to the distal tip of the insertion tube, and remove the scope-forceps ensemble together.
- C. Complain to the forceps manufacturer.

**Answer V.7:** B

The entire ensemble should be gently removed, and the forceps replaced. If it is difficult to pull an instrument back through the working channel of the bronchoscope, it is best to leave it inside and to send everything out for repair, rather than to force an instrument up through the channel by pulling on it strongly (See Figure below of a wire forceps that unraveled when pulled on with force because it would not come up through the working channel). Repair costs can be exorbitant!

There is no need to complain to the manufacturer..they already know that forceps are fragile instruments. They become stuck in the open or closed position easily and they also may break.

Stubborn and persistent force used to close the forceps by ramming them into the working channel of the scope might sometimes be effective, but it is inelegant and can potentially damage the scope. A partially open forceps inside the working channel of a bronchoscope can cause as much damage as a needle.



**Question V.8** Moderate bleeding has occurred during an endobronchial biopsy of a nodule lying in the left main bronchus. The patient was immediately moved into the position shown. This is commonly called the

- A. Fetal position
- B. Trigger position
- C. The safety position
- D. The awkward position



**Answer V.8:** C

The lateral decubitus position, bleeding side down, is commonly called the safety position. Blood pools in the dependent bronchial tree as gravity promotes clot formation. This position protects the contra lateral airway from blood spillage up and over the carina. In addition, blood is easily evacuated from the oropharynx. Because blood does not pool in the hypopharynx and oropharynx, patients do not gag or cough as much. Blood can be removed using a large-bore suction catheter.

The position might seem a bit strange at first for the bronchoscopist, especially when the dependent side is opposite to the ‘working’ space. If necessary, and so long as there is enough leeway between the light source and the patient, the bronchoscopist can ‘change sides’.

The fetal position could be used by the bronchoscopist while sleeping and dreaming about bronchoscopy. The trigger position, also known as chien de fusil in French, or referred to as the plegaria mahometana in Spanish, is the position used by patients with pancreatic disease to diminish their abdominal pain. The awkward position is any position that might be uncomfortable to either the bronchoscopist or the patient!



**Question V.9:** All of the following can be done to increase fluid return during bronchoalveolar lavage except:

- A. Wedging the flexible bronchoscope deep within the bronchus.
- B. Asking the patient to take a deep breath and hold it while instilling fluid and during suctioning.
- C. Instilling aliquots of 20-50 cc only, very slowly. Intermittent or partial suction rather than continuous suction should be applied.
- D. Hang the lavage fluid from an IV pole. Let gravity assist fluid instillation rather than using rapid and forceful instillation with a syringe.
- E. Increase suction to its maximum on the wall outlet control.

**Answer V.9:** E

Bronchoalveolar lavage should be atraumatic and gentle. Excessive coughing should be avoided because it leads to contamination of fluid with blood or mucus, and increases patient discomfort. Warming the lavage fluid to 37 degrees Centigrade may help prevent coughing or bronchospasm, especially in patients with known hyperreactive airways disease.

Careful wedging of the bronchoscope within the lavaged bronchial segment assures that lavage fluid does not spill out past the distal end of the bronchoscope, and avoids contamination with bronchial cells. Levels of suction greater than 50 mm Hg are known to cause distal airway collapse that hinders fluid collection.

**Question V.10:** While performing bronchoscopy in a trauma victim, which of the following might only be noticed by changing patient position, manipulating an indwelling endotracheal tube, or changing inspiratory lung volumes.

- A. Bronchial contusion
- B. Aspirated material
- C. Mucous plugging and thick secretions or blood clots
- D. Ongoing distal hemorrhage secondary to pulmonary contusion
- E. Tracheal or bronchial laceration

**Answer V.10:** E

The most difficult abnormalities to discover during bronchoscopy are lacerations of the trachea or bronchus. Sometimes there is simply a subtle disruption of posterior longitudinal elastic (often referred to as tramlines). Other times the disruption is difficult to see because the space has been filled with a forward-displaced esophagus.

Flexible bronchoscopy is helpful in patients with blunt or sharp chest trauma in order to exclude airway injury. Bronchoscopy is also helpful to treat related problems such as atelectasis by removing blood, foreign bodies, or mucous from the central and peripheral airways. Ongoing distal hemorrhage might require endotracheal intubation or other bronchoscopic therapies including electro coagulation or balloon tamponade.

Airway injury is not always clinically suspected so many practitioners perform bronchoscopy routinely in all cases of blunt chest trauma. Patients with symptoms such as flail chest, pneumothorax, hemothorax, subcutaneous emphysema, pneumomediastinum, stridor, or focal wheezing should undergo bronchoscopic examination.

In order to fully inspect the airways, each and every portion of the tracheobronchial tree, including the subglottis (there can be a tear at the level of the cricoid cartilage for example) should be repeatedly examined.

**Question V.11:** The appearance of the endobronchial abnormality shown in the Figure below is most consistent with

- A. Carcinoid Tumor
- B. Adenoid cystic carcinoma
- C. Squamous papillomatosis
- D. Sarcoma
- E. Lipoma



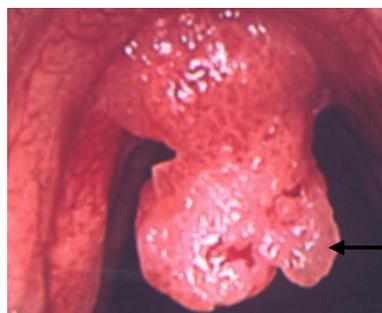
**Answer V.11:** C

Recurrent respiratory papillomatosis is a chronic disease caused by human papilloma virus (HPV). Clinical manifestations range from hoarseness to complete central and peripheral airway obstruction. This disease affects both children and adults, and was first described in the 17<sup>th</sup> century as “warts in the throat”. The most frequent site of occurrence is the vocal cords. Often patients are erroneously treated for asthma for years before diagnosis is made by laryngoscopic or bronchoscopic examination.

Currently reported incidence is 1.8 per 100,000 population. The Recurrent Respiratory Papillomatosis Foundation (RRPF) regularly updates these statistics. Several different HPV subtypes have been identified. Mode of transmission remains unclear, but genital-oral sex has been a proposed mechanism. Disease is recurrent and persistent. Remission is variable and unpredictable.

Proposed treatments include bronchoscopic laser resection, photodynamic therapy, and antiviral therapy. Malignant transformation has been reported.

Carcinoid tumors, adenoid cystic carcinoma, endobronchial sarcomas, and endobronchial lipomas have very distinct appearances. Check out the Bronchoscopy Atlas to learn more!!!



Large papilloma

**Question V.12** All of the following statements regarding chest trauma victims are correct except

- A. Hoarseness, cough, dyspnea, stridor, and hemoptysis should prompt bronchoscopic examination.
- B. Blow out injuries caused by sudden increases in intratracheal pressure usually involve the membranous portion of the trachea.
- C. Shear forces such as those resulting from acceleration-deceleration can “widen” the carina and cause unilateral or bilateral main bronchial injury.
- D. The majority of tracheobronchial lacerations are discovered 2 cm beyond the carina.
- E. Sudden deceleration can cause high tracheal disruption because the trachea is tethered at the cricoid cartilage.

**Answer V.12** D

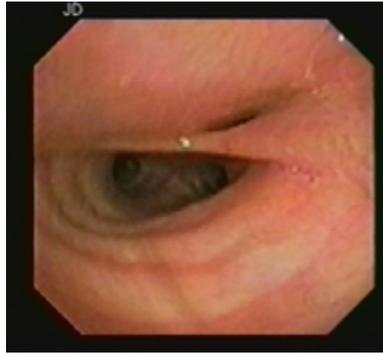
The majority of tracheobronchial injuries are discovered within 2 centimeters of the carina. Injuries include bruising with focal or diffuse mucosal erythema and swelling, partial and total mucosal disruption, intrapulmonary hemorrhage with airway bleeding, tracheal or bronchial laceration with displacement, airway disruption with associated esophageal injury, and foreign body (teeth for example) inhalation.

Knowledge of the mechanism of injury can help the bronchoscopist plan an airway examination. Blunt injuries such as those from direct chest impact during a motor vehicle accident often cause pulmonary contusion with associated interstitial and alveolar hemorrhage or edema.

Trauma victims are at increased risk for acute respiratory distress syndrome. Tracheal or bronchial disruptions may be discovered immediately on arrival to the hospital or later during the course of hospitalization. The bronchoscopic examination must be done carefully. The adage “airway injury is present until I have proven to myself otherwise” is a good rule of thumb.

**Question V.13:** The abnormality shown in the Figure below is most consistent with

- A. Segmental stenosis
- B. Tracheocele
- C. Tracheoesophageal fistula



**Answer V.13:** C

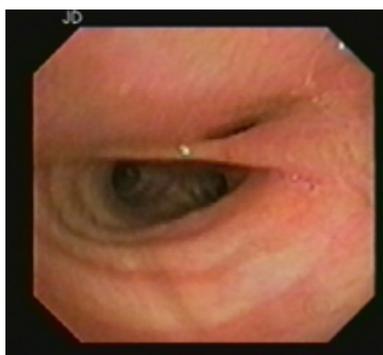
The abnormality shown along the posterior wall of the trachea is an H-fistula in a 30 year old woman who had been erroneously treated for asthma for several years. She reported recurrent episodes of pneumonia and bronchitis with wheezing and shortness of breath. She also had a history of several minor congenital defects, including an esophageal abnormality that required surgical correct shortly after birth.

The H-type fistula is the only congenital tracheoesophageal fistula without esophageal atresia. It comprises about 5-8 percent of all congenital tracheoesophageal fistulas (the most common type is that of complete esophageal atresia with a high blind esophageal pouch and a low tracheoesophageal fistula connecting the lower esophageal portion with the trachea at the level of the carina or left main bronchus).

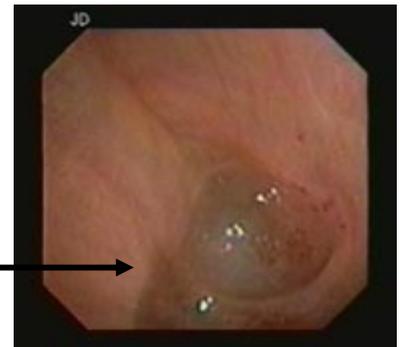
In the H-type fistula, the esophagus is normal except for the high communication with the trachea. Surgical repair of the fistula can leave a blind pouch extending from the trachea, which was the case in this patient. The pouch would regularly fill airway secretions, which would become infected, prompting cough, bronchitis, and wheezing.

Segmental stenosis can occur anywhere along the length of the trachea, and may be funnel-shaped or consistently narrow along its entire length. It may accompany a tracheal bronchus to the right upper lobe bronchus, often arising directly below it.

Tracheoceles are an outpouching of the posterior membranous wall of the trachea, forming a true diverticulum. They are usually the result of structural weakness. Although usually asymptomatic, they can also cause recurrent aspiration pneumonia from retention of secretions.



Blind pouch



**Question V.14:** Which of the following statements about bronchoscopic treatment of benign central airway obstruction is correct.

- A. Procedures are limited to nonsurgical candidates
- B. Metal stents, rather than silicone, are warranted most of the time
- C. Few critically ill patients benefit from intervention
- D. More than one therapeutic attempt is usually necessary
- E. Procedure-related mortality may be as high as two percent

**Answer V.14**            D

Most patients with benign airway strictures require more than one therapeutic bronchoscopy. More than half the strictures treated by dilatation alone will recur. In addition, many patients treated by laser resection alone also recur. When airway stenting is warranted, stents are usually left in place for many months before removal is attempted. This allows a circumferential rim of scar tissue to form around the stent. When the stent is removed, this scar tissue helps maintain a patent airway lumen.

Stent related complications such as stent migration, granulation tissue formation and obstruction by thick secretions might require repeat procedures. These complications have been noted to occur in as many as 20 percent of patients with indwelling airway stents. Most experts agree that silicone stents migrate more frequently than self-expanding metal or hybrid (metal and silicone) stents, but cause less tissue overgrowth.

Although stent-related complications occur frequently, they are very rarely life-threatening. In addition, bronchoscopic therapy (dilatation, laser resection, or stenting) is frequently successful in applying or curing the effects of benign airway stenosis. Therefore, bronchoscopic therapies should probably be considered in patients who are unsatisfactory surgical candidates because of poor respectability or poor operability, in patients who are temporarily too ill to undergo curative surgery, and in those patients who do not desire surgery for personal reasons.

Of course, in expert hands, most benign tracheal strictures can be repaired surgically. However, many expert bronchoscopists believe that bronchoscopic therapies such as dilatation, airway stenting, argon plasma coagulation and electrocautery, and Nd:YAG laser resection should also be considered even if patients are surgical candidates. Procedure related mortality is less than 1 percent. If unsuccessful, surgical management remains possible so long as a potentially permanent foreign body (such as a metal stent) has not been inserted.



Before and during Nd:YAG laser resection of subglottic stenosis

**Question V.15:** You are on your way to the hospital when the emergency department physician calls you on your cellular telephone. She is examining a 28-year-old patient with limited Wegener's granulomatosis. The patient is increasingly short of breath, coughing, and using accessory muscles to breathe. Stridor is audible, and breath sounds are present bilaterally. The patient has a history of airway stent insertion for right main bronchial and tracheal stenosis six months ago. You give the emergency room doctor each of the following instructions **except**.

- A. Place the patient on supplemental oxygen and obtain a slightly over-penetrated chest radiograph.
- B. Respiratory therapy and nursing should be called and asked to prepare for flexible bronchoscopy at the bedside in the emergency department.
- C. Should the patient deteriorate further and immediate intubation become necessary, a # 6 uncuffed single lumen endotracheal tube should be used.
- D. The emergency department staff should immediately set up a percutaneous tracheostomy tray and notify otolaryngology and anesthesia of the situation.
- E. The interventional bronchoscopist should be immediately notified and the operating room should be called in case a bronchoscopic therapeutic procedure becomes necessary.

**Answer V.15**            D

Percutaneous tracheotomy is not warranted and could be hazardous in this patient. Access to the trachea might be prevented because of the tracheal stent. In addition, the condition of the tracheal and bronchial stricture is not known.

All of the other behaviors described are possible warranted. It is most reasonable to provide supplemental oxygen, and to obtain a chest radiograph in order to identify the airway stent and assess the radiographic integrity of the tracheobronchial lumen. It is reasonable to prepare for flexible bronchoscopy in case a procedure needs to be performed urgently to establish an airway.

The interventional bronchoscopist should also be notified in case further intervention is required. In addition, an anesthesiologist with experience in difficult airway management should probably be asked to come to the bedside until the patient is clinically and hemodynamically stable.

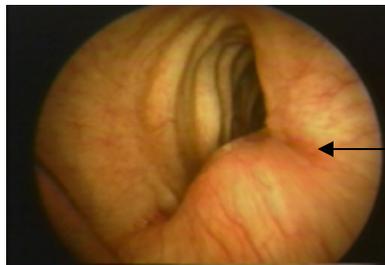
**Question V.16:** All of the following are indications for airway stent insertion **except**

- A. Extrinsic compression of the right main bronchus
- B. Intraluminal disease involving the left main bronchus and distal trachea, associated with extrinsic compression of the left main bronchus.
- C. Benign tracheal stenosis that has recurred two months after laser resection and bronchoscopic dilatation.
- D. Intraluminal tumor involving the right main bronchus
- E. Tracheal-esophageal fistula in a patient with esophageal cancer and persistent cough

**Answer V.16:** D

Patients with intraluminal disease only can usually be treated using bronchoscopic modalities other than stenting. Airway stents, however, have become a necessary adjunct to other bronchoscopic therapies in order to palliate extrinsic compression due to malignant and benign tumors, and to treat airway strictures in patients who refuse curative surgery, are not candidates for surgery because of underlying disease, and in patients who are unresectable because of extent of airway involvement.

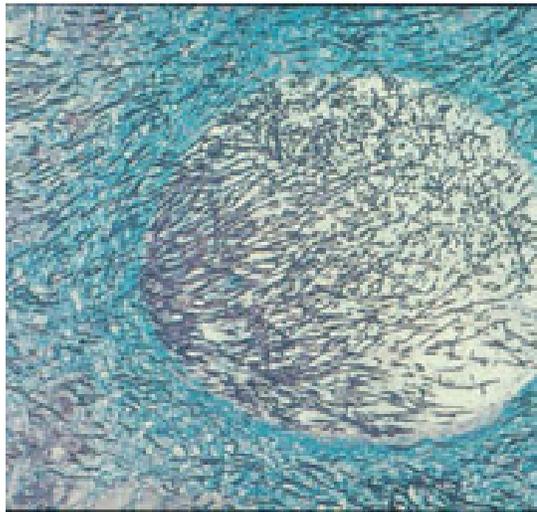
Patients with tracheo-esophageal fistulas can receive airway stents as well as esophageal stents in an effort to palliate symptoms and improve quality of life. Airway stents are made of silicone, metal, or both. They may be self-expanding or require dilatation. Stents can be placed using rigid and flexible bronchoscopy.



Intraluminal bulge in along the posterior and right lateral wall upper trachea caused by esophageal stent in patient with esophageal cancer. An airway stent is warranted if patient has dyspnea.

**Question V.17:** Bronchoscopy is performed four months after unilateral lung transplantation in a patient complaining of increased dyspnea and cough. The anastomotic site is friable, and there is evidence of dehiscence of the bronchial sutures. Thick greenish-yellow secretions are noted, and a felt-like membrane covers the anastomosis site. Fungal stain is shown. Which of the following is most likely.

- A. Tracheobronchial aspergillosis
- B. Tracheobronchial mucormycosis-zygomycosis
- C. Tracheobronchial candidiasis
- D. Tracheobronchial lymphoma



**Answer V.17:** A

Aspergillus species are hyphae with narrow, parallel walls, frequent septa and dichotomous branching at 45-degree angles. Tissue invasion is noted on biopsy when aspergillus infection is tracheobronchial, or invasive. Bronchoscopically, aspergillus infections are suspected when a felt-like membrane is found covering the main stem or parts of the lobar or segmental bronchi.

Greenish-yellow thick exudates such as those seen in the figure below are found overlying an easily friable airway mucosa. Positive sputum or airway secretions, including BAL cultures in patients with severe neutropenia suggest an invasive form of the disease.



Greenish secretions within a bronchus and surrounding a visible nonabsorbable suture in a lung transplant recipient.

**Question V.18** A 50-year-old black woman is referred for increasing shortness of breath, and cough. A course of corticosteroids provided temporary relief but symptoms promptly returned when drugs were stopped. She is a lifelong nonsmoker. Physical examination reveals clear lung fields. Chest radiograph reveals bilateral interstitial infiltrates. There is no adenopathy. Flexible bronchoscopy shows a slightly erythematous granular mucosa with some small raised white lesions. Which of the following is the most likely cause of this patient's disease

- A. Histoplasma capsulatum infection
- B. Mycobacterium tuberculosis infection
- C. Sarcoidosis
- D. Sarcoma
- E. Small cell carcinoma



**Answer V.18:** C

Sarcoidosis remains a diagnosis of exclusion. Sarcoidosis may have several endobronchial appearances, none of which are specific: mucosal nodularity, hypertrophy hyperemia, edema, and bronchial stricture). Small raised whitish lesions can be seen, or mucosa may be granular, firm, erythematous or thickened. Other granulomatous diseases may also have these appearances. Greatest yield for diagnosis is from combined bronchoscopic and endobronchial biopsies. Endobronchial biopsies may contain disease even when the mucosa appears normal bronchoscopically. Transcarinal needle aspiration can also be helpful in patients with mediastinal adenopathy.

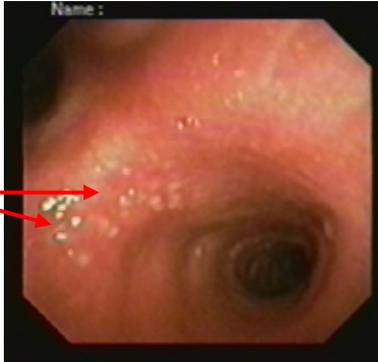
Histoplasma infection would usually appear as a hard, glistening mass with adjacent calcified adenopathy. Mycobacterial infection usually causes chronic strictures. During acute disease, caseous material from enlarged lymph nodes can penetrate through the bronchial wall, but this material is usually soft, gritty and white.

Small cell carcinoma is unlikely in a lifelong nonsmoker (women, and lifelong nonsmokers more frequently have adenocarcinoma). In addition, the bronchoscopic appearance of small cell carcinoma is usually that of an infiltrating mucosal and submucosal abnormality.

Sarcoma usually appears as a rubbery, difficult to grasp endobronchial abnormality. Sometimes, symptoms are not evident until complete bronchial obstruction occurs. The base of an endobronchial sarcoma is usually large. Tumors might extend into the main bronchus from an origin deep within a segmental bronchus. During

bronchoscopic resection tumor must be removed down to their base in order to determine surgical respectability.

Abnormal  
mucosa



**Question V.19:** During bronchoscopy you become rapidly frustrated because of repeated slipping of your cup biopsy forceps off a small endobronchial abnormality located on the lateral wall of the lower lobe bronchus. You could now attempt all of the following **except**.

- A. Switch to a biopsy forceps with a central impaling needle.
- B. Open the biopsy cups and use one cup to “dig” into the lesion. Then close the forceps to obtain the biopsy.
- C. Instruct the patient to hold their breath while you are obtaining the biopsy
- D. Use an alligator forceps instead of a smooth cup forceps.
- E. Twist the insertion tube in order to reorient the direction of the biopsy cups.

**Answer V.19:** E

Rather than twist the insertion tube, which might damage the bronchoscope (and, by the way, is very inelegant), it is wiser to ask the assistant to rotate the handle of the forceps until reorientation of the distal biopsy cups occurs. One can also ask the assistant to hold the bronchoscope where it enters the nose or the mouth so that vertical motion of the bronchoscope is stopped.

Multiple submucosal passes with a bronchoscopic needle can be made to obtain cytology samples. Occasionally, the needle will make holes that are big enough for the biopsy forceps to “latch onto” in order to obtain a deeper submucosal tissue specimen.

Sometimes blood and secretions prevent block the view whenever a forceps is “pushed out” beyond the tip of the bronchoscope. In this case, consider removing the bronchoscope and preloading it with the forceps. The distal end of the forceps should be kept at the distal extremity of the bronchoscope’s working channel, and the ensemble reinserted. This way, when the lesion is approached, the forceps can be advanced without any accompanying secretions or blood coming out from within the working channel.

The toothed forceps (see figure below) will sometimes anchor itself in the lesion, which can then be sampled in depth.



**Question V.20:** After taking an endobronchial biopsy, the video screen shows red. You should

- A. Place the patient into the reverse Trendelenberg position because it is likely a major airway bleed has occurred.
- B. Place the patient into the lateral safety position because mild to moderate bleeding will more easily cease and the contra lateral airway will remain protected.
- C. Place a second pair of nasal prongs on the patient in order to maximize oxygen delivery in case substantial bleeding has occurred.
- D. Irrigate with large amount of saline solution in order to wash away the blood and restore visualization.
- E. Move the bronchoscope proximally into the trachea or contra lateral bronchial tree. Then flex the bending tip in order to wipe the distal lens against the airway wall.

**Answer V.20:** E

All of the proposed answers are correct in regards to response to bleeding. Most frequently, however, bronchoscopy-induced bleeding is slight, and the tip of the flexible bronchoscope is simply covered with a film of blood. This film is best removed by scraping the distal tip of the bronchoscope against the airway wall of a nonbleeding area. The examination can then be resumed.

Should such “red out” recur more than once during the course of an examination, this procedure can be repeated as often as necessary. A small amount of saline instilled through the bronchoscope might also help. Has anyone invented a “bronchoscopic windshield wiper yet”?

**Question V.21:** Maximum yield from bronchoscopic lung biopsy reportedly occurs with which of the following optimal number of specimens.

- A. 1 specimen
- B. 2-3 specimens
- C. 4-6 specimens
- D. More than 6 specimens

**Answer V.21:** C

Results from most studies suggest that at least four biopsy samples are necessary for diagnosis of most illnesses. Yield increases with the number of samples up to 6 samples, but does not increase after that. Of course, if specimens are being sent for culture, additional specimens may be necessary. More samples may also be warranted in lung transplant recipients for diagnosis of lung rejection and other disease processes.

Whether large or smaller sized forceps should be used for tissue retrieval has been controversial. It appears that greater numbers of alveoli per piece of tissue increases the ability to make a diagnosis of infection if tissue is handled properly. There does not appear to be an increased risk of bleeding or pneumothorax based solely on forceps size.

**Question V.22:** What is the reported frequency of pneumothorax after bronchoscopic lung biopsy

- A. Less than 1 %
- B. 1%-4 %
- C. 5%-10%
- D. Greater than 10%

**Answer V.22:** B

The reported incidence of procedure related pneumothorax is 1 %-4 %. Not all of these require chest tube drainage, and not all of these are symptomatic. Conventional wisdom rather than clinical research suggests that fluoroscopic guidance, proper biopsy technique, and careful patient selection help decrease the risk of pneumothorax.



**Question V.24:** The “float sign” is often used to determine whether representative tissues sampled have been obtained after bronchoscopic lung biopsy. Most experts agree that this sign is

- A. Reliable
- B. Unreliable

**Answer V.24:** B

The use of the “float sign”...where a biopsy specimen is seen to float on the surface of liquid fixative because it contains aerated alveoli has been shown to be unreliable in predicting the presence of representative tissue.



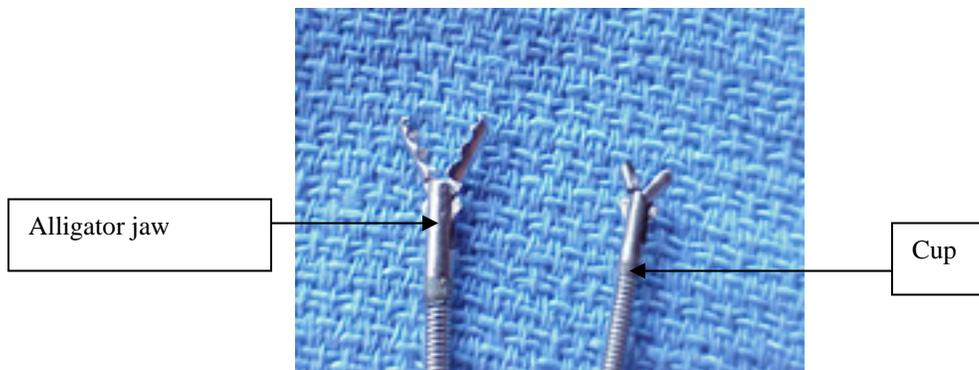
**Question V.25:** Which of the following factors most likely reduces diagnostic yield of forceps bronchoscopic lung biopsy

- A. Use of alligator instead of cup forceps
- B. Use of larger instead of smaller forceps
- C. Unrepresentative tissue specimens or samples that do not contain alveoli
- D. Using cup forceps instead of alligator forceps

**Answer V.25:** C

Most important in achieving a diagnosis is to sample a representative area and to obtain representative tissue. If only bronchial tissue is obtained, the procedure should not be called negative. Rather, one should recognize that the procedure was not diagnostic because nonrepresentative tissue samples were obtained. The procedure should be repeated unless physicians prefer to select a different diagnostic approach.

Although smaller sample size can make histologic interpretation more difficult, most studies have not shown that smaller samples significantly reduce diagnostic yield from bronchoscopic lung biopsy. In fact, at least one study has shown that small cup forceps, which are easily passed into the peripheral subsegmental bronchi, perform better in obtaining alveolar samples than larger alligator forceps. Alligator forceps have a greater tissue-tearing action than a cup forceps, but studies have not shown that the type of forceps blade effects diagnostic yield (See Figure of alligator and cup forceps).



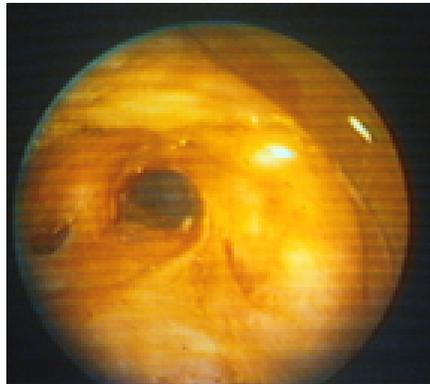
**Question V.26:** Diffuse tracheal narrowing is commonly seen in all of the following illnesses **except**

- A. Relapsing polychondritis
- B. Amyloidosis
- C. Tracheobronchopathia osteochondropastica
- D. Klebsiella rhinoscleromatis
- E. Saber sheath trachea

**Answer V.26:** D

Diffuse narrowing of the entire trachea is seen in all but *Klebsiella rhinoscleromatis* infection (although exceptions may occur!). This disease, which is endemic in parts of Mexico, can also involve the sinuses. Both short and long segments of trachea can be narrowed. Also known as Scleroma, this illness usually causes focal tracheal narrowing in the upper half of the trachea (see figure below).

Often, secretions and airway mucosa have a yellowish color. Scleroma is usually responsive to trimethoprim-sulfa antibiotics. Other diseases that frequently cause strictures in the upper half of the trachea are Wegener's granulomatosis (usually firm erthematous or pale stricture), squamous papillomatosis (single or multiple papillomas easily visible), and viral tracheitis (mucosa red and inflamed).



**Question V.27:** Pulmonary veins are an important danger for an interventional bronchoscopist because

- A. They are very close to the medial and posterior walls of the bronchial tree along the entire length of the middle lobe bronchus, and along the entire lengths of the lower lobe bronchi bilaterally.
- B. Veins bleed more than arteries
- C. They lie anterior to the lower lobe bronchial wall

**Answer V.27:** A

The proximity of the pulmonary veins at the level of the middle lobe bronchus and lower lobe bronchi bilaterally increase the dangers of bronchial wall perforation during bronchoscopic debulking, laser resection, brachytherapy and stenting in these areas. The operating ‘angle’ readily prompts one to work increasingly posterior and medially; thus directly threatening vascular structures such as the pulmonary veins that lie along the medial and posterior walls of the lower lobe bronchi.

**Question V.28**  
Figure below.

How many endobronchial lesions are present and visible in the

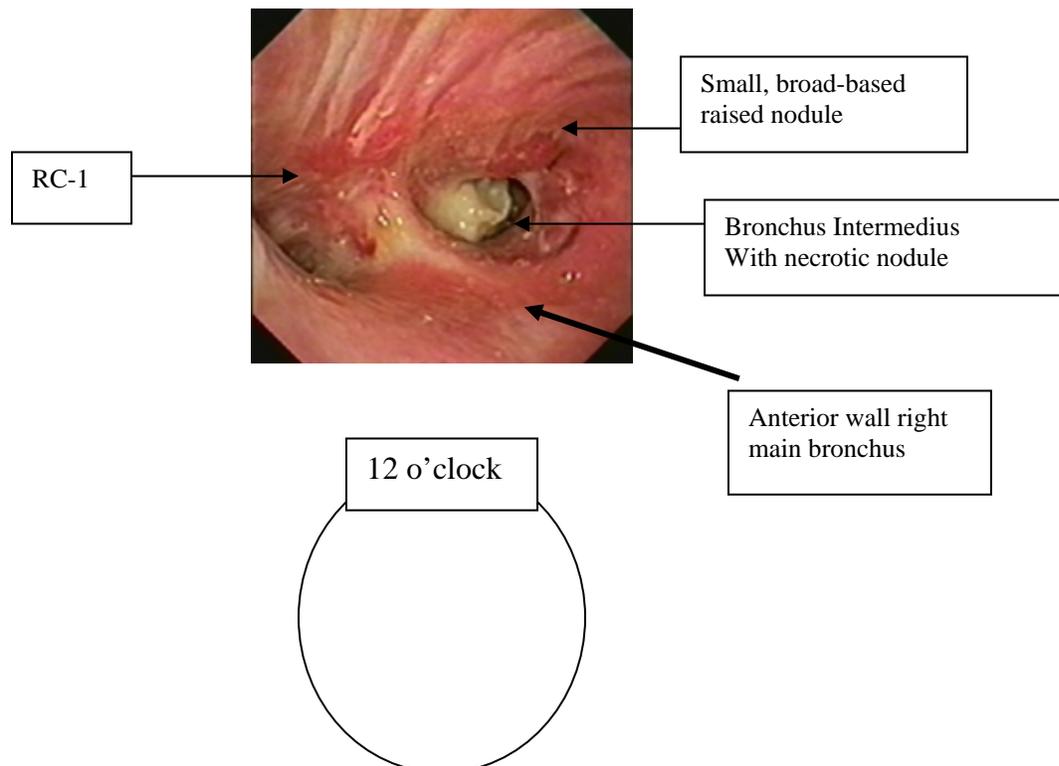
- A. 1
- B. 2
- C. 3



**Answer V.28**

C

Three endobronchial lesions are clearly visible. Imagining the airway as a clock face, and the carina as the central reference point, this is a photo of the right upper lobe bronchus (AT 9 O'CLOCK) and bronchus intermedius (AT 3 O'CLOCK). Bronchial thickening and probably intraepithelial carcinoma are present on the lateral wall of RC-1 at the entrance of the right upper lobe bronchus. The necrotic tumor is obstructing most the bronchus intermedius. In addition, a small, broad-based, raised erythematous nodule is present on the posterior-medial wall of the bronchus intermedius, directly above, but not attached to the white necrotic nodule below.



**Question V.29:** Which of the following “consequences of previous surgical or bronchoscopic therapies” would most likely be visible in a patient who had photodynamic therapy less than one day ago.

- A. Suture dehiscence
- B. Focal stricture
- C. Charring and focal necrosis
- D. Inflammation, swelling and bronchial segmental narrowing
- E. Erythema and edema

**Answer V.29:** E

Photodynamic therapy causes erythema and edema shortly after treatment. This is followed by necrosis and sloughing of “dead” tissues, which requires flexible bronchoscopy for removal. Suture dehiscence can be a sign of local bacterial or fungal infection in patients that have undergone bronchial resection and reanastomosis for lung transplantation, tumor resection, or repair of benign strictures and traumatic injuries. Focal strictures can occur as a result of bronchoscopic therapies, but also following open surgical airway repair. Strictures may be firm or with associated malacia.

Charring and focal necrosis may be seen following laser resection, electrocautery or argon plasma coagulation. Inflammation, swelling and segmental narrowing may be the result of brachytherapy, endobronchial injection of chemotherapeutic agents, resectional modalities, but also of external beam radiation therapy.

**Question V.30:** One French size equals

- A. 0.2 mm
- B. 0.3 mm
- C. 0.4 mm
- D. 0.5 mm

**Answer V.30:** B

One French size corresponds to 0.333 mm, and 1.0 mm corresponds to 3 French. A 5 French balloon catheter, therefore, is about 1.65 mm wide. It is important to know the balloon size of any balloon catheter being used for bronchoscopic therapy. Usually, the deflated balloon size for most catheters is at least 1 French greater than the French size of the catheter itself.

The inflated balloon size is about double the French size of the catheter itself. Therefore, a 5 French catheter would have a deflated balloon measuring approximately 6 French (about 2.0 mm), and an inflated balloon size of about 10 mm.

Using a normal size diagnostic bronchoscope with a working channel diameter of 2.2 mm, a 7 French balloon catheter will not fit easily through the working channel. A 3 French catheter will not have a balloon big enough to fully occlude a proximal segmental bronchus or distal lobar bronchus. A tamponade balloon could be used, but this would oblige the assistant to search for another bronchoscope. Remember that an 8 French catheter will be too large for the working channel of even a larger 2.6 mm working channel bronchoscope.

Hah! And you thought balloon dilatation was easy!