

The Essential Flexible Bronchoscopist

Learning bronchoscopy in the
world today: 2nd edition



Henri Colt MD

THE ESSENTIAL FLEXIBLE BRONCHOSCOPIST

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Laguna Beach, CA

THE ESSENTIAL FLEXIBLE BRONCHOSCOPIST



THE ESSENTIAL FLEXIBLE BRONCHOSCOPIST[®]

The Essential Flexible Bronchoscopist[®] is the first volume of the Essential Bronchoscopist[™], a series of books containing numerous question/answer sets pertaining to the art, science, techniques and overall practice of bronchoscopy. This series attempts to cover major elements of cognitive, affective and experiential knowledge, and technical skill needed to become a competent bronchoscopist. Each volume of the series also serves as a major reading assignment of the Bronchoscopy Education Project, an officially endorsed endeavor striving to create a uniform approach to the teaching, training, and practice of bronchoscopy around the world.

The Essential Flexible Bronchoscopist[®] (EFB) is comprised of six modules, each with a module-specific competency-oriented list of learning objectives. There are a total of 186 multiple choice question sets. These are also viewable on line in several languages (www.Bronchoscopy.org). Information pertains to major topics represented in traditional textbooks of bronchoscopy, including anatomy and airway abnormalities, patient preparation, indications, contraindications, complications, techniques and solutions to technical difficulties, primary and metastatic lung cancer, infections, tracheal stenosis and other airway disorders of benign etiology, anesthesia and moderate sedation, medications, informed consent, patient safety issues, equipment maintenance, history of bronchoscopy, bronchioloalveolar lavage, endobronchial biopsy, washings, brushings, conventional transbronchial needle aspiration, bronchoscopic lung biopsy, and basics of interventional bronchoscopy).

The aim of The Essential Flexible Bronchoscopist[®] is to enhance the learner's progress along the learning curve from novice to competent practitioner. To encourage interactive learning and communication among peers, many question/answer sets are intentionally written so that a correct response is not readily apparent. Sometimes, as in real life, more than one answer may be acceptable to the learner. Other times, the learner or their mentors may disagree with what is written. We hope these differences of opinion and practice will enrich the reader's experience, and serve as a helpful addition to their affective and experiential knowledge base.

At the end of each module is a set of ten post-test questions. These are best answered before moving to the next module. Many of the questions/answer sets of The Essential Flexible Bronchoscopist[®] have been used to design validated tests of bronchoscopic knowledge, and are published in peer-reviewed literature. Other times, questions are used during didactic lectures or as part of pretest-posttest sessions at regional meetings conducted as part of Bronchoscopy International inspired training sessions. None of these questions are meant to serve as high stakes tests, but rather as low-stakes continuing self-learning assessments that help document the progressive acquisition of knowledge needed for the safe and competent practice of bronchoscopy.

Henri G. Colt MD, FCCP, FAWM

The Essential Bronchoscopist[™] Series includes

- The Essential Flexible Bronchoscopist[®]
- The Essential EBUS Bronchoscopist[®]
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The Essential Flexible Bronchoscopist© Second Edition, 2015, revised September 2026

From, The Essential Bronchoscopist Series™

ISBN-13: 978-151-7270896 ISBN-10: 1517270898

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SECOND EDITION

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Henri Colt MD, FCCP, FAWM

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

Funding statement

Funding for The Essential Flexible Bronchoscopist© is a result of Dr. Colt's philanthropic endeavors and from the general support of the University of California, Irvine. No corporate support was either solicited or received for this work.

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Acknowledgements

This book would not have been possible without the support of many friends and colleagues from around the world, who not only assure its inclusion in numerous training programs, but also translations into more than a dozen languages. My appreciation particularly to Silvia Quadrelli, Eric Edell, Septimiu Murgu, Patricia Vujacich, Pyng Lee, Norihiko Ikeda, Shiyue Li, Jean-Michel Vergnon, Maria Simon, Grigoris Stratakos, Mauro Zamboni, Omer Elhag, Zsolt Papai, and dozens of other physicians who promote our philosophy of an “education without borders.” Thank you.

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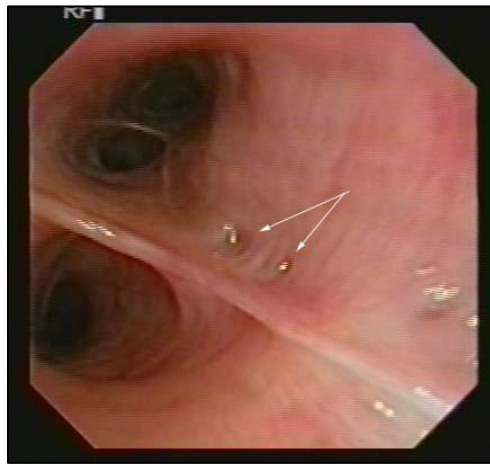
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MODULE I

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE I

Welcome to Module I of The Essential Flexible Bronchoscope, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this Module I, the learner should be able to:

1. List three figures important to the history of bronchoscopy.
2. Describe the “ideal” prebronchoscopy patient assessment.
3. List at least FOUR instances in which flexible bronchoscopy are of limited value.
4. Describe at least THREE scenarios of a difficult airway, and solve their specific management problems.
5. Define flexion, extension, and rotation of the flexible bronchoscope.
6. Identify major upper airway anatomy.
7. Compare ester and amide topical anesthetics.
8. Describe at least THREE effects of flexible bronchoscopy on cardiovascular hemodynamics.
9. List the names of abnormal and normal trachea shapes.
10. Define the terms “resolution” and “radiation exposure”.

Question I.1: The first flexible bronchoscope was introduced to the world in

- A. Freiberg, Germany
- B. Copenhagen, Denmark
- C. Philadelphia, PA

Answer I.1: B

Shigeto Ikeda, of Tokyo Japan introduced the first flexible fiberoptic bronchoscope at the Ninth International Congress on Diseases of the Chest held in Copenhagen in 1966. Freiberg is an important city for the history of bronchoscopy because it is the mother city of Gustav Killian (1860-1921), often called the father of bronchoscopy. Chevalier Jackson, the famous North American Otorhinolaryngologist, was from Philadelphia, where he produced a rigid bronchoscope with a distal illuminating tip in 1904.

Question I.2: Flexible fiberoptic bronchoscopy resides on the principle that light can be transmitted through glass fibers. This discovery is credited to

- A. Baird and Hansell
- B. Heel and O'Brien.
- C. Hopkins and Kapany



Answer I.2: A

In 1927-1930, Baird (an Englishman) and Hansell (a North American) proposed that optical properties of glass fibers could be utilized. Heel (from Holland) and O'Brien (from the United States) developed cladding glass; the technique used to insulate and coat each light-transmitting optical glass fiber so that light could be transmitted through the fiber even if it were twisted and bent. Hopkins and Kapany (both from Great Britain) developed the optically arranged fiber bundle and are thus credited with the introduction of the word "fiberscope".

Question I.3: Which of the following should be addressed during a consultation for bronchoscopy

- A. Analyze the request for bronchoscopy and justify the indication
- B. Review history and physical and pertinent radiographic images
- C. Formulate a prebronchoscopy plan with consideration to all bronchoscopic and nonbronchoscopic procedures needed to maximize diagnostic yield or therapeutic success
- D. Discuss patient safety issues, comfort, and informed consent
- E. All of the above

Answer I.3: E

Bronchoscopy is a minimally invasive procedure, but an invasive procedure nevertheless. Every indication for bronchoscopy must be justified, and alternatives means (invasive and noninvasive) for diagnosis or treatment should always be considered. Bronchoscopy can also be a very costly procedure. Use of accessory instruments, specimen processing, and time in the hospital, and consequences of potential procedure-related complications further increase the cost. If possible, everything should be done so that diagnostic yield is maximized and diagnosis is obtained from a single (and not repeated) procedure.

For example, if bronchoscopic inspection reveals no airway abnormalities, the bronchoscopist should be ready to perform transbronchoscopic sampling. In this case, yield might be increased if radiographic guidance is used, and is definitely increased if cytopathologic analysis is performed on-site. Informed consent is ethically justified because patients “have a right to know”, and has become mandatory in an increasing number of countries.

Question I.4: All of the following should be routinely obtained prior to performing flexible bronchoscopy **except**

- A. Chest radiograph
- B. Platelet count
- C. Physical examination with special attention to heart and lung examination
- D. Allergy history and history and procedure-related adverse events
- E. Review of potential risk factors

Answer I.4: B

Surveys performed by the American College of Chest Physicians and the American Association for Bronchology show that the number of laboratory tests routinely obtained prior to performing bronchoscopy are decreasing. Flexible bronchoscopy is very safe. In the absence of risk factors, complications such as bleeding are rare. Not all patients need to have platelet counts. In fact, in severely thrombocytopenic patients, flexible bronchoscopy with bronchoalveolar lavage has proven safety even when the scope is inserted nasally. Increasingly, experts advocate that platelet counts be obtained only in patients with a history and physical suggestive of a bleeding or coagulation disorder and undergoing endobronchial or bronchoscopic lung biopsies.

Question I.5: According to American Thoracic Society guidelines, which of the following is an absolute contraindication to flexible bronchoscopy:

- A. Patient with unstable asthma or status asthmaticus.
- B. Patient with refractory hypoxemia or inadequate oxygenation during the procedure.
- C. Recent or unstable angina or recent myocardial infarction.
- D. Severe hypercarbia and significantly reduced forced expiratory volume in one second.
- E. Superior vena cava obstruction.

Answer I.5: B

It is wiser to postpone or defer a procedure if patients are severely hypoxemic. Bronchoscopy itself causes a fall in oxygen saturation. In addition, every procedure-related complication causes hypoxemia. It is true that sometimes, “a bronchoscopist must be lucky”, but what if it is not your or the patient’s lucky day. The risks of the procedure, including potential need for intubation and mechanical ventilation should be carefully explained to critical patients and to their families. One good question to always ask is “will the results of this procedure alter medical management”? If the answer is “no”, it is wiser to postpone the procedure.

Bronchoscopy has repeatedly been shown to be an extremely safe procedure. The patient trusts your judgment. Your “contract” is with the patient. Curiosity about the disease, outcome, or a macho attitude that ‘I can do this’ are nice, but in the grand scheme of medical ethics and morality, have no place here. Now, after that short editorial comment, back to the question... The American Thoracic Society has listed only four contraindications to bronchoscopy. These are absence of informed consent, operator inexperience, inadequate facilities, and inability to assure adequate oxygenation during the procedure. Prolonged hypoxemia during the procedure can lead to cardiac arrhythmias, myocardial infarction, mental status changes, and respiratory failure. In fact, some experts suggest that uncorrectable hypoxemia, hypertension, or elevated intracranial pressures are relative contraindications to bronchoscopy. Any procedure-related event such as bleeding or post-lavage related hypoxemia can increase or prolong a hypoxemic episode. Textbooks state that bronchoscopy is less safe in patients with recent or unstable angina, hypercarbia, superior vena cava obstruction, and unstable asthma, as well as in patients with uremia, pulmonary hypertension, and advanced age. Specific data regarding this “increased risk” are controversial.

Question I.6 Originally, the flexible bronchoscope was designed to be held as shown in the Figure below. A reason for this is

- A. The operator must always stand behind the patient; therefore it is best for the control section to be held in the left hand.
- B. Dr. Ikeda, original designer of the flexible bronchoscope, was left-handed.
- C. The operator must always stand to the right of the patient; therefore, it is best for the control section to be held in the left hand so that the bronchoscopist's right hand can be closest to the patient.
- D. The operator must always stand to the left of the patient; therefore, it is best for the control section to be held in the left hand so that the bronchoscopist's right hand can be closest to the patient.



Answer I. 6 B

The originator of the scope was left-handed! It really does not matter where one stands while performing flexible bronchoscopy. The scope can be held in either the left or the right hand, depending on personal comfort, teacher biases, and where one places one's assistants.

If held in the right hand (as shown in the Figure and standing at the supine patient's right, the free left hand is closest to the patient's head, and comfortably holds the scope at the insertion site.

Similarly, if the bronchoscopist were standing to the patient's left, a scope held in the left hand would allow the free right hand to be closest to the patient's head.



Question I.7 Maximum flexion of the distal bending tip of the flexible bronchoscope is obtained by which of the following

- A. Moving the thumb upwards
- B. Moving the thumb downwards

Answer I.7 B

Moving the thumb downwards will flex the bending tip maximally. Forceps or other instruments should never be advanced forcefully through a maximally flexed bronchoscope because this risks tearing the working channel. Maximum flexion may be necessary to enter the apical segments of the upper lobes, but is otherwise rarely needed because simple turning of the wrist will satisfactorily guide most movements of the bronchoscope.

The flexion-extension movement is particularly useful in order to examine first the middle lobe bronchus (slight flexion), then the superior segmental bronchus of the right lower lobe (slight extension), without moving the bronchoscope.



Question I.8: Each of the following is considered “poor technique” when handling a flexible bronchoscope **except**

- A. Twisting the insertion tube rather than rotating the entire instrument along its entire longitudinal axis.
- B. Advancing the bronchoscope by pushing down from the handle.
- C. Exerting excessive pressure with one’s fingers on the patient’s nostril or cheek.
- D. Attempting to pass an instrument through a fully flexed distal extremity of the bronchoscope
- E. Keeping the bronchoscope “in the midline” of the airway lumen throughout as much of the procedure as possible.

Answer I.8: E

“Stay in the middle” is a favorite phrase of several teachers of bronchoscopy. This provides the bronchoscopist greater visibility inside the airway and avoids unnecessary mucosal trauma, minimizes gagging, deglutition, and cough, and maximizes flexion and extension capabilities. Twisting the insertion cord is inelegant and can damage the fragile fibers of either a fiberoptic or videobronchoscope.

Exerting excessive pressure onto the patient’s nostril with the hand holding the distal extremity of insertion cord causes patient discomfort. One might cause nasal trauma and bleeding, insert one’s gloved finger into the patient’s eye, lacerate the former of the patient’s lip, or dislodge a loose tooth. Attempting to forcefully pass an instrument such as a forceps through the fully flexed distal extremity of the bronchoscope is a big “no no”, because of the great risk of damaging the working channel of the bronchoscope.

Advancing the bronchoscope by pushing down on the handle causes excessive bending of the instrument proximally. This prompts the bronchoscopist to bend over at the shoulders, which is very poor posture, and over time and hundreds of bronchoscopies can cause backache. In addition, it will be more difficult and potentially harmful to the bronchoscope to insert instruments through the working channel. This is especially the case for transbronchial needles! It is more elegant to lean back slightly, straightening the shoulders, and to straighten the insertion cord of the bronchoscope by stepping a bit away from the patient. The bronchoscope is advanced by moving the entire ensemble (insertion cord and control section).

Ideally, the bronchoscope can be advanced as the patient inhales, and, if necessary, pulled back when the patient exhales. Thus, the bronchoscopist, the bronchoscope, and the patient remain “in harmony” throughout the procedure.

Question I.9: Sensory anesthesia from the epiglottis to the vocal cords is obtained by numbing which of the following.

- A. The Sphenopalatine nerve fibers
- B. The Glossopharyngeal nerve
- C. The Recurrent laryngeal nerve
- D. The Superior laryngeal nerve
- E. The second (maxillary) division of the trigeminal nerve

Answer I.9: D

Anesthesia of the superior laryngeal nerve results in blocking sensory innervation to the base of the tongue, epiglottis, periform fossa, and valleculae. This is usually satisfactory after administration of nebulized topical anesthetic. The Glossopharyngeal nerve innervates the posterior third of the tongue, the tonsillar region and the oropharynx. A bilateral glossopharyngeal nerve block (performed by injection behind each posterior tonsillar pillar) can be used to completely abolish the gag reflex in selected patients. This can result in sudden respiratory compromise from rapid paralysis of the pharyngeal muscles and the base of the tongue.

Bilateral nasal administration of anesthetic provides partial posterior pharyngeal anesthesia by affecting the Sphenopalatine nerve fibers. The recurrent laryngeal nerve supplies sensory and motor innervation of the intrinsic muscles of the larynx. The second division of the trigeminal nerve supplies much of the sensory innervation to the nasal mucosa.

Question I.10: All of the following are responsible for a difficult or painful insertion of the flexible bronchoscope through the nasopharynx and oropharynx **except**.

- A. Swelling of nasal mucosal membranes
- B. Septum deviation
- C. Nasal polyps
- D. Hypertrophy of the nasal turbinates
- E. Enlarged adenoids

Answer I.10: E

Swelling of the mucosal membranes can often be reduced through application of cocaine (using small cotton pledgets) and other vasoconstrictors (Lidocaine with epinephrine), which help to increase the diameter of the nasal passage and decrease the incidence of bleeding. If swollen membranes are noted, patients should be warned that they might experience discomfort during passage of the bronchoscope. Sufficient amounts of lubrication and topical anesthetic should be applied.

Patients with a deviated nasal septum, nasal polyps, and turbinate hypertrophy may also experience discomfort during nasal insertion of the flexible bronchoscope. Satisfactory anesthesia should be administered topically, and the bronchoscopist should not hesitate to attempt insertion in the contra lateral side. Repeated unsuccessful attempts should be avoided because of increased patient discomfort, risk for bleeding, and patient loss of confidence (bronchoscopy assistants don't like watching this either). It is preferable to change to a transoral approach.

Enlarged adenoid tissue (also known as the nasopharyngeal tonsils) in the mucous membrane of the posterior wall of the nasopharynx can cause partial airway obstruction that prevents nasopharyngeal insertion of an endotracheal tube, but usually does not prevent insertion of the flexible bronchoscope.

Question I.11: Which of the following topical anesthetics should be used in a patient who has just informed you of a severe allergic reaction to Novocaine during a recent visit to the dentist.

- A. Lidocaine
- B. Benzocaine
- C. Tetracaine
- D. Cocaine
- E. All of the above

Answer I.11: A

There are two families of topical anesthetics; these are the Amides: Bupivacaine (Marcaine), Lidocaine (Xylocaine), Mepivacaine (Carbocaine), Ropivacaine (Naropin), and the Esters: Procaine (Novocaine), Cocaine, and Benzocaine, and Tetracaine (Pontocaine). One way to remember which drugs belong to which family, is to remember that drugs spelled with one “i” are Esters, whereas those spelled with two (ii) are Amides.

Allergic reactions (usually rash, urticaria, laryngeal edema, or bronchospasm) as well as anaphylaxis are common within a same family, but much less frequent between families. If a patient reports allergy to a drug belonging to one family, anesthesia using a drug from another family is usually safe. However, preservatives used in the manufacture of these drugs can have cross reactivities. Allergy can therefore occur when using different drugs, especially within the Ester class.

Because some preservatives are structurally similar to the allergen para-aminobenzoic acid (PABA), many allergic reactions are caused by antibody response to the preservative and not to the local anesthetic agent. Local anesthetics of the Ester class have metabolites related to PABA, and are therefore most likely to cause allergic reactions. If a patient has had an allergic reaction to a drug of the Ester class of local anesthetics, it is almost always safe to administer a drug from the Amide class. Some pharmacies carry “preservative free” drug preparations. True lidocaine allergies are extremely rare, and often the “allergic” reaction is actually an adverse response to epinephrine or phenylneprine contained in the preparation. Allergic reactions and drug-related complications can be prevented by (1) always asking patients about medication allergies before performing the procedure, (2) using the least amount of anesthetic possible, especially in elderly patients or in those with significant comorbidities, (3) watching for drug reactions and adverse effects.

Question I.12: What is the official and commonly accepted name for the epiglottis shown.

- A. Omega or infantile epiglottitis
- B. Horseshoe epiglottitis
- C. U-shaped epiglottitis
- D. Normal appearing epiglottitis

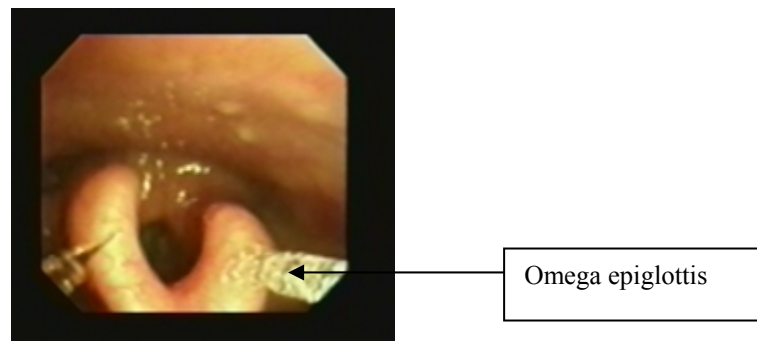
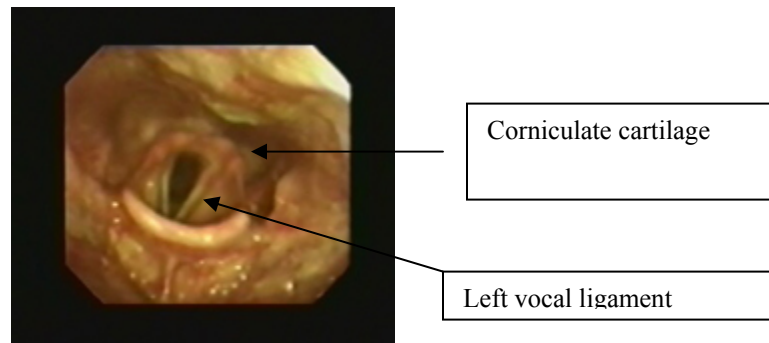


Answer I.12: D

This is a normal appearing epiglottis. In the adult male, the larynx is 5-7 cm in length and lies opposite the 4th, 5th, and 6th cervical vertebrae. It is usually shorter and smaller in women. The inferior margin of the cricoid cartilage is the most inferior portion of the larynx. The cricoid is the narrowest portion of the airway in children (whereas the glottic opening, or rima glottidis, is the most narrow portion of the upper airway in adults).

Two arytenoid cartilages are pyramid-shaped and articulate with the superior margin of the cricoid cartilage. On their superior aspects are the corniculate cartilages. True vocal cords, also called vocal ligaments, are attached posterior to the base of the arytenoids cartilages, whereas the false vocal cords, also known as vestibular ligaments, are attached higher on the vertical walls of the arytenoids.

The epiglottic cartilage is a single cartilage lying behind the base of the tongue. The epiglottic cartilage is attached to the tongue by a median and two lateral glossoepiglottic folds. The depressions between the lateral and median folds are called the valleculae. In children and in some adults, the epiglottis is elongated and curved. This is called an infantile, elongated, or omega epiglottis.



Question I.13: You have been asked to develop a bronchoscopy service in your hospital. You recognize that your success, income, and future hospital funding depends on clinical activity. You also recognize that declining to perform a procedure may not be conducive to your ambitions. You have spoken with several colleagues who have been in similar situations. One way to build and maintain a busy service and perform bronchoscopy in virtually every patient referred to you is to say that

- A. Bronchoscopy is justified “in anyone who has an airway”
- B. Bronchoscopy is justified in anyone with an abnormal chest radiograph.
- C. Bronchoscopy is justified because you are working in a training program
- D. Bronchoscopy is justified in order to avoid litigation
- E. Bronchoscopy is justified in order to keep the referring physician happy

Answer I.13: E

None of the above responses are ethically, morally, or medically justified. Were you uncertain, and, in doubt, answered the “lesser evil” E? To say that bronchoscopy is performed to keep the referring physician happy, even if the indication is unclear, is perhaps the most tenable position for one’s conscience, although not necessarily morally appropriate. Sometimes, a person might additionally justify this action on the grounds that bronchoscopy is safe and provides minimal or no discomfort for the patient. However, no person would want a surgeon to operate if it were not medically indicated and justifiable. The same holds true for minimally invasive procedures.

Although there are no scientific studies of this question, all of the above responses have been heard either jokingly or seriously in bronchoscopy circles. It is the bronchoscopist’s moral and ethical responsibility to provide a service when it is medically indicated and to help educate other health professionals about the indications for bronchoscopy, potential dangers, and about alternative procedures even if it means referral to other physicians.

In a training program, computer simulation, case studies, didactic teaching, guided reading, and video rounds can help trainees learn appropriate and justifiable indications for each procedure they perform or might perform in the future. If bronchoscopy is being performed for other reasons, such as to avoid possible litigation, or “because the patient wants to be certain that a diagnosis of cancer has been excluded”, trainees should be allowed to witness the conversation between the bronchoscopist and the patient so that misperceptions and misunderstandings about the medical justifications for the procedure are avoided.

Question I.14: All the following statements regarding the effects of flexible bronchoscopy on cardiovascular hemodynamics are correct **except**

- A. Flexible bronchoscopy increases oxygen consumption ($\dot{V}O_2$), decreases mixed venous oxygen (SvO_2), and oxygen delivery ($\dot{D}O_2$) remains unchanged.
- B. Flexible bronchoscopy increases cardiac index (CI) by at least 10-15 percent.
- C. Flexible bronchoscopy increases heart rate, and correlations have been noted between presence of arrhythmias and depth of oxygen desaturation, but not with presence of cardiovascular disease or chronic obstructive pulmonary disease.
- D. Known coronary artery disease does not appear to increase the frequency of bronchoscopy-related cardiac ischemic events as long as precautions are taken (use of supplemental oxygen, judicious use of sedation, rapid procedure performance).
- E. Impact of flexible bronchoscopy on cardiovascular function and oxygen saturation ends when the bronchoscope is removed from the airways.

Answer I.14: E

The impact of flexible bronchoscopy on cardiovascular function and oxygen saturation persists for several minutes, and, as in the case of oxygen desaturation, for several hours after the bronchoscope is removed from the airways. Most studies of the hemodynamic effects of bronchoscopy have been performed in critically ill, mechanically ventilated patients, and very little has actually been done in the awake nonintubated patient.

The effects of procedure duration and patient position have not been thoroughly examined. Potential concomitant factors that can potentially alter hemodynamic effects are underlying disease status, medication use, and conscious sedation.

Question I.15: When referring to digital photography, video imaging, television, or fluoroscopic image intensifiers, the term “resolution” is defined as

- A. Number of pixels per square centimeter
- B. Number of lines per inch or line pairs per millimeter
- C. Brightness of an image on screen
- D. Sharpness of an image on screen

Answer I.15: B

Resolution is defined as the number of lines per inch or line pairs per millimeter. In general, picture resolution is often referred to when describing the quality of an image. For fluoroscopic image intensifiers resolution is usually best in the center of the screen, where the image is also brighter and has less geometric distortion. For television and video, resolution can depend on the type of equipment used and design refinements. For example, a television receiver can generally reproduce 320 vertical black and white stripes, whereas more advanced designs can resolve over 560 lines.

A typical VHS (Video Home System) video recorder resolves about 250 lines, and an S-VHS (Separate, or Super VHS) recorder about 400 lines. In digital photography, resolution refers to the number of pixels per *linear* inch (ppi) in an image. A resolution of 72 ppi therefore, means there are 72 pixels horizontally and 72 pixels vertically, or 5,184 pixels for each square inch of image. With fewer pixels, more detail will be lost.

Question I.16: When using a fluoroscopy C-arm, radiation exposure rates to the patient are higher when

- A. The x-ray tube is closer to the table top
- B. The x-ray tube is farther from the table top
- C. X-ray tube to table distance is irrelevant

Answer I.16: A

Radiation exposure rates are measured at the tabletop. They are excessively large if the x-ray tube, which is a standard rotating anode tube operated at currents that are much lower than those used in radiography, is closer than 12 inches (approximately 30 cm) to the table top. Shutters in the x-ray tube allow the operator to regulate the size and shape of the x-ray beam.



Question I.17: Which of the following statements pertaining to bronchoscopy-related complications is least likely to be justified by anecdotal experience or clinical studies.

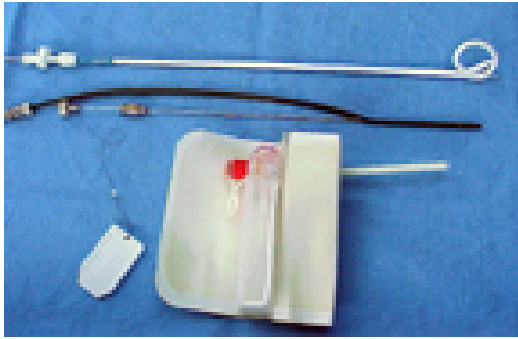
- A. Fever and chills may occur as late as 6-8 hours after bronchoscopy.
- B. Transient pulmonary infiltrates secondary to saline retention after bronchoalveolar lavage should be in the differential diagnosis of any patient with new or increased pulmonary infiltrates.
- C. Continuous suction during bronchoscopy can reduce tidal volume and exacerbate preexisting hypoxemia.
- D. Most bronchoscopy-related pneumothoraces occur several hours after the procedure.
- E. The addition of conscious sedation can increase the likelihood of post-procedure hypoxemia or respiratory insufficiency

Answer I.17: D

Most experts agree that the true incidence of bronchoscopy-related pneumothorax may not be known, although pneumothorax usually occurs during or immediately after bronchoscopy and bronchoscopic lung biopsy. This justifies chest radiographs or fluoroscopic examination within two hours after biopsies are taken, especially if patients are symptomatic. Late pneumothorax has been reported, but is very rare. Regardless, patients should be instructed to call their health care provider or go to the nearest emergency room for a chest radiograph in case of new-onset or increased shortness of breath or pain during the first 24 hours after a bronchoscopic lung biopsy.

When bronchoscopy-related pneumothorax occurs, it is often small. If the patient has symptoms, or if the pneumothorax increases on subsequent chest radiographs, drainage using a small-bore chest tube or simple aspiration is warranted. Many patients can be sent home with an indwelling chest tube and one-way valve if clinically stable. Indications for hospitalization should be individualized. Chest tubes should be available in every bronchoscopy procedure cart because in very rare instances, emergency chest tube insertion may be necessary and therefore life-saving.

The other possible responses have been documented by various investigators. The possible occurrence of fever or chills prompts many bronchoscopists to suggest use of acetaminophen as needed post procedure. Transient pulmonary infiltrates can be seen on chest radiograph or computed tomography scans, and should not be misinterpreted as new infection. Continuous suction has been shown to reduce tidal volumes, and obviously excessive sedation increases the risk for respiratory insufficiency, and in some cases, might even prompt bronchoscopists to electively intubate patients prior to procedure performance.



Van Sonnenberg, Cook, and TruClose chest tubes for small iatrogenic pneumothoraces

Question I.18

The abnormality shown in the Figure below is on the

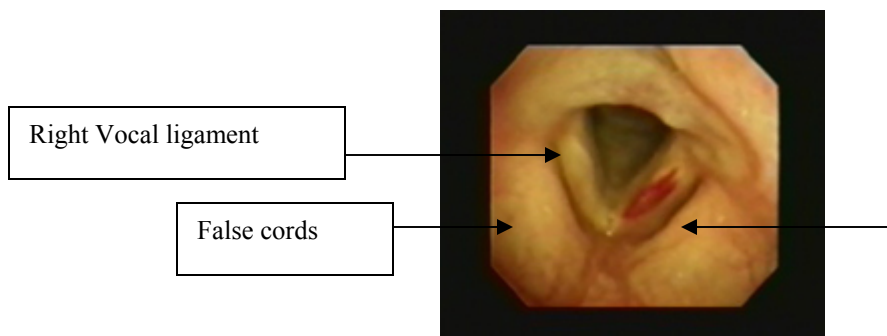
- A. Left vocal cord
- B. Right vocal cord
- C. Epiglottis
- D. Arytenoids



Answer I.18

A

This ecchymosis of the left vocal cord is the result of an unsuccessful attempt to pass the flexible bronchoscope past the vocal cords into the trachea. The Epiglottis is not visible in the photograph. Both cords are well seen, and both the anterior (point of the V), and posterior (wide commissures of the larynx) are visualized. The arytenoid cartilages (which are not visible in the photograph) are at either end of the wide base of the V.



Question I.19 The larynx seen in the Figure below is from an adult

- A. Man
- B. Woman
- C. Horse

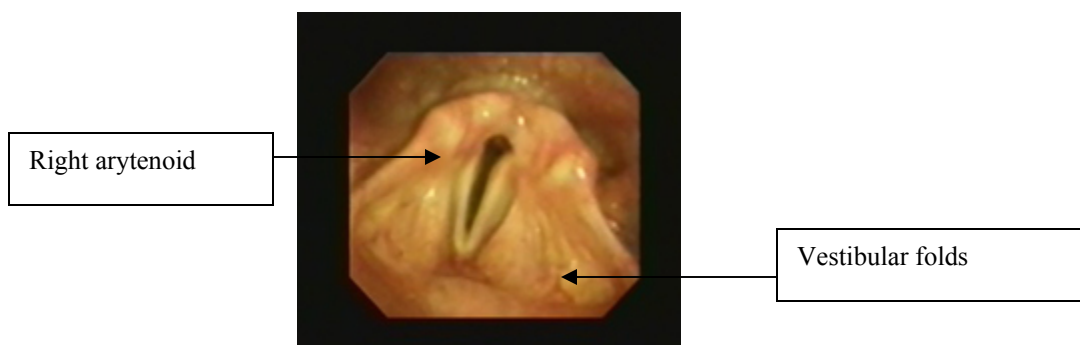


Answer I.19 B

The larynx shown belongs to a woman. The triangular-shaped anterior aspect of the “rima glottidis (the middle space between the vocal cords)” is well visualized. A man’s vocal folds are usually thicker than a woman’s, and in full abduction noticed if the patient is asked to inhale deeply; the man’s glottic opening is larger (on average about 19 mm). An adult woman’s glottis is usually smaller than that of a man (on average a woman’s rima glottidis is 12 mm in diameter with maximum abduction of the white vocal folds).

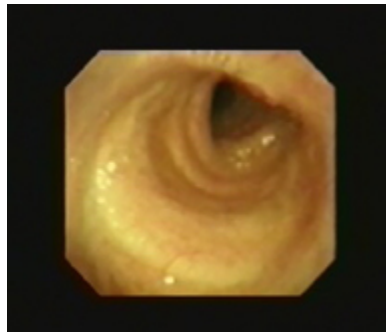
Vocal folds move with respiration, whereas the vestibular folds just above should not. In horses, a huge decrease in air pressures during inhalation would cause the larynx to collapse if it were not for the abductor cricoarytenoid muscle. During exercise, quasi-permanent contraction of this muscle dilates the larynx by pulling the arytenoid cartilage and vocal cord out of the airstream.

Some horses develop what is known as left recurrent laryngeal hemiplegia. In this case, paralysis of the dorsal cricoarytenoid muscle causes the arytenoid cartilage and vocal cord on the affected side to collapse into the larynx during inhalation and obstruct the airways. By the way, similar findings occur in humans! Unlike in horses though, where the cause is often hereditary, it is often from tumor, infection, or trauma.



Question I.20 The anatomic structure shown in the Figure below is

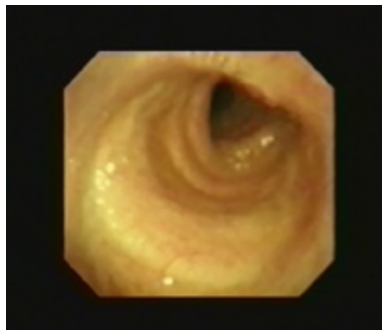
- A. The most narrow part of the adult airway
- B. The most narrow part of the pediatric airway
- C. The most narrow part of the adult female airway
- D. The most narrow part of the adult male airway



Answer I.20 **B**

The cricoid is the narrowest part of the pediatric airway. The glottis is the narrowest part of the adult airway. If one is called to perform a bronchoscopy in a child, it is important to recall that the epiglottis and larynx are usually more anterior, that the trachea is more pliable and easily collapsible, and that tissues and mucous membranes are floppy in the mouth and pharynx.

If intubation is necessary, uncuffed endotracheal tubes should be used in children under age 8. The external diameter of the endotracheal tube should approximate the size of the size of the child's nares. Better still to use Broeslow tape measure available in most emergency rooms.



Question I.21: The average cross-sectional area of the trachea in a 30-year-old male is

- A. 1.5 cm^2
- B. 2.8 cm^2
- C. 3.2 cm^2
- D. 5.0 cm^2

Answer I.21: B

The average cross-sectional area of the male adult trachea is approximately 2.8 cm^2 . The average cross sectional area, as well as tracheal length, diameter and volume correlate with body height. In adults, the average cross-sectional area at age 30 is about 2.8 cm^2 , increasing to an average of approximately 3.2 cm^2 by age 60. The cross-sectional area of a female is about 40 percent less than that of a male.

The tracheal index (TI) is characterized by the ratio of transverse and sagittal diameters. Normally, the tracheal index is about 1 (the transverse diameter is usually a couple of millimeters less than the sagittal diameter). Saber sheath tracheas, for example, have a reduced tracheal index (TI is 0.6 or less), because the sagittal diameter is large and the transverse diameter is small.

Question I.22: How would you describe the trachea shown in the Figure below.

- A. Normal C-shaped
- B. Normal U-shaped
- C. Normal horseshoe-shaped
- D. Abnormal saber-shaped
- E. Abnormal Lunate shaped



Answer I.22: B

This is a normal U-shaped trachea (although some might actually call it a triangular shape) in an elderly male with increased ossification of prominent cartilaginous rings and The adult tracheal diameter is usually reached by the age of 20. The trachea consists of a cervical extrathoracic segment (encompassing the first 6 tracheal rings and ending at the manubrium), and an intrathoracic segment that accounts for about 2/3 of tracheal length ending at the carina.

Length, diameter, volume, and cross-sectional area correlate with body height. Cross-sectional area increases with age, probably as a result of age-related loss in elastic recoil. The cross-sectional area of a male's trachea is about 40 % larger than that of a female. A transverse diameter of 25 mm and sagittal diameter of 27 mm are the upper limits of normal usually cited for males. The lower limit of normal for both transverse and sagittal diameters being about 13 mm in men and 10 mm in women.

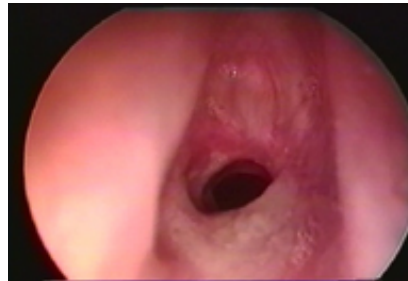
The C-shaped trachea is the most common cross-sectional tracheal shape described in adults (49 %). The second most common shape is the U-shape (27%). Saber and Lunate shaped trachea may reflect chronic obstructive airways disease, and are also found in patients with other respiratory disorders.



U-shaped trachea

Question I.23 A 29-year-old woman with Wegener's granulomatosis and increasing shortness of breath undergoes flexible bronchoscopy. Based on the finding shown you should.

- A. Attempt to pass the bronchoscope beyond the subglottic stricture in order to measure its length.
- B. Request an angioplasty balloon in order to dilate the stricture immediately.
- C. Request an endotracheal tube at the bedside, then attempt to push the bronchoscope beyond the stricture in order to determine whether it is simple or complex
- D. Stop the examination, remove the bronchoscope. Keep the patient under observation, and notify otolaryngology, thoracic surgery and an interventional bronchoscopist of the finding.



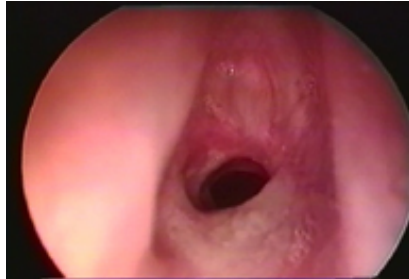
Answer I.23 D

Continuing the examination or attempting to dilate the stricture is potentially dangerous. Subglottic edema or reflex laryngospasm are potentially life threatening. Remember, "Never take away something you cannot give back". Before proceeding any further, one should be ready to perform an emergency tracheostomy. It might also be necessary to proceed with rigid bronchoscopy in case stenoses are at multiple levels inside the airway. Although limited Wegener's may initially involve only the subglottis, usually causing firm subglottic narrowing, it may also involve the upper and even the entire trachea as well as lobar and segmental bronchi.

Thus, it is wiser to continue the evaluation in the hands of an experienced interventional bronchoscopist able to organize a multidisciplinary approach to this patient's airway problem and systemic vasculitic disease. Less than 10 percent of patients with Wegener's are believed to have tracheobronchial involvement. Response to cytotoxic agents and corticosteroids is variable. In patients with systemic Wegener's combined therapy increases survival and decreases relapse compared to corticosteroids alone.

Response A is of course possible if one uses a small 3mm diameter bronchoscopy. In this case, however, secretions beyond the stricture may easily occlude the working channel of the scope. It could be used, however, to document patent distal airways and to measure the length of the stricture. Dilating the stricture immediately can be dangerous unless all materials necessary for balloon dilatation (and other interventional techniques) are readily available. These strictures can be very firm, making accidental tracheal or bronchial rupture a possibility. In regards to passing an endotracheal tube through this stricture...such a maneuver is likely to be unsuccessful, even when using a #6 or #5

uncuffed tube. Regardless, introduction of the tube will not allow one to determine whether the stricture is complex or simple, which requires a careful assessment of cartilage involvement, inspection of airway mucosa, presence or absence of additional strictures, and presence or absence of malacia.



Question I.24: Bleeding-related morbidity and mortality after flexible bronchoscopy is most frequently caused by

- A. Massive pulmonary hemorrhage
- B. Hypoxemia and respiratory insufficiency resulting from filling of ventilatory dead space
- C. Dysrhythmias from hypovolemia
- D. Hypotension and myocardial infarction

Answer I.24: B

A patient's left main bronchus, right main bronchus, and trachea make up ventilatory dead space. This structure can completely fill with only 150 ml of blood or fluid, causing hypoxemia and respiratory arrest. For this reason, patency of the contralateral airway must be maintained while the bronchoscopist attempts to stop the bleeding. Massive hemorrhage is rare, usually occurring only when large vessels or bronchial arteries are perforated during laser resection or bronchoscopic debulking. Tradition has it that bleeding is also feared in patients with uremia, thrombocytopenia, renal cell carcinoma, and carcinoid tumors.

Question I.25: A patient with breast cancer and venous thromboembolism is on Warfarin (Coumadin). Her INR is 2.1. Flexible bronchoscopy is scheduled for tomorrow. Bronchoalveolar lavage and biopsy are planned. You are concerned about procedure-related bleeding. You might choose to do which of the following.

- A. Refer the patient to someone else
- B. Proceed with bronchoscopy. There is no need to hold Warfarin
- C. Hold Warfarin the day of the procedure only
- D. Hold Warfarin today and tomorrow, administer vitamin K 2.5 mg orally today, and repeat INR measurement the day of the procedure.
- E. Administer vitamin K, 10 mg intravenously now. Fresh frozen plasma should be available for the procedure in case it is needed.

Answer I.25: C

Well, this is not a trick question, but this issue certainly comes up quite often. Although you might choose any of the possible responses, in this case it is probably safe to proceed with bronchoscopy after holding Warfarin the day of the procedure. If the INR were 4 or greater, 1-2.5 mg of Vitamin K orally should decrease the INR to 1.8-3.2 in at least 50% of patients. In general, intravenous administration of vitamin K is usually reserved for patients with INR >20 or active bleeding. Additional vitamin K and fresh frozen plasma transfusion can be repeated every ten hours as needed.

There is no “cookbook” approach to dealing with patients on Warfarin. Some bronchoscopists routinely hold medications and administer vitamin K. Others “ignore” the INR and proceed with bronchoscopic inspection (with washings or bronchoalveolar lavage). When in doubt, it is always safe to AVOID doing biopsies or brushings. If an abnormality is seen that requires biopsy, the patient can always be rescheduled after the coagulation abnormality is corrected, and normal coagulation profiles are noted on subsequent laboratory reports.

Question I.26: A 43-year-old woman with a history of healed tracheostomy presents to the emergency department with dyspnea and stridor. The first thing you do while preparing for flexible bronchoscopy is

- A. Administer intravenous sedation and heliox
- B. Place the patient's head and neck in the "sniff" position.
- C. Administer oxygen and mist humidification.
- D. Prepare for immediate tracheal dilatation using rigid bronchoscopy tubes of increasing diameter.

Answer I.26: B

The sniff position is frequently the first step required to improve passage through the upper airways, glottis, and subglottis. The sniff position is reached by simply placing a small pad under the patient's head for adults. This allows proper opening of the mouth, and extends the cervical vertebrae at the atlantoaxial joint, as well as flexes the lower cervical vertebral joints. Additional jaw elevation results in extension of the head and forward projection of the base of the tongue. Placing a pad that is too large will hinder maximal mouth opening.

Question I.27: Laryngoscopy and flexible bronchoscopy are frequently used to evaluate and monitor patients with potential or known inhalation injury. They are least helpful in patients with

- A. Supraglottic edema from direct heat-induced mucosal injury
- B. Glottic edema from smoke-induced mucosal injury
- C. Soft tissue swelling that accompanies general body edema from fluid resuscitation
- D. Bronchospasm

Answer I.27: D

Upper airway evaluation is crucial in patients with known or suspected inhalation or burn injury. Inhalation injury should always be suspected in burn victims, especially if the face, neck or chest are burned, or if there is presence of burned nasal hairs, or if soot is found in the nostrils, mouth or throat.

In burn and trauma victims the upper airway and tracheobronchial tree are frequently examined while other diagnostic and therapeutic measures are being instituted, central lines are being placed, and radiographs are being obtained. Oxygenation using nasal prongs or a facemask is always warranted. Special attention is necessary to avoid additional facial trauma in patients with burns to the face. Soot may additionally obstruct an already swollen and inflamed nasal passage. Examinations should be done gently in order to avoid hurting the patient, and to decrease the potential for bronchoscopically-induced laryngospasm and bronchospasm.

Conscious sedation should be used sparingly in the acute burn victim because the burn surgical team is interviewing the patient in order to discover additional symptoms, sites of injury, and mode of injury (enclosed environment, smoke exposure, heat exposure, chemical exposure, exposure to asphyxiant gases). After providing the patient gentle, confident reassurance, the bronchoscopist should be able to perform a thorough examination of the nasal passages, oral pharynx, larynx, and tracheobronchial tree.

An awake, bronchoscopically guided intubation avoids the dangers associated with muscle relaxation or paralysis. If injury is noted and intubation is warranted, an endotracheal tube can be inserted using bronchoscopic guidance. The burn surgeon and the bronchoscopist should discuss the advantages and disadvantages of oral or nasal intubation. Indications for each should be individualized based on extent of inhalation injury, potential for delayed injury, need for prolonged intubation or tracheostomy, and presence of comorbid diseases. Once intubated the patient can be thoroughly sedated.



Question I.28: Flexible bronchoscopy has been shown to be of limited value in all of the following except.

- A. Pulmonary atelectasis after thoracic surgery
- B. Solitary pulmonary nodules less than 2 cm in diameter
- C. Isolated, unexplained pleural effusion
- D. Hemoptysis with a nonlocalizing chest radiograph
- E. Persistent asthma-like symptoms and chronic cough

Answer I.28: E

Although flexible bronchoscopy is commonly performed for each of the above indications, it has been shown to be of limited value in all except individuals with persistent asthma-like symptoms and chronic cough. In these patients, bronchoscopy might reveal tracheal stenosis or benign airway tumors such as carcinoids. If the past medical history includes tuberculosis, inhalation injury, foreign body ingestion, childhood lung infections, intubation, or tracheostomy, flexible bronchoscopy should be performed early in the course of the diagnostic evaluation and prior to instituting empiric therapy for hyperreactive airways disease. Percutaneous needle aspiration is favored over bronchoscopic lung biopsy in most patients with lung nodules 2 cm or less.

In patients with hemoptysis and a nonlocalizing or normal chest radiograph, approximately 5 % are ultimately found to have a malignancy. Clinical data do not support the routine use of bronchoscopy to exclude lobar obstruction, and therefore a cause for trapped lung, in patients with unexplained pleural effusion. Bronchoscopy should be considered in patients with recurrent malignant effusions or poor lung reexpansion after thoracentesis. Flexible bronchoscopy is also of limited value in community-acquired pneumonia unless patients have failed antibiotics.

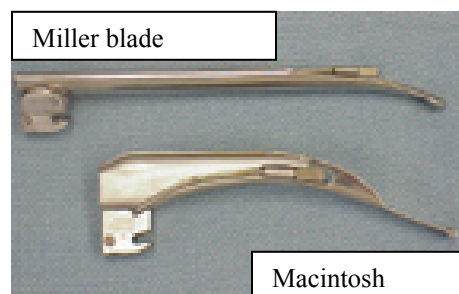
Question I.29: All of the following statements about endotracheal intubation are correct except

- A. In obese patients in the supine position, elevating and supporting the shoulders in addition to elevating the head optimizes visualization by direct laryngoscopy
- B. It is preferable to use a Miller Laryngoscope blade in patients with and anteriorly situated larynx
- C. Rapid sequence induction (preoxygenation-sedation-muscle relaxation) facilitates bronchoscopic intubation
- D. Cricoid pressure can be safely applied in patients who are at risk of aspiration
- E. Patients with heart failure, myocardial ischemia or hypovolemia are at higher risk of peri-intubation mortality

Answer I.29: C

Elevating and supporting the shoulders in addition to elevating the head with pillows or towels places the head of the obese patient more readily into the “sniff” position (neck flexion, head extension). The sniff position improves access to an upper airway otherwise hindered by fat and redundant tissues. The Miller blade is a straight laryngoscopic blade that is inserted past the epiglottis. The epiglottis is then lifted out of the way in order to visualize the vocal cords. Many experts advocate using this blade in patients with a large epiglottis or anterior larynx. The wider, curved Macintosh blade, on the other hand, is also frequently shorter. It is inserted into the valleculae immediately anterior to the epiglottis. The Macintosh blade exposes the vocal cords after lifting the tongue anterior, which keeps the tongue from obscuring the visual field.

Cricoid pressure, also known as the Sellick maneuver, when performed correctly, is often warranted in patients at risk for aspiration. This includes patients who are obese, have recently eaten, and patients with known diabetic gastroparesis, pregnancy, or bowel obstruction. Rapid sequence intubation should only be performed in patients who are not believed to be difficult intubations. Muscle relaxation and sedation hinder visualization of the vocal cords, even with the flexible bronchoscope. Bronchoscopic intubation can be even more difficult when blood, mucus, secretions, or vomitus collect in the hypopharynx.



Question I.30 All the following findings are likely to make flexible bronchoscopic intubation of trauma victims more difficult except

- A. Posterior displacement of the tongue and soft tissue edema
- B. Vomitus, blood, and foreign bodies (teeth)
- C. Agitation and anxiety
- D. Using a larger caliber endotracheal tube over a larger caliber flexible bronchoscope
- E. Rapid sequence anesthesia

Answer I.30

D

Using a larger caliber endotracheal tube and a larger diameter bronchoscope facilitates bronchoscopic intubation in most patients. Bronchoscopy can be performed via the nasal or oral passage. When using an oral approach, a bite block should always be used. Nasal intubation may be necessary in patients wearing high riding cervical collars. Posterior displacement of the tongue and soft tissue edema should be expected. It may be necessary to grasp the swollen tongue with a gauze pad and pull it partially out of the mouth to help expose the larynx. Vomitus, blood, and thick secretions should be aspirated using a Yankaur suction catheter rather than the flexible bronchoscope. The mouth should be carefully examined with the gloved hand, and accessible foreign bodies or broken teeth removed. Agitation and anxiety are common, and usually warrant conscious sedation.

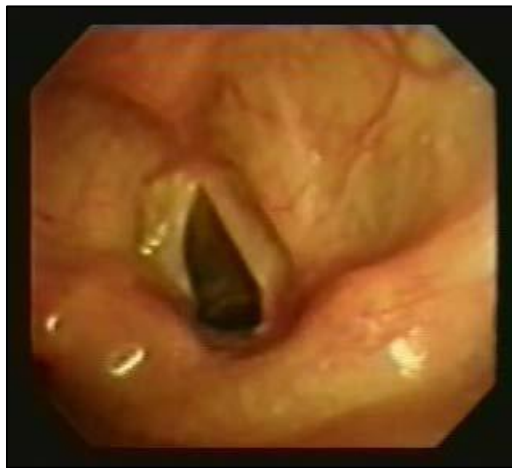
An awake intubation, might be easier than attempting intubation of a fully sedated patient. Intubation should be performed prior to examination of the lower airways. Once the patient is intubated, additional sedation can be administered. Rapid sequence anesthesia should be avoided prior to bronchoscopic evaluation and intubation because muscle relaxation and paralysis will cause collapse of muscle tone of the upper airway, making it more difficult to visualize the larynx. In addition, muscle relaxation before obtaining an adequate and secured airway increases the risks of hypoxemia and cardiac disturbances.

Other elements that make flexible bronchoscopic intubation more difficult in the trauma victim include known or suspected cervical spine injury, frequent need to keep the patient in the prone or supine position, and abundant carbonaceous material, secretions, inflammation, and pain caused from burns and inhalation injury.

NOTES

The Essential Flexible Bronchoscopist

Learning bronchoscopy in the world today



MODULE II

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE II

Welcome to Module II of The EFB, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this module, the learner should be able to:

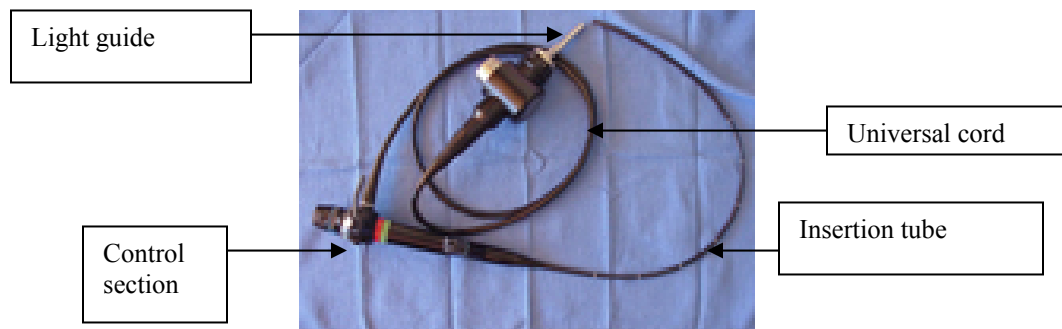
1. Identify the different parts of a flexible bronchoscope.
2. State the current perceived role for atropine and other premedication.
3. Describe ethical and acceptable practices of bronchoscopy in critically ill patients.
4. Identify vocal cord dysfunction.
5. Define the term “dynamic bronchoscopy” and list its indications.
6. Compare and contrast at least THREE types of oral intubating airways.
7. Describe the advantages and disadvantages of ethylene oxide sterilization.
8. List at least FOUR different ways a bronchoscope may be damaged, and how such damage be avoided
9. Describe the advantages and disadvantages of the Montgomery T-tube.
10. Compare and contrast various drugs used as topical anesthesia and conscious sedation for bronchoscopy or awake intubations.

Question II.1: Electrical contact, the venting connector, and light guide are all considered part of which section of the flexible bronchoscope.

- A. Universal cord section
- B. Control section
- C. Light guide connector section
- D. Eyepiece (or video) section
- E. Insertion tube section

Answer II.1: C

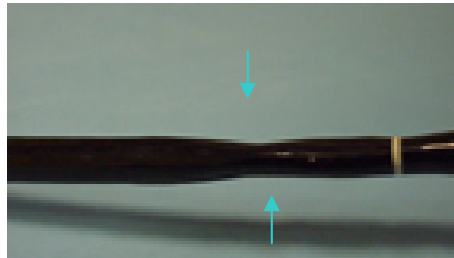
The light guide section plugs into the light source via the light guide. Light is transmitted through fiberoptic bundles to the distal end of the bronchoscope via the universal cord, the control section (which includes the eyepiece section) and the insertion tube section. Each optic fiber is clad with glass in order to isolate it. Fibers are arranged into a coherent bundle, and are thus easily broken when the scope is knocked, banged against hard surfaces, twisted, or bent excessively.



Question II.2

What happened to the flexible bronchoscope shown in the Figure.

- A. It was bitten
- B. It was caught in the drawer of a procedure cart
- C. It was squeezed by an angry bronchoscopist

**Answer II.2**

A

This scope was bitten, but the same appearance occurs when a scope is caught in a drawer. When bronchoscopy is performed through the mouth, a bite block should always be used. Drawers of procedure carts should never be left open during a procedure. This way, they cannot be inadvertently closed onto a bronchoscope. Bronchoscopists should treat their scopes gently. Scopes should not be bent excessively, bitten, slammed against bedrails or carts, caught in procedure cart drawers, or dropped onto the floor. Treat your bronchoscope... as you would like to be treated.



DANGER!



Question II.3: Most experts agree that which of the following is no longer routinely warranted before flexible bronchoscopy

- A. Informed consent
- B. Atropine
- C. Fasting state for at least 6 hours
- D. Electrocardiographic monitoring

Answer II.3: B

Several studies have now demonstrated that premedication with atropine or glycopyrrolate is not beneficial in decreasing bronchoscopy-related cough or secretions. In addition, coagulation profiles, blood type and screen, serum electrolytes, platelet counts, blood count, and serum chemistry panels are not routinely warranted and should be individualized. Electrocardiograms are desirable in patients at risk for heart disease or when pertinent history or physical findings are discovered. During the procedure, pulse rate and oxygen saturation can be monitored by oximetry. Electrocardiographic monitoring is unnecessary.

Increasingly, a fasting state of 6 hours or greater appears to be unwarranted, and should be individualized. A number of institutions are studying this classic rule of anesthesia in the outpatient surgical arena. Informed consent is mandatory. Bronchoscopists should never begin a procedure without first reviewing the history and physical, speaking with the patient and family members about the procedure and its risks, and reviewing the radiology reports.



Question II.4: Which of the following might prompt you to carefully reexamine the indications for outpatient bronchoscopy in your institution

- A. Bronchoscopy is frequently performed for “surveillance” purposes every 4 months in most patients with indwelling airway stents
- B. Bronchoscopy is frequently performed in patients with indwelling airway stents and new onset of respiratory symptoms such as hemoptysis, cough, or dyspnea.
- C. Bronchoscopy is frequently performed in most patients with cough who have failed empiric therapy with antireflux or antihistamine medications
- D. Bronchoscopy is routinely performed for diagnostic purposes in patients with solitary pulmonary nodules, even when nodules are less than 2 cm in diameter
- E. Bronchoscopy is performed for "exploratory" purposes in all patients referred for therapeutic bronchoscopic procedures even if they have been recently bronchosced at another institution.

Answer II.4: D

Most experts agree that diagnostic yield of bronchoscopy for solitary pulmonary nodules is extremely low, and that other diagnostic alternatives (percutaneous needle aspiration, thoracoscopic biopsy, wedge resection by open thoracotomy) are more likely to be effective. In patients with known bronchogenic carcinoma is unlikely that bronchoscopy will discover a synchronous or asynchronous ipsilateral or contra lateral metastasis that will change surgical management. Bronchoscopy is warranted in many patients with history of cough and who have not responded to therapy for reflux or postnasal drip. In these cases, problems that might be discovered include benign or malignant intraluminal tumors, airway strictures, tracheoesophageal or tracheomediastinal fistulas, tracheobronchomalacia, dynamic airway collapse, obstruction by inhaled foreign bodies, and vocal cord or laryngeal dysfunction.

The role for surveillance bronchoscopy in patients with indwelling airway stents is still unclear. Complications (granulation tissues formation, abundant secretions, stent migration) might be expected in as many as 20 percent of patients with stents. Most of these can be managed using the flexible bronchoscope. Some experts recommend a “surveillance bronchoscopy” even when patients are asymptomatic. Others prefer to intervene only when new or increased symptoms prompt consultation. In this regard, most stented patients with new or increased respiratory symptoms have been shown to have a stent-related problem.

Question II.5: Which of the following should be considered to be unacceptable practice

- A. Performing bronchoscopy without routine administration of conscious sedation
- B. Performing bronchoscopy in a patient who appears uncooperative despite having signed informed consent
- C. Obtaining bronchoscopic biopsies from the healthy lung because chest radiographs were not reviewed prior to the procedure.
- D. Allowing the patient's family members to observe the bronchoscopy
- E. Using the words "bite", "blood", "dangerous", "cancer" or "bad" during the procedure when such words might startle the patient or promote greater anxiety and fear.

Answer II.5: C

It is definitely unacceptable to perform a procedure on the "wrong" side, whether it is an amputation, or a bronchoscopic lung biopsy. Measures to avoid such an event should be instituted in every bronchoscopy suite. Nurses should be instructed to review radiograph reports and to personally interview and examine patients. Trainees should have x-ray reports and original imaging studies available at the time of the procedure. Informed consent should be specific. The other answers are debatable. In some institutions there is a bias against using conscious sedation. Medications should, however, probably be offered to the patient before and certainly, during the procedure. It is well recognized that health care providers inaccurately judge degrees of procedure-related anxiety and fear. Some patients are originally uncooperative at the time of bronchoscopy even though they had previously signed an informed consent. Most of these patients can be gently convinced to proceed with the bronchoscopy when the nurses and physicians provide greater reassurance, a calm and safe environment, an opportunity for conscious sedation, compassion and caring. If patients are still combative or reluctant to proceed, the procedure should be postponed. Coercion and force should be avoided, even if the health care providers believe that it is in the patient's best interests to undergo the procedure.

In many institutions, it is believed to be unwise for patient's family members to observe bronchoscopic procedures. Others believe that family members have a right to be present, since they are the true support services for the patient, and, after all, the proficient bronchoscopist should have nothing to "hide". Observers should be told, however, that complications could occur. Each bronchoscopist and health care team should do what they feel most comfortable with, and of course, abide by their institution's policy. Using words that might shock or traumatize patients cannot always be avoided during a bronchoscopy. Still, many experts advocate using the words "mitosis" instead of cancer, "heme" instead of blood, "close" instead of bite, and "interesting" instead of bad or dangerous.

Question II.6: The lesion shown in the Figure below is

- A. A small contact nodule on the left vocal cord near the posterior commissure
- B. A small contact nodule on the right vocal cord near the anterior commissure
- C. A small contact nodule on the right vocal cord near the posterior commissure
- D. A small contact nodule on the left vocal cord near the anterior commissure

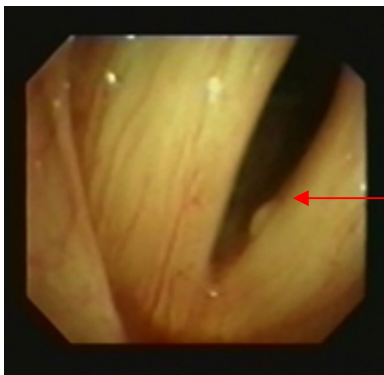


Answer II.6

D

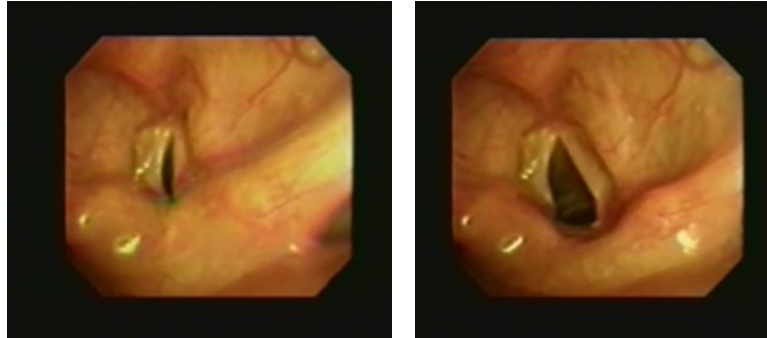
The abnormality is on the left vocal cord near the anterior commissure (located at the 6 o'clock position in the first figure below). It is probably of little or no consequence, but otolaryngology should be consulted for evaluation and possible removal. A hurried bronchoscopist easily overlooks laryngeal abnormalities. The larynx and hypopharynx (which extends from the tip of the epiglottis to the pyriform sinuses lateral to the aryepiglottic folds bilaterally) should be routinely examined during all flexible bronchoscopy.

Ahhhh, but look again!! Using the bronchoscope we were able to aspirate the small abnormality: it was just some mucus. Note the normal larynx in the second photograph. The view is different because the scope has been rotated such that the arytenoids cartilages are now seen in a 6 o'clock position and the V-shaped anterior commissure is at the 12 o'clock position.



Question II.7 A 58-year old man smoker has noted voice change and increased coughing during and after meals. Flexible laryngoscopic examination reveals the findings shown in the Figures below. Which of the following might be expected on chest radiograph.

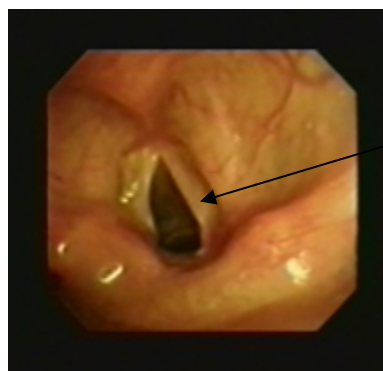
- A. Subglottic narrowing
- B. Left lower lobe atelectasis
- C. Left perihilar mass with obliteration of the aortopulmonary window
- D. Normal radiograph



Answer II.7 C

A mass filling the aortopulmonary could compress the left recurrent laryngeal nerve, causing the left vocal cord paralysis noted in the figures. Both the left and the right vocal cords are shown in adduction in the first figure, but only the right vocal cord abducts normally during phonation. The left vocal cord does not move. A careful inspection of laryngeal function is a routine part of any flexible bronchoscopic examination.

Patients should be asked to swallow, inhale, exhale, and speak. Vocal cord and arytenoids cartilage movements should be assessed and the aryepiglottic folds should be inspected. The left recurrent laryngeal nerve is a branch of the vagus nerve. It innervates the mucous membranes directly below the vocal cords, passing posterior within the superior mediastinum to hook around the aortic arch.



Right vocal cord
abducts normally

Question II.8: Mechanical and chemical irritation of laryngeal mucosa, such as that which occurs during flexible bronchoscopy, elicits cough and bronchoconstriction. Which of the other normal responses to upper airway stimuli could be considered most dangerous for patients undergoing flexible bronchoscopy.

- A. Hypertension from sympathetic stimuli
- B. Bronchodilatation from nasal and epipharyngeal irritation
- C. Cardiac arrhythmia and even cardiac arrest most likely resulting from irritation of the superior laryngeal nerve
- D. Increased mucous secretions that prompt cough and prevent penetration of extraneous materials.

Answer II.8: C

Laryngeal irritation has been shown to cause cardiac arrhythmias and even cardiac arrest in humans and in experimental studies. Repeated traumatic attempts at passing the flexible bronchoscope past the vocal cords should be avoided. During visualization of laryngeal function, vocal cord mobility, and during administration of topical anesthetic onto the larynx, the bronchoscope should be pulled back so that the larynx is clearly in view. Most experts agree that in a controlled setting, the tip of the bronchoscope should be kept above the epiglottis before intubating the trachea.

Question II.9: All of the following are potential indications for performing a “dynamic” bronchoscopy **except**.

- A. Spastic dysphonia due to adductor spasm
- B. Bronchoesophageal fistula
- C. Tracheal bronchomalacia
- D. Circumferential subglottic tracheal stricture
- E. Wide-based tumor obstructing the proximal aspect of a main bronchus

Answer II.9: E

Dynamic bronchoscopy consists of asking the patient to perform specific maneuvers while the airways are being visualized with the bronchoscope. These maneuvers include forced deep breathing, forced exhalation, and hyper flexion or hyperextension of the neck. Airways are examined after moving the patient into the supine, lateral decubitus, and seated postures. Dynamic bronchoscopy might be accompanied by a dynamic examination of the larynx during phonation in patients with hoarseness, dysphagia, or with symptoms suggestive of recurrent aspiration (cough, recurrent bronchitis, or pneumonia). Dynamic bronchoscopy might result in distending the folds or cartilaginous rings to identify a fistula. It might also identify dynamic collapse of the pars membranosa, an occasional cause for persistent cough and shortness of breath.

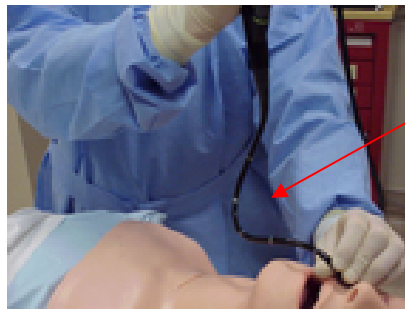
In patients with subglottic strictures, the patency of the airway should be assessed in multiple positions. Sometimes, there is a tendency for the stricture to become more severe during exhalation, or when the patient assumes certain positions. When the trachea or bronchi are obstructed by tumor, dynamic bronchoscopy is usually not necessary. “Ball-valving” is usually evident during a routine bronchoscopic examination, and rarely requires specific maneuvers. This occurs most frequently when tumors are on a small stalk, membranes protrude into the airway lumen, and when elastic tumors such as sarcomas extend out of a segmental bronchus into a main bronchus.

Question II.10 Which of the following positions is inelegant and risks damaging the flexible bronchoscope

- A. Pushing downwards on the bronchoscope so that a bend forms in the insertion tube.
- B. Standing up straight, shoulders back, weight equally distributed on both feet.
- C. Sitting on a stool, keeping the insertion tube straight at approximately patient height.

Answer II.10 A

Pushing downwards on the bronchoscope is inelegant, bad for the posture, and risks damaging the scope. Standing straight with weight equally distributed is much more comfortable, as is flexible bronchoscopy in the seated position.



BAD

Question II. 11 What is most inelegant about the bronchoscopist shown?

- A. He is scratching his beard
- B. He is “flapping” his right elbow
- C. He is holding the scope in the wrong hand
- D. He is wearing blue



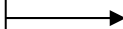
Answer II. 11 B

Flapping the elbow is inelegant and appears clumsy. A more elegant posture is that shown in the Figures below. Here, the elbow can rest, if necessary, on the bronchoscopist's hip. The arm is held close to the body and the control section of the videobronchoscope is held directly in front of the body. There is no awkward body language, dancing or swaying from one foot to the other. The insertion tube is relatively straight throughout the procedure.

In order to maintain an upright posture, the bronchoscopist can move closer to the patient. Scopes can be held in either the left or the right hand, depending on operator comfort, preference, and use of ancillary instruments.



Flapping the
elbow is
inelegant



Question II.12: Three months ago, you purchased two flexible bronchoscopes for your hospital. Today, your new bronchoscopy nurse informs you that the bronchoscopes had been stored in a haphazard way into small, padded procedure cart drawers. Visualization and light transmission is normal, yet she requests permission to install new full-length cabinets in which to hang the bronchoscopes. This is because she has noted which of the following in one of the scopes

- A. The outer sheath is ruptured
- B. The distal lens has turned yellow
- C. Multiple black dots are visible when looking through the eyepiece
- D. The steel components of the bronchoscope have corroded
- E. The bronchoscope has a new, fixed C-shaped curve along its entire length

Answer II.12: E

Fixed “memory” curves occur when flexible bronchoscopes are not stored in a full-length cabinet where bronchoscopes can hang. This can occur when scopes are rolled, folded, or placed into drawers for extended periods of time. Cabinets should be padded so that the distal extremity of the scope does not bang up against cabinet walls. Folding bronchoscopes into drawers for storage increases the risk of breaking fibers and sheaths by excessive bending, banging, or other mishandling such as closing the drawer onto the bronchoscope.

Rupture of an outer sheath easily occurs if the venting cap of the bronchoscope is not placed prior to ethylene oxide gas sterilization. The distal lens may turn yellow if repeated cleaning with povidone-iodine (Betadine) occurs or if the scope is exposed to radiation. Steel components can erode if scopes are immersed for excessively long periods in Glutaraldehyde.

Question II.13: The oral airway shown in the Figure below is the

- A. Ovassapian airway
- B. Williams airway intubator.
- C. Berman pharyngeal airway.



Answer II.13: B

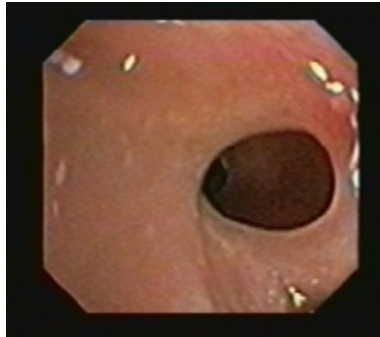
Oral intubating airways help the bronchoscopist keep the flexible bronchoscope in the midline, expose laryngeal structures, and maintain an open pharynx. The Williams airway intubator was designed for blind orotracheal intubation. However, in order to remove the Williams airway after intubation, the endotracheal tube adaptor must be removed prior to intubation. The Ovassapian airway, on the other hand, can be removed without disconnecting the endotracheal tube adaptor. The length and tubular shape of the Berman airway hinders maneuverability of the flexible bronchoscope.



Williams airway
intubator

Question II.14: The appearance of the airway stricture seen in the Figure should be described as

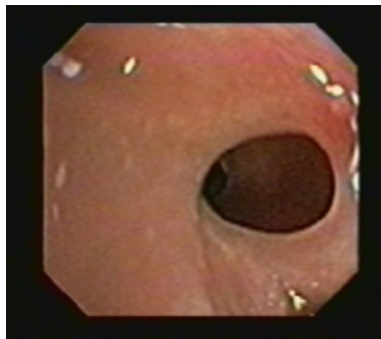
- A. Simple
- B. Hourglass
- C. Complex



Answer II.14: A

This is a simple circumferential membranous stricture. Tracheal stenosis can be congenital, acquired, or idiopathic. Histopathologically, there may be mucosal erosion, destroyed cartilage, granulation tissue formation, or full thickness dense fibrotic scar. It is important to understand the histopathologic process underlying the bronchoscopic abnormality when making management decisions regarding therapy.

A simple stenosis is defined as a partially or completely concentric, circumferential-type stricture in which a fibrous scar grows from the tracheal wall towards the center of the airway lumen. A bottleneck or hourglass stricture is characterized by localized collapse of tracheal cartilage. A complex stricture is one that includes a combination of other abnormalities, or extends for more than 5 cm or 6 cartilaginous rings.



Question II.15
seen in the Figure.

Which of the following best describes the airway device

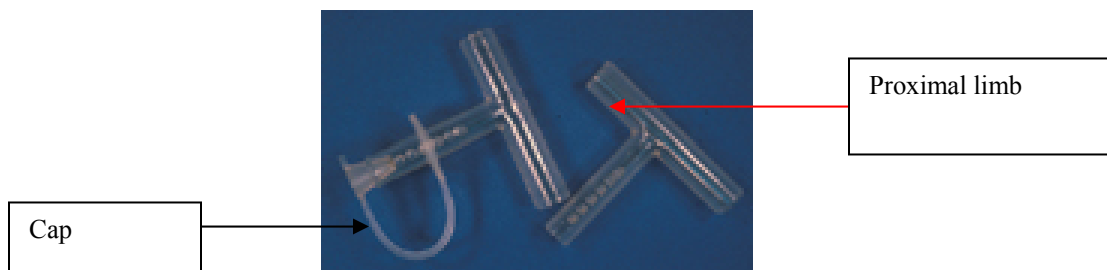
- A. Its popularity during the 1990s revolutionized interventional bronchoscopic practice
- B. Best used for patients with subglottic and upper-mid tracheal stenosis, this device requires a tracheostomy. A small cap on the device can be removed to allow suctioning and airway access if needed.
- C. Made of silicone, this device is usually inserted and removed using a rigid bronchoscope.



Answer II.15 B

The Montgomery T-tube was introduced in the 1960s. It is extremely useful for treating patients with subglottic stenosis or strictures involving the upper and mid trachea. It can be left in place indefinitely, or used temporarily as part of an endoscopic or open surgical management of tracheal stenosis. The vertical limb of the T-tube exits the patient through the tracheostomy stoma.

Patients can speak normally when this vertical limb is closed with a cap. Patients should keep the cap on at all times to avoid drying airway secretions. If the patient becomes short of breath because of recurrent tracheal stricture or accumulated secretions, the cap can be removed. The proximity of the horizontal (and shortest) limb of the T-tube to the vocal cords favors granulation tissue formation. The two other responses apply to studded silicone stents used to palliate central airways obstruction.



Question II.16: All of the following statements regarding bronchoscopy-induced hypoxemia are correct **except**

- A. Prebronchoscopy PaO₂ fails to predict the degree of fall in arterial PO₂ during flexible bronchoscopy
- B. Suctioning during bronchoscopy may contribute to a fall in alveolar PO₂, resulting in a decline in arterial PO₂.
- C. Hypoxemia may occur even in the absence of respiratory depression from sedatives.
- D. Hypoxemia has been associated with development of dysrhythmias.
- E. Arterial PO₂ falls by about 5 mm Hg on average during bronchoscopy.

Answer II.16: E

Bronchoscopy related fall in arterial PO₂ has been reported to be as high as 20 mm Hg on average. It has, for the most part, become standard of care to administer supplemental oxygenation to all patients undergoing flexible bronchoscopy and to monitor oxygen saturation, heart rate and blood pressure by pulse oximetry. One principle reason for this is to prevent hypoxemic events potentially related to respiratory depression when conscious sedation is administered..

Transient hypoxemia can occur during bronchoscopy because of excess sedation, respiratory insufficiency, diminished airway caliber and poor ventilation, or because of excessive washing or suctioning. Bronchoalveolar lavage can cause persistent hypoxemia lasting up to six hours after the procedure in rare instances.

The exact mechanisms of bronchoscopy-induced hypoxemia are not clear, but are likely to reflect altered ventilation-perfusion relationships. Note that some older studies and some guidelines, such as those of the British Thoracic Society or Argentinian Society for Bronchosophagology suggest that supplemental oxygen be administered only if oxygenation cannot be monitored or if oxygen saturation falls to below 90 percent.

Question II.17: Patients with which of the following disease are most likely to develop acute central airway obstruction after general anesthesia is initiated in the supine position.

- A. Posterior nerve sheath tumor
- B. Hodgkin's lymphoma
- C. Bronchogenic cyst

Answer II.17: B

Patients with a mediastinal mass, especially those with Hodgkin's lymphoma, are most likely to develop severe airway obstruction when anesthetized in the supine position. In addition to compression of the airway by the mass, airway obstruction is increased because of loss of bronchial smooth muscle tone, loss of spontaneous ventilation, and loss of negative intrathoracic pressure on inspiration. Loss of the airway on induction of anesthesia can be life threatening. Anesthesiologists may frequently call a bronchoscopist for assistance in such cases.

Question II.18: All of the following statements pertaining to ethylene oxide gas (ETO) sterilization of flexible bronchoscopes are correct except

- A. ETO sterilization penetrates all portions of the flexible bronchoscope
- B. ETO sterilization is highly effective against all types of microorganisms
- C. ETO sterilization without using an ETO venting cap will result in rupture of the outer polyurethane sheath of the flexible bronchoscope.
- D. ETO sterilization usually takes about 4 hours, and requires up to 24 hours of degassing time during which the scope cannot be used.
- E. ETO guarantees sterility and is therefore preferred over liquid chemical disinfection modalities.

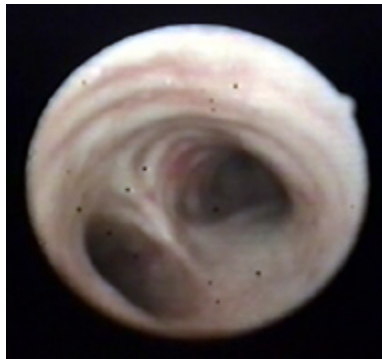
Answer II.18: E

Ethylene oxide (ETO) processing does not guarantee sterility. This and other disadvantages such as long degassing time and lengthy turnover make it impractical for busy bronchoscopy services. High-level disinfection, which inactivates all fungi, viruses, and vegetative organisms, but not all bacterial spores, is the modality used most frequently around the world. Disinfection for 45 minutes at 25 degrees Centigrade and using 2% Glutaraldehyde will also destroy all mycobacterial organisms.

After disinfection, scopes are rinsed with sterile water and dried using air suction. Any bronchoscope being cleaned must be “leak tested” first. If a leak is found coming from the working channel of the scope, or from a damaged exterior surface of the universal cord or extension tube, the scope should NOT be submersed in cleaning solution. Many services use older flexible fiberoptic bronchoscopes. An accessory “teaching head” is used to allow observation by a second person. The teaching head CANNOT be immersed or sterilized. It should, therefore, be kept as clean as possible, and wiped with alcohol after each use.

Question II.19: When looking through the eyepiece of a flexible bronchoscope you notice that multiple small black dots are visible. This means that

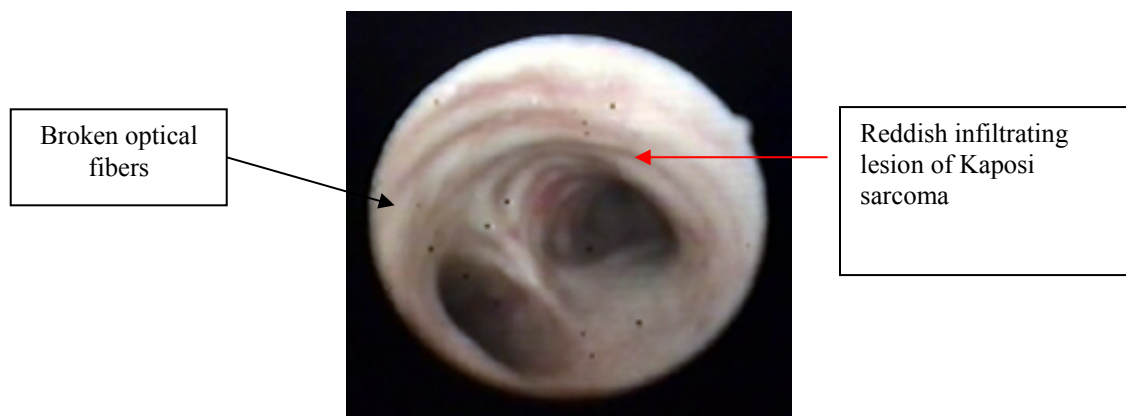
- A. Water has leaked into the bronchoscope
- B. The bronchoscope has been excessively exposed to radiation
- C. Multiple fiberoptic bundles are broken
- D. The bronchoscope needs to be replaced



Answer II.19: C

Multiple black dots are caused because light is no longer transmitted along individual or groups of glass optical fibers. As additional fibers are broken, dots multiply until they eventually fill a significant portion of the viewing field. Light transmission decreases and visualization eventually becomes unsatisfactory. Sooner or later, the bronchoscope will need to be replaced. A yellowish discoloration and darkening of the fiberoptic bundles occurs when a scope is exposed to excessive amounts of radiation.

When visualization is blurred, the lens should be wiped with saline or alcohol in order to remove a film caused by blood, secretions, or inadequate drying during the cleaning-disinfection process. If visualization does not improve, a leak-test should be performed because fluid may have entered the bronchoscope. No further washing and disinfection should be attempted. The bronchoscope needs to be sent out for repair.



Question II.20: Which of the following pulmonary function disturbances can be seen when performing bronchoscopy in a mechanically ventilated patient

- A. Increased airway resistance
- B. Reduced positive end-expiratory pressure
- C. Reduced functional residual capacity
- D. Increased arterial oxygen saturations
- E. Increased expiratory flow rate

Answer II.20: A

Airway resistance is increased because the cross sectional area of the trachea, usually about 3 cm², is reduced by the endotracheal tube and by the flexible bronchoscope within the endotracheal tube. Oxygen saturations and expiratory flow rates are reduced, although saturations might actually increase if abundant mucous plugs or secretions are removed. End-expiratory pressure and functional residual capacity are increased because of the increase in airway resistance.

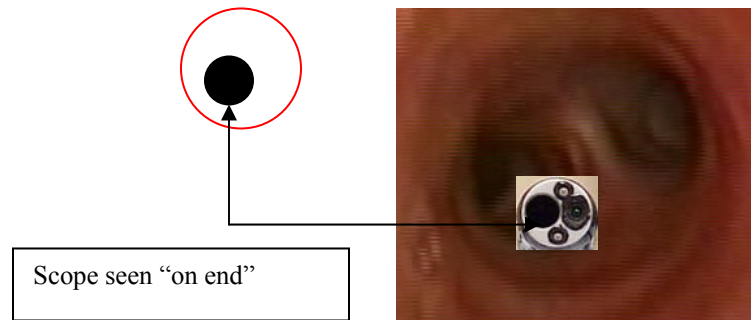
Most experts suggest increasing FiO₂ to 100 percent during bronchoscopy. Procedures should be stopped if peak airway pressures increase significantly, or if bronchoscopy is causing hypertension, significant tachycardia or dysrhythmias, or oxygen desaturation. However, in some cases, it is essential to remove mucous plugs or blood in order to restore adequate ventilatory function. In these cases, bronchoscopy should be judiciously performed while staying in the patient's airway as little time as possible.

Question II.21: In a tall adult male patient with normal airways, a standard flexible bronchoscope occupies approximately what percentage of cross-sectional area of the trachea.

- A. 5 percent
- B. 10-15 percent
- C. 20-25 percent
- D. more than 25 percent

Answer II.21: B

In an adult male with a normal trachea 12-24 mm in diameter, the flexible bronchoscope occupies approximately 10-15 percent of the cross-sectional area of the tracheal lumen. Obviously, the area occupied by the bronchoscope is increased in the presence of tracheal strictures caused by benign or malignant processes, when there is an indwelling endotracheal tube, and in smaller patients. In these cases, the size of the bronchoscope contributes to increased airway resistance, decreased expiratory flow rates, and increased functional residual capacity. Occasionally, increased positive end-expiratory pressure has also been noted.



Question II.22: Which of the following “expressions” is most appropriate for flexible bronchoscopic examination

- A. The middle way
- B. Gentleness is a virtue
- C. A bronchoscopist must have eyes on the tips of his fingers
- D. Never give up
- E. Feel the wall

Answer II.22: A

One of the secrets to performing a non traumatic and “gentle” examination is to always keep the flexible bronchoscope in the middle of the airway lumen (when using video, keep the image in the middle!). This improves overall visibility, decreases the likelihood to become lost, and avoids mucosal injury, cough and patient discomfort. This position within the airways also allows the bronchoscopist to maintain excellent posture and maneuverability no matter what hurdles may be encountered. Thus, harmony is maintained during the procedure.

Of course, the “middle way”, is that of Chinese Tao and Japanese Zen Buddhism: A way in which one is not distracted by the objective world nor disturbed in one’s own mind. The middle way is a way of inner peace, harmony, and transcendence of dualism. To quote Chuang Tzu, “when the shoe fits, the foot is forgotten”.

Another way to achieve bronchoscopic harmony is to perceive limitations, and to move beyond them. The expression “feel the wall” is attributed to Jean-Francois Dumon of Marseille, France. Dumon is perhaps the single most important personality in interventional bronchoscopy of recent years. Through his technical expertise, talent, and passion for endoscopy, this Frenchman from Marseille raised awareness about the usefulness of therapeutic bronchoscopy among extremely hesitant and skeptical pulmonary, oncology, and surgical communities. “Feel the wall” refers to the techniques of probing a tumor’s surface with forceps or suction catheter in order to best recognize consistence, state of necrosis, vascularity, risk of biopsy and potential for debulking by rigid bronchoscopy.

Undoubtedly, this expression also reflects a philosophy and a way of life. It represents a need to “feel” the boundaries of thought and the limitations of medical science. Those who question conventional wisdom in order to bathe in the realm of innovation and originality transcend these boundaries. There is, in fact, a way to “become One with the bronchoscope”, but that is another story....

Question II.23: The best reason to not administer conscious sedation before or during bronchoscopy is

- A. The patient is a military commando and his friends are watching
- B. The bronchoscopist is a macho
- C. The patient must drive immediately to work after the procedure
- D. The patient is allergic to Lidocaine
- E. The patient is critically ill and is a high risk intubation

Answer II.23: C

Patients should be warned that conscious sedation may be administered, and therefore, they should have someone accompany them after the procedure, and they should NOT drive their own automobile or motorcycle after receiving such medication, even if their vital signs (blood pressure, heart rate, oxygen saturation, and level of consciousness) have returned to normal. This is because of reflexes in case of need for emergency responses (like driving) are delayed for several hours.

Do you think conscious sedation should be a “negotiation” between yourself and the patient? Many studies have shown that physicians are poor judges of the anxiety levels and comfort levels of patients undergoing invasive procedures. Remember that small amounts of a sedative given orally or intravenously can help alleviate procedure-related anxiety. Thus the benefits of conscious sedation (anxiety relief, amnesia, analgesia, improved cooperation) should be weighed against the disadvantages of conscious sedation (need for additional monitoring, risk of respiratory depression, risk for decreased patient cooperation because of inhibitions or restlessness).

Decisions should also include the type of procedure being performed (is this a very short inspection or a longer procedure with biopsies, needle aspiration, washings, brushings). What is the risk of a procedure-related complication? What is the risk of a drug-induced adverse event? Is the patient clinically stable, ambulatory, or critically ill? Whether to administer sedation, and which drug or drug to administer can and should be individualized based on the above scenarios.

Of course, some patients do not desire conscious sedation because of other disadvantages: perceived loss of self-control, need to be observed until return to baseline mental status after the procedure, danger of driving an automobile, and fear of allergic reactions or other medication-related adverse events.

In case of a true allergy to lidocaine, a medication belonging to the Ester group, such as Tetracaine could be administered.

Although bronchoscopy has been shown to be safe in unsedated patients, most bronchoscopists today believe that short-acting sedation should be offered to patients in order to help improve patient comfort during the procedure. In certain instances, however, procedures might be warranted in a fully awake, but cooperative individual. This might include cases where the patient has hemoptysis or a foreign body (where conscious cough or breathing can prove advantageous), cases where a dynamic examination is warranted, and cases where loss of the airway might be irreversible.

Question II.24 The image shown demonstrates

- A. Paralyzed vocal cords in abduction
- B. Normal vocal cords seen from below
- C. Subglottic tracheal stenosis
- D. The anal canal during sigmoidoscopy



Answer II.24 B

The image is that of the vocal cords seen from below. The flexible bronchoscope was introduced through the tracheostomy, after removing the tracheotomy tube. The scope is flexed caudally in order to examine the subglottis. The patient is asked to phonate. Here, normal vocal cords are seen in abduction. The subglottis is normal. Reason to perform this type of an examination are to exclude a subglottic or peristomal source of bleeding, to inspect the subglottis for cartilaginous abnormality, stricture, or to fully evaluate laryngeal function in patients with tracheostomies prior to permanent removal of the tracheostomy tube.



Question II.25: Which of the following is usually an early complication of tracheostomy tubes

- A. Tracheoinnominate artery fistula
- B. Granulomas
- C. Tracheomalacia
- D. Suprastomal tracheal flap
- E. Stenosis at the level of the stoma

Answer II.25: A

Tracheoinnominate fistulas have been reported in as many as 0.7 % of patients with a tracheostomy. Tracheoesophageal fistula can occur early or late and has been reported in as many as 0.5 % of patients with a tracheostomy. Cough, hemoptysis, or dyspnea in a patient with a history of tracheostomy should prompt bronchoscopic examination in order to identify airway abnormalities responsible for the symptoms.

Question II.26: Which of the following drugs used for conscious sedation, consistently suppresses airway reflexes and is therefore most beneficial for awake tracheal intubation

- A. Midazolam
- B. Diazepam
- C. Lorazepam
- D. Fentanyl
- E. Morphine

Answer II.26: D

Large doses of each of these drugs will produce general anesthesia and suppress all reflexes. Fentanyl is the preferred drug because of its faster action and shorter duration of action. From a pharmacological point of view, morphine is as good as Fentanyl for depressing airway reflexes. Propofol, a hypnotic agent that may also cause severe hypotension, especially in the elderly and in patients with known hypotension, also consistently suppresses airway reflexes. Propofol is an excellent choice for awake intubation, and certain bronchoscopic procedures. It is also useful for procedures in highly anxious patients and when a deeper level of anesthesia is desired.

Question II.27: You and your assistants are called to the emergency room because the anesthesiologist and emergency room physicians are unable to intubate a 33-year-old obese woman in status asthmaticus. She has known acute and chronic sinusitis and a deviated nasal septum. She is fully sedated. Oxygenation has been maintained by manual ventilation using an ambu-mask. The patient is tachycardic, hypotensive, and severely hypercarbic. Central venous access is being attempted. You have just finished a bronchoscopy and your 6 mm diameter flexible bronchoscope is in the automatic washer. You had a 4.8 mm videobronchoscope, but it was damaged yesterday when one of your patients accidentally bit it (you have since transferred the pulmonary trainee who was doing the procedure without the use of a bite block to a clinic in Siberia). The only scope you have available is a 3.2 mm pediatric flexible bronchoscope with a 1.2 mm working channel. The intensivist tells you that she wants this patient intubated with a # 7.5 mm endotracheal tube. The patient's husband, who is a famous medical malpractice attorney, refuses to leave the bedside. Which of the following will most likely facilitate a successful and safe oral intubation using bronchoscopic guidance in this patient.

- A. You remove the patient from the Trendelenburg position, and place her in the supine position before beginning bronchoscopically-guided intubation using a # 7.5 mm adult cuffed endotracheal tube via the oral route and through a bite block.
- B. You ignore the request of the intensivist and you begin bronchoscopically-guided intubation using a # 6 uncuffed endotracheal tube through the nares.
- C. You ignore the request of the intensivist and you begin bronchoscopically guided intubation using an # 8.0 cuffed, endotracheal tube via the oral route and through a bite block.
- D. You place a well-lubricated, uncuffed 5.0 mm internal diameter pediatric endotracheal tube inside a # 7.5 cuffed adult endotracheal tube and begin bronchoscopically-guided intubation via the oral route and through a bite block.
- E. You ignore the request of the intensivists and begin bronchoscopically guided intubation using a # 6.0 cuffed endotracheal tube via the oral route and through a bite block.

Answer II.27: E

This is one of those questions where the correct response is to do whatever you can to establish an airway quickly. Many experts would suggest using a small endotracheal tube that snugly fits over the 3.2 mm bronchoscope. Going through the mouth is often possible even as one ventilates and oxygenates the patient using the ambu mask. On the other hand, some would advocate first trying the nasal route anyway (if there are excessive secretions in the nares and oral pharynx one can always insert a nasal trumpet).

Placing a pediatric endotracheal tube inside a larger endotracheal tube can allow the bronchoscopist to “close the gap” between the tube and the bronchoscope. This facilitates maneuvering within the airway. The pediatric bronchoscope should protrude beyond the distal extremity of the smaller endotracheal tube, which itself, protrudes slightly beyond the distal extremity of the large endotracheal tube. This technique also helps avoid accidental passage of the small caliber bronchoscope through the Murphy eye of the large endotracheal tube. The problem is finding the right endotracheal tube size

“mix” to make this work, and having plenty of silicone lubricant available to make sure one tube can slide over the other. Beware...the pediatric endotracheal tube is frequently too short. If it has a cuff on it, it will not fit through the larger tube. Like all “emergency” techniques, this technique should be practiced in an inanimate model. It might be wiser to use other methods such as an intubating oral airway, a light wand or optical stylet, if you gain experience with these.

A variety of cuffed and uncuffed endotracheal tubes should always be available inside the airway procedure cart. Other intubation aids (tube changers, light wands, optical stylets, oral airways) should also be available. Bronchoscopic intubation without the use of an oral intubating airway increases the chance that the bronchoscope and endotracheal tube will deviate away from the midline. If the larynx is not seen before advancing the endotracheal tube, the endotracheal tube may get caught on the epiglottis, arytenoids, or in the hypopharynx.

One should attempt to make the first intubation attempt the last. Repeated attempts increase the risk for airway trauma, prolonged hypoxemia, and death.



Question II.28: Your newly hired and inexperienced technician has finished sterilizing a flexible bronchoscope using ethylene oxide gas sterilization. He calls to say that he forgot to place the ETO venting cap onto the venting connector before sterilization. You immediately say &#@&*!. Upon examining the bronchoscope you notice that

- A. The outer sheath is ruptured
- B. The distal lens has turned yellow
- C. Multiple black dots are visible when looking through the eyepiece
- D. The steel components of the bronchoscope have corroded
- E. The bronchoscope has a new, fixed S-shaped curve along its entire length

Answer I.28: A

Ethylene oxide gas is noncorrosive and able to penetrate otherwise inaccessible components of the flexible bronchoscope. If the ETO venting cap is not placed onto the venting connector, however, pressures inside and outside the bronchoscope will not equalize, and rupture of the outer sheath of the bronchoscope can occur. ETO provides extremely satisfactory sterilization for bronchoscopes used in patients with AIDS or hepatitis. The ETO venting cap must be removed prior to immersing the bronchoscope into cleaning solutions of any kind otherwise fluid will enter the bronchoscope.

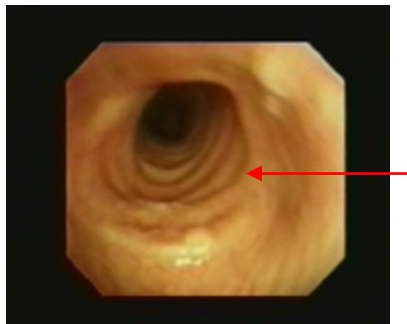
Question II.29: You are asked to come to the operating room because a patient with a massive goiter is about to undergo general anesthesia. The anesthesiologist performed flexible bronchoscopy and informs you that when the patient was completely supine, he was unable to pass the bronchoscope beyond the subglottis. When referring to the subglottic larynx, which distance is the anesthesiologist referring to.

- A. 1 cm beyond below the level of the vocal cords
- B. 2 cm below the level of the vocal cords
- C. 3 cm below the level of the vocal cords
- D. 4 cm below the level of the vocal cords

Answer I.29: B

The trachea is a cylindrical tube that projects onto the spine from C6 to the level of T5. As it passes downwards, it follows the curvature of the spine, and courses slightly backward. Near the tracheal bifurcation, it deviates slightly to the right. The subglottis ends 2 cm below the level of the vocal cords. This corresponds cranially to the inferior margin of the cricoid cartilage, which forms the only complete cartilage ring in the airway.

The thyroid gland surrounds the cervical trachea anterolaterally at the level of the second to fourth cartilaginous rings. Mediastinal masses, goiters, and thyroid or other head and neck cancers can cause significant extrinsic compression resulting in tracheal obstruction. Occasionally, an awake intubation with the patient in the seated position may be warranted prior to surgical resection.



Question II.30: A 25-year-old woman with a bilateral micronodular infiltrate, ten pound weight loss, morning headache, and persistent low-grade fever undergoes flexible bronchoscopy with bronchoscopic lung biopsy and bronchoalveolar lavage. Topical anesthesia is achieved using 2 puffs of 10% Lidocaine, and 4 cc of 2% Lidocaine instilled onto the main carina. In addition, 3 mg of Midazolam is administered for conscious sedation. The BAL is done within the right middle lobe bronchus. The bronchoscopic lung biopsy is obtained after wedging the flexible bronchoscope in the left lower lobe bronchus. The patient is asked to exhale, and at end expiration, the biopsy is taken. The patient has no pain. Shortly after the fourth biopsy, mild bleeding is noted. The patient begins to have a tonic-clonic seizure rapidly followed by respiratory arrest. Bleeding is stopped using a saline wash and suctioning. Cardiopulmonary resuscitation is successful. The patient is intubated and transferred to the intensive care unit. The biopsy sample showed miliary tuberculosis and small segment of pulmonary vein. What is the most likely cause of this patient's procedure-related complication?

- A. Lidocaine toxicity
- B. Midazolam toxicity
- C. Cardiac arrhythmia and myocardial injury
- D. Gas embolism
- E. Procedure-related elevation of intracranial pressure in a setting of tuberculous meningitis

Answer II.30: D

Wow...this patient had a cerebral gas embolism. It is likely that air entry occurred after laceration of a small pulmonary vein. Anecdotally, it has been taught that larger biopsy specimens are obtained when samples are taken at end-exhalation. This recommendation dates to the original descriptions of bronchoscopic lung biopsy by Dr. Donald Zavala from the University of Iowa back in the 1970s. On the other hand, because of a potential, although unproven increased risk for bleeding, pneumothorax, or air embolism, some experts do not advocate the end-exhalation biopsy technique.

Transbronchial lung biopsy (TBB or TBLB) is actually a misleading name for a procedure which is neither trans (across) nor bronchial (the goal is to obtain representative lung parenchyma containing bronchioles and alveoli, and an occasional blood vessel). Many experts today advocate the name bronchoscopic lung biopsy (BLB) instead. What do you think?

By the way, the only way to find out if you are obtaining representative samples of tissue (not necessarily diagnostic samples), is to review all specimens with the surgical pathologist, and to practice the various techniques described for obtaining bronchoscopic lung biopsies.

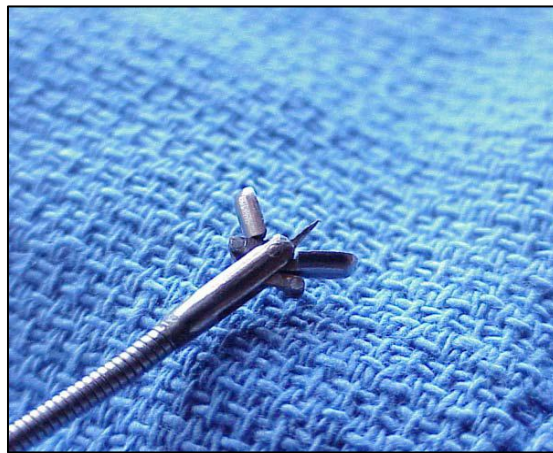
Regarding the other potential answers. Lidocaine does cause seizures. The appearance of serious adverse effects are not necessarily preceded by mild side effects especially if the patient has liver disease (lidocaine is metabolized in the liver).

Had the surgical pathology of the biopsy sample revealed Lupus erythematosus. And had you answered cardiac arrhythmia and myocardial injury, you could have been correct, because Lupus can cause a vasculitis and thus, coronary arteritis. Regarding

midazolam toxicity, respiratory depression and hypoxemia usually precedes any additional adverse events. The presence of the sudden neurologic event and the presence of the pulmonary vein in the biopsy sample are probably enough to suggest the diagnosis of gas embolism, making Tuberculous meningitis and elevated intracranial pressures an unlikely cause for her symptoms.

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MODULE III

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE III

Welcome to Module III of The EFB, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this module, the learner should be able to:

1. Compare and contrast at least THREE maneuvers used when difficulty is encountered during intubation over the flexible bronchoscope.
2. Define the term “scattered radiation”
3. List at least THREE disadvantages of Glutaraldehyde disinfection.
4. Identify the Ovassapian oral intubating airway and list its advantages as compared to other oral airways.
5. List and describe various descriptive terms of airway mucosal abnormalities.
6. Describe a tracheal abnormality in relation to normal anatomic airway structures.
7. Describe different appearances of tracheobronchial secretions.
8. List at least THREE adverse effects related to bronchoalveolar lavage.
9. Compare and contrast the use of opiates with other drugs administered for conscious sedation.
10. Describe a systematic approach to bronchoscopic inspection and diagnosis.

Question III.1: All of the following are potential causes of confusion and seizures in an elderly man undergoing bronchoscopic biopsies of a large right upper lobe mass except.

- A. Silent brain metastases from bronchogenic carcinoma
- B. Hydration and paraneoplastic inappropriate SIADH-like syndrome
- C. Lidocaine toxicity
- D. Midazolam toxicity
- E. Methemoglobinemia

Answer III.1: D

Midazolam (Versed) is currently the most widely used agent for conscious sedation. It is a water-soluble benzodiazepine with rapid onset of action. It is four times more potent on a mg per mg basis than diazepam for sedation and amnesia. When 5 mg are administered intravenously, sedation and anxiolysis usually occurs within 2 minutes. Complete recovery of motor performance and consciousness occurs within one hour in most individuals.

Sedative responses are increased in patients who have received opioids or other benzodiazepines. In addition, level of sedation and risk for respiratory depression are increased in the elderly and in patients with pre-existing respiratory dysfunction.

Combining Midazolam and opioids increases the incidence of apnea. Large doses can produce prolonged drowsiness and cardio respiratory arrest.

Midazolam does not cause seizures. Central nervous system dysfunction, including confusion and seizures can be seen in patients with brain metastases and in patients with paraneoplastic syndromes.

Seizures can also occur from Lidocaine toxicity (especially if hepatic dysfunction results in increased plasma levels) and Benzocaine-induced methemoglobinemia.

Question III.2: During intubation over the flexible bronchoscope the endotracheal tube can become caught on laryngeal structures and not enter into the trachea. All of the following maneuvers are warranted **except**.

- A. Partially withdrawing the endotracheal tube over the bronchoscope, rotating it 90 degrees clockwise and readvancing the tube.
- B. Partially withdrawing the endotracheal tube over the bronchoscope, rotating it 90 degrees counter-clockwise and readvancing the tube.
- C. Changing from a small 4.8mm diameter bronchoscope to a larger 6 mm diameter bronchoscope
- D. Withdrawing the endotracheal tube over the bronchoscope and repeating multiple attempts at intubation

Answer III.2: D

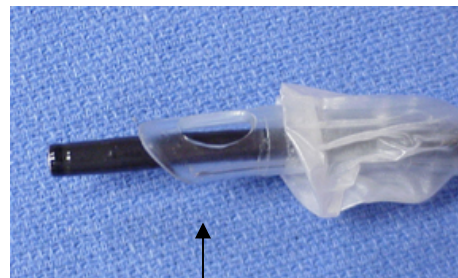
Although one might withdraw the scope and endotracheal tube once and try again as described in response D, such repeated attempts at intubation are often unsuccessful and traumatic. Precious time is wasted and the risks for hypoxemia are increased. Repeated trauma to the larynx can also prompt reflex laryngospasm, reflex arrhythmias and vomiting. Inadvertent esophageal intubation is a possibility, and tracheal esophageal fistulas have been known to occur.

If resistance is met during intubation, remember that the epiglottis or the arytenoids are a frequent encountered obstruction after passing an endotracheal tube over a bronchoscope through the nares or through the mouth. Endotracheal tubes can also inadvertently enter aryepiglottic folds. Sometimes it helps to grasp the patient's tongue with a gauze pad, and to ask an assistant to pull the tongue out of the mouth slightly. This creates more space to maneuver in the oropharynx.

If intubation is still unsuccessful, it is best to change techniques in order to facilitate passage of the endotracheal tube between the vocal cords. All the techniques described in responses A, B, and C should be considered. A larger diameter bronchoscope allows for better manipulation and control of the endotracheal tube than a small diameter bronchoscope. By filling up more of the space within the endotracheal tube, the larger-sized scope and endotracheal tube ensemble is more readily maneuverable. Although it is recommended to intubate with the largest size endotracheal tube possible, most experts agree that a 7.5 endotracheal tube is the largest diameter tube that should be inserted through the nares. Rotating the scope 90 degrees clockwise or counterclockwise will change the angles of the curved tip of the endotracheal tube and might facilitate laryngeal intubation.



No space with smaller caliber tube



Space between scope and 8.0 endotracheal tube

Question III.3: Fentanyl is a short acting opioid 100 times more potent than morphine. Its onset of action is within 2 minutes of intravenous injection. In addition, its maximum respiratory depression effect occurs

- A. Immediately upon injection
- B. Within 2-4 minutes after injection
- C. 5-10 minutes after injection
- D. 11-15 minutes after injection
- E. More than 15 minutes after injection

Answer III.3: C

Fentanyl is a synthetic opiate analog that is structurally different from morphine or meperidine. The usual adult dose is 50-100 micrograms. Given intravenously, its onset of action and maximum respiratory depression effect occurs about 5-10 minutes after administration, and lasts anywhere from 30-60 minutes. Given intramuscularly, the onset of action is within 7-15 minutes with duration of action lasting up to two hours. Fentanyl should never be used in patients receiving MAO inhibitors because of increased risk of respiratory depression and coma.

Question III.4: All of the following statements about Naloxan (Narcan) are true **except**

- A. It reverses all effects and side effects of narcotics including sedation, respiratory depression, apnea, and pain control.
- B. Standard practice is to dilute 1 ampoule (0.4 mg or 1 ml) in 10 ml volume to make 0.04 mg/ml.
- C. In order to reverse respiratory depression and apnea, 1 ml of dilute solution (0.4 mg) is injected intravenously every 2-4 minutes until consciousness is regained.
- D. In the intensive care unit or on the ward, it is best to immediately administer the entire ampoule (0.4 mg) if the patient is severely respiratory depressed and if expert airway management is not available.
- E. No more than 5 ml total should be administered because of risk of narcotic withdrawal.

Answer III.4: E

Naloxone is a pure opiate antagonist that reverses all effects and side effects of opiates. Actually, no more than 10 mg should be administered because this might lead to increased activity of the sympathetic nervous system from acute termination of analgesia. Consequently, patients may develop hypertension, dysrhythmias, and pulmonary edema.

In case of over sedation with benzodiazepines, the benzodiazepine antagonist Flumazenil should be administered (0.2 mg iv over 15 seconds then repeated every minute up to a maximum of 1 mg). Low doses of Flumazenil will reliably reverse sedation within 2 minutes, but higher doses are needed to reverse benzodiazepine-related anxiolysis. Side effects include nausea, vomiting, tremors, seizures, tears and dizziness. Contrary to naloxone, it does not cause hemodynamic instability.

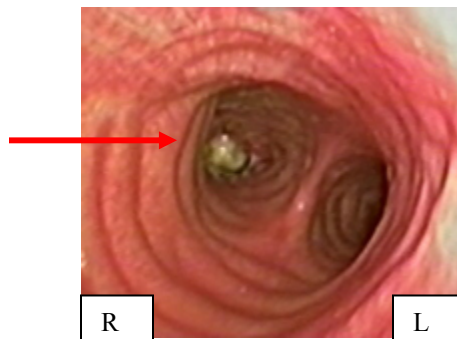
Question III.5 Bronchoscopy is performed in a patient with cough and partial unilateral atelectasis. Based on the findings shown below, bronchoscopic examination should proceed with

- A. Examination of the left bronchial tree, then inspection and biopsy of the lesion on the right.
- B. Inspection and biopsy of the lesion on the right, then examination of the left bronchial tree.
- C. Examination of the right bronchial tree, then inspection and biopsy of the lesion on the left.
- D. Inspection and biopsy of the lesion on the left, then examination of the right bronchial tree.



Answer III.5 A

The lesion is noted in the right main bronchus. The anterior cartilaginous rings and posterior membrane of the trachea are well visualized. It is prudent to proceed with an examination of the left bronchial tree before intervening in any way on the right side. This way, the presumed normal airway is examined and secretions are cleared. Should bleeding occur after biopsy of the lesion on the right, the bronchoscopist will know that the left airway is normal, able to assure respiration, and that there are no contra lateral abnormalities that might effect patient management.



Question III.6: While intubating a patient over the flexible bronchoscope, it suddenly becomes difficult to advance the bronchoscope. Although you are able to see the vocal cords, it is impossible to advance the endotracheal tube over the bronchoscope. What happened and what should you do next?

- A. The bending tip of the bronchoscope broke. You remove the bronchoscope from the endotracheal tube.
- B. The tip of the bronchoscope has accidentally passed through the Murphy eye of the endotracheal tube. You remove the scope and the tube together as an ensemble.
- C. The polyurethane covering of the bronchoscope has slipped and intussuscepted over itself, occluding the endotracheal tube lumen. You remove the bronchoscope from the endotracheal tube.
- D. The tip of the bronchoscope is flexed too much and the endotracheal tube is caught in the aryepiglottic fold. You partially withdraw the endotracheal tube over the bronchoscope.

Answer III.6: B

Each of the above problems can be encountered during intubation over a flexible bronchoscope. It is probably wisest to remove the bronchoscope and endotracheal tube together as a unit. If one withdraws one without the other, one risks damaging the bronchoscope. In addition, the problem may not be fixed.

Before intubating over a bronchoscope, one should fully load the endotracheal tube onto the bronchoscope under direct vision, taking care to identify the radio-opaque markers on the tube, as well as the Murphy eye and direction of the distal opening of the endotracheal tube. Some experts believe that the endotracheal tube should remain fully loaded onto the bronchoscope until the scope is passed beyond the vocal cords. The endotracheal tube is then fed into the trachea using the Seldinger technique.

Other experts recognize that on some occasions, such as when there is subglottic stenosis, laryngeal edema, tumor, blood or secretions, it might be preferable to keep the tip of the bronchoscope inside the endotracheal tube. The bronchoscope-endotracheal tube ensemble is then passed simultaneously past the cords. In case of severe tracheal stenosis, this technique avoids blind forceful dilation of the stricture as the bronchoscopist can see and feel the tube enter the stenotic area.

Each of the above techniques should be practiced on inanimate models. The bronchoscopist should use the technique with which he or she is most experienced, and always choose the safest technique based on the patient's underlying illness and ventilatory status.



Question III.7: Glutaraldehyde is frequently used for bronchoscope disinfection. All of the following side effects can be noted in persons exposed to this chemical **except**

- A. Headache
- B. Conjunctivitis
- C. Dermatitis
- D. Asthma-like symptoms
- E. Diarrhea

Answer III.7 : E

Exposure to Glutaraldehyde may cause nasal irritation and all the other symptoms listed above except diarrhea. It is important that cleaning areas be well ventilated. Automated cleaning and disinfecting machines relieve personnel from the time-consuming manual disinfection process. They do not replace manual cleaning that is necessary before and often after machine disinfection. Specific infectious outbreaks have been reported with a variety of organisms, and cross infection has occurred between bronchoscopes and among patients.

For example, organisms have been found in the rinse water of automated machines. Fundamental errors in disinfection and cleaning regularly occur in many institutions. There is substantial intrahospital and interhospital variability regarding policies and procedures for bronchoscope decontamination, cleaning, disinfection, and maintenance.

Close collaboration between infectious disease specialists (hospital epidemiologists), bronchoscopists, nursing personnel is advantageous. Learning sterilization and cleaning procedures and policies can help future bronchoscopists institute appropriate rules and regulations in their own hospitals later on.

Question III.8: All of the following statements pertaining to bronchoscope cleaning and disinfection are correct **except**.

- A. High-level disinfection with 2% Glutaraldehyde for 45 minutes inactivates all fungi, viruses, and vegetative organisms.
- B. High-level disinfection with 2% Glutaraldehyde for 45 minutes will not inactivate all bacterial spores.
- C. Video bronchoscopes with a distal CCD chip are more likely to be damaged by Glutaraldehyde disinfection than fiberoptic bronchoscopes.
- D. A positive leak test can indicate damage to the proximal polyurethane or distal rubber sheath of the insertion tube, or rupture of the integrity of the working channel of a flexible bronchoscope.

Answer III.8: C

Video bronchoscopes are as likely to be damaged by Glutaraldehyde as fiberoptic scopes. The CCD (charge coupled device) is a solid-state imaging sensor that is able to produce higher resolution images than a purely fiberoptic system. Fiberoptic bundles are still used in the light guide and universal cord. High-level disinfection requires a 45 minutes immersion to inactivate all fungi, viruses, and vegetative organisms, as well as about 95% of bacterial spores. To eradicate all mycobacteria, a 45 minutes immersion is necessary.

In fact, the 10 minutes immersion time used in many institutions to accelerate bronchoscope turn around time eradicates 99.8 % of Mycobacteria. Glutaraldehyde-based chemicals such as Cidex or Sporicidin corrode the steel components of any bronchoscope after 24 hours of contact time. These chemical solutions can be toxic to exposed persons.

Question III.9: During fluoroscopy, x-rays that pass through the patient and strike the image detector or fluoroscopic screens is called

- A. Scattered radiation
- B. Remnant radiation
- C. Primary radiation

Answer III.9: B

Primary x-rays are those photons emitted by the x-ray tube, whereas scattered x-rays are those photons produced when primary photons collide with electrons in matter. Did you think this information is irrelevant? In the United States, many states or institutions require certification (by studying for and passing a special examination) in order to personally control a fluoroscopy machine!

Question III.10: While using fluoroscopy, scatter of radiation is increased when

- A. Allied voltage (kVp) is decreased
- B. Wavelength is decreased
- C. Tissue density is decreased
- D. Tissue thickness is increased

Answer III.10: D

Scatter, also known as Compton scatter, is non-useful ionization of patient tissue caused by x-ray bombardment. Scatter occurs when an x-ray photon with increased energy strikes an electron and is deviated from its original path. This is potentially caused by increased voltage or decreased wavelength, and also when tissues thickness is increased and tissue density is increased. The x-ray photon thus travels in a different direction, but with less energy.

An increase in scatter diminishes the quality of the fluoroscopic image, and decreases the contrast of the image seen on the monitor by increasing what is referred to as quantum mottle. Quantum mottle looks like “crawling ants” on the screen. It results from an insufficient number of photons and can be reduced by increasing the milliamperage i.e. anode tube current.

Question III.11: Which of the following might prompt you to carefully reexamine the indications for bronchoscopy in the intensive care unit of your institution

- A. Bronchoscopy is frequently performed in critically ill patients with copious secretions and elevated airway pressures while on mechanical ventilation
- B. Bronchoscopy is frequently performed in critically ill patients without radiographic evidence of atelectasis, and has not prompted significant changes in medical management
- C. Bronchoscopy is frequently performed in critically ill patients with new onset of hemoptysis
- D. Bronchoscopy is frequently performed in critically ill patients with new or persistent radiographic pulmonary infiltrates despite use of empiric antibiotics

Answer III.11: B

Bronchoscopy is frequently indicated and performed in critically ill patients. For example, accepted indications include copious secretions that cannot be cleared by routine suctioning, persistent or acute unexplained hypoxemia, unexplained failure to wean from mechanical ventilation, new onset of hemoptysis, pulmonary infiltrates with suspicion for infection when the bronchoscopic procedure is likely to alter therapy, and persistent or hemodynamically significant radiographic atelectasis that is unresponsive to chest physical therapy or suctioning.

If it appears that numerous procedures are being performed without good evidence of radiographic abnormalities, impaired oxygenation or ventilation status, or difficulties with secretion management, indications for bronchoscopy should probably be closely examined to be certain that procedures are being performed in the appropriate circumstances.

Of course, the decision to perform bronchoscopy can often be based on a subjective assessment of the situation rather than on hard objective data. This can easily lead to bronchoscopy in the intensive care unit being easily performed in excess. Practices can also vary according to available resources, staffing, and referring physician preferences.

Question III.12: Which of the following intubation-oral airways will most likely allow adequate visualization of the larynx and vocal cords, even if the airway is inserted too far?

- A. Berman pharyngeal airway.
- B. Williams airway intubator.
- C. Ovassapian airway

Answer III.12: C

Oral intubating airways help the bronchoscopist keep the flexible bronchoscope in the midline, expose laryngeal structures, and maintain an open pharynx. The Ovassapian fiberoptic intubating airway provides an open space in the oropharynx and protects the bronchoscope from being bitten by the patient. The airway can be removed without disconnecting the endotracheal tube adaptor. The wider distal half of the airway prevents the tongue and soft tissues of the anterior pharyngeal wall from falling back and obstructing the view of the glottis. The proximal half has a pair of guide walls that provide a space for the bronchoscope and endotracheal tube. This airway accommodates endotracheal tubes up to 9 mm inner diameter.

The Berman airway is also recommended for bronchoscopic intubation, but its length and tubular shape hinder maneuverability of the flexible bronchoscope once it is inserted. If the distal end of this airway is not perfectly in line with the glottic aperture, the airway must be partially withdrawn in order to expose the vocal cords. The Williams airway intubator was designed for blind orotracheal intubation. Its distal half has an open lingual surface, which makes lateral and anteroposterior maneuverability of the bronchoscope difficult. In order to remove the Williams airway after intubation, the endotracheal tube adaptor must be removed prior to intubation.



Question III.13: You are about to describe a tracheal abnormality to a surgeon. In which of the following might she be most interested

- A. Distance of the abnormality from the carina
- B. Whether the abnormality has a wide or narrow base
- C. Location of the abnormality in relation to the bronchial wall
- D. Size of the abnormality (length, diameter, degree of airway obstruction)
- E. Distance of the abnormality from the inferior margin of the vocal cords

Answer III.13: E

Well, you probably had to think about this one. In fact, when considering a tracheal lesion for surgical repair, all of the above should be well described. The reason the noted response is E, is because the distance from the inferior margin of the vocal cords, may, in many instances, be the deciding factor regarding evaluation of complexity of surgical resection.

Of course, other components of tracheal disease that should be described are length of the stricture in centimeters and number of cartilage rings involved, consistency (firm, rubbery, soft), appearance (glistening, vascular), fragility (oozing, actively bleeding, pus-filled), color (white, red, dark, yellow), shape (regular, round, irregular, elongated, bulging), dynamics (mobile with respiration or cough, ball-valving, immobile), degree of airway wall involvement, associated airway wall abnormalities (malacia, cartilaginous destruction, foreign body). Having a videotape of the examination available for review by surgical colleagues is always appreciated.

Question III.14: A 76-year-old patient with chronic cough, difficulty swallowing and new onset hoarseness is referred for bronchoscopic evaluation. 1 mg of Midazolam is injected intravenously and abundant topical anesthetic is applied to the oropharynx and larynx. The vocal cords move normally, but a firm lesion resembling adenoid cystic carcinoma obstructing 20 percent of the subglottis is seen. Because of the lesion's proximity to the vocal cords, no biopsies are obtained. About one hour after the procedure the patient develops a bluish discoloration of the lips. Arterial oxygen saturation decreases from 98 percent to 88 percent despite administration of supplemental oxygen. The patient has become anxious and combative in the recovery area. Resting heart rate increases to from 110 to 150. The most likely cause for this patient's symptoms is.

- A. Cetacaine spray induced methemoglobinemia
- B. Procedure-induced laryngospasm
- C. Tetracaine toxicity
- D. Myocardial infarction from prolonged hypoxemia
- E. Lidocaine toxicity

Answer III.14: A

Methemoglobinemia can result from exposure to Benzocaine, the Esther family local anesthetic contained in Cetacaine and Hurricane, two aerosol sprays frequently used for topical anesthesia of the oropharynx. Risk is greatest in the elderly and in infants. Diagnosis should be suspected in patients who develop cyanosis with bluish discoloration of the skin, lips and mucous membranes. It is confirmed by Co-oximetry. Up to a methemoglobin level of 20 percent, oxygen saturation drops by about half the methemoglobin percentage. Patients develop a functional anemia because the ferrous hemes of hemoglobin are unable to bind oxygen. Treatment is by intravenous injection of 1-2 mg/kg Methylene blue.

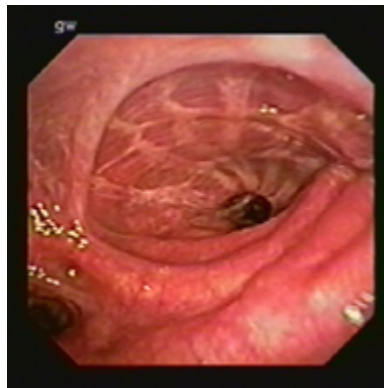
Acute onset laryngospasm would cause stridor and respiratory distress. Tetracaine, a long-acting and potent topical anesthetic, is also a component of Cetacaine aerosol spray (2% Tetracaine, 14% Benzocaine, 2% butyl ester of *para*aminobenzoic acid). Tetracaine is a derivative of *para*aminobenzoic acid, and can thus cause allergic reactions. Its rapid rate of absorption and prolonged duration of action compared to Lidocaine are in part responsible for its narrow margin of safety when used for bronchoscopy. Systemic effects include convulsions and sudden death. Other symptoms include restlessness, numbness around the lips and mouth, tonic-clonic seizures, hypotension, and apnea. Lidocaine is an amide local anesthetic that is less potent and has a shorter duration of action than Tetracaine. It comes in various solutions ranging from 0.5% to 4%. The 4% solution provides about 15 minutes of reliable topical anesthesia. A 10% solution is available for spraying the oral and nasopharynx. Each spray delivers 0.1 ml (10 mg) of Lidocaine. A 2.5% and 5% gel is also available, and usually preferred by patients for anesthesia of the nasal passages. Peak concentration is usually reached within 30 minutes of airway application.

The maximum dose of Lidocaine recommended is 300 mg in adults. Blood concentration is directly related to total dose used regardless of the concentration of solution employed. When Lidocaine is administered by aerosol spray, it is absorbed less rapidly than if it is administered by ultrasonic nebulizer. In addition, when swallowed, less Lidocaine is absorbed into the bloodstream than when it is deposited onto the mucous membranes of the upper and lower respiratory tract.

Because Lidocaine is metabolized in the liver, patients with hepatic dysfunction or low cardiac output will have high Lidocaine plasma levels. Side effects include hyperactivity, restlessness, tingling of the lips, slurred speech and tremors. At higher blood levels, seizures and cardiorespiratory depression occur, including bradycardia, hypotension, and cardiac arrest.

Question III.15: Tracheomalacia is defined as a loss of longitudinal elastic fibers of the posterior tracheal membrane with or without destruction or damage to tracheal cartilage leading to loss of rigidity and tracheal collapse. During an airway examination, which of the following is seen.

- A. Collapse of the malacic intrathoracic segment during expiration and/or collapse of the malacic cervical segment during inspiration
- B. Collapse of the malacic intrathoracic segment during inspiration and/or collapse of the malacic cervical segment during expiration
- C. Collapse of the malacic intrathoracic segment during expiration and/or collapse of the malacic cervical segment also during expiration
- D. Collapse of the malacic segment during expiration or inspiration with substantial inward movement of the pars membranosa

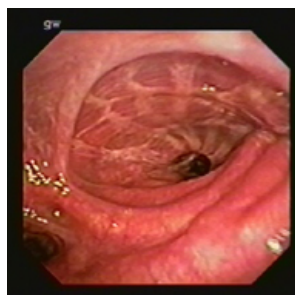


Answer III.15:

A

Inspiratory collapse should be noted in a malacic cervical trachea when the malacic tracheal wall is sucked inwards by negative intratracheal pressure. During expiration, collapse of the intrathoracic malacic segment occurs when intrathoracic pressure exceeds intratracheal pressure. Tracheomalacia can be noted during bronchoscopic examination and electron beam computed tomography scanning. It should be suspected in patients after longstanding intubation, in patients with history of pneumonectomy and herniation of the remaining lung into the vacant hemithorax, and in patients with dyspnea, difficulty raising secretions, and chronic cough.

Usually, malacia is diagnosed when cartilaginous collapse is noted during airway inspection. Some experts believe that it should be differentiated from dynamic airway collapse where significant obstruction is due to inward movement of the pars membranosa, but without evidence of cartilaginous destruction or loss of rigidity and shape of cartilaginous rings. To avoid confusion or misunderstandings, one should be explicit in describing the extent, severity, location, and nature of all anomalies noted.



Loss of support at junction between anterior lying cartilaginous rings and pars membranosa.

Question III.16: All of the following reasons for immediate intubation of the inhalation injury victim are correct **except**

- A. Intubation before the development of significant airway edema and respiratory compromise avoids an emergency procedure, the outcome of which may be disastrous.
- B. Burn-related chest restriction and circumferential neck burn related airway obstruction further reduces ventilatory flow.
- C. Noted airway abnormalities such as soot, charring, mucosal necrosis, edema, and inflammation below the level of the carina antedate blood gas and radiographic changes suggestive of parenchymal injury.
- D. Parenchymal damage is frequently delayed.
- E. Maximum upper airway edema occurs within the first 24 hours after injury

Answer III.16: E

Actually, maximum upper airway edema peaks as late as 36-48 hours after injury! If a patient is intubated, extubation is frequently delayed until all edema has resolved. The absence of edema, stricture, or subglottic swelling during bronchoscopically-guided extubation, or a leak around the endotracheal tube are two indicators that are used to help determine the time for extubation.

When patients present with inhalation injury, chest radiographs and arterial blood gases are notoriously unhelpful in predicting whether parenchymal injury has occurred. In addition, findings may be delayed hours and even days. For these reasons, in many burn centers, all smoke exposed victims are bronchoscoped routinely. Presence of dyspnea, wheezing, laryngeal abnormalities, tracheobronchitis, and abnormal arterial blood gases or chest radiographs almost always warrants intubation. Delayed problems include tracheobronchial tissue sloughing, decreased mucociliary clearance, mucous plugging, atelectasis, impaired clearance of secretions, pneumonia, pulmonary edema and acute respiratory distress syndrome.

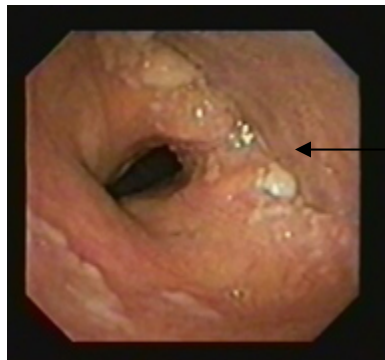
Question III.17: All of the following statements about inhalation injury in burn victims are correct **except**

- A. The use of bronchoscopy for diagnosis has resulted in a recognized increase of the incidence of inhalation injury from a 2-15 percent incidence (based on history, carbonaceous sputum, and facial burns) to as high as 30 percent incidence.
- B. When inhalation injury is present, mortality is greater than when cutaneous burns alone are noted.
- C. Bronchoscopic findings consistent with inhalation injury in burn victims are usually airway edema, inflammation, or carbonaceous secretions (presence of soot).
- D. Erythema, hemorrhage and ulceration rarely occur within the tracheobronchial tree.
- E. Gaseous and particulate products of incomplete combustion are associated with the tracheobronchial injury of smoke inhalation.

Answer III.17: D

Erythema, hemorrhage and ulcerations are frequently noted as a direct effect of thermal injury to the upper or lower airways. This occurs most frequently from hot smoke or steam inhalation, but can also result from direct heat injury during therapeutic bronchoscopic electrocautery and laser resection. Although the upper airway protects the lower airway and parenchyma, any exposures to hot air may cause reflex laryngospasm. Laryngeal complications can occur acutely, but also many hours after injury. They are frequently life threatening. Edema and inflammation are proof of upper airway injury and are often immediately visible to the bronchoscopist.

The presence of carbonaceous secretions in the oropharynx also suggests airway damage. Lower airway injury, however, is typically delayed. Many experts say that “if in doubt” about upper or lower airway injury, immediate intubation should be preferred to a “watch and wait” approach. The presence and extent of lower airway injury can be ascertained on follow-up flexible bronchoscopy. Extubation should be done carefully because of the risk of persistent laryngeal and subglottic edema as well as laryngeal swelling due directly to the endotracheal tube or prolonged intubation.



Laryngeal edema and ulcerations from thermal injury in a burn victim

Question III.18 A 63-year-old man comes to your office because of a three-year history of dyspnea. He is short of breath with minimal exertion. Asthma was diagnosed one year ago. He is using inhaled bronchodilators and oral corticosteroids occasionally. Physical examination reveals mild stridor. Laboratory tests are normal. Chest radiograph and computed tomography scan of the chest reveal a 3 cm intraluminal mass narrowing the midportion of the trachea to 5 mm. There is no evidence of extraluminal tumor or enlarged mediastinal adenopathy. Flexible bronchoscopy confirms the presence of the 3 cm intraluminal mass in the midtrachea. Airway lumen is narrowed but adequate. Biopsy reveals adenoid cystic carcinoma. Which of the following would you recommend next

- A. Referral to radiation oncology for external beam irradiation
- B. Referral to medical oncology for systemic chemotherapy
- C. Referral to interventional Pulmonology for Nd:YAG laser resection
- D. Referral to thoracic surgery for sleeve resection of the trachea

Answer III.18: D

The major question here is whether this patient should be referred for laser resection or immediate surgery. Adenoid cystic carcinoma (previously known as cylindroma) accounts for about 0.1% of all primary lung tumors and 10% of bronchial adenomas (which also include carcinoid tumors and mucoepidermoid tumors). If the patient is clinically and hemodynamically stable, has no contraindications for surgery, and is willing to undergoing tracheal resection, referral for sleeve resection with removal of at least 6 tracheal rings (there are about two tracheal cartilages per centimeter) and reanastomosis is warranted.

Often, surgical margins reveal microscopic tumor. Many patients are subsequently referred for external beam radiation therapy. Despite resection, recurrence occurs in more than 50% of patients, and metastases are known to occur to the lung, brain, liver, bones and skin. Tumors usually grow very slowly. Even in case of tumor recurrence, survival can be 10–15 years.

Question III.19: It is most likely that the patient with this abnormal airway seen in the Figure has which one of the following disorders

- A. Sarcoidosis
- B. Relapsing polychondritis
- C. Teratoma with extrinsic tracheal compression
- D. Underlying chronic obstructive pulmonary disease
- E. Pulmonary amyloidosis

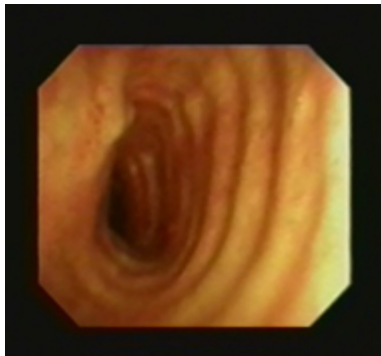


Answer III.19: D

The figure is that of a saber-sheath or scabbard trachea. Saber-sheath trachea is defined as a trachea with excessive transverse narrowing and widened sagittal diameter of the intrathoracic portion of the trachea. This is very different from the C-shaped trachea seen in about 49% of normal adults. The saber has been described in up to 5 % of elderly men. In these instances, ossification of tracheal rings may also be found. Usually, the abnormality spares the cervical portion.

The majority of patients with saber-shaped trachea have chronic obstructive pulmonary disease, and it is believed that the narrowing is related to air-trapping in emphysematous upper lobes, chronic cough, and cartilaginous degeneration. When discovered, additional study by computed tomography scanning may be warranted. The differential diagnosis includes extrinsic compression by extratracheal mediastinal mass, tracheobronchopathia osteochondroplastica, amyloidosis, relapsing polychondritis, and saber-sheath trachea in patients with excessive kyphosis.

Saber-sheath trachea





C-shaped trachea



Horseshoe-shaped trachea

Question III.20: You are asked to emergently bronchoscope a 33-year-old male in the intensive care unit. The patient has been intubated and mechanically ventilated for the past week. He was the victim of a motorcycle accident causing closed-head trauma and loss of consciousness. Respiratory therapy just noted fresh blood tinged secretions on suctioning. Some watery secretions and blood are in the endotracheal tube. The patient is hemodynamically stable, but hypertensive. Which of the following bronchoscopic appearances is most likely to account for this patient's problem?

- A. Diffuse tracheobronchial erythema, purulent secretions, and tissue sloughing.
- B. Diffuse swelling and erythema of bilateral airways.
- C. Raised whitish plaques with surrounding erythema in the distal lower lobe bronchi.
- D. Edema, erythema, and petechia in the right main bronchus and on the main carina.
- E. Swollen airway mucosa and pink frothy secretions.

Answer III.20. D

A frequent cause of hemoptysis during mechanical ventilation is suction trauma due to stiff suction catheters. The figures below shows petechia and erythematous swelling from aggressive suctioning with a stiff-tipped catheter. Underlying tracheal and bronchial mucosa is often erythematous, swollen and easily bruised.

Other causes of hemoptysis that must be excluded are necrotizing pneumonia (response A), severe tracheobronchitis (response B), tracheobronchial herpes (response C), pulmonary edema (response E), mycobacterial infection, pulmonary thromboembolism, pulmonary artery dissection from a pulmonary artery catheter, erosions from the endotracheal tube cuff, and innominate artery-tracheal fistula.

Of course, bleeding can also be due to underlying diseases such as Wegener's granulomatosis, Goodpasture's syndrome and other vasculitities, neoplasms, and disseminated intravascular coagulopathy.



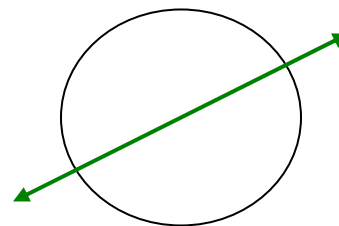
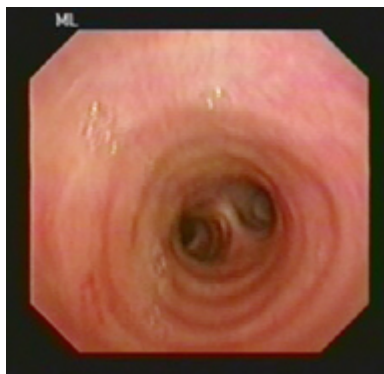
Question III.21: While performing a bronchoscopy in an adult patient with presumably normal airways, you ask the patient to inhale, exhale, and cough. Which of the following changes in airway anatomy would be abnormal

- A. The tracheal length increased by 20 % (about 1.5 cm) during normal inspiration
- B. The tracheal transverse diameter decreased by 10% (about 2 mm) during normal expiration
- C. The tracheal transverse diameter decreased by 30 % during cough
- D. The tracheal sagittal diameter decreased to 0 during cough
- E. The tracheal sagittal diameter decreased by 30 % during normal expiration

Answer III.21: E

The cross-sectional shape of the trachea is characterized by the ratio of transverse (separates trachea into front and back) and sagittal (separates trachea into left and right) diameters. Women tend to preserve a round configuration, while men tend to have some sagittal widening and transverse narrowing. The tracheal lumen changes dimensions depending on the phase of the respiratory cycle. For example, during coughing, intrathoracic pressure increases and becomes supra-atmospheric. This results in a narrowing of intrathoracic tracheal lumen as witnessed by decreased sagittal and transverse diameters.

The invagination of the posterior membrane can easily reduce the sagittal diameter to zero. Usually there should be no significant change in tracheal sagittal diameter during normal expiration because surrounding negative intrathoracic pressure supports airway patency. If there is intrathoracic tracheomalacia, expiratory collapse will occur, whereas extrathoracic tracheomalacia results in variable inspiratory obstruction, the major force opposing collapse being the upper attachment to the cricoid cartilage.



Transverse

Question III.22: All of the following “habits” can cause a bronchoscopist to miss a diagnosis or inadvertently harm a patient **except**.

- A. Placing one hand under the chin while the other pushes downward on the top of the head while preparing to perform rigid laryngoscopic intubation.
- B. Rapidly withdrawing the flexible bronchoscope without visualization and without careful attention to the subglottic larynx.
- C. Repeatedly administering additional amounts of topical anesthetic to a coughing patient
- D. Routinely performing the bronchoscopic airway inspection in the same sequence in all patients.

Answer III.22: D

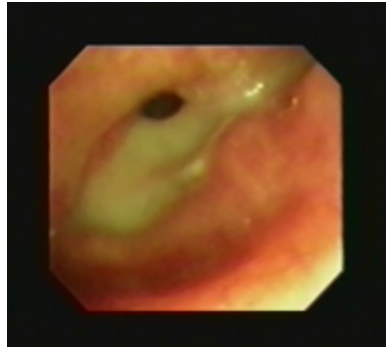
Routinely performing the bronchoscopic inspection in the same sequence in all patients is a good habit. The “normal” airways should be inspected first, leaving observations of abnormalities for last. By inspecting segmental bronchial anatomy in the same order, the bronchoscopist will never inadvertently overlook a segment. Many bronchoscopists leave the upper lobe bronchi for last because inspection of these segments can be more difficult, and because inspection of these segments often causes patients to cough. The habit of placing a hand on the chin while pushing down on the top of the head should be avoided because this maneuver can drive the odontoid process into the medulla oblongata. This is especially dangerous in patients with weakened C 1 vertebra such as that which occurs in trauma victims, in patients with bony erosion from metastases or primary tumor, and in patients with Paget’s disease, severe osteoporosis, or platybasia (softening of skull bones).

Rapid removal of the bronchoscope from the airway without a repeat inspection of the airways and subglottis is unwarranted. For trainees, it is great practice to remain in the midline up to and above the larynx. Lessons learned would come in handy the day one faces a difficult intubation! In addition, careful inspection may detect abnormalities not seen during bronchoscope insertion. These include subglottic strictures, vocal cord polyps or contact ulcers, small endobronchial abnormalities, and tracheoesophageal fistulas. Administering additional topical anesthetic or conscious sedation agents because a patient is coughing or is increasingly anxious or combative can abolish any existing airway reflexes remaining for the patient. In addition, it may delay recognition of other problems such as drug reaction or mental status changes from hypoxemia, and prompt adverse events caused by excess medication.

Many patients can be “talked down” or soothed by a confident and gentle bronchoscopist and assistant. In others, it might be best to temporarily stop the procedure until the patient calms down. Improper bronchoscopy technique such as repeatedly scraping the bronchoscope against the bronchial wall, frequent suctioning, and repeated unsuccessful attempts to enter an upper lobe bronchus is often responsible for patient discomfort.

Question III.23: The airway secretions seen in the Figure below should be described as

- A. Clear
- B. Viscous
- C. Muroid
- D. Purulent

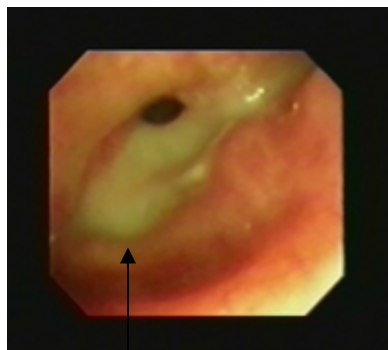


Answer III.23

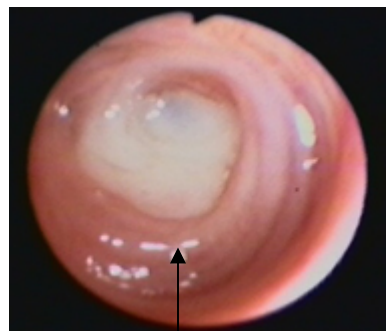
D

Purulent secretions can be yellow, green, white, or greenish-brown. Secretions can also be gray, blood-tinged, bloody, and black. As for all secretions, other descriptive terms include clear, milky, watery, thick, tenacious, scant, and abundant. Viscous means possessing viscosity, which is a property of a body by which flow occurs inside it. The term is inappropriately used in bronchoscopy reports.

Mucoid refers to a group of glycoproteins resembling mucin, as in normal secretions present in the cornea and in cysts. This is a descriptive term that is frequently used in bronchoscopy reports. Most readers understand that it describes secretions that are slightly tenacious, thick, and yet clear.



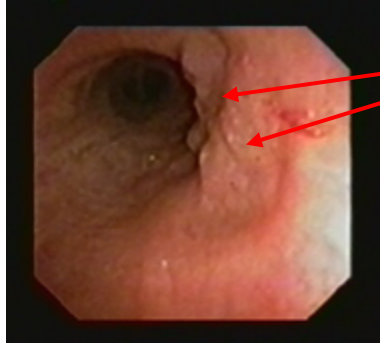
Thick, purulent green



Milky white

Question III.24: The appearance of the bronchial mucosa along the lateral wall of the bronchus shown in the Figure below should be described as

- A. Pale, raised, and granular
- B. Thickened and erythematous
- C. Erythematous, shiny and edematous
- D. Thickened, red and swollen



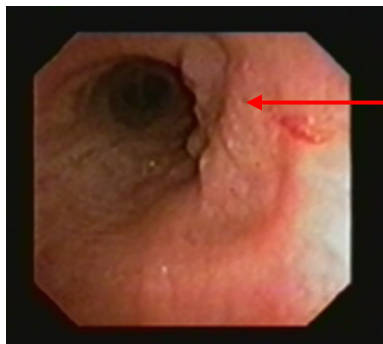
Answer III.24:

A

The mucosa of the lateral wall of this bronchus is pale, raised and granular. It is difficult to assure a universal nomenclature for describing mucosal changes. The important thing is to develop a vocabulary for airway abnormalities that is constant, clear, and precise. As the operator, there should be a consistency in how you describe abnormalities. Misinterpretations should be avoided. Whenever possible, attach a photograph to the bronchoscopy report.

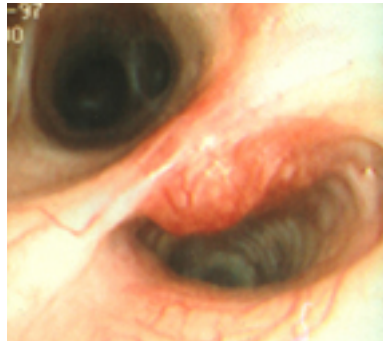
Use simple vocabulary. The location, size, and extent of each abnormality should be noted. Its impact on airway caliber and the degree of stenosis or airway narrowing should be estimated. Friability and texture (granular, waxy, shiny, thickened, swollen) should be noted, and concomitant findings (dynamic collapse, cartilaginous damage, focal, extensive or diffuse infiltration, or extrinsic compression) can be described. Lesions should be referred to as intraluminal (nodular, polypoid, or membranous) or extrinsic. Color might be important (pale, dark, brownish-black, white, yellow, greenish, red, purplish).

Airways might be inflamed, swollen or erythematous...but does not “inflamed,” suggest swollen and erythematous? The bronchoscopy report should tell a story that everyone could read and understand the same way. Bronchial segments should be numbered and named. Lymph nodes sampled should be named and noted using the widely accepted IASLC nodal station classification or the less widely accepted bronchoscopic classification system. In truth...it isn't easy.



Question III.25: The appearance of the airway abnormality shown in the Figure below should be described as

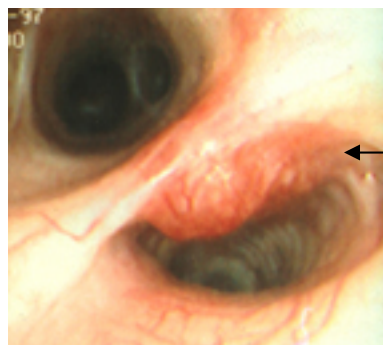
- A. Polypoid
- B. Nodular invasive
- C. Superficial invasive
- D. Intraepithelial neoplasia



Answer III.25: B

A generally accepted, but infrequently referred to classification of bronchoscopic findings is that of the Japan Lung Cancer Society. In this classification, bronchoscopic findings are described as mucosal or submucosal. Early stage cancer is a mucosal histopathologic change. Polypoid tumors are described as tumors attached to the bronchial wall at their base only: a typical lesion extends into the airway lumen and moves with respiration.

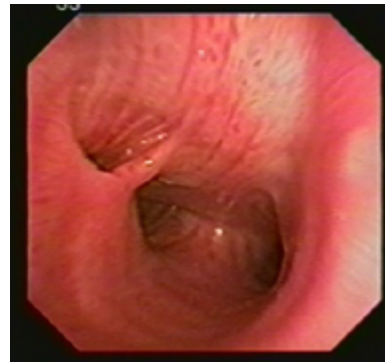
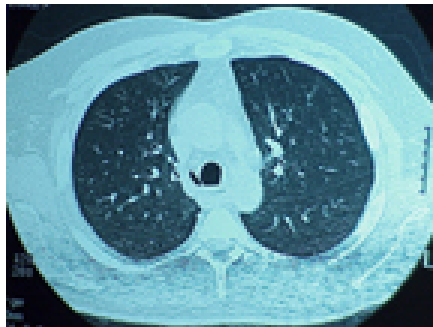
A nodular tumor has a mound-like shape and also extends into the bronchial lumen. The surface of both polypoid and nodular lesions may be granular, engorged with capillary vessels, or covered with necrotic material.



Wide-base nodular lesion

Question III.26: The bronchial anomaly seen in the figures below is.

- A. A subapical segment of a right lower lobe bronchus
- B. A tracheal bronchus, extending downwards and laterally from the right tracheal wall
- C. An accessory right upper lobe bronchus



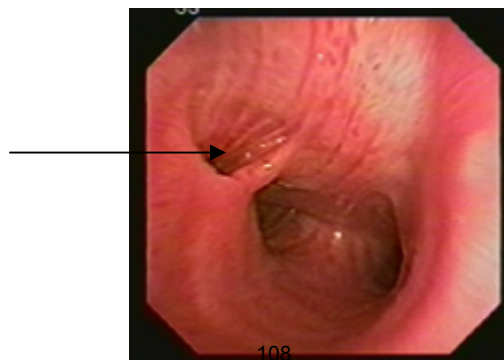
Answer III.26: B

The tracheal bronchus, also called “pig bronchus” because of its frequent presence in pigs, is usually a large developmental variation of the bronchial supply to an upper lobe, in this case, the right upper lobe bronchus. In humans, the tracheal bronchus is seven times more frequent on the right side of the trachea than the left. When it originates on the left, it is usually associated with other congenital abnormalities.

The tracheal bronchus can be seen in as many as 1% of individuals, although most authors cite a frequency of 0.25%. It is also seen in whales, giraffes, sheep, goats, and camels. In humans it is usually an incidental finding on bronchoscopy, chest radiograph, or computed tomography scan. When the orifice of the tracheal bronchus is relatively horizontal, recurrent episodes of aspiration, cough, bronchitis, and pneumonia may occur.

There are several types of tracheal bronchus. The rudimentary type is a blind pouch. There is the “displaced” bronchus, the most common variant, which supplies the apical segment of the right upper lobe. In this case, the segmental bronchi to this segment are missing within a regularly placed right upper lobe bronchus. The supernumerary supplies the right upper lobe in addition to a normal right upper lobe bronchus. Finally, there is the right upper lobe tracheal bronchus, which has three normal segmental bronchi, all arising above the main carina, but without a right upper lobe bronchus below the tracheal bifurcation.

Tracheal Bronchus
located 2 cm above
the carina along
right lateral wall of
trachea



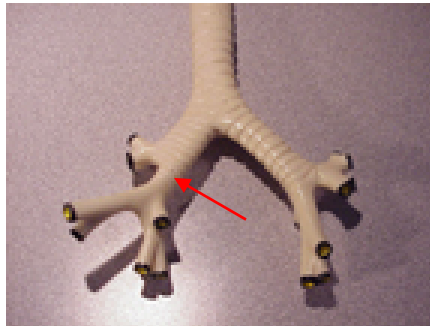
Question III.27: All of the following airway dimensions in the adult are correct except.

- A. The left lower lobe bronchus beyond the origin of the superior segment is usually 1 cm in length before giving rise to the basal segmental bronchi.
- B. The usual length of the trachea (distance from the cricoid cartilage to the main carina) ranges from 9-15 cm.
- C. The usual internal caliber of the trachea ranges from 1.2 cm -2.4 cm.
- D. The right upper lobe bronchus is usually located about 1.5-2.0 cm below the main carina.
- E. The usual length of the bronchus intermedius ranges from 2-4 cm beyond the origin of the right upper lobe bronchus.

Answer III.27: E

The bronchus intermedius of the right bronchial tree is actually quite short, extending for 1.0-2.5 cm until its anterior wall extends into and becomes the middle lobe bronchus. Its posterior wall extends into and becomes the right lower lobe bronchus.

Volume loss caused by pleural effusion, radiation fibrosis, elevated right hemidiaphragm, as well as traction or torsion from a fibrotic or scarred right upper lobe often cause shortening of the bronchus intermedius.



Question III.28. All of the following may damage a flexible bronchoscope except:

- A. Forceps biopsy in the apical segment of the right upper lobe.
- B. Bronchoalveolar lavage in the lingula
- C. Bronchoscopy through an endotracheal tube in a mechanically ventilated patient.
- D. Transcarinal needle aspiration
- E. Catheter brushing within the medial basal segment of the right lower lobe.

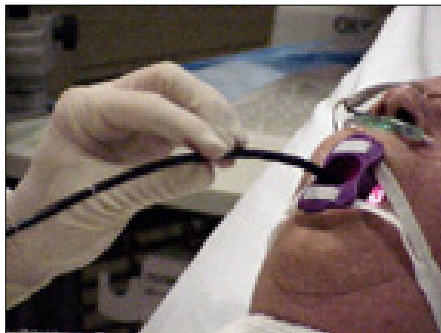
Answer III.28: B

Bronchoalveolar lavage should never damage a bronchoscope. Passing a forceps, needle, or even a catheter, however, through the working channel of a flexible bronchoscope can easily damage it. The risk for damage increases when the instrument is forced through an acute angle formed by the bronchoscope as it enters the apical segment of an upper lobe bronchus. In these cases it is safer and easier to keep the tip of the bronchoscope at the entrance of the upper lobe bronchus, and to pass the forceps into the apical segment, watching it pass beyond the tip of the bronchoscope. If the bronchoscope needs to be wedged into the apical segment, it can be advanced gently over the forceps.

A bronchoscope can be damaged anytime it is inserted through an endotracheal tube, even when one assumes that a patient is paralyzed. Paralysis may be incomplete. Other times, bite blockers slip and the endotracheal tube becomes wedged between the teeth. Lubrication with silicone, xylocaine gel, or normal saline solution should be routine before inserting the bronchoscope into the endotracheal tube. Acute angles between the scope and the endotracheal tube at the scope's insertion site should be avoided. An assistant can be asked to hold the scope and endotracheal tube upright.

A bite block should be used whenever a flexible bronchoscope is inserted into the mouth, regardless of the patient's level of consciousness. Short, longitudinal bite blocks used to protect endotracheal tubes from patient biting slip easily. The full sized mouth bite block is a safer tool that can be firmly held in place by an assistant, or tied into place using an around-the-head Velcro strap. The bite block can usually be placed in the middle of the mouth, displacing the endotracheal tube to the corner of the mouth, or the bite block can be placed in the corner of the mouth, displacing the endotracheal tube towards the midline. On rare occasions, it might be necessary to untape the endotracheal tube in order to place the bite block over it inside the mouth.

Note that purple bite block is attached using Velcro bands



Question III.29: All of the following statements pertaining to the safety of bronchoalveolar lavage are correct **except**

- A. BAL can cause cough, bronchospasm, and dyspnea
- B. BAL can cause a temporary decrease in Forced Expiratory Volume (FEV₁) of up to 20 %.
- C. BAL can cause transient hypoxemia persisting for up to 6 hours.
- D. BAL can cause radiographic lobar consolidation or peripheral opacities that might be suggestive of new onset procedure-related infection.
- E. BAL can cause transient fever, chills, and myalgias.

Answer III.29: D

BAL has not been shown to cause pulmonary infections, although radiographic infiltrates may be visible for up to 24 hours after a procedure. For this reason, experts advocate obtaining radiographic studies prior to BAL rather than afterwards, when the presence of an infiltrate within a lobar segment that has been lavaged may erroneously be considered pathologic.

Most experts keep patients under observation for up to 2 hours after BAL. In the presence of dyspnea or bronchospasm, inhaled bronchodilators are usually administered. Supplemental oxygen is routine until arterial saturation has returned to baseline or is normal on room air. Patients should be warned about the possibility of delayed onset fever, chills, or myalgias. In this event, Patients should be instructed to take an antipyretic or other anti-inflammatory for symptomatic relief.

Question III.30: Each of the following airway findings adversely effect staging and prognosis in a patient with bronchogenic carcinoma **except**

- A. Discovery of occult vocal cord paralysis
- B. Discovery of contralateral endobronchial nodule
- C. Discovery of main carinal involvement
- D. Discovery of infiltrating mucosal involvement within 2 centimeters of the main carina
- E. Discovery of a lesion obstructing the central airways

Answer III.30

E

Bronchoscopy plays a major role in lung cancer staging. One of the reasons for performing an “inspection” bronchoscopy in all patients with diagnosed bronchogenic carcinoma is because discovery of occult vocal cord paralysis, an ipsilateral or contralateral endobronchial metastasis, or involvement of and near the main carina alters therapeutic management and prognosis.

Discovering a lesion that obstructs the central airways might prompt endoscopic resection in order to decrease chances for post obstructive pneumonia, improve symptoms such as dyspnea and cough, and increase ventilatory function and exercise tolerance.

Often, a lesion that appears to obstruct a main bronchus and require pneumonectomy is actually originating from within a lobar bronchus and extending into the main bronchus without main bronchial wall involvement. In these cases, lobectomy or sleeve resections are possible instead of pneumonectomy. In addition, clinical Tumor stage is affected since patients might no longer have a tumor “within two centimeters of the main carina”.

The Essential Flexible Bronchoscopist

Learning bronchoscopy in the world today



MODULE IV

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE IV

Welcome to Module IV of The EFB, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this module, the learner should be able to:

1. Compare and contrast airway dimensions of the right and left bronchial trees.
2. List FIVE causes of endobronchial metastases.
3. Describe “carinal” nomenclature.
4. List right bronchial anatomy nomenclature.
5. List at least THREE different characteristics of bronchoalveolar lavage.
6. Define “intraepithelial neoplasm” and related histopathologic terms.
7. Describe at least THREE different techniques used to help remove a blood clot from the airways.
8. Describe the Ikeda classification of bronchoscopic findings and what element might be added today.
9. Compare and contrast at least FOUR different interventional bronchoscopic therapeutic modalities.
10. State why and when bronchoscopy may be helpful in patients with suspected tuberculosis.

Question IV.1: While intubating a patient over the flexible bronchoscope, the endotracheal tube is repeatedly caught on the right arytenoid cartilage. The distal tip of the bronchoscope is in the trachea. Which of the following maneuvers is most likely to help you pass the endotracheal tube between the vocal cords and into the trachea.

- A. Maintain constant downward pressure on the endotracheal tube until it “pops” off the arytenoids and enters the trachea
- B. Twist the endotracheal tube towards clockwise and counterclockwise until it “pops” off the arytenoids and enters the trachea
- C. Twist the endotracheal tube 90 degrees counterclockwise in order to reverse the locations of its beveled end and Murphy eye. Then gently advance the tube again.
- D. Withdraw the flexible bronchoscope from the trachea up into the endotracheal tube. Then reattempt intubation.
- E. Ask your assistant to withdraw the endotracheal tube while you maintain the bronchoscope in position directly below the vocal cords. This straightens the tube so that intubation can be reattempted.

Answer IV.1: C

Actually, each of the above techniques could be used. Asking an assistant to manipulate the endotracheal tube, however, is always a risk. Even while holding the bronchoscope firmly in position, it could be accidentally displaced and pulled out of the trachea. Removing the scope from the trachea into the oral or nasopharynx can also be dangerous since you might never visualize the cords again. Intubation might become impossible if blood, secretions, redundant tissues, or reflex laryngospasm impairs visualization.

As long as the bronchoscope is in the lower airways, even if intubation is delayed, oxygen can be delivered directly through the working channel of the bronchoscope into the trachea to prevent hypoxemia. The opportunity for this potentially life-saving gesture is lost if the scope is removed from the trachea.

Persistent pressure on the endotracheal tube might, on occasion, “pop” the tube off the arytenoids. However, it might land in the esophagus or aryepiglottic fold. There is also a risk of arytenoid fracture, arytenoid dislocation, and esophageal trauma. The same comment applies to twisting the endotracheal tube back and forth.

Therefore, a prudent alternative is to keep the flexible bronchoscope in position within the trachea. Gently rotate the endotracheal tube 90 degrees clockwise or counterclockwise, changing the place of the bevel tip and Murphy eye.

Beyel tip

Murphy eye



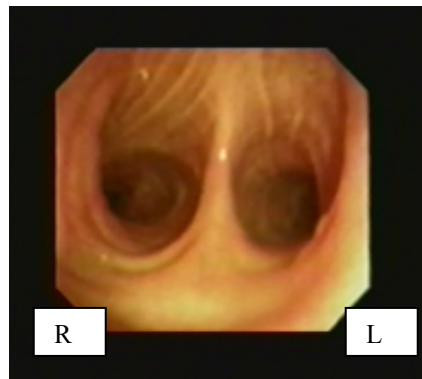
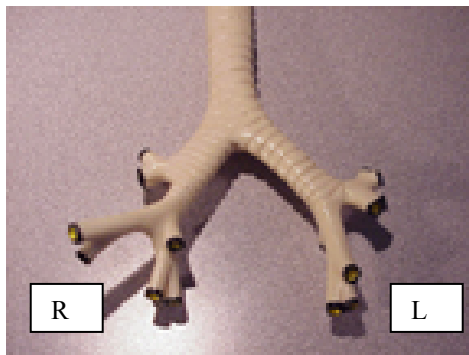
Question IV.2: All of the following approximate airway dimensions are correct except.

- A. The usual length of the left lower lobe bronchus beyond the origin of the superior segment is 1 cm.
- B. The usual length of the right upper lobe bronchus is 1.0 cm.
- C. The usual length of the left main bronchus is 4-5 cm. It bifurcates sharply from the midline of the trachea at an angle of 45 degrees.
- D. The usual length of the right main bronchus is 1.0 cm. It bifurcates at an angle of 25 degrees from the midline of the trachea.

Answer IV.2: D

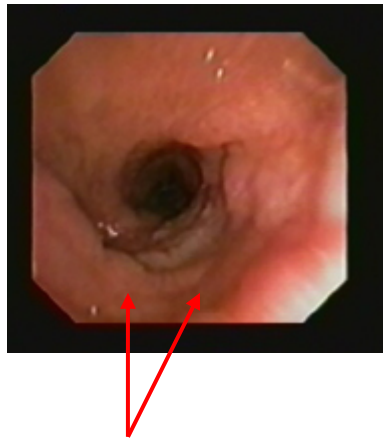
The right main bronchus is 2 cm long on average (not 1 cm as mentioned in response D), and has an internal diameter of 10-16 mm. This is slightly larger than the diameter of the left main bronchus. Because the right main bronchus is relatively straight and vertical, aspiration into this bronchus is more frequent than on the left.

The left main bronchus is much longer than the right main bronchus. It is usually 4-5 cm long. Because its lumen is narrow and relatively horizontal, rigid bronchoscopy, bronchoscopic laser resection, dilatation, and stenting of the left main bronchus is considered by many experts to be more dangerous than on the right side. The usual length of the left lower lobe bronchus beyond the origin of the superior segmental bronchus is 1 cm.



Question IV.3: The appearance of the bronchial mucosa along the anterior wall of the bronchus shown in the Figure below should be described as

- A. Pale, raised, and granular
- B. Thickened and erythematous
- C. Erythematous, shiny and edematous
- D. Thickened, erythematous and swollen

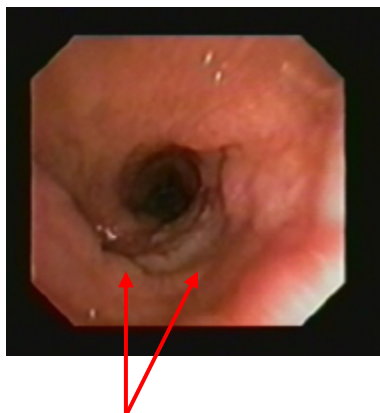


Answer IV.3: D

Thickened, erythematous, and swollen is one way to describe these abnormalities located along the anterior and lateral walls of this bronchus. Endobronchial biopsy revealed adenocarcinoma.

Assuring uniform descriptions of airway abnormalities is very difficult. Showing this photograph to five different bronchoscopists could result in five different descriptions! Wouldn't that be a fun exercise for a noon lecture?

Most important is to choose a simple vocabulary from which you select descriptive words. Always use the same words, so that your descriptions are concise and reproducible.



Thickened, erythematous, and swollen mucosa

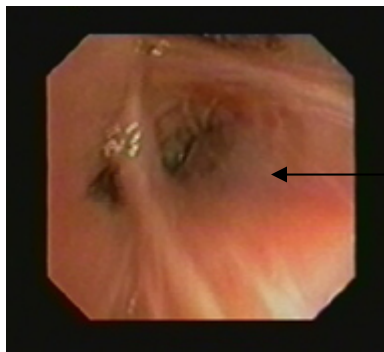
Question IV.4: Endobronchial metastases are more likely in each of the following malignancies except

- A. Colon cancer
- B. Breast cancer
- C. Hypernephroma
- D. Hodgkin's lymphoma
- E. Ovarian cancer

Answer IV.4: E

Colon, breast, renal cell carcinoma and melanoma are each malignancies that spread readily to the tracheobronchial tree. In addition, airway abnormalities are seen in patients with Hodgkin's lymphoma and in patients with esophageal cancer: One proposed mnemonic is Even Henri Colt's Bronchoscope Reveals Metastases (EHCBRM). If you have trouble remembering this one, don't hesitate to invent your own!

Cancer of the ovary rarely metastasizes to the airways, but does spread frequently to the pleura. Patients with malignant pleural effusions might have bronchoscopic signs of volume loss, lower lobe bronchial stricture, retraction, and localized erythema.



Lower lobe bronchi compressed by pleural effusion causing volume loss in a patient with ovarian



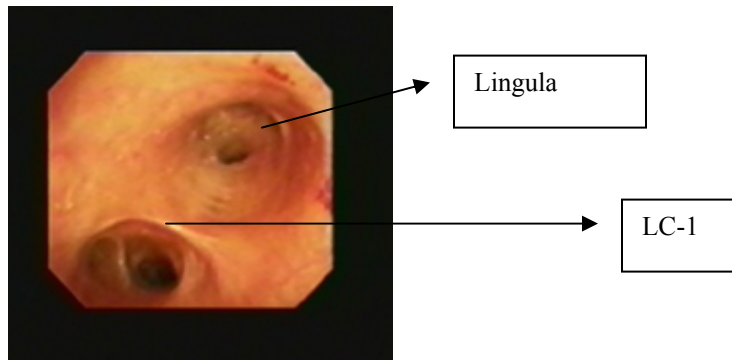
Other patient: Endobronchial metastases from Renal cell carcinoma.

Question IV.5: During bronchoscopy you note a redness and thickening on the carina between the anterior segment of the left upper lobe and the lingular bronchus. Suspecting carcinoma in-situ, but unsure whether other lesions might have been missed the patient is referred for fluorescence bronchoscopy. During your conversation with the interventional bronchoscopist, you state that the lesion is on

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

Answer IV.5: A

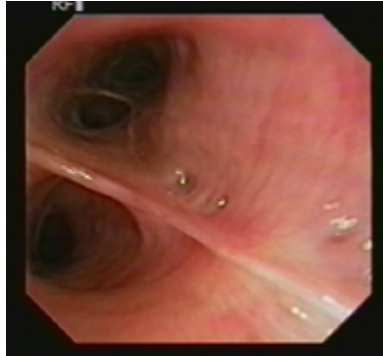
On the left, the carina separating the anterior segment of the left upper lobe bronchus from the lingual is termed LC-1, whereas the carina separating the lingular segment of the left upper lobe from the left lower lobe bronchus is called LC-2. Carina nomenclature is important because it helps describe potential need for pneumoplasty instead of pneumonectomy. With an abnormality only on LC-1, this patient could potentially undergo a lobectomy. On the other hand, had the lesion been located at the level of LC-2, a pneumonectomy or bronchoplasty would be warranted.



Question IV. 6

The findings shown in the Figure below are

- A. Mucous duct orifices
- B. Anthracotic pigment
- C. Bronchoesophageal fistula

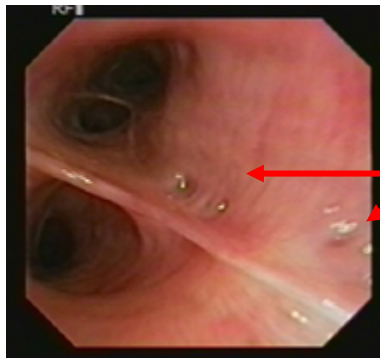


Answer IV. 6

A

Mucous duct orifices are usually seen on the medial and posterior aspects of the bronchial wall bilaterally. These pin-size “indentations” are found where the bronchial cartilage meets the posterior membrane of the left or right main bronchi. They are also frequently seen along the caudal (inferior) walls of the upper lobe bronchi. They may be dilated in patients with chronic bronchitis.

Anthracotic pigment is dark, blackish discoloration within bronchial mucosa, and is of no clinical or physiological consequence.



Mucous ducts
Also known as
bronchial pits

Question IV.7: Chronic cough and a single episode of hemoptysis prompt flexible bronchoscopy in a 65-year-old smoker with a normal chest radiograph. There is no evidence of purulent secretions or endobronchial obstruction. No cause for the hemoptysis is found. A small area of pale, thickened bronchial mucosa is noted at the spur of the superior segment of the right lower lobe bronchus. Washings, brushings, and endobronchial biopsies are taken. The next day, the pathologist calls you to say that there is evidence of nuclear enlargement, hyperchromatism, pleomorphism, and abundant mitoses at all levels of what appears to be a very disorganized epithelium. What is the most likely diagnosis?

- A. Squamous cell metaplasia
- B. Squamous cell dysplasia
- C. Squamous carcinoma in-situ
- D. Proliferation of bronchial neuroendocrine cells
- E. Squamous cell carcinoma

Answer IV.7: C

The presence of abundant mitoses on a background of hyperchromatism, pleomorphism and nuclear enlargement describes squamous dysplasia. There has been much debate regarding progression of dysplasia to carcinoma. Certainly specimens should be carefully examined, because carcinoma in-situ can be cured using a variety of bronchoscopic as well as open thoracic surgical resectional techniques.

Squamous metaplasia consists primarily of increased cellular atypia with increased proliferation of damaged bronchial epithelial cells and formation of intercellular bridges.

Frank squamous cell carcinoma is diagnosed when epithelial cell proliferation is accompanied by intercellular bridges and keratinization. Tumor thus invades longitudinally along the bronchial lumen, or transmurally through bronchial mucosa.

Bronchial neuroendocrine cells are normally present in the basal layer of normal bronchial epithelium. These cells can proliferate in response to irritants such as tobacco smoke, but are not malignant.

Question IV.8: Which of the following statements about bronchoscopic treatment of malignant central airway obstruction is correct

- A. Results are unsatisfactory most of the time
- B. Procedure-related mortality is about 10 percent
- C. Mean survival is about three months
- D. Indications are limited to those patients with good prognosis
- E. All procedures require general anesthesia



Answer IV.8: C

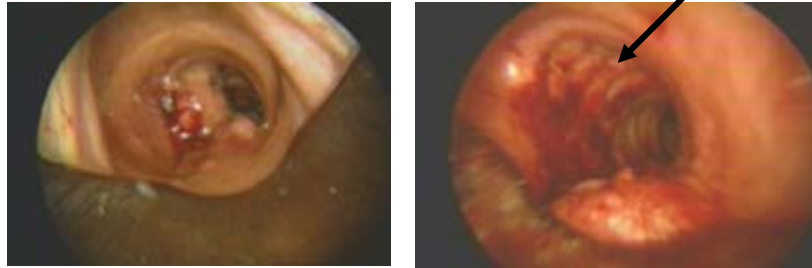
Bronchoscopic treatment of malignant central airway obstruction is frequently successful, has been shown to prolong life, improve ventilatory function, increase exercise tolerance, and improve quality of life. Even patients with an extremely poor prognosis should be referred for bronchoscopic treatment because airway obstruction can be palliated, which improves quality of life, and permits greater tolerance of other therapeutic modalities such as external beam radiation. Procedure-related mortality is less than 1 percent. Unfortunately, mean survival is low. This may be because patients are referred late in the course of their disease.

Palliative procedures are performed under general anesthesia or with conscious sedation. Procedures include Nd:YAG laser resection, dilatation, electrocautery, argon plasma coagulation, debulking, airway stent insertion using silicone, metal, or hybrid (silicone and metal) stents, photodynamic therapy, and brachytherapy.

Rigid bronchoscopy
being performed under
general anesthesia



Anterior
cartilaginous rings



Before and after laser resection of
tumor obstructing trachea and
extending along left lateral wall
of the trachea.

Question IV.9: All of the following statements about bronchoalveolar lavage are correct except.

- A. The typical lavage zone of an average size adult patient at total lung capacity represents 165 ml.
- B. The volume of fluid recovered is decreased in cigarette smokers and in the elderly.
- C. Specimens usually contain Lidocaine at concentrations great enough to inhibit bacterial and fungal growth.
- D. A 100 ml saline lavage results in the sampling of about 10^6 alveoli.
- E. In the absence of grossly purulent secretions, pooling all aspirated lavage fluid will provide a mostly alveolar sample.

Answer IV.9: C

Most studies do not demonstrate that lidocaine, used in normal doses for topical airway anesthesia, inhibits growth of bacterial and fungal pathogens. Bronchoalveolar lavage (BAL) allows recovery of cellular and noncellular components from the epithelial surfaces of the lower respiratory tract. BAL is different from bronchial washings that always contain far more than 3% bronchial squamous cells.

Experts believe that a 100 ml lavage of a single bronchial segment samples about 10×10^6 alveoli. In most instances about 50 % of fluid instilled should be recovered. BAL “return” (the fluid recovered by aspiration) is decreased in smokers, in the elderly, and when upper lobe segmental bronchi are sampled.

Experts advocate that at least 100 ml of fluid must be instilled into a single bronchial segment using proper technique in order to obtain an adequate alveolar sample. This includes careful and complete wedging of the bronchoscope within the segment to be lavaged.

Pooling lavage fluid by combining all the fluid obtained in one specimen container will still provide a mostly bronchioloalveolar sample so long as the lavage was performed using proper technique, and the sample is not grossly purulent from contaminated bronchial secretions.

Question IV.10: All of the following statements about bronchoalveolar lavage in stem cell transplants recipients are correct except

- A. BAL is safe even in thrombocytopenic patients
- B. Because of risk of bleeding, the oral route is always preferred to the nasal approach
- C. Negative BAL does not exclude the presence of fungal infection
- D. Negative BAL does not confirm the diagnosis of idiopathic pneumonia
- E. To diagnose lower respiratory tract infection, process BAL fluid for bacteria, fungal, virus stains and cultures, cytology for Cytomegalovirus inclusion bodies and Pneumocystis carinii, as well as for Immunofluorescence monoclonal antibody staining for respiratory syncytial virus, adenovirus, Para influenza virus, and influenza virus.

Answer IV.10: B

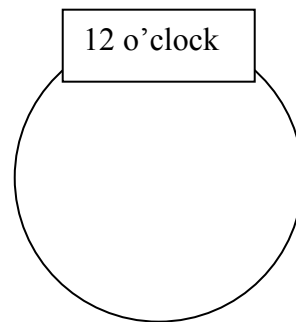
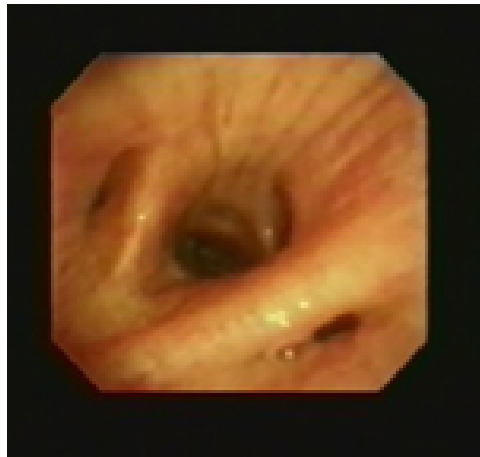
Bronchoscopy is safely performed even in patients with moderately severe (<50,000 platelets) and severe thrombocytopenia (<20,000 platelets) so long as careful and gentle technique is employed. If resistance is felt upon scope insertion, an attempt can be made in the contralateral nares. If resistance is again encountered, the oral route should be used (remember to always insert a bite block). Patients should be asked if they have had recent episodes of spontaneous or procedure-induced bleeding, and potential risks should be explained. Some operators prefer the oral route for bronchoscope insertion regardless.

Stem cell transplant patients may require multiple flexible bronchoscopies during the course of their illness. Therefore, special care should be taken so that each procedure is perceived as nonthreatening, gentle, and caring.

As always, patients should be asked if they desire conscious sedation. Generous amounts of topical anesthetic should be used to prevent cough so that a nontraumatic examination (avoid beating up the airway walls) is assured.

Question IV.11 Using the figure below, and imagining the interior of the airway as a clock face and using the carina as the central reference point. Where is RB 6?

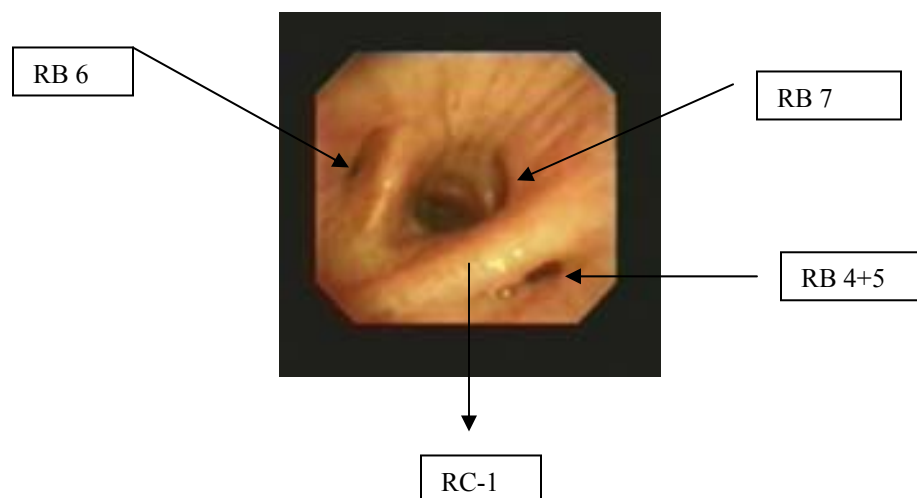
- A. At 3 o'clock
- B. At 9 o'clock
- C. At 5 o'clock



Answer IV.11

B

RB 6 is the superior segment of the right lower lobe. It is almost directly across from the right middle lobe bronchus (RB 4 and RB 5). The muscular posterior wall of the right main bronchus and bronchus intermedius is well recognized in this photograph because of the distinct elastic fibers. During bronchoscopy, one can always be aware of one's position within the airway, by identifying anterior lying cartilage, or the posterior lying membranous portion of the tracheobronchial tree.



Question IV.12: The right pulmonary artery is most adjacent to the anterior wall of the right main bronchus at

- A. The level of the carina
- B. The level of the right upper lobe bronchial orifice and origin of the bronchus intermedius
- C. The origin of the right lower lobe bronchus

Answer IV.12: B

At the level of the orifice of the right upper lobe bronchus, needle insertion through the anterior wall of the right main bronchus risks entering the right pulmonary artery, which lies immediately anterior to the bronchus at this level. Note that the right upper lobe bronchus in this cast is more vertical than usual.



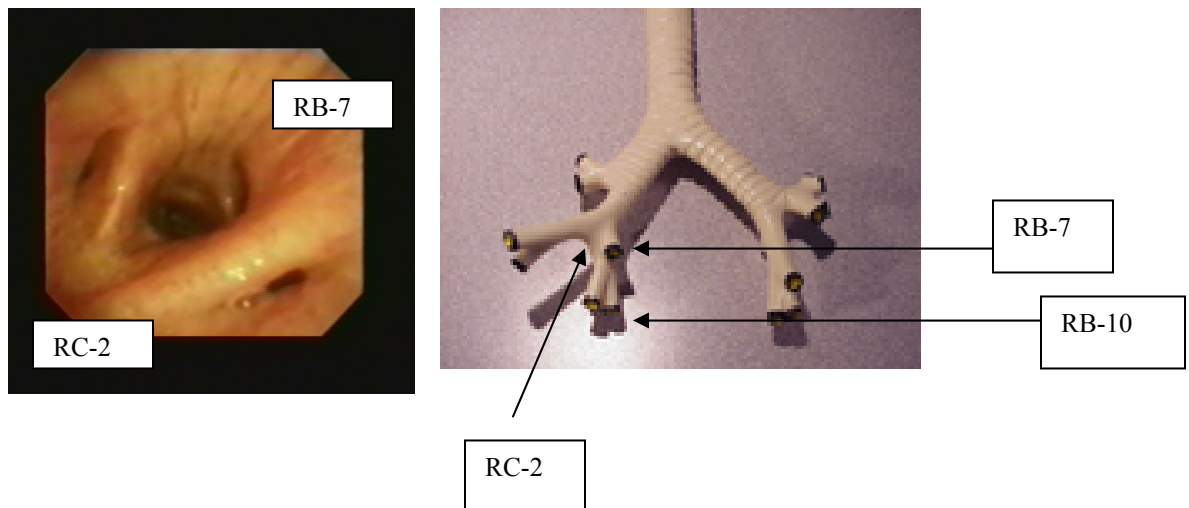
Question IV.13: During bronchoscopy a nodular abnormality is noted on the carina between the middle lobe bronchus and the right lower lobe bronchus, with erythema extending into the posterior basal lower lobe bronchus. During presentation of the case to your thoracic surgical and oncology colleagues you should describe these findings as which one of the following.

- A. Nodular abnormality involving RC-1 with erythema extending into RB 10.
- B. Nodular abnormality involving RC-2 with erythema extending into RB 10.
- C. Nodular abnormality involving RC-1 with erythema extending into RB 8.
- D. Nodular abnormality involving RC-1 with erythema extending into RB 7.

Answer IV.13: B

The posterior basal segment is always B 10. On the right, the carina between the right middle lobe bronchus and the bronchus to the right lower lobe is named the right carina 2 or RC-2, whereas the carina dividing the right upper lobe and the bronchus intermedius is termed the right carina 1 or RC-1.

Lower lobe bronchi are classified as bronchi B 6- B10. An airway nomenclature helps bronchoscopists describe extent of neoplastic involvement and sites of early lung cancer, and delineate limits for surgical resection.



Question IV.14: Bronchoalveolar lavage is most helpful for providing histologic confirmation of diagnosis in all of the following diseases **except**

- A. Chronic eosinophilic pneumonia
- B. Histiocytosis X
- C. Lymphangitic spread of carcinoma to the lungs
- D. Pulmonary alveolar proteinosis
- E. Invasive aspergillosis

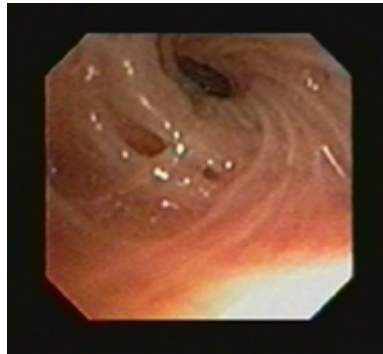
Answer IV.14: E

In patients with invasive aspergillosis, culture of BAL specimens is positive in less than 30 percent of cases; therefore negative results do not exclude this diagnosis in susceptible individuals.

In addition to those illnesses listed above, BAL is also helpful for making a diagnosis of occult pulmonary hemorrhage, fat embolism, and infectious lung diseases such as mycobacterial, pneumocystis carinii, and cytomegalovirus pneumonia.

Question IV.15 The abnormality shown in the figure below is consistent with which of the following

- A. Bronchogenic carcinoma
- B. Chronic bronchitis
- C. Endobronchial tuberculosis



Answer IV.15 B

Chronic bronchitis changes include erythema or pallor, scarring, and exaggerated bronchial pitting. Bronchitis changes are a frequent finding and are not necessarily of clinical significance. Endobronchial tuberculosis may cause fibrous strictures, redness, swelling, or scar formation. Features of bronchogenic carcinoma include intraluminal nodules, polypoid lesions, mucosal thickening, erythema, and extrinsic compression.



Question IV.16: Flexible bronchoscopy reveals small slightly swollen erythematous bronchial mucosa about 1 cm in surface area along the lateral wall of the bronchus intermedius directly below the right upper lobe bronchial orifice. Biopsy shows squamous cell carcinoma. The patient refuses thoracotomy. Which of the following bronchoscopic therapies should be recommended

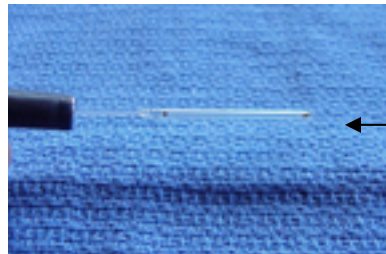
- A. Nd:YAG laser resection
- B. Photodynamic therapy
- C. Brachytherapy
- D. Electrocautery
- E. Argon plasma coagulation

Answer IV.16: B

Photodynamic therapy has been shown to achieve complete response in up to 80 percent of patients with superficial squamous cell carcinomas. Results are best when lesions are small, less than 3 cm in total surface area, and do not penetrate more than 4-5 mm into the bronchial wall. Recurrence is approximately 15 percent.

Photodynamic therapy requires injection through a peripheral vein of a hematoporphyrin derivative which is originally taken up by all organ systems, but rapidly and selectively accumulates in tumor cells, skin, liver and spleen. Photosensitization and cell death occurs after exposing the involved bronchial mucosa to nonthermal light energy, usually 630 nm wavelength. This light is absorbed to an average depth of 5 mm. The subsequent formation of oxygen free radicals results in cell death.

Procedures can be performed using a flexible bronchoscope and topical anesthesia. Follow-up bronchoscopy is usually required within 72 hours to remove necrotic tissues from the treated airways. The other techniques might also be effective, but firm clinical data are lacking to justify their use at this time.



Cylindrical diffuser fiber used to deliver nonthermal laser energy during PDT

Question IV.17 In a patient with an upper lobe infiltrate on chest radiograph and three AFB smear negative sputum samples, all of the following are reasons for proceeding with bronchoscopy **except**

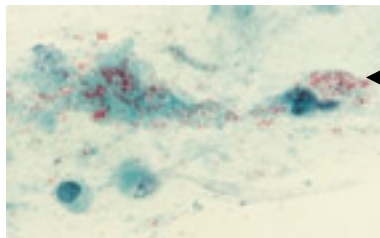
- A. The likelihood of identifying an organism for susceptibility testing is increased
- B. The likelihood of making another diagnosis is increased
- C. Early diagnosis of tuberculosis is made in up to 40% of smear negative cases
- D. Sputum collected after bronchoscopy may also be helpful for a diagnosis
- E. Routine bronchoscopic lung biopsy will increase the diagnostic yield

Answer IV.17 **E**

Bronchoscopy is extremely helpful in making a diagnosis of tuberculosis. Culture proof of disease is obtained in more than 70 percent of instances when disease is in fact present.

In patients with miliary tuberculosis, the value of bronchoscopy with bronchoalveolar lavage and bronchoscopic lung biopsy is well recognized, providing diagnostic material in more than 70 percent of cases when sputum smears are negative. If granulomas are seen on biopsy, diagnosis may be presumed, but should not be confirmed until mycobacteria organisms are noted.

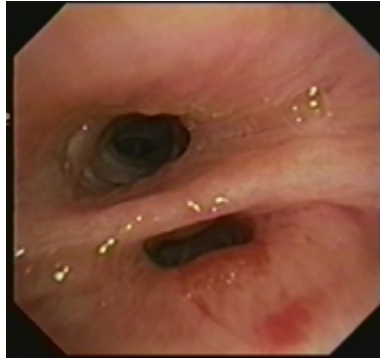
In some institutions it is common practice to send all bronchial washings for mycobacterium smear and culture, regardless of the indication for bronchoscopy. Studies have shown that the incidence of tuberculosis among such “routine” procedures ranges from 0.8% to 6 %.



“ Acid-fast bacteria” in BAL

Question IV.18: The appearance of the airway abnormality seen in the Figure below should be described as

- A. Polypoid
- B. Nodular invasive
- C. Superficial invasive
- D. Intraepithelial neoplasia

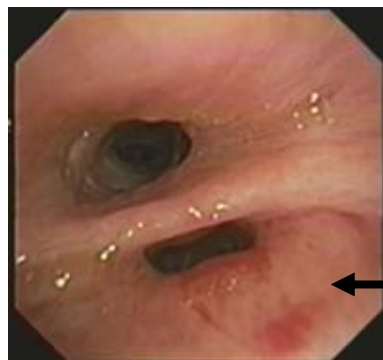


Answer IV.18: C

A generally accepted but infrequently referred to classification of bronchoscopic findings is that of the Japan Lung Cancer Society. In this classification, bronchoscopic findings are described as mucosal or submucosal.

Early stage cancer is a mucosal histopathologic change. Superficial invasive lesions have a loss of luster and disruption of mucosal folds. Lesions are often pale, red, or granular. Increased friability causes lesions to bleed easily when touched. Stenosis of the lumen is slight, but necrotic material may adhere to the lesion's surface.

Intraepithelial neoplasia is a term that encompasses histopathologic abnormalities including mild, moderate and severe dysplasia (which are considered to be premalignant lesions), and invasive (malignant) neoplasia or carcinoma *in situ*. Often these abnormalities are found at bronchial bifurcations. Carcinoma should be suspected whenever mucosal thickening, redness, or swelling are noted at these locations.



Superficial invasive carcinoma along posterior wall of middle lobe bronchus

Question IV.19: The esophagus is usually considered to be “adherent” to

- A. The carina
- B. The first two centimeters of the left main bronchus
- C. The right upper lobe bronchus
- D. The proximal right main bronchus

Answer IV.19: B

The esophagus is considered to be “adherent” to the first two centimeters of the left main bronchus. Bronchoesophageal fistulas can be found in this area in patients with malignancy or a history of interventional esophageal procedures, external beam radiation therapy, brachytherapy, and laser resection.

Question IV.20: You are about to describe an endobronchial abnormality to an interventional bronchoscopist. In which of the following might he be least interested

- A. Distance of the abnormality from the carina and other ipsilateral bronchial segments
- B. Whether the abnormality has a wide or narrow base
- C. Location of the abnormality in relation to the bronchial wall
- D. Size of the abnormality (length, diameter, degree of airway obstruction)
- E. Distance of the abnormality from the inferior margin of the vocal cords

Answer IV.20: E

If a lesion is noted in the bronchial tree, it is not necessary to report its distance from the vocal cords. Of course, this distance would be reported were the lesion in the trachea. Additional components of endobronchial disease that should be described are consistency (firm, rubbery, soft), appearance (glistening, vascular), friability (oozing, actively bleeding, pus-filled), color (white, red, dark, yellow), shape (regular, round, irregular, elongated, bulging), and dynamics (mobile with respiration or cough, ball-valving, immobile).

Question IV.21: You are asked to bronchoscope a patient who completed a three-week course of high-dose brachytherapy for a proximal right main and right upper lobe bronchial tumor ten days ago. The patient had previously undergone laser resection, which successfully restored central airway patency. The patient now complains of cough, dyspnea, and occasional hemoptysis. Which of following bronchoscopic findings is most likely.

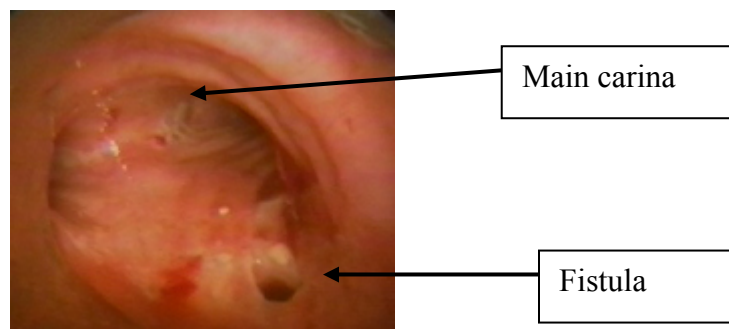
- A. Right main bronchial stenosis
- B. A fistulous tract beginning at the posterior wall of the right main or right upper lobe bronchus.
- C. Right lower lobe bronchial stricture
- D. Tumor extension from the right upper lobe bronchus to the proximal trachea

Answer IV.21: B

Brachytherapy is warranted in selected patients with intraluminal disease or extrinsic compression from tumor. Results are best when tumor does not extend more than a few millimeters beyond the bronchial wall. Success is most likely in patients who have had previous favorable responses to external beam radiation therapy. The radiation is applied using a radiation source delivered through a nylon catheter. The catheter is inserted bronchoscopically. Dosimetric analyses are performed by radiation oncology depending on the length and depth of tumor that must be treated.

Brachytherapy causes tissue necrosis, localized edema, hemorrhage, and fistulas. Complications are increased in patients undergoing concomitant Nd:YAG laser resection. Brachytherapy of a segmental bronchus may temporarily increase or even cause bronchial narrowing, but should not cause bronchial stenosis at a site that is distant from the treatment zone.

In the case described above, it is unlikely that the brachytherapist would have proceeded with lobar brachytherapy had significant residual tumor involving the right main bronchus and trachea been noted on bronchoscopy.



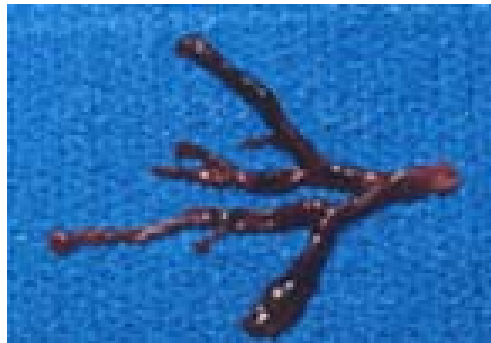
Question IV.22: While attempting to remove a large blood clot from the endotracheal tube and tracheobronchial tree in an intubated and mechanically ventilated patient of the intensive care unit, you should

- A. Use small cup forceps
- B. Request Nd:YAG laser assistance
- C. Move the endotracheal tube proximally
- D. Apply suction intermittently

Answer IV.22: C

Moving the endotracheal tube proximally will often help loosen the clot, which is frequently at least partially “caught” in the Murphy eye of the endotracheal tube. Most clots can be removed using a flexible bronchoscope, even when they form casts of the bronchial tree as seen in the Figure below.

In order to facilitate clot removal, one might (1) use the bronchoscope with the largest working channel possible, (2) use large alligator forceps to break up the clot, (3) use abundant saline washings and constant as well as intermittent suction, or (4) instill Streptokinase. (5) Cryotherapy can also be used to freeze and immediately extract the clot. (6) When the clot is pulled up within the trachea, one can remove the bronchoscope if necessary and insert a large-bore suction catheter to blindly aspirate the clot using high suction. If these efforts are unsuccessful, rigid bronchoscopy is warranted.



Question IV.23: Which of the following techniques is best used to facilitate wedging the flexible bronchoscope into a hard to reach segment of an upper lobe.

- A. Changing the V-shaped bend of the bending tip to a U-shaped bend by simultaneously flexing the tip and advancing the bronchoscope.
- B. Withdrawing the bronchoscope from the segmental bronchus in order to insert a cytology brush through the working channel into the apical segment. The scope is then advanced over the brush until wedged.
- C. Rotating the distally flexed tip of the bronchoscope by twisting the bronchoscope proximally between the index finger and the thumb at the nasal or oral insertion site.
- D. Using fluoroscopic guidance to monitor the position of the distal tip of the bronchoscope while rotating the patient's chin to the opposite side.

Answer IV.23: A

This is not a trick....Each of the described techniques can be used. Changing the shape of the bending tip of the bronchoscope by “bouncing” it off the bronchial wall, however, is probably the most elegant and time effective of the techniques proposed, and therefore choice A has been chosen as the “correct” response.

Insertion of a cytology brush takes time, does not always work, and risks inadvertent pneumothorax by advancing the brush too far. Many experts say that although they have heard of this technique, they have never seen it work when they have tried it themselves (personal communications).

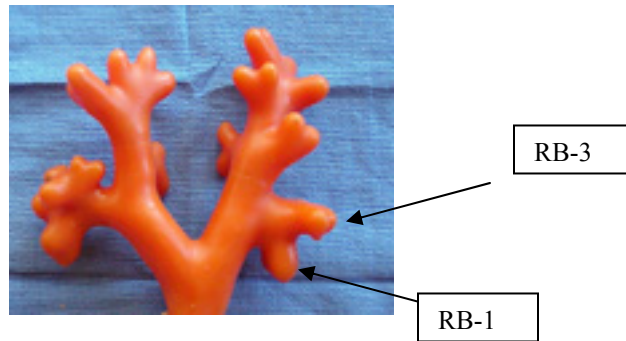
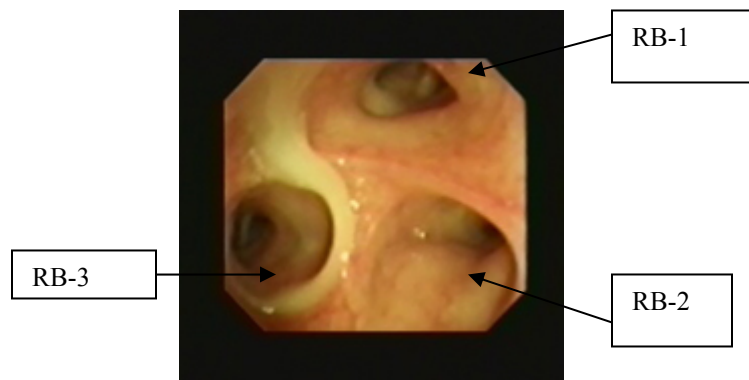
Fluoroscopic guidance, although often effective, may not be readily available. Rotating the distally flexed tip by twisting the bronchoscope at the oral or nasal insertion site can be effective, but is inelegant and can damage the scope. Remember, proper technique means driving the bronchoscope with only the hand holding the bronchoscope's control section. The other hand simply stabilizes the scope at the insertion location. Yes, it is indeed amazing...but it appears that all experts agree that flexible bronchoscopes should be “driven” by the hand holding the proximal portion of the scope known as the control section (many many personal communications).

Question IV.24: A thoracic surgery colleague has referred a patient for bronchoscopic removal of a foreign body located in RB2. On bronchoscopy, you will find the foreign body in

- A. The posterior basal segment of the right lower lobe.
- B. The medial basal segment of the right lower lobe.
- C. The anterior segment of the left upper lobe.
- D. The posterior segment of the right upper lobe.
- E. The anterior segment of the right upper lobe.

Answer IV.24: D

RB2 represents the posterior segment of the right upper lobe. Rb1 and RB3 represent the apical and anterior segments of the right upper lobe respectively. Regardless of nomenclature employed, carinal, lobar, and proximal segmental nomenclature are relatively constant. Bronchi are thus named from 1-10 (1-3 upper lobe, 4-5 middle lobe or lingual, 6-10 lower lobe), while carinii are named C-1 or C-2. Nomenclature can be helpful for communicating with foreign as well as surgical colleagues.

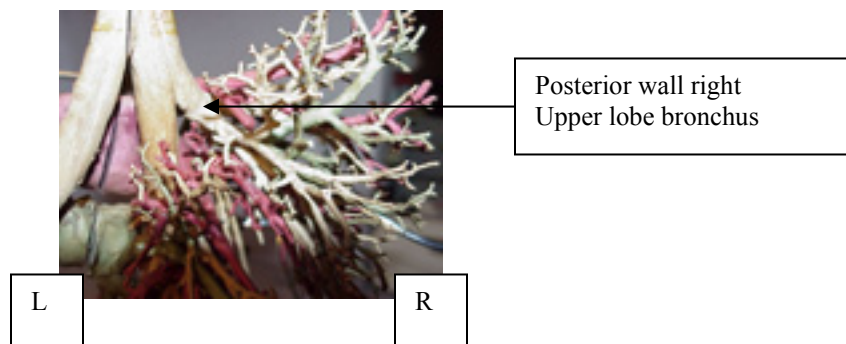


Question IV.25: Which of the following statements about the right upper lobe bronchus is correct

- A. The posterior portion of the right upper lobe bronchus is devoid of any vascular relationships
- B. The anterior portion of the right upper lobe bronchus is devoid of any vascular relationships
- C. The pulmonary vein is in direct contact with the right upper lobe bronchus

Answer IV.25: A

No vascular structure is directly adjacent to the posterior aspect of the right upper lobe bronchus. Anterior lies the pulmonary vein, but it is not in direct contact with the bronchus. The right pulmonary artery is adjacent to the anterior wall of the right upper lobe bronchus and origin of the bronchus intermedius. Needle aspiration at this site would be dangerous. Note that the direction of the right upper lobe bronchus in this cast is more vertical than usual.



Question IV.26: A previously healthy 40-year-old Brazilian physician living outside Manaus presents with acute onset of dyspnea, fever, myalgias, and dry cough. Ten days ago he cleaned out a chicken shack, which he rebuilt as a Japanese teahouse after removing soil and laying down a hardwood floor. Chest radiographs reveal lobar consolidation in the right mid and upper lung fields. Several small sub pleural nodular calcifications are present in the right and left upper lung zones. A skin test for tuberculosis is positive. Flexible bronchoscopy shows focal narrowing of the right middle lobe bronchus with surrounding erythema. The right main bronchus is also compressed. The patient notes dyspnea and dysphagia when placed in the supine position. Which of the following is the most likely diagnosis?

- A. Acute Histoplasmosis
- B. Influenza-like illness on a background of chronic Histoplasmosis
- C. Acute Cryptococcus infection
- D. Bronchogenic carcinoma

Answer IV.26: B

Sounds like this fellow has the flu as well as chronic findings of Histoplasmosis. Histoplasmosis capsulatum is a soil-inhabiting fungus most frequently found in chicken coops, cellars, and caves. Infection also occurs in city dwellers after exposure on excavation and construction sites, particularly in the Mississippi valley of the United States, although the disease has been noted among residents of fertile river valley basins in Malaysia, Vietnam, Paraguay, Brazil, and India. Acute infection in nonimmune individuals causes influenza-like illness after an incubation period of 10-16 days.

In other individuals, the incubation period may be as short as 3 days. Pulmonary infiltrates, often with an associated hilar and mediastinal adenopathy are noted on chest radiographs. Eventually, lymph nodes and pulmonary nodules calcify. Enlarged nodes may compress the right middle lobe bronchus, causing right middle lobe syndrome. Less frequently, calcifications may erode through the bronchial wall, forming an intraluminal broncholith. Compression of the superior vena cava, esophagus, and main bronchus (mediastinal fibrosis) occurs when mediastinal lymph nodes fuse into a single large mass surrounded by tissue necrosis and ultimately fibrosis.

Diagnosis is made by observation of free organisms in necrotic material, or when single round budding yeasts with bubbly cytoplasm are seen. In immunocompetent patients, necrotizing epithelioid and giant cell granulomas similar to those of tuberculosis may be found.

Question IV.27: An inhalation injury victim who has been in the intensive care unit for five weeks. Several episodes of gastric aspiration were witnessed during the last 7 days since extubation. During an acute aspiration event, you are asked to perform emergency flexible bronchoscopy. You note severe laryngeal edema, thickened vocal cords, and hemiparesis of the left arytenoids. These findings predispose to recurrent aspiration. You also note the abundant yellow secretions filling the lower lobe bronchi bilaterally. Surprisingly, there is no local bronchial inflammation, and bronchial mucosa looks normal except for a small raised erythematous plaque on the spur of the superior segmental bronchus of the right lower lobe bronchus. The abnormality is biopsied. The next day, the pathologist says that round black yeast forms are present on silver stained tissues. Which of the following infectious fungal diagnoses is most likely in this patient?

- A. Allergic bronchopulmonary aspergillosis
- B. Mucomycosis-zygomycosis
- C. Invasive Candidiasis
- D. Torulopsis Candida Galbrata infection

Answer IV.27: D

Torulopsis Candida Galbrata infection commonly follows aspiration of gastric contents. Yeast forms are best seen on silver stained tissue sections, where they appear as black round or oval spores in small clusters. Although Torulopsis Candida Galbrata can invade vascular structures, it is associated with minimal inflammatory or granulomatous airway mucosal reactions. In case you are curious, these are the major teaching points and purpose for this question.

Invasive candidiasis could have been suspected had oral thrush also been noted. Aspergillus may be a colonizer or a truly infectious organism, and can be found in greenish-yellow secretions, but may also be seen even when secretions do not appear purulent. The same comments regarding bronchoscopic appearance can be made about Mucor.

Question IV.28: In 1970, Shigeto Ikeda of Japan proposed a classification of bronchoscopic findings that is still extremely useful today. This classification includes all of the following except

- A. Abnormal organic changes of the bronchial wall
- B. Endobronchial abnormalities
- C. Abnormal substances in the bronchial lumen
- D. Dynamic disorders
- E. Consequences of previous surgical or bronchoscopic therapies.

Answer IV.28: E

Professor Ikeda built upon the classification proposed by Dr. Huzley and Dr. Stradling who had previously advocated a classification of bronchoscopic findings based on examination using the rigid bronchoscope. Today, many bronchoscopists inadvertently use this “Ikeda” classification to describe findings (although no one I know refers to this classification as belonging to Ikeda).

By using proper technique and keeping all the elements listed in this classification in mind the bronchoscopist can assuredly discover endobronchial abnormalities and describe them appropriately. As a reminder, the elements are as follows: (1) Abnormal organic changes of the bronchial wall (2) Endobronchial abnormalities (3) Abnormal substances in the bronchial lumen (4) Dynamic disorders

Today, one could add “Consequences of previous surgical or bronchoscopic therapies” to the list. This element pertains to surgical sutures, bronchial stump appearances, airway anastomoses, and mucosal changes from biopsy, laser resection, cryotherapy, electrocautery, photodynamic therapy, or brachytherapy.

Question IV.29: A 39-year-old man with a history of testicular cancer three years ago is now found to have a 3 cm right lower lobe opacity on chest radiograph. Computed tomography scan reveals that the mass contains calcifications. The mass is located in the right lower lobe, and is relatively central. Radiographically, there is no endobronchial disease or associated lymphadenopathy. The patient has no symptoms. The case is presented at a weekly chest conference. The medical oncologist fears that the mass is a metastasis. The radiologist is not as certain, but states that the lesion should be accessible by bronchoscopy. The interventional radiologist states the patient has a 30 percent chance for pneumothorax if the lesion is sampled percutaneously using fluoroscopic or computed-tomographic guidance. A thoracic surgeon recommends immediate thoracotomy and lung resection if frozen sections during thoracotomy are positive for malignancy. An inspection flexible bronchoscopy had been performed before the chest conference. No airway abnormalities were seen and only nondiagnostic bronchial washings had been obtained. You would now propose which of the following.

- A. Thoracotomy with lower lobectomy
- B. Video-assisted thoracoscopy with needle aspiration under thoracoscopic guidance
- C. Flexible bronchoscopy with computed tomography guidance for biopsy or needle sampling of the abnormality and on-site cytopathology.
- D. Flexible bronchoscopy with blind transbronchial needle aspiration.

Answer IV.29: C

Computed tomography-guided flexible bronchoscopy is a well-described procedure and should be considered in certain instances. This technique may be superior to fluoroscopically guided procedures if lesions are not well visualized fluoroscopically.

This patient should probably NOT have undergone the “exploratory” flexible bronchoscopy that provided no diagnostic material or useful information for subsequent decision-making, and did cause increased health care expenditures and patient discomfort. It would be unclear why bronchoscopic lung biopsy or needle aspiration would not have been attempted using fluoroscopic guidance.

A nonbronchoscopic option is to proceed with thoracoscopically guided needle aspiration. An open thoracotomy can probably be avoided. Remember, particularly if lesions are central, close to the esophagus, or left-sided (which was not the case in this instance)..that endoscopic ultrasound guided needle aspiration may help make a diagnosis...especially if there is evidence of mediastinal adenopathy. This diagnostic alternative should be considered even if it means referring the patient to a gastroenterologist specialist!

Question IV.30: A 67-year-old patient with lung cancer and central airways obstruction had photodynamic therapy (PDT) at another institution 5 days ago. He is now seeing you for follow-up and immediate referral to radiation therapy. You suggest that

- A. Radiation therapy be delayed for 4-6 weeks
- B. Radiation therapy be started immediately
- C. Radiation therapy be postponed until symptomatic relief is obtained from bronchoscopic therapies

Answer IV.30: A

Because both photodynamic therapy and external beam radiation therapy cause necrosis and tissue swelling, most experts suggest that radiation therapy be delayed for 4-6 weeks after PDT. This is different from Nd:YAG laser resection, a procedure during which post procedure necrosis and edema are minimal since most tissues are removed by debulking at the time of the bronchoscopy. The combination of PDT and radiation therapy can restore airway patency, even in patients with significant central airways obstruction.

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MODULE V

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE V

Welcome to Module V of The EFB, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this module, the learner should be able to:

1. Describe left bronchial anatomy nomenclature
2. Compare and contrast bronchoscopic aspects of T2 and T4 nonsmall cell lung cancer
3. Define the “safety position”. Discuss its advantages and disadvantages.
4. Describe areas of the tracheobronchial tree that might be most susceptible to trauma-related injury or fistula.
5. Describe the airway manifestations of endobronchial sarcoidosis.
6. List at least three advantages and disadvantages of airway stent insertion.
7. Describe what to do in case “red out” occurs after endobronchial biopsy.
8. List the indications and complications of bronchoscopic lung biopsy.
9. Compare and contrast at least FIVE different disease states that might cause bronchial obstruction.
10. Identify at least THREE specific scenarios where airway stent insertion, rather than bronchoscopic resectional techniques, should be considered.

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.



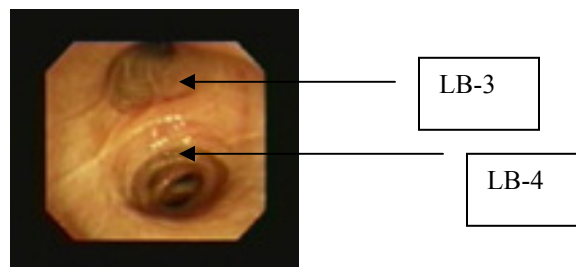
Question V.2: A non-English speaking colleague has referred a patient with an obstructing lesion in LB 4. The lesion is in

- 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, Nagaishi 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.



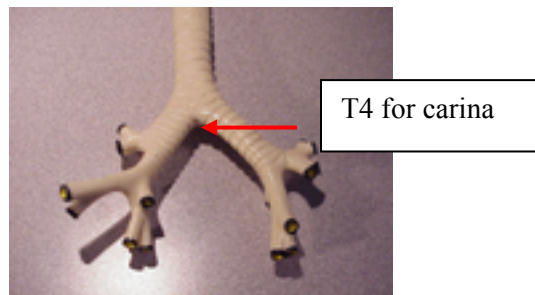
Question V.3: Which of the following should be classified as nonsmall cell lung cancer stage T4

- 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.

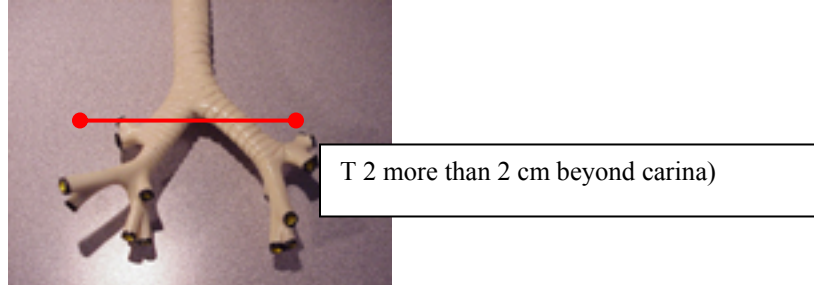


Question V.4: Which of the following should be classified as nonsmall cell lung cancer stage T2

- 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.



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

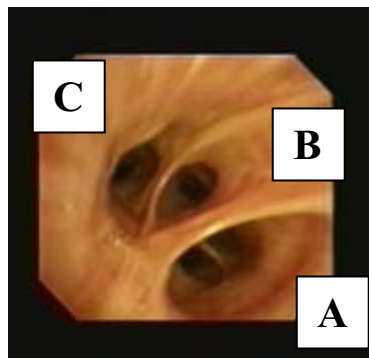
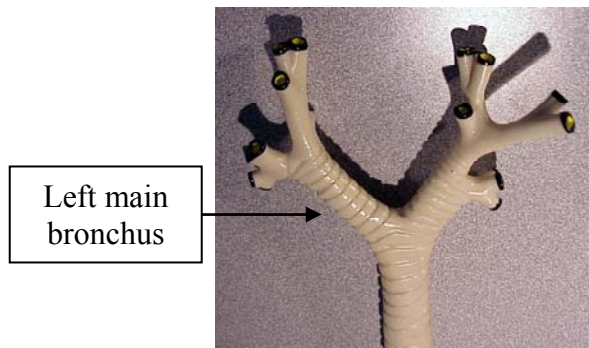
Nd:YAG laser resection can be performed under general anesthesia or using topical anesthetic and conscious sedation. Laser energy is delivered as a 1,064 nm wavelength derived from a Neodymium yttrium-aluminum garnet crystal (Nd:YAG). Tissue effects include photocoagulation and necrosis. Survival benefits 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.

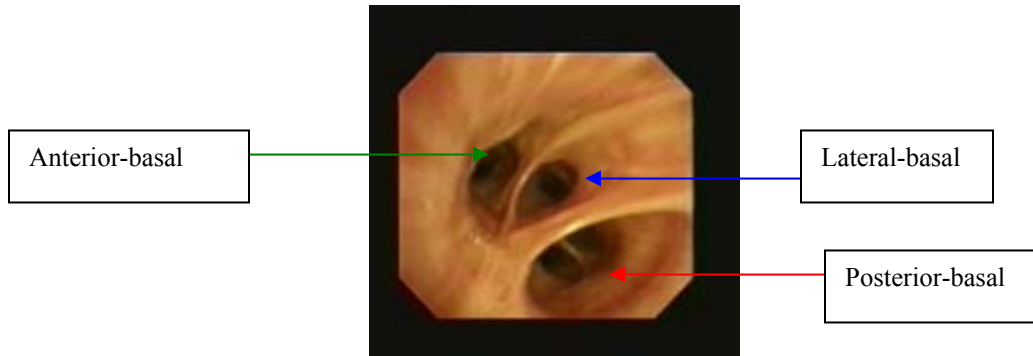
Question V.6 In the Figure below, the letters A, B, and C correspond to which of the following basal segments of the left lower lobe bronchus

- 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

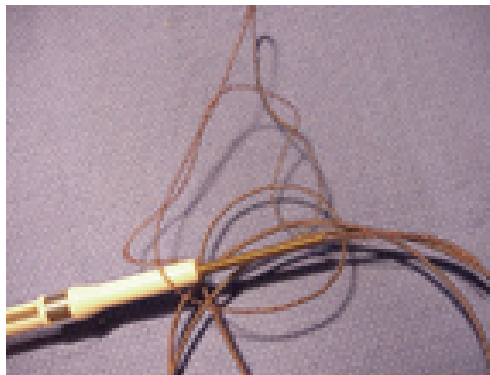
- A. Pull the open forceps back firmly into the working channel to force the cups to close.
- B. Straighten the bronchoscope. Pull the open forceps back to the distal tip of the insertion tube, and remove the scope-forceps ensemble together.
- C. Complain to the forceps manufacturer.

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

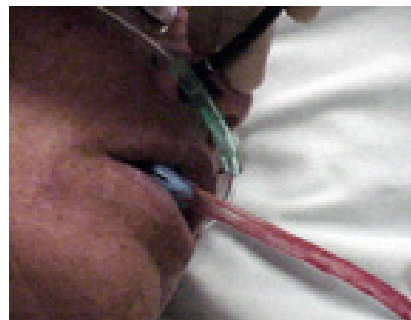


Answer V.8: C

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 17th 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
correct except

All of the following statements regarding chest trauma victims are

- 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

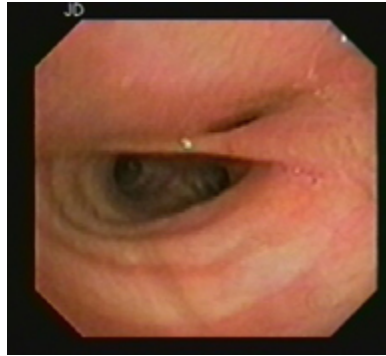
The majority of tracheobronchial injuries are discovered within 2 centimeters of the carina. Injuries include bruising with focal or diffuse mucosal erythema and swelling, partial and total mucosal disruption, intrapulmonary hemorrhage with airway bleeding, tracheal or bronchial laceration with displacement, 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

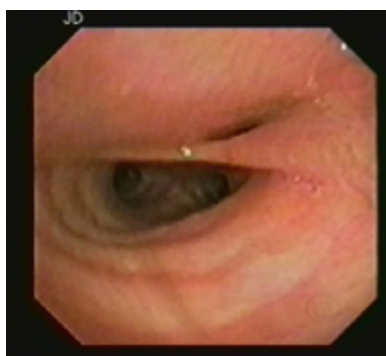
The abnormality shown along the posterior wall of the trachea is an H-fistula in a 30 year old woman who had been erroneously treated for asthma for several years. She reported recurrent episodes of pneumonia and bronchitis with wheezing and shortness of breath. She also had a history of several minor 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).

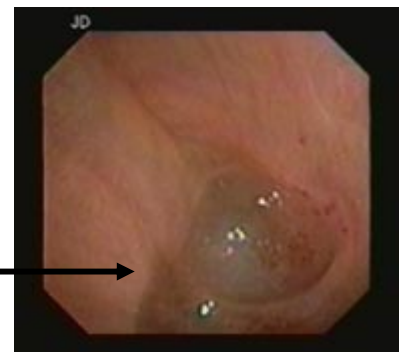
In the H-type fistula, the esophagus is normal except for the high communication with the trachea. Surgical repair of the fistula can leave a blind pouch extending from the trachea, which was the case in this patient. The pouch would regularly fill airway secretions, which would become infected, prompting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

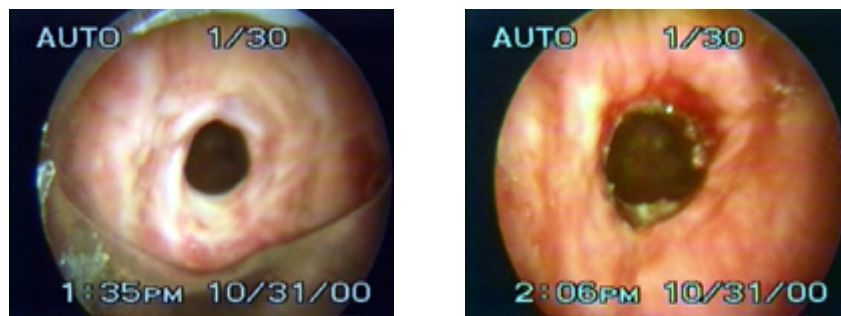
Answer V.14 D

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.

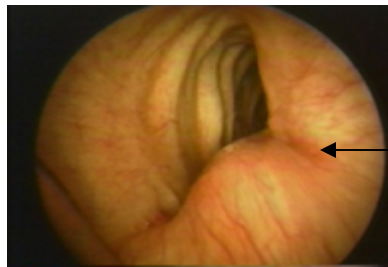
Question V.16: All of the following are indications for airway stent insertion **except**

- 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.

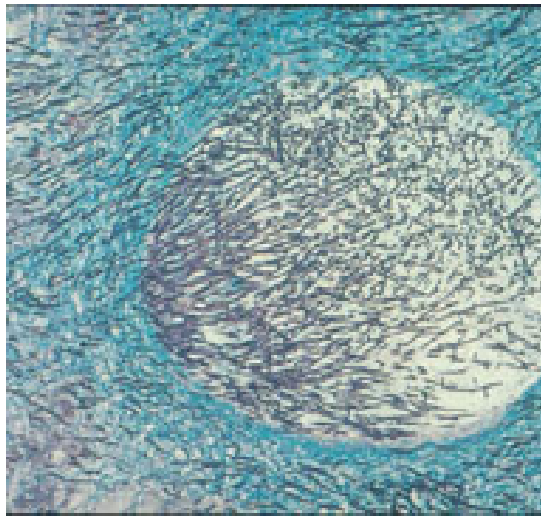
Patients with tracheo-esophageal fistulas can receive airway stents as well as esophageal stents in an effort to palliate symptoms and improve quality of life. Airway stents are made of silicone, metal, or both. They may be self-expanding or require dilatation. Stents can be placed using rigid and flexible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

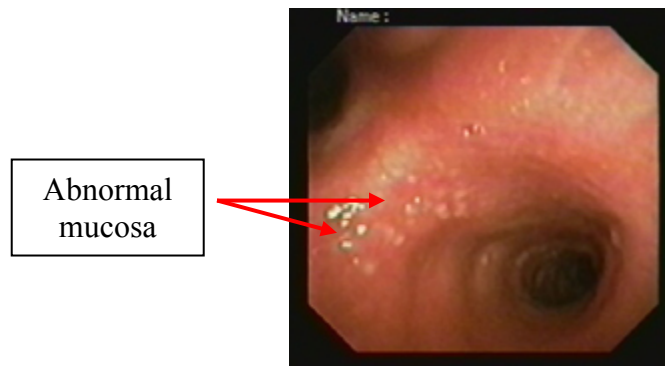
Sarcoidosis remains a diagnosis of exclusion. Sarcoidosis may have several endobronchial appearances, none of which are specific: mucosal nodularity, hypertrophy hyperemia, edema, and bronchial stricture). Small raised whitish lesions can be seen, or mucosa may be granular, firm, erythematous or thickened. 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.



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.23: Bronchoscopic lung biopsies are frequently helpful in providing histologic diagnosis in each of the following **except**

- A. Hypersensitivity pneumonitis
- B. Desquamative interstitial pneumonitis
- C. Sarcoidosis
- D. Miliary tuberculosis
- E. Diffuse pulmonary mycoses

Answer V.23

B

There seem to be fewer and fewer reasons to obtain bronchoscopic lung biopsies. The yield for infectious lung disease using bronchoalveolar lavage alone is excellent, and little is gained by obtaining tissue specimens. In patients with miliary tuberculosis and in whom sputum smears are negative, the combination of brushing, BAL, and biopsy, however, are diagnostic in 80% of patients.

Tissue is also useful for diagnosing diffuse pulmonary mycoses, although biopsy is seldom helpful when lesions are focal and nodular. In patients with sarcoidosis, noncaseating granulomas may be found in endobronchial biopsies, transcarinal needle aspiration specimens, and bronchoscopic lung biopsy samples. It appears reasonable to obtain tissue using all methods in an attempt to increase diagnostic yield for this disease.

In patients with interstitial lung diseases, findings are too often nonspecific. A diagnosis of “fibrosis” is of little benefit. Patients are better served by careful evaluation of computed tomography scan results and clinical history. Bronchoscopic biopsy can be helpful to confirm hypersensitivity pneumonitis. Thoracoscopic lung biopsy is eventually required for satisfactory and definitive tissue diagnosis of many interstitial lung diseases other than Idiopathic pulmonary fibrosis.

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.



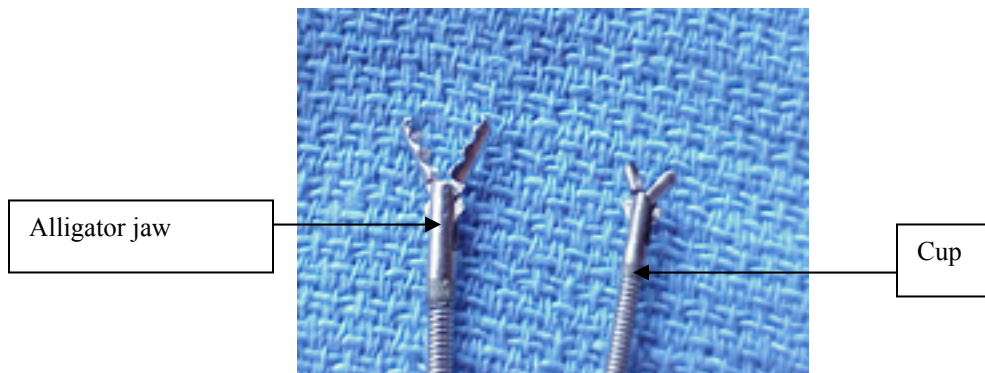
Question V.25: Which of the following factors most likely reduces diagnostic yield of forceps bronchoscopic lung biopsy

- 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).



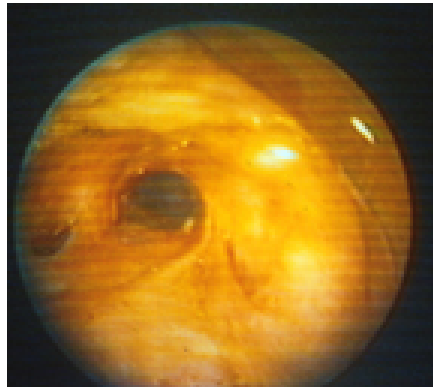
Question V.26: Diffuse tracheal narrowing is commonly seen in all of the following illnesses **except**

- 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

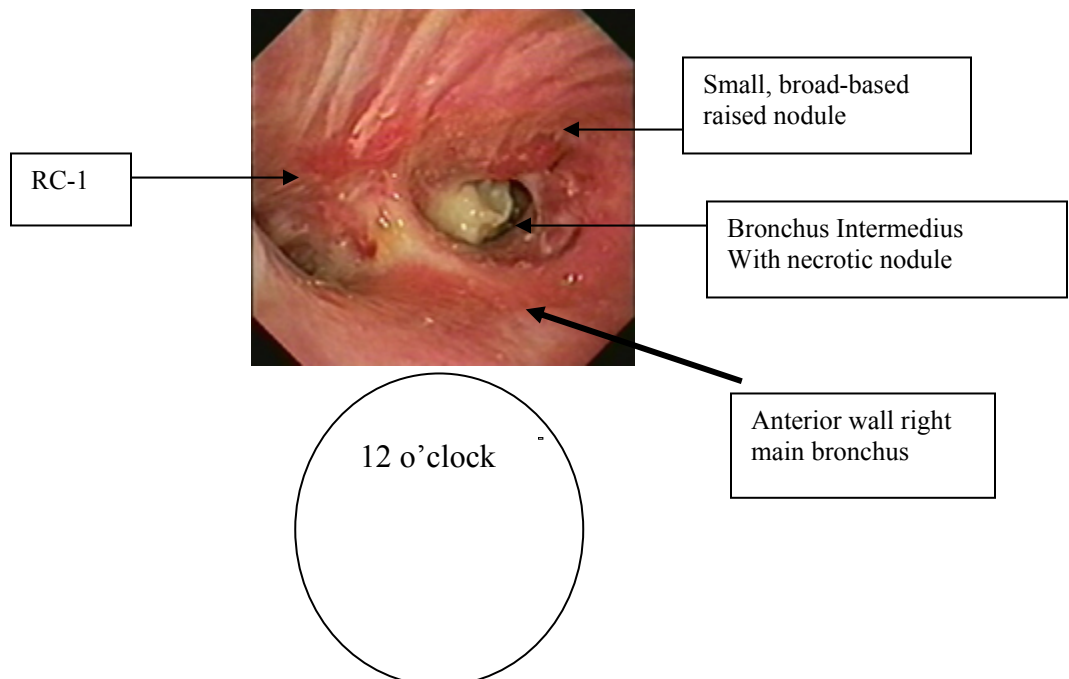
- A. 1
- B. 2
- C. 3



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. Necrotic tumor is obstructing most of 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!

NOTES

The Essential Flexible Bronchoscopist

Learning bronchoscopy in the world today



MODULE VI

THE ESSENTIAL BRONCHOSCOPIST™ SERIES

LEARNING OBJECTIVES TO MODULE VI

Welcome to Module VI of The EFB, a core reading element of the Introduction to Flexible Bronchoscopy Curriculum of the Bronchoscopy Education Project. Readers of the EFB should not consider this module a test. In order to most benefit from the information contained in this module, every response should be read regardless of your answer to the question. You may find that not every question has only one “correct” answer. This should not be viewed as a trick, but rather, as a way to help readers think about a certain problem. Expect to devote approximately 2 hours of continuous study completing the 30 question-answer sets contained in this module. Do not hesitate to discuss elements of the EFB with your colleagues and instructors, as they may have different perspectives regarding techniques and opinions expressed in the EFB. While the EFB was designed with input from numerous international experts, it is written in such a way as to promote debate and discussion.

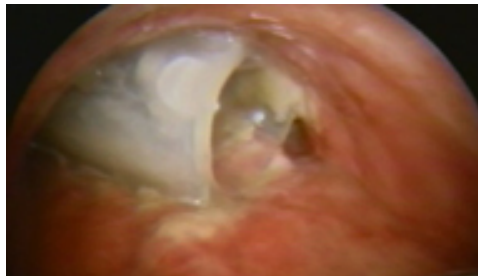
When you are ready, you may choose to take the post-test. This ten multiple choice question test addresses specific elements of the learning objectives of each module. Questions pertain to information found in the answer paragraphs or figures in the module, but may not correspond directly with a question found in the module. A 100% correct answer score is hoped for on the post-test although most programs accept 70% as a passing score.

At the conclusion of this module, the learner should be able to:

1. Compare and contrast IASLC and WANG nomenclatures for mediastinal lymph node sampling.
2. Identify Adenoid Cystic Carcinoma, carcinoid tumors, and specific assessments relating to evaluation for sleeve resection or bronchoplasty.
3. List THREE causes of tracheobronchomegaly.
4. Describe THREE different methods of transcarinal needle aspiration.
5. Describe THREE different ways to improve diagnostic yield from transbronchial needle aspiration.
6. Describe at least THREE different strategies used to control bronchoscopy-related bleeding.
7. Describe THREE strategies to remove an obstructed silicone stent from the airways.
8. Describe the importance and the consequences of the leak test.
9. Describe the major venous and arterial relationships with the left and right bronchial tree.
10. Identify and describe THREE different bronchoscopy scenarios where “gentleness” is a virtue.

Question VI.1 A left main bronchial stent was placed four months ago to palliate central airways obstruction from unresectable squamous cell carcinoma. The patient has had good response to external beam radiation therapy as demonstrated by tumor shrinkage on computed tomography scans. Last night the patient called to report acute onset of shortness of breath after a violent coughing episode. Emergent bronchoscopy reveals the finding shown. The most appropriate next step is to

- A. Immediately transfer the patient to an interventional bronchoscopist for rigid bronchoscopy, stent removal and evaluation for possible stent replacement.
- B. Introduce a large arterial embolectomy balloon catheter through the working channel of the flexible bronchoscope. After passing it through the stent, you inflate the balloon and pull the stent proximally into the trachea, and up past the vocal cords to remove the stent from the airways.
- C. Grasp the proximal edge of the stent with the largest alligator forceps available and pull the stent proximally into the trachea, and up past the vocal cords to remove the stent from the airways.
- D. Introduce a balloon catheter alongside the flexible bronchoscope using the suture and catheter technique. After passing the catheter through the stent, you inflate the balloon and pull the stent proximally into the trachea, and up past the vocal cords to remove the stent from the airways.



Answer VI.1 A

The most conservative approach is to transfer the patient to an interventional bronchoscopist. It is likely that tumor shrinkage resulted in stent migration. It is also likely that another stent will not be necessary at this time. It is safest to remove large silicone stents using a rigid bronchoscope because the stent can be pulled up into the rigid tube and removed from the airway without risk of damaging the vocal cords. If necessary, however, each of the other techniques described is possible. If repositioning with forceps is attempted, one must avoid tearing or cutting the stent. Alligator forceps, rat tooth with alligator jaws, rubber tip forceps, and shark tooth forceps might be used with varying

levels of success. Of course, techniques will vary depending on the bronchoscopist's experience and resources available.

In order to introduce a balloon catheter using the suture-catheter technique, one can introduce a balloon catheter that does not fit through the working channel of the flexible bronchoscope. The loop of a 100 cm O silk suture is placed through the working channel of the bronchoscope using forceps. In an emergency, waxed dental floss can also be used. The catheter is then placed through the loop, which is tightened around the catheter (see Figure below). An assistant holds the tightened suture while the bronchoscope-catheter ensemble is inserted into the airways via the oral route. The catheter can be advanced into position when the assistant releases the suture. Another method is to insert a bronchial blocker balloon (See Figure below). It is always risky to remove a silicone stent using flexible bronchoscopy because the stent may become lodged in the subglottis, or the stent may damage the vocal cords.



Question VI.2 A patient had a stent placed for benign postintubation tracheal stenosis two months ago. Abrupt onset of hoarseness and dyspnea prompts emergency consultation. Which of the following has most likely occurred.

- A. Granulation tissue has obstructed the stent
- B. The stent has migrated proximally
- C. The stent and lower trachea have become obstructed with thick secretions
- D. The stent has migrated distally
- E. The stricture has become more severe and has compressed the stent

Answer VI.2: B

Proximal migration of an airway stent can cause hoarseness, cough, throat pain, difficulty swallowing, and dyspnea. Sometimes the proximal extremity of the stent touches the caudal surface of the vocal cords. Other times, the stent might be coughed out and become caught between the vocal cords. In this case there is usually complete loss of voice. Stents that have migrated can be removed using rigid bronchoscopy under general anesthesia, or using flexible bronchoscopy, balloon catheters, or a # 5 cuffed endotracheal tube. Sometimes, a stent can be removed using the flexible bronchoscope and forceps, or by flexing the tip of the bronchoscope while pulling the bronchoscope-stent ensemble upwards.

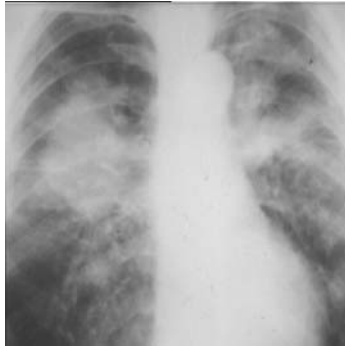
If intubation is necessary, a # 6 cuffless endotracheal tube should be used because it will usually pass beyond the stent. Depending on the site and severity of the airway stricture, however, the endotracheal tube may not pass beyond the stricture. Distal migration obviously prompts symptom recurrence but does not cause hoarseness. Thick secretions cause cough and dyspnea, but do not cause hoarseness or loss of voice. Granulation tissue can obstruct any and all airway stents. This complication occurs more frequently in patients with indwelling metal stents than in those with silicone stents. An increase in the severity of the airway stricture usually causes increasing dyspnea or cough, but should not result in hoarseness.

Cuffless # 6
endotracheal tube



Question VI.3: A 58-year-old coal miner complains repeatedly of coughing up dark phlegm. He has rheumatoid arthritis and chronic bronchitis. He coughed up a teaspoon of blood three months ago. He continues to smoke cigarettes. Chest radiograph reveals bilateral slightly cavitating lung nodules in the upper lung fields with associated volume loss and retraction of the hila upwards. The most likely diagnosis that **best** explains all these symptoms is

- A. Malignant melanoma metastatic to the large airways
- B. Bronchogenic carcinoma with occasional bleeding and presence of old blood clot
- C. Active, necrotizing tuberculosis with lymphadenopathy eroding through bronchial wall
- D. Caplan's syndrome
- E. Broncholithiasis from prior infection with *Coccidioides immitis*



Answer VI.3: D

This patient probably has Caplan's syndrome, which includes multiple pulmonary nodules, rheumatoid arthritis, a cigarette smoking history and employment as a coal miner. The expectoration of black sputum, also known as melanoptysis, occurs in patients with complicated coal workers pneumoconiosis (CWP). Disease presents as bilateral large or confluent nodules in the upper lung fields. Often there is a background of simple coal worker's pneumoconiosis. The prognosis for patients with complicated CWP is poor.

For the patient described in this case, flexible bronchoscopy was performed to exclude other diseases that might be responsible for symptoms. Malignant melanoma can metastasize to the large airways, resulting in a blackish nodular obstruction that bleeds easily and might require bronchoscopic laser resection. Parenchymal melanoma nodules, however, are usually small and do not cavitate. If there were airway obstruction, one would expect to see radiographic signs of atelectasis. In addition, patients with bronchial metastases from melanoma, usually have a known history of malignant melanoma.

Patients with necrotizing tuberculosis may have erosion of caseous material and mediastinal lymphadenopathy through the medial walls of the left or right main bronchi. This might warrant stent insertion. Material is usually yellowish and thick, which does not fit the description given above. Old blood clot from a previously or actively bleeding

endobronchial tumor can appear black on bronchoscopic examination. In fact, such clots may be erroneously believed to be endobronchial tumors. Removal is often difficult because clots tear easily when grasped with biopsy forceps. It may be necessary to use rigid bronchoscopy, specially designed foreign body removal instruments or balloon catheters to remove tenacious clots from the airway.

Broncholiths are usually whitish, firm, calcified nodules that have eroded through an airway wall or otherwise entered the distal lobar or segmental bronchial lumen. They are often surrounded by granulation tissue that can bleed easily. Often asymptomatic, they may also cause hemoptysis, cough, localized wheezing, postobstructive pneumonia, and radiographic or bronchoscopic signs of endobronchial obstruction. Etiologies for broncholithiasis include *Coccidioidomycosis*, *Histoplasmosis*, and *Mycobacterium tuberculosis*. Sometimes it is necessary to use Nd:YAG laser to break up these benign broncholiths, and to remove them piecemeal using foreign-body removal techniques.



Question VI.4: A 35-year-old male reports increasing shortness of breath during the past 5 years. He recently quit his job as a sand blaster because chest pain, cough, and increasing fatigue prevented him from working. On physical examination, decreased breath sounds with ronchi at the lung bases are noted. The patient has digital clubbing. There is no peripheral lymphadenopathy. He denies fever or weight loss. He denies risk factors for HIV. Arterial blood gases reveal a PaO₂ of 54 mm Hg. Diffusion capacity and Total Lung Capacity are also decreased. Chest radiograph reveals bilateral alveolar infiltrates. Patchy bilateral consolidation is noted on chest computed tomography scan. Flexible bronchoscopy with bronchoscopic lung biopsy reveals nonrepresentative tissue. Bronchoalveolar lavage shows dense eosinophilic material, which stains positive for PAS and fat. Silver stain is negative. The next step in the diagnostic evaluation is

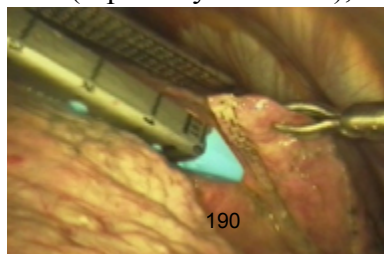
- A. High resolution computed tomography
- B. Thoracoscopic lung biopsy
- C. Repeat bronchoscopic lung biopsy
- D. Repeat BAL with repeat shell vial viral cultures
- E. Echocardiogram

Answer VI.4: B

Thoracoscopic lung biopsy rather than repeat bronchoscopic lung biopsy and bronchoalveolar lavage is most likely warranted in this case. It is noteworthy that the bronchoscopy was not “nondiagnostic”, but “nonrepresentative”. One could argue to repeat the biopsy. Satisfactory material, however, was obtained from the bronchoalveolar lavage, suggesting a diagnosis. The differential diagnosis includes Idiopathic alveolar proteinosis, Acute silicotic alveolar proteinosis, Hematologic malignancy, AIDS with cytomegalovirus infection, and new onset right heart failure in a patient with silicosis.

This particular patient had secondary alveolar proteinosis. This entity has been noted in up to 5 percent of patients with hematologic malignancies and pulmonary symptoms, and in up to 10 percent of patients with myloid disorders. Patients who are immunosuppressed, including patients with AIDS or immunoglobulin deficiencies may also have an alveolar proteinosis-type reaction, although infections are often present as well. These include *Pneumocystis carini*, cryptococcosis, tuberculosis, and viral infections. Right heart failure and associated pulmonary edema may simulate the radiographic pattern of alveolar proteinosis, but edema fluid lacks eosinophilic material.

Patients with acute silicosis may also develop silicotic alveolar proteinosis. Acute silicosis can present after several years of steady exposure, usually in sand blasters, tunnelers or silica flour workers. BAL fluid might also reveal birefringent material with polarization. Idiopathic alveolar proteinosis has a variable prognosis. Although infiltrates occasionally clear spontaneously, it is more often necessary to proceed with bilateral whole lung lavage. Abundant milky fluid removed during lavage is diagnostic. About 30 percent of individuals will eventually succumb to the disease, which can progress to intractable hypoxemia, infection (especially *Nocardia*), and respiratory failure.



Question VI.5: 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 VI.5: B

Approximately 80 percent of tracheal cancers are either squamous cell carcinomas or adenoid cystic carcinomas. Most squamous cell cancers occur in male smokers over the age of sixty, whereas adenoid cystic carcinomas occur without gender predilection over a wide age range. For adenoid cystic carcinoma, open surgical resection is the treatment of choice, although positive surgical margins occur in about 40 percent of patients. Patients with acute symptoms of central airway obstruction can be considered for bronchoscopic resection.

Patients who are not surgical candidates may require bronchoscopic resection and airway stent insertion. The tumor shown in the figure below is deep and infiltrating. Multiple endoscopic treatments, including insertion of an airway stent may be warranted. Surgical resection is difficult, and margins are likely to be positive. Local recurrence with or without synchronous distal metastases occurs in up to 25 percent of patients despite local open surgical resection with or without external beam radiation therapy, and even very late recurrences may occur.



Question VI.6: Two weeks ago, you referred a 58 year old woman with inoperable squamous cell carcinoma and right main bronchial obstruction to a colleague who performed Nd: YAG laser resection followed by silicone stent insertion. During a consultation to discuss external beam radiation therapy, she asks you about potential stent-related complications. You tell her all of the following **except**

- A. Potential complications include stent migration and stent obstruction from secretions, granulation tissue or tumor.
- B. Complications are rarely life-threatening, but some experts recommend surveillance flexible bronchoscopy.
- C. If airway patency has been satisfactorily restored, she may resume a normal life, including travel, exercise and nutrition.
- D. She should contact you or the nearest emergency room in case of new or increased cough, shortness of breath, hoarseness, chest pain, or fever.
- E. She should postpone external beam radiation therapy for at least two more weeks because it may facilitate stent migration.

Answer VI.6

E

Neither external beam radiation therapy nor brachytherapy have adverse effects on indwelling airway stents. Therefore radiation therapy and other systemic therapies should not be postponed because of airway stenting. Stent-related complications do occur, however, but are less frequent in patients with malignant central airway obstruction than in patients with benign causes of central airway obstruction. This is presumed to be because growing neoplastic tissues keep stents in position with the airway lumen. Shrinkage of these tissues from radiation therapy or response to chemotherapy will predispose to stent migration.

Should a patient develop symptoms suggestive of stent-related complications, emergent consultation is warranted. Physical examination might reveal decreased breath sounds, wheezing, or stridor. Chest radiographs may reveal stent migration, atelectasis, or pulmonary infiltrates. Flow-volume curves might reveal decreased ventilatory flow. Bronchoscopy might reveal stent migration or obstruction from granulation tissue, tumor, or secretions.

Question VI.7: A 62-year-old male with carcinoma in-situ underwent photodynamic therapy one week ago in an institution 1000 miles away from his home. He telephones your office asking whether he can watch television. You tell him that

- A. Light from the television, as well as any form of artificial light is dangerous
- B. The effects of photosensitivity last up to 6 weeks, but exposure to television and artificial light is safe.
- C. Protective clothing and eyewear should be worn while watching television
- D. He must telephone the physician who performed PDT for that information.

Answer VI.7: B

Photosensitivity precautions are essential to avoid side effects, especially skin hypersensitivity, in all patients undergoing PDT. All patients from the time of drug injection to approximately 6 weeks after treatment must wear protective clothing and special eyewear. Exposure to any bright light is dangerous. Artificial light and light from television, however, are safe.



Question VI.8: While performing transbronchial needle aspiration of IASLC nodal station 4R (right paratracheal), you insert the needle 2 cm above the carina, and laterally at the 3 o'clock position (imagining the interior of the airway as a clock face and using the carina as the central reference point). Which of the following is a major anatomic danger

- A. The aorta
- B. The right pulmonary artery
- C. The mediastinal reflection of the pleura and the azygos vein
- D. The esophagus

Answer VI.8: C

Anterior and to the right of the distal third of the trachea lie the superior vena cava and the Azygos vein. Needle insertion at this site risks causing pneumothorax or bleeding. The right pulmonary artery is anterior to the right main bronchus and origin from the right upper lobe bronchus. Needle insertion through the anterior wall of the right main bronchus at the level of the origin of the right upper lobe bronchus should be avoided.

The esophagus lies closely (within 2-3 mm) behind the posterior wall of the trachea and left main bronchus. The innominate artery and the aortic arch lie directly anterior to the trachea, just above the main carina and coursing slightly to the left of the distal trachea where one can see a slight indent and faint pulsations. Obviously, it would be unwise to insert a needle into this area!

Question VI.9: During transbronchial needle aspiration of mediastinal lymphadenopathy, Which of the following is most likely to help increase diagnostic yield?

- A. Performing needle aspiration before airway examination or acquisition of other samples.
- B. Maintaining suction during needle withdrawal from the lymph node.
- C. Rinsing the working channel of the bronchoscope before needle insertion.
- D. Using a histology needle rather than the smaller gauge cytology needle only.
- E. Asking the cytopathologist to be present to immediately examine the specimens.

Answer VI.9: E

Several studies have shown that onsite examination of TBNA specimens by a trained cytopathologist results in greater diagnostic yield. In addition, this might allow the bronchoscopist to perform fewer needle passes, and might make additional specimens such as biopsies or brushing less necessary. Most experts recommend rinsing the working channel prior to performing needle aspiration. In addition, in order to avoid false positive results, needle aspiration should be performed prior to airway inspection or biopsies of endobronchial abnormalities. Once the needle is inserted through the airway wall and into the tumor or lymph node, suction is applied to obtain the sample. Suction should be released prior to removing the needle from the tumor or lymph node in order to avoid avoid contamination from bronchial wall tissue. The bronchoscope should not be connected to wall suction until all needle aspiration samples have been obtained. In many cases of mediastinal node aspiration, using the larger histology needle might result in greater yield, especially for diagnosis of lymphoma.

Question VI.10: Symptoms of cough, low-grade temperature, and shortness of breath prompt flexible bronchoscopy in a 44-year-old man two months after autologous stem cell transplantation for B cell lymphoma. His lymphocyte and neutrophil counts are normal but he remains thrombocytopenic and receives periodic platelet transfusion. Chest radiographs and computed tomography scans show unilateral right mid and lower lung zone alveolar infiltrates without lobar consolidation. On inspection, tracheobronchial mucosa is diffusely inflamed and erythematous. There are no purulent secretions. Bronchoalveolar lavage is grossly bloody and rich in hemosiderin-laden macrophages. Which of the following most likely accounts for the bronchoscopic findings?

- A. Idiopathic interstitial pneumonia
- B. CMV pneumonia
- C. Invasive pulmonary aspergillosis
- D. Acute pulmonary edema secondary to sepsis
- E. Alveolar hemorrhage

Answer VI.10: E

Blood in airway means the patient is bleeding. It is difficult to determine the precise etiology of the bleed itself. However, Hemosiderin-laden macrophages, although nonspecific as to underlying etiology, are indicative of blood in the alveoli, suggesting alveolar hemorrhage when found in a well performed bronchoalveolar lavage

Alveolar hemorrhage is frequently a complication of any inflammatory pulmonary process in thrombocytopenic patients or those with coagulopathies.. When seen as part of the Diffuse Alveolar Hemorrhage syndrome within weeks after transplantation, the process is usually fatal. Diffuse Alveolar Hemorrhage is reported in up to 20 percent of patients following autologous transplantation, and may occur in patients with normal coagulation activity. Its cause is unknown.

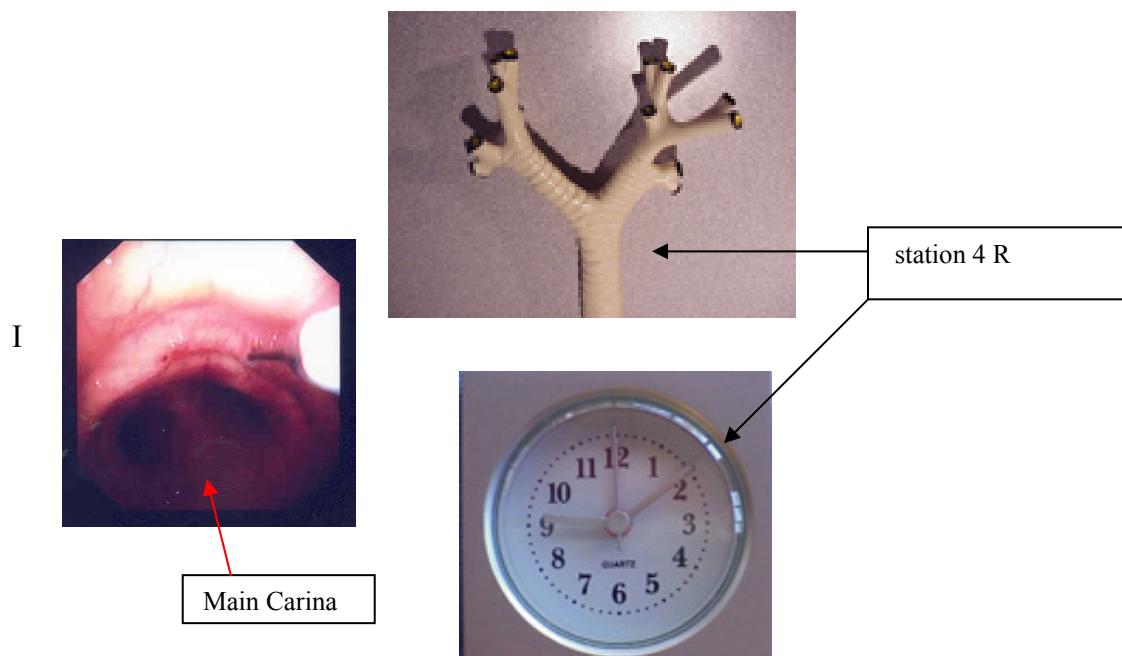
CMV pneumonia, pulmonary edema and idiopathic interstitial pneumonia usually present with diffuse radiographic findings, but could each cause alveolar hemorrhage also. Invasive pulmonary aspergillosis could be unilateral and cause alveolar hemorrhage, but would not be expected in the absence of neutropenia or corticosteroids (corticosteroids are frequently used to treat graft-versus-host disease among allogeneic transplant recipients. Because this patient had autologous transplant, it is unlikely that corticosteroids would have been administered, making invasive aspergillosis less likely).

Question VI.11: Where are the right paratracheal lymph nodes (IASLC stations 4R, Wang bronchoscopic nodal station 3) in relation to the trachea

- A. Posterior-lateral
- B. Anterior-lateral
- C. Lateral
- D. Posterior

Answer VI.11: B

IASLC nodal station 4 R is anterolateral to the trachea, and can be accessed by needle aspiration at a site that is two-four intercartilaginous spaces above the carina, aiming the needle anterolaterally towards the 1 or 2 o'clock position (imagining the interior of the airway as a clock face and using the carina as the central reference point). Aiming the needle more laterally risks puncturing the azygos vein. The paratracheal lymph nodes are generally located slightly lateral to the trachea. They are difficult to access because of the very lateral position required of the needle and of the tip of the flexible bronchoscope, especially on the left (IASLC station 4L or aortopulmonary window node).



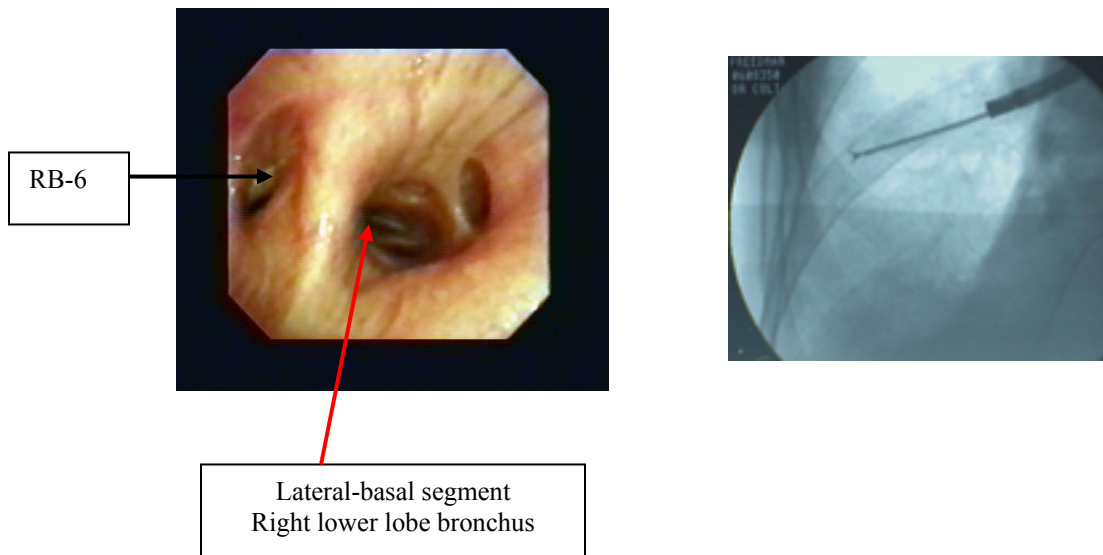
Question VI.12: Bronchoscopic lung biopsy through which bronchial segment is most likely to present fluoroscopically an exact position of the forceps in relation to the pleura:

- A. The lateral basal segment of either lower lobe.
- B. The medial basal segment of the right lower lobe.
- C. The posterior basal segment of either lower lobe.
- D. The apical segment of either lobe upper lobe.
- E. The superior segment of either lower lobe

Answer VI.12: A

The lateral-basal segment of either lower lobe extends into the costophrenic sulcus, and thus provides an accurate picture of the exact location of the forceps in relation to the rib cage and pleura. In addition, should biopsy-related bleeding occur, tamponade is readily possible in this gravity dependent basal segment. The flow of blood downwards will also enhance clot formation and prevent contamination of the contralateral airways.

Knowing the exact location of the forceps in relation to the pleura is difficult in the posterior basal and medial basal segments of the lower lobes, partially obscured by the heart borders, and in the apical segments of the upper lobes, where the pleural reflection actually extends above the clavicles. Biopsy through the superior segmental bronchus (RB-6) might increase the risk for pneumothorax because the superior segment of the lower lobe is directly adjacent to the major fissure.

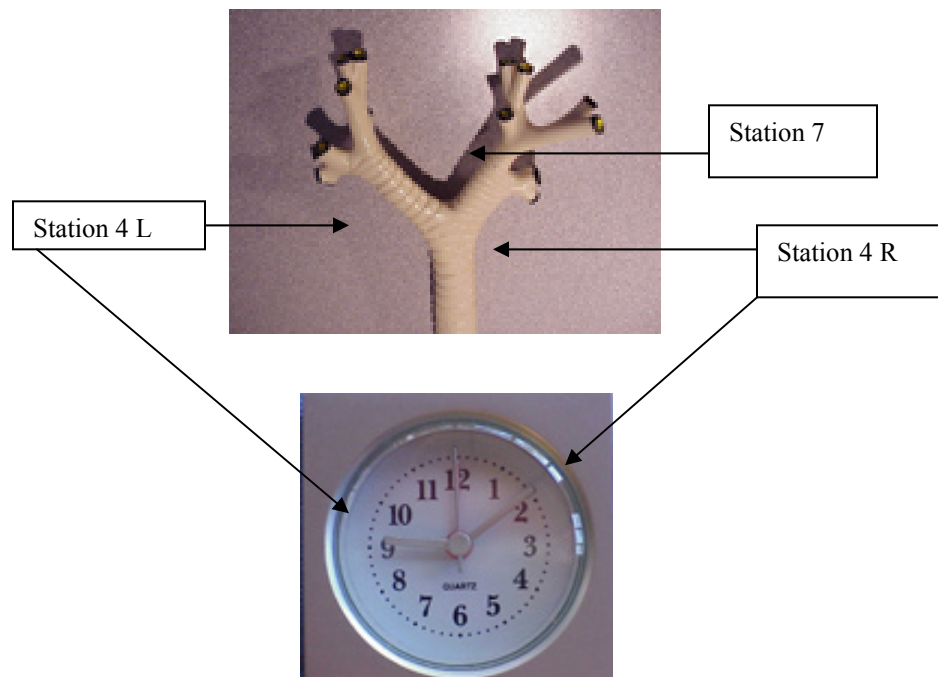


Question VI.13: The Wang bronchoscopic nomenclature (proposed for mediastinal lymph node transbronchial needle aspiration) for the anterior carina (Wang station 1), posterior carina (Wang station 2), subcarinal (Wang station 8), left paratracheal (Wang station 4), and right paratracheal (Wang station 3) lymph nodes correspond to which of the following nodal combinations using the IASLC map.

- A. IASLC station 7, IASLC station 4L, and IASLC station 4 R.
- B. IASLC station 6, IASLC station 4L, and IASLC station 4 R.
- C. IASLC station 7, IASLC station 8, IASLC station 4L, and IASLC station 4 R.

Answer VI.13: A

The IASLC station 7 corresponds to the anterior, posterior, and subcarinal nodes. Stations 4L and 4R correspond to the lower paratracheal nodes (station 5 being the aortopulmonary window node). The right paratracheal nodes are best sampled by inserting the needle about 2 cm above or from the second or third intercartilaginous space above the carina at the 1 o'clock or 2 o'clock position (imagining the interior of the airway as a clock face and using the carina as the central reference point). The left paratracheal (aortopulmonary) nodes should be sampled from the lateral wall of the left main bronchus at the level of the carina by inserting the needle at the 9 o'clock position.



Question VI.14: 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 VI.14: A

Carcinoid tumors are usually round, smooth-walled, fleshy appearing, and glistening. They may be partially or completely obstructive. At least one study has convincingly shown that cherry red, atypical carcinoid tumors bleed most easily. Carcinoid tumors are classified as either typical or atypical tumors. Typical carcinoids are defined as a group of neuroendocrine cells with an alveolar or glandular appearance. 5-10 year survival is greater than 90 percent, and only 10 % of deaths that occur are due to local recurrence. Atypical carcinoids have increased mitotic activity, necrosis, or disorganized architecture. 5-10 year survival is about 60 percent, and more patients have lymph node involvement.

Carcinoid tumors can be resected and treated endoscopically (Nd:YAG laser resection appears to be most beneficial long-term). Current conventional wisdom suggests, however, that definitive treatment is surgical (pneumonectomy, lobectomy or parenchymal-sparing such as segmentectomy and sleeve resections). Surgical management decisions depend on extent of tracheobronchial disease, invasion within and through the airway wall, existence of nodal disease, available interventional bronchoscopist and thoracic surgical expertise, underlying patient health, and type of disease.

Question VI.15 A patient with renal cell carcinoma and malignant melanoma presents with persistent cough, decreased exercise tolerance, and severe shortness of breath. Bronchoscopy reveals the abnormality shown in the Figure below. Which of the following steps is most appropriate now.

- A. The abnormality should be biopsied using forceps through the flexible bronchoscope
- B. The abnormality is most consistent with metastatic melanoma. The patient should be referred to an interventional bronchoscopist for biopsy and removal.
- C. The abnormality is most consistent with metastatic renal cell carcinoma. The patient should be referred to an interventional bronchoscopist for biopsy and removal.
- D. The patient should be referred for external beam radiation therapy
- E. The patient should be referred to hospice. No aggressive bronchoscopic therapies are warranted.



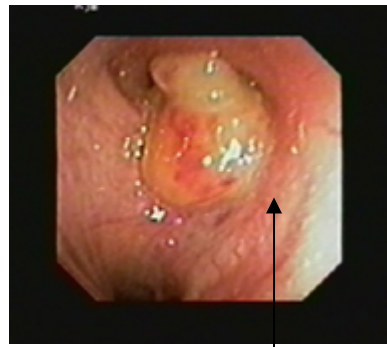
Answer VI.15. B

The large and darkly pigmented intraluminal tracheal mass is most suggestive of metastatic melanoma. It appears to be growing up and out of the left main bronchus, and does not appear to be adherent to the anterior wall of the trachea. This patient should be immediately referred to an interventional bronchoscopist for laser resection. The lesion appears very amenable to rigid bronchoscopic resection. It is unlikely that a stent will be needed. External beam radiation will not immediately improve symptoms.

Hospice care and end-of-life issues should be discussed because the patient has a potentially terminal illness, however, aggressive bronchoscopic therapies and further systemic therapy should be offered. Interventional bronchoscopic therapies improve quality of life, improve lung function and exercise tolerance, provide symptomatic relief, and give patients “time” and energy to undergo additional systemic therapy. The abnormality does not look like metastatic renal cell carcinoma, which is usually red, relatively smooth-walled, and bleeds easily.

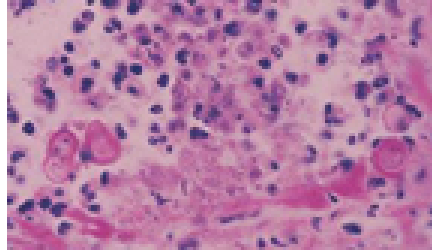


Malignant melanoma



Renal cell carcinoma

Question VI.16: A 53-year-old woman has been homeless for two years. She lives along a small riverbank in Southwestern Mexico. She sleeps under aluminum siding, and smokes abundantly. She has been hospitalized with weight loss, productive cough of unclear duration, and a chest radiograph showing a large perihilar mass. Flexible bronchoscopy with BAL and bronchoscopic lung biopsy is performed. Histopathology is shown in the Figure below. Which of the following bronchoscopic abnormalities helps increase your certainty that perhaps Blastomycosis, and not cancer, is the cause for her symptoms and radiographic findings?

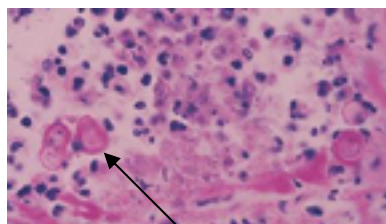


- A. Circumferential narrowing of the right upper lobe bronchus associated with mucosal granularity and thrush-like whitish plaques.
- B. Right main bronchial compression with near total closure of the right upper lobe bronchus from extrinsic compression.
- C. Abundant, white mucosal plaques in the lower trachea with small nodules and vesicular lesions surrounding an area of focal bronchial narrowing within the right main bronchus and right upper lobe bronchus.

Answer VI.16: C

Blastomyces dermatidis is another dimorphic soil-dwelling fungus. In the United States, most cases occur in states surrounding the Mississippi and Ohio rivers. Cases have also been noted in Canada, Venezuela, Mexico, Africa, and the Middle East. Infection is signaled by a febrile influenza-like illness. Incubation periods are unclear. Patients can present with productive cough of mucopurulent sputum and a chest radiograph showing lobar consolidation or multiple small pleural-based round opacities. When abnormalities coalesce to form large masses, the appearance is suggestive of bronchogenic neoplasm. Pneumothorax, pleural effusions, or pleural thickening are frequently associated findings.

Disease also affects the skin, the central nervous system, the genitourinary tract, and articulations. Diagnosis is made by identification of dark, large-based, round single budding yeast forms with thick refractile walls on tissue sections. Staining with 10% KOH of BAL fluid may also be positive. Skin testing and complement fixation tests are insensitive and unreliable.



Thick-walled yeast forms

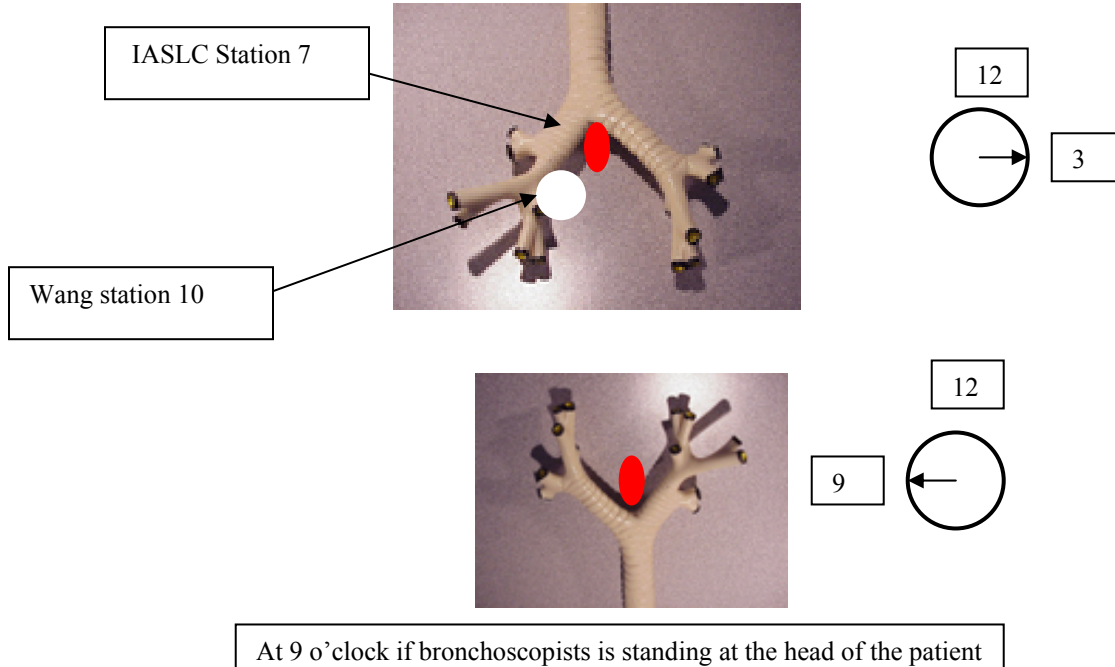
Question VI.17: Imagining the interior of the airway as a clock face and using the carina as the central reference point, transbronchial needle aspiration at the 9 o'clock position along the medial wall of the bronchus intermedius at a level just proximal to the right middle lobe bronchial orifice will sample

- A. The right lower hilar lymph node
- B. The sub-subcarina lymph node
- C. The right main bronchus lymph node
- D. The sub carina lymph node

Answer VI.17: B

The sub-subcarina lymph node (Wang nodal station 10) is often seen on computed tomography scan. It is located between the bronchus intermedius and the left main bronchus, at or near the level of the right middle lobe bronchus. The subcarina lymph nodes on the other hand (IASLC station 7, Wang station 8), are between the right and left main bronchus, at or near the level of the right upper lobe bronchus on computed tomography scanning.

In order to sample the subcarina lymph node, the needle should be inserted at the 3 o'clock position along the medial wall of the right main bronchus, just proximal to the level of the right upper lobe bronchial orifice (if the bronchoscopist is standing in front of or to the side of the patient). The Wang nodal classification scheme is not commonly used in bronchoscopic practice (yet).



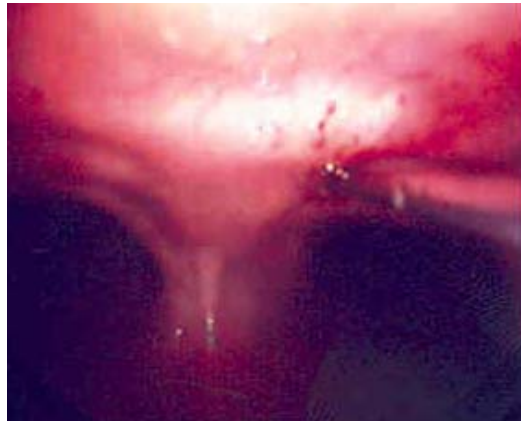
Question VI.18: Imagining the interior of the airway as a clock face and using the carina as the central reference point, transbronchial needle aspiration at the 12 o'clock position along the anterior wall of the trachea at a level between the first and second intercartilaginous interspace from the lower trachea will sample

- A. The right lower hilar lymph node
- B. The sub carina lymph node
- C. The posterior carina lymph node
- D. The anterior carina lymph node

Answer VI.18: D

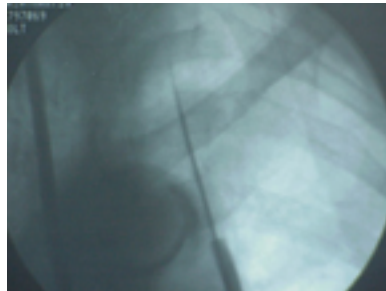
The anterior carina lymph node is in front and between the proximal portion of the right and left main bronchus on computed tomography scanning. It may be helpful to first lodge the needle tip into the mucosa, then to advance the needle catheter so that the entire length of the needle protrudes beyond the tip of the bronchoscope. For example, using the free hand, the bronchoscopist fixes the proximal end of the catheter to the bronchoscope, preventing the needle from recoiling into the bronchoscope when resistance is encountered.

The scope and the needle catheter can then be pushed simultaneously and as a single unit into the lesion. As the ensemble is advanced, the bronchoscope and catheter will curve slightly in a cephalad direction, moving the needle tip into a more perpendicular orientation at the puncture site. This helps avoid cartilaginous rings and also prompts a deeper insertion depth of the needle. In order to sample the posterior carina lymph node, the needle should be inserted at the posterior portion of the carina at about the 6 o'clock position.



Question VI.19: Bronchoscopic lung biopsy is performed in the patient seen in the Figure below. Severe bleeding has begun. Which of the following is most correct

- A. Wedging the bronchoscope in an upper lobe segment can be difficult, if not impossible
- B. A bolus of straight epinephrine; 1:10.000 will cause vasoconstriction and stop the bleeding
- C. It would have been safer to biopsy the anterior segment of the left upper lobe
- D. The patient's abnormal bleeding time predicted the likelihood of bleeding, so ancillary instruments should be opened and ready to use.



Answer VI: 19

A

Wedging the bronchoscope while applying suction is often effective to tamponade the bleeding bronchus, enhance clot formation, and maintain airway patency in the rest of the tracheobronchial tree. The patient should also be placed into the safety position (lateral decubitus, left side down). A bolus of epinephrine will probably be pushed back by blood or during a cough. Regardless, epinephrine should be diluted in normal saline before administration (1:1,000 use 1 ml of epinephrine diluted in 10-20 ml of solution).

In patients potentially at risk for bleeding, it is wisest to biopsy gravity dependent areas such as the lower lobe bronchi and the posterior segmental bronchus of the upper lobes. This way the contralateral lung and other segments are more easily protected from blood spillage. The anterior segment is not a gravity-dependent segment when patients are supine. An abnormal bleeding time (normal is 2-9 minutes) does not predict likelihood of bleeding, nor does it predict safety of the procedure.

Question VI.20: A patient has a smooth-walled, fleshy appearing tumor that looks like a carcinoid. Which of the following statements about the amount, consistency, and quality of the literature is most correct.

- A. Evidence is high demonstrating that biopsy will make a diagnosis in 80 percent of cases, and that the risk of bleeding from biopsy is about 1 percent.
- B. Evidence is low demonstrating that biopsy will make a diagnosis in 80 percent of cases, and that the risk of bleeding from biopsy is about 1 percent.
- C. It is impossible to analyze risk of bleeding or chance for making a diagnosis.

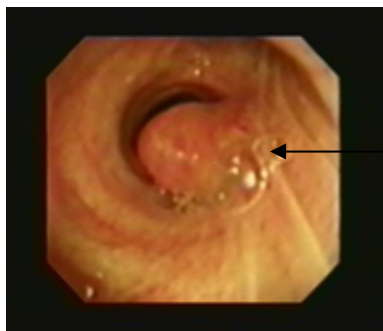


Answer VI.20:

A

Historically, it has been taught that carcinoid tumors bleed easily and that great caution is warranted when bronchoscopic biopsies are obtained. Although this may be true, this “fact” has not been addressed in prospective studies. Many experts recommend applying topical epinephrine to the lesion immediately before biopsy to reduce the risk of bleeding. Although potentially effective, this practice has not been validated in prospective studies. It is well recognized that when biopsies are done, the chance of making a diagnosis of carcinoid by endobronchial biopsy is about 80 percent.

From historical studies it is also recognized that major bleeding risk is about 1 percent. Differentiating between typical and atypical carcinoids preoperatively, including by frozen section, is difficult. In addition, washings, needle aspiration, and brushings are rarely useful in establishing a diagnosis of carcinoid tumor. Many experts believe that endobronchial biopsies should be deep because some tumors are covered superficially by normal bronchial mucosa as in the figure below. In many instances, the diagnosis on biopsy may be falsely reported as small cell or squamous cell carcinoma.



Typical carcinoid at
entrance of right upper
lobe bronchus

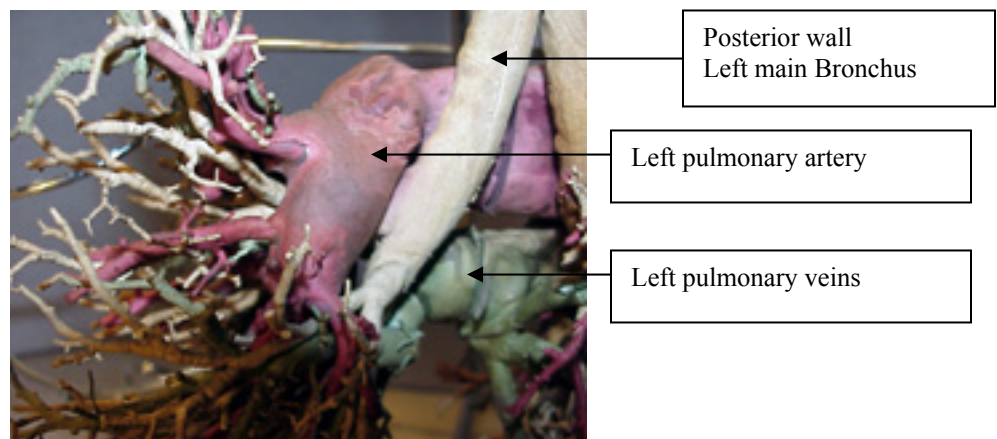
Question VI.21: Transbronchial needle insertion through the anterior wall of the proximal left upper lobe bronchus, just above the carina dividing the lingual from the upper division bronchus risks entering

- A. The left pulmonary vein
- B. The left pulmonary artery
- C. The aorta
- D. The esophagus

Answer VI.21: A

The left pulmonary veins lie immediately anterior to the left main bronchus and left upper lobe bronchus. The left pulmonary artery is a major vascular danger for interventional bronchoscopists because it forms a long “S” around the left main bronchus and around the left upper lobe bronchus.

The aortic arch is in contact with superior and posterior portion of the left main bronchus. In order to access aortopulmonary lymph nodes (station 5, Wang bronchoscopic station 4) by needle aspiration, the needle should be inserted posterolaterally at about the 9 o'clock position (imagining the interior of the airway as a clock face and using the carina as the central reference point) at the level of the carina or one intercartilaginous space below along the lateral wall of the left main bronchus.



Question VI.22: Which of the following actions is widely accepted and without controversy in regards to bronchoscopy-induced bleeding

- A. Moving the patient into the “safety” position; lateral decubitus with bleeding side down.
- B. Wedging the flexible bronchoscope into the bleeding bronchial segment while applying continuous suction.
- C. Keeping the bronchoscope mobile (without wedging) in order to suction, wash with abundant saline, and protect the contralateral lung
- D. Administering a bolus of epinephrine before biopsy
- E. Administering boluses of cold saline when bleeding occurs

Answer VI.22: A

Moving the patient into a gravity dependent position is widely accepted and considered routine preventive practice when bronchoscopy-related bleeding occurs. This position promotes clot formation and protects the contralateral airway. Each of the other actions is appropriate, but each is controversial. Some experts advocate wedging, others advocate keeping the scope mobile. Some advocate cold saline wash, others advocate epinephrine administration before biopsy. Of course one does not exclude the other. The important thing when bleeding occurs is to keep the patient calm, to give clear orders to one's assistants, maintain adequate oxygenation, protect the contra lateral lung, and attempt tamponade using suction, the bronchoscope, and ancillary instruments.



Question VI.23: When performing transbronchial or transcarinal needle aspiration, which of the following appears to be most important for increasing diagnostic yield.

- A. Performing at least 3-4 passes blindly.
- B. Having a cytopathologist present “in the procedure suite” to examine each specimen immediately.
- C. Using the largest and stiffest needle possible
- D. Obtaining the needle specimen after bronchoalveolar washings or biopsies

Answer VI.23: B

Needle aspiration has been shown to have an increased yield when cytopathologists are present at the bedside to determine whether samples are representative. This has become standard of practice and should be encouraged in institutions where bronchoscopic needle aspiration is performed. Needle aspiration should be performed before any other bronchoscopic specimens are collected in order to avoid contamination and false positives. The stiffer, larger-bore, two part histology needle appears to be very helpful for transcarinal sampling, but is more difficult and sometimes impossible to use in more distal airways. Most investigators have found that at least 3-4 needle passes are necessary to make a diagnosis.

Question VI.24: Which of the following statements about bronchoscopy-induced bleeding is correct

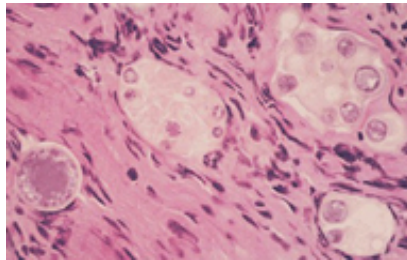
- A. Usually, the overall risk of bleeding more than 50 ml after bronchoscopic lung biopsy is about 1-2 % but is reportedly as high as 45% in patients with uremia (serum creatinine > 2, blood urea nitrogen > 25 mg/dl)
- B. Once bleeding has stopped, the clot should be removed in order to be certain that there is no active bleeding distally.
- C. All patients undergoing bronchoscopy should have platelet counts and coagulation profile measured before the procedure
- D. Most experts agree that patients with a platelet count below 50,000/mm³; blood urea nitrogen of 45 mg/dl, and a serum creatinine of 3 can safely undergo endobronchial biopsy.

Answer VI.24: A

The risk of bleeding is real, and most definitely increased in patients with uremia, dysfunctional platelets, liver failure (Bilirubin > 1.5 mg/dl, alkaline phosphatase > 110, SGOT > 25) and known coagulopathy. Routine measurement of platelets and coagulation profile is unwarranted except in patients in whom the history and physical has documented a potential bleeding risk. Findings include a history of anticoagulation, known diseases associated with platelet dysfunction, hereditary disorders such as Von Willebrand's disease or hemophilia, drugs such as sulfa, thiazides, disorders associated with decreased platelet production such as leukemia, myeloma, lymphoma, and secondary cancers involving the bone marrow, and diseases associated with platelet destruction such as immune (ITP, drugs, systemic lupus) and nonimmune (disseminated intravascular coagulation, burns, trauma, TTP) disorders.

Although precise "numbers" pertaining to bleeding risk have not been studied, it is reasonable to avoid biopsy in patients with elevated BUN (>45) or creatinine (>3), and to perform biopsies only if absolutely necessary if platelets are less than 50,000 mm³. Inspection and bronchoalveolar lavage in such patients, however, is safe. Should bleeding occur, it is usually easily controlled. Fresh clots should not be removed even when they obstruct lobar or segmental bronchi. One well known expression is "leave the clot". A bronchoscopy can readily be performed the next day in order to remove clot if there is symptomatic deterioration or radiographic evidence of atelectasis.

Question VI.25: A 45 year old woman with a history of breast cancer 15 years ago frequently goes hiking and camping in the desert valley east of San Diego, California. Her dog is with her constantly during her camping trips. He was recently very ill, but improved after a course of antibiotics and itraconazol. Now, the woman is febrile and has a fine erythematous rash on her forearms and legs. Skin test for tuberculosis is nonreactive and she is anergic to Mumps and Candida. Fine crackles are noted on auscultation over the lung bases bilaterally. Chest radiograph reveals bilateral pulmonary infiltrates greatest in the right lower and mid lung fields. Because of persistent fever and pulmonary symptoms despite three days of bed rest and intravenous antibiotics, she is referred for flexible bronchoscopy with lavage and bronchoscopic lung biopsy. Histopathology results are shown in the Figure below. Which of the following bronchoscopic findings increases your certainty regarding a diagnosis of acute Coccidiomycosis infection?



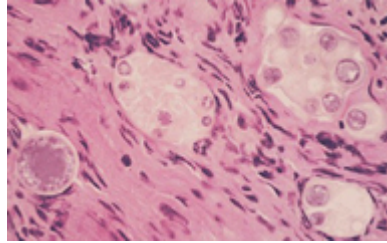
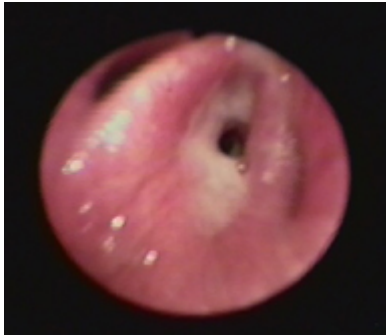
- A. Circumferential narrowing of the right lower lobe bronchus associated with mucosal granularity and a firm, raised polypoid endobronchial abnormality
- B. Substantial focal narrowing of the right middle lobe bronchus with complete bronchial obstruction by a glistening smooth walled mass and surrounding erythema.
- C. Soft whitish secretions with surrounding bronchial mucosal edema and erythema within the right lower lobe bronchus.

Answer VI.25: C

Coccidiomycosis immitis is a dimorphic fungus easily airborne and aspirated when groundwork or construction occurs in semiarid regions with a short but intense rainy season followed by dry weather. These conditions occur in areas of California, Mexico, and Central and South America. Although most infections are asymptomatic, signs of lung disease may occur 1-3 weeks after inhalation. Patients present with cough, fever, pleuritic chest pain, myalgias, and occasionally a fine erythematous rash, erythema nodosum or erythema multiform. Reactivation can occur even many years after travelers have left an endemic area. Skin tests become positive within 4 weeks of exposure, and usually remain positive for life. Rising IgG complement fixation (which remains positive for up to 8 months after exposure) may signal progressive or reactivation disease.

Bronchoscopic appearances are nonspecific, and can mimic those of neoplasm, although endobronchial polyps and nodules are usually not seen. Large and deep biopsies of abnormal appearing mucosa are often necessary for diagnosis. Fungi are large

spherules with doubly refractile walls and numerous endospores. Yield of BAL and BLB is greater in patients with pulmonary infiltrates than in those with pulmonary nodules.



Whitish secretions with mucosal erythema and edema

Question VI.26: Tracheal enlargement is commonly associated with all of the following except

- A. Ehlers-Danlos syndrome
- B. Mounier-Kuhn syndrome
- C. Ataxia-teleangiectasia
- D. Chronic obstructive airway disease
- E. Tuberculosis

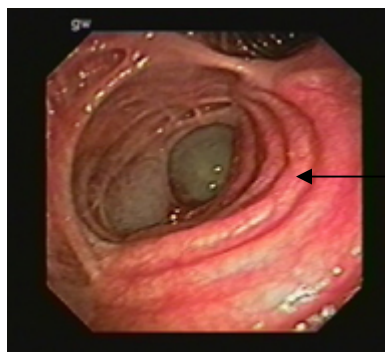
Answer VI.26

E

Focal segmental strictures are commonly found in patients with a history of tuberculosis. Some patients, however, can also have tracheobronchomegaly, probably due to traction and scarring between the lung, trachea, mediastinum, and parietal pleura. This finding, apparently, is relatively infrequent. Diffuse tracheobronchomegaly is found in each of the other entities named above. Malacia may or may not accompany tracheal dilatation.

In some patients, dynamic bronchoscopy will reveal floppy airways. Mounier-Kuhn syndrome consists of diffuse dilatation that involves the entire trachea. Inefficient cough, retained secretions, and recurrent bronchopneumonia, bronchiectasis and emphysema result from this anomaly. The lungs are usually hyperinflated. Patients with Ehler-Danlos syndrome also have recurrent joint dislocations, hypermobility, and bowel diverticulosis. Ataxia telangiectasia consists of progressive skin telangiectasias and cerebellar ataxia.

Some patients with COPD, as well as some patients with cystic fibrosis may acquire tracheomegaly as a result of chronic inflammation and degenerative changes of the elastic fibers of the pars membranosa, leading to malacia and floppy airways.



Bronchomegaly and retained purulent secretions

Question VI.27: Which of the following is most difficult to avoid despite proper and repeated education of bronchoscopists and their assistants.

- A. Improper handling of a transbronchial needle
- B. Forceful passage of a forceps through a flexed or hyperextended distal extremity of the flexible bronchoscope
- C. Forceful flexion or twisting of the bronchoscope at any point along its insertion tube
- D. Crushing by teeth, or the drawers, doors, or wheels of a procedure cart.
- E. Repeated banging of the distal tip of insertion tube onto the side of a cart or bedrails.

Answer VI.27: E

Proper education regarding the use and abuse of a flexible bronchoscope is mandatory! When damaged, most scopes are returned to the manufacturer or to a third party for repairs. Parts are readily replaced, but are very costly. Repairs to flexible fiberoptic and video bronchoscopes usually cost thousands of dollars, and can rapidly deplete endoscopy section budgets. In order to avoid damage to the working channel of a bronchoscope, all transbronchial needles should be handled properly. No needle should be inserted or withdrawn if its sharp tip is visible and protruding beyond the protective sheath.

Instruments should not be inserted forcefully through a flexed bronchoscope when the distal tip is bent at an acute angle. The insertion tube of the bronchoscope should never be forcefully twisted between the fingers, and of course, bite blocks should always be used when a scope is inserted orally. During procedures, all drawers of procedure carts should be closed, making sure that the insertion tube or the universal cord of the bronchoscope is not caught inside. Each of these “mishaps” can and should be avoided! It is difficult, however, to avoid the occasional banging of a scope on the side-rails of a bed or on the side-rails of a procedure cart. When this occurs, it might be helpful to remind persons handling the scope that the purchase price of the scope might be greater than the purchase price of the automobile they drive...and the repair cost, most definitely greater than their insurance premiums!



Question VI.28: All of the following statements pertaining to patients with indwelling airway stents are true **except**

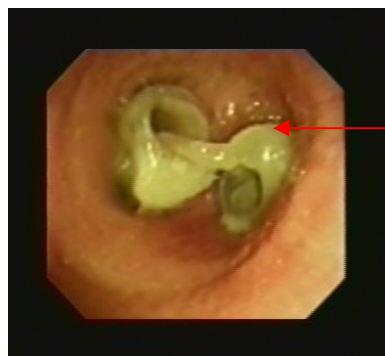
- A. Stent related complications are seen less frequently in patients with cancer than in patients with benign disease
- B. Flow volume loops and spirometry are warranted to document clinical and symptomatic improvement after stent insertion
- C. Because of the risk of migration and obstruction, many experts advocate surveillance bronchoscopy during the first three months after stent insertion.
- D. Retained secretions are frequently noted within indwelling stents during follow-up bronchoscopy, but active infection is unlikely and antibiotics are usually not needed.

Answer VI.28

B

Symptomatic improvement after stenting occurs in most patients and is usually clinically apparent. Surveillance pulmonary function tests, therefore, are not necessary unless one is performing a research study. Surveillance bronchoscopy remains a controversial topic. It is unclear whether patients with indwelling stents should undergo flexible bronchoscopy on a regular basis, or whether bronchoscopy should be performed only in the presence of new or increased symptoms suggestive of a stent related complication.

Symptoms include cough, respiratory distress, hemoptysis, radiographic atelectasis or focal pulmonary infiltrates, hoarseness, loss of voice, and decreased exercise tolerance. Although retained secretions and potentially pathogenic organisms are frequently noted on follow-up bronchoscopies, stent-related infection is rare and antibiotics are rarely warranted.



Thick secretions partially occlude silicone stents in left and right main bronchus

Question VI.29: Which of the following known complications of bronchoscopic needle aspiration can be avoided if proper technique is used.

- A. Hemomediastinum
- B. Pneumothorax
- C. Bronchial hemorrhage
- D. Fracture of needle catheter
- E. Bacterial pericarditis

Answer VI.29: D

Proper technique, training, and practice should prevent fracture of the needle catheter by the needle during use. In addition, proper technique will also prevent harming the working channel of the bronchoscope with a protruding needle tip. The needle should never be withdrawn or inserted into the bronchoscope without first ensuring that the needle is well within the catheter. Other complications of needle aspiration such as those listed above occur rarely and are probably unavoidable. Significant bleeding after needle aspiration occurs rarely, even when vascular puncture is confirmed by bloody return in the syringe or catheter during suctioning.

Question VI.30: In regards to transbronchial needle aspiration, which of the following has the greatest risk of damaging the flexible bronchoscope

- A. Jabbing method for needle penetration
- B. Piggyback method for needle penetration
- C. Hub against wall method for needle penetration
- D. Use of a nonretractable needle
- E. Cough method for needle penetration

Answer VI.30: D

Using a nonretractable needle or a needle-catheter ensemble that has been damaged such that the needle cannot be retracted into its catheter is most likely to damage the working channel of a flexible bronchoscope. The other methods are each useful for penetrating through the airway wall. While keeping the bronchoscope as straight as possible, and with the bending tip in a neutral position, the retracted needle-catheter ensemble is advanced through the working channel of the bronchoscope. The needle is advanced and locked into place after the metal hub is visible beyond the tip of the scope. The catheter is retracted and the scope is advanced to the target area.

With the “jabbing method”, the needle is thrust through the intercartilaginous space using a quick firm jab to the catheter while the scope is held at the nose or mouth.

The “hub method” has the needle in the retracted position so that the distal end (metal hub) of the catheter is placed in direct contact with the airway wall, and held firmly while the needle is pushed out of the catheter and through the airway wall.

The “piggyback method” has the catheter fixed against the proximal end of the instrument insertion port (using either an index finger or with the help of an assistant). This is done after the needle has been advanced and locked into position at the target site. The bronchoscope and the needle-catheter ensemble are then advanced together until the entire needle penetrates the airway wall.

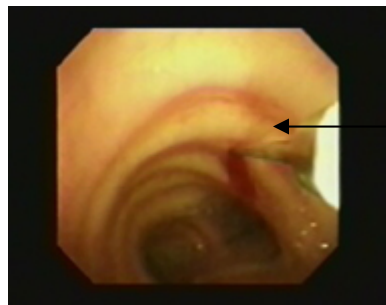
With the “cough method” the bronchoscopist first employs the piggyback or jabbing technique. The needle is placed directly against the target area and the patient is asked to cough. The cough forces the needle through the airway wall. Once the needle is inside the target, it should be moved forward and backward while suction is maintained in order to shear off cells. Suction is then released, the tip of the bronchoscope is straightened if necessary, the needle is withdrawn from the target, retracted into its catheter and the needle-catheter ensemble is withdrawn from the scope.

Question VI.31: After performing transbronchial needle aspiration, the needle cannot be withdrawn into its catheter. You should

- A. Pull the needle completely into the working channel of the scope anyway in order to remove it.
- B. Straighten the bronchoscope. Then remove the needle and the flexible bronchoscope simultaneously while keeping it in the middle of the airway but without pulling the needle back into the working channel of the scope.
- C. Straighten the bronchoscope. Pull the needle into the working channel so that only the tip of the needle is visible beyond the tip of the scope. Then remove the needle and the flexible bronchoscope simultaneously while keeping it in the middle of the airway.
- D. Straighten the bronchoscope. Then pull the needle back into the working channel in order to remove it.

Answer VI.31: C

It is safest to straighten the bronchoscope, and while keeping the needle tip in view, to pull the entire ensemble out. By keeping the scope and needle tip in the middle of the airway, there is no risk of injury the airway mucosa. The only danger is to scratch pharyngeal or nasal mucosa. This risk is minimal if the scope is “straight” and without distal flexion or extension, and if only a small portion of the needle tip is visible beyond the distal tip of the bronchoscope.



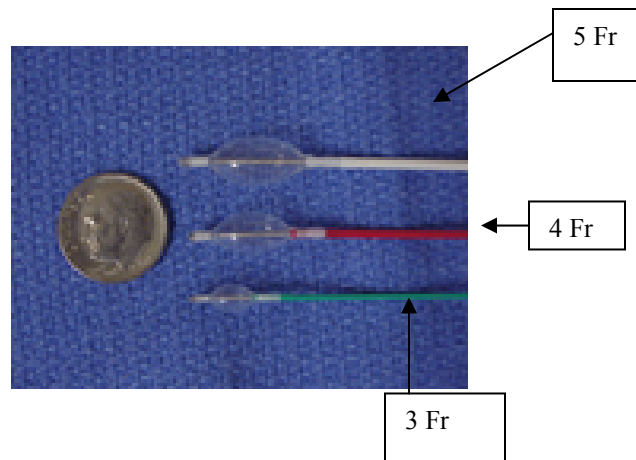
Mucosal trauma caused by scope
not kept in midline during removal

Question VI.32: Bronchoscopic lung biopsy in the right lower lobe using a diagnostic flexible fiberoptic bronchoscope prompted a moderate amount of bleeding that you are unable to control by saline washings and suction alone. The adult male patient is not in respiratory distress. He remains alert and is breathing comfortably. You request an arterial embolectomy balloon catheter. Your assistant, after two minutes of searching through the cabinets in your procedure room, returns to your side with several different catheters in hand, and asks which size catheter you want. You ask for

- A. A 3 Fr catheter.
- B. A 5 Fr catheter.
- C. A 7 Fr catheter.
- D. An 8 Fr tamponade balloon instead.
- E. An endotracheal tube instead and perform a controlled intubation of the right main bronchus.

Answer VI.32: B

A 5 F catheter is 1.5 mm wide and should fit easily through the working channel of a diagnostic flexible bronchoscope or videobronchoscope. It would have a deflated balloon measuring 6F (18 mm), and an inflated balloon size of about 10 mm. A variety of balloon catheters should be available in your procedure cart. Only those instruments you are familiar with and have practiced using should be stocked. You and your assistants should know the outer diameters and working channel diameters of all flexible bronchoscopes in your possession. Measurements should be written down on your procedure cart in case you forget or have an inexperienced assistant. Working channel may be different depending on the bronchoscope being used. As of this writing, most videobronchoscopes have outer diameters of either 4.9 mm or 6.0 mm and are 60 cm long. Flexible fiberoptic bronchoscopes have outer diameters of 4.0mm and 6.0 mm, and are 55 cm long. Working channel diameters of fiberoptic and videobronchoscopes are 2.2 mm or 2.8 mm. Remember that intubation is warranted only if bleeding cannot be controlled.



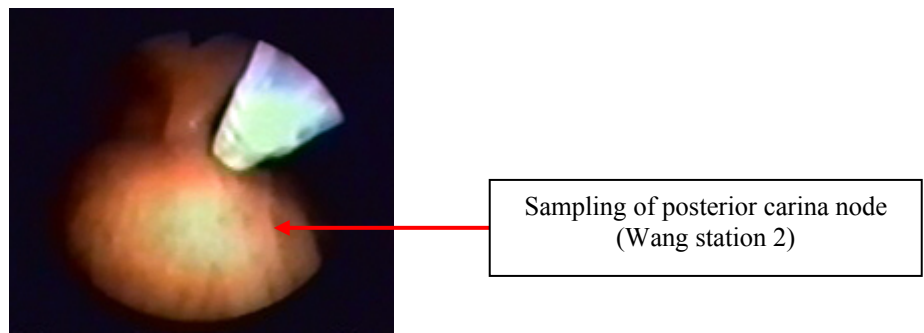
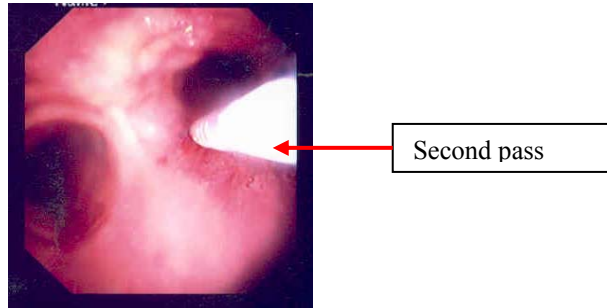
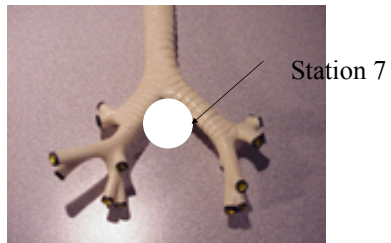
Question VI.33 A patient with subcarinal adenopathy undergoes flexible bronchoscopy and transcarinal needle aspiration. The cytopathologist is present on site to inform you that the first pass (shown in the Figure below) has no material in it. The second pass could be made

- A. 3-5 mm below on either side of the carina in an infero-medial direction.
- B. One intercartilaginous space above and directed more anterior.
- C. Two intercartilaginous spaces above and in an anterolateral direction



Answer VI.33 A

Subcarinal lymph nodes (IASLC station 7, Wang bronchoscopic station 1 and 2) can be sampled by inserting the needle directly through the main carina in an inferior direction, or by inserting the needle 3-4 mm below on either side of the carina, directing the needle inferiorly and medially. If the needle were directed more superiorly, anteriorly and laterally (answer c) the right paratracheal node would be sampled. If the needle were directed more superiorly and anteriorly (answer b) the anterior carinal node would be sampled. If the needle were directed posterior, the posterior carinal node could be sampled (but this also risks causing pneumothorax because of proximity of the azygoesophageal recess).



Question VI.34: Flexible bronchoscopy with transbronchial needle aspiration of a left upper lobe abnormality is performed in a 33-year-old patient with Acquired Immune Deficiency Syndrome (AIDS). After the procedure, the technician notices that the leak test is positive. An air leak is detected from the surface of the flexible bronchoscope. He asks you for instructions. You should tell him to

- A. Disinfect the scope in a Glutaraldehyde bath before packing it and sending it to the manufacturer for repair.
- B. Clean only the working channel with warm water and detergent, then pack the scope and send it to the manufacturer for repair.
- C. To not clean the bronchoscope at all. Place the bronchoscope in a biohazard bag. Pack the scope and send it to the manufacturer with a note explaining the circumstances of scope damage.
- D. Continue with manual cleaning of the bronchoscope and all internal channels using only warm water and detergent, then pack it in a biohazard bag and send it to the manufacturer for repair.

Answer VI.34: C

Bronchoscopes should not be submerged in fluid until a leak test has been performed. If the leak test is positive, water or fluid immersion risks serious and costly damage to the bronchoscope. The bronchoscope will need to be sent bronchoscope out for repair. Universal precautions should be routinely followed in order to prevent the transmission of infection. The patient's known AIDS infection is therefore irrelevant.

Question VI.35: Which of the following “expressions” is most appropriate for bronchoscopic lung biopsy

- A. Keep the middle way
- B. Gentleness is a virtue
- C. A bronchoscopist must have eyes on the tips of his fingers
- D. Never give up
- E. Feel the wall

Answer VI.35: C

This expression, originally attributed to Chevalier Jackson, the well-known otolaryngologist and teacher from Philadelphia, also suggests that one must “feel” the maximum distance forceps can be inserted into a peripheral bronchus before opening and obtaining representative lung tissue, but without causing pneumothorax. Bronchoscopic lung biopsy is easier when using fluoroscopic guidance, but the expression “eyes on the tips of the fingers” still applies.

Of course, the expression “gentleness is a virtue” would also be correct because most experts advocate that a biopsy sample should be grasped then tugged on gently, rather than briskly ripping the sample from the airway mucosa or lung parenchyma. One technique is to insert the forceps under fluoroscopic guidance into a peripheral bronchus. The forceps is watched as it is advanced to within one or two centimeters of the chest wall. Still under fluoroscopy, the forceps is withdrawn 2 to 3 cm, opened and advanced once more 1 to 2 cm. The forceps is closed and gently removed. If the patient feels pain at any time during the procedure, it usually means that the forceps has been advanced too far. It should be pulled back, and the procedure repeated taking care to not advance the forceps as far. Therefore, “Gentleness is a virtue” also allies to the relationship between the bronchoscopist and the patient.

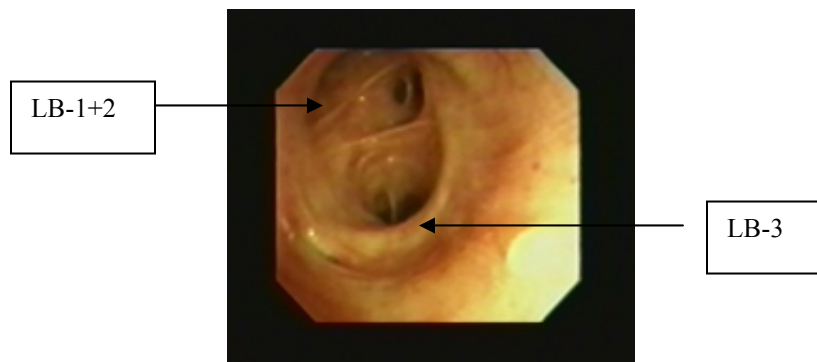
The expression “Never give up” was the life motto of Shigeto Ikeda, the famous Japanese bronchoscopist who introduced flexible bronchoscopy to the world in the 1960s. Ikeda subsequently devoted his life to technical innovations and the science of Bronchology. He also founded the World Association for Bronchology, an organization that is still active today.

Question VI.36: All of the following descriptions of left bronchial anatomy variants are correct except.

- A. The left upper lobe upper division bronchus, normally of bipartite appearance, sometimes has a tripartite appearance, dividing into three distinct branches rather than two.
- B. The bipartite appearance of the left upper lobe upper division bronchus is caused by a displacement of the apical-posterior bronchus to a separate origin during embryonic development.
- C. The posterior, lateral and anterior basal bronchi of the left lower lobe frequently mirrors the anatomic appearance of the right lower lobe basal segmental bronchi, except that for the frequent absence of a medial basal bronchus on the left.
- D. Equally common to a tripartite division of the left lower lobe basal bronchi, is that of a bipartite division that gives off two main basal branches each of which immediately divides again.

Answer VI.36: B

The bipartite variation is actually caused by displacement of the anterior segmental bronchus to a separate origin during embryonic development. This causes the separation into apical-posterior (LB 1 and 2) and anterior (LB 3) bronchus. The left lower lobe frequently has only 4 basal bronchi (LB 6, 8, 9 and 10) because the medial basal bronchus (LB 7) is often not formed. When there is a bipartite division of the left lower lobe bronchi, however, the most anterior branch usually gives rise to a medial and anterior basal bronchus, while the more posterior segment gives rise to a posterior and lateral bronchus.



NOTES

CONGRATULATIONS

You have now completed studying the Essential Flexible Bronchoscopist[®].

You can now take the post-test for each module. The following section contains the hard copy of all six post-tests and their corresponding answers.

Post-tests are multiple-choice, single BEST answer. Please remember that while many programs consider 70% correct responses a passing grade, the student's "target" score should be 100%.

Please send us your opinion regarding Bronchoscopy Education Project materials by contacting your national bronchology association or emailing us at www.bronchoscopy.org.



EssentialFlexibleBronchoscopist[©]

Post-tests

Post-tests are multiple choice, single BEST answer.

While many programs consider 70% correct responses a passing grade, the learner's "target" score should be 100%.

Passing grades on each of the post-tests are desirable and should be noted on the Bronchoscopy Education Project program completion checklist.

TheEssentialFlexibleBronchoscopist[©] is comprised of six modules, each with a module-specific competency-oriented list of learning objectives. There are a total of 186 multiple choice question sets. These are also viewable on line in several languages (www.Bronchoscopy.org). Information pertains to major topics represented in traditional textbooks of bronchoscopy, including anatomy and airway abnormalities, patient preparation, indications, contraindications, complications, techniques and solutions to technical difficulties, primary and metastatic lung cancer, infections, tracheal stenosis and other airway disorders of benign etiology, anesthesia and moderate sedation, medications, informed consent, patient safety issues, equipment maintenance, history of bronchoscopy, bronchioloalveolar lavage, endobronchial biopsy, washings, brushings, conventional transbronchial needle aspiration, bronchoscopic lung biopsy, and basics of interventional bronchoscopy.

Each set of ten post-test questions are best answered before moving to the next module. None of these questions are meant to serve as high stakes tests, but rather as low-stakes continuing self-learning assessments that help document the progressive acquisition of knowledge needed for the safe and competent practice of bronchoscopy. Many question/answer sets of **The Essential Flexible Bronchoscopist[©]** used to design validated tests of bronchoscopic knowledge have been published in peer-reviewed literature. Other times, questions are used during didactic lectures or as part of pretest-posttest sessions at regional meetings conducted as part of Bronchoscopy International inspired training sessions. The reader is encouraged to answer these questions **AFTER** reading each corresponding module. An honor system is assumed in regards to viewing provided answers to these post-tests on the following pages.

§

The Essential Flexible Bronchoscopist[®] Module I Post-test Questions

Question 1: In addition to Shigeto Ikeda and Gustav Killian, a critical figure in the history of bronchoscopy education and practice is:

- A. Sir William Osler
- B. *Chevalier* Jackson
- C. Laennec
- D. William Harvey

Question 2: Which of the following should be required of every patient undergoing flexible bronchoscopy?

- A. Coagulation profile
- B. Serum chemistries, especially blood urea nitrogen and creatinine
- C. Electrocardiogram
- D. Review of known or suspected allergies to medications

Question 3: Among which of the following settings has flexible bronchoscopy been shown to be of greatest value ?

- A. Patient with hemoptysis and a nonlocalizing chest radiograph
- B. Patient with smoking history, cough, weight loss, and lung mass on chest radiograph
- C. Patient with a peripheral lung nodule less than 1 cm in diameter
- D. Prior to thoracentesis in a patient with suspected malignant pleural effusion

Question 4: Scenarios where airway management might be difficult and could therefore warrant bronchoscopic assistance include each of the following except ?

- A. An 18 year old male with status asthmaticus and altered mental status who just vomited his dinner.
- B. Pregnant 30 year old obese woman with third degree facial burns.
- C. Edentulous male undergoing cardiopulmonary resuscitation
- D. Elderly trauma victim wearing neck brace

Question 5: In regards to handling the flexible bronchoscope, which of the below is considered correct technique?

- A. Moving the scope between the left hand and the right hand during the procedure.
- B. Keeping the scope in the middle of the airway lumen as much as possible during the procedure.
- C. Twisting the scope at its insertion point at the mouth or the nares in order to direct it into an upper lobe bronchus.

D. Moving the thumb downwards to flex the distal aspect of the insertion tube.

Question 6: Which of the following statements pertaining to local anesthetics is false ?

- A. Lidocaine and Bupivacaine are both esters
- B. Amides, as Mepivacaine, as well as esters, such as Tetracaine can cause laryngeal edema.
- C. Bilateral nasal administration of anesthetic causes partial posterior pharyngeal anesthesia by affecting the Sphenopalatine nerve fibers.
- D. Administration of lidocaine with epinephrine can decrease swelling of the nasal mucosal membranes.
- E. Many side effects of topical anesthetics are dose related, but anaphylaxis is not.

Question 7: Which of the following statements about upper airway anatomy is incorrect?

- A. In adults, the glottic opening (also called the rima glottides) is more narrow than the cricoid.
- B. An omega epiglottis is elongated, curved and is seen in adults but also in many infants.
- C. The arytenoid cartilages lie superior to the corniculate cartilages at the posterior commissure of the larynx.
- D. The adult trachea cross-sectional area, usually about 2.8 cm^2 , increases with age
- E. The recurrent laryngeal nerve supplies motor and sensory innervation of the intrinsic muscles of the larynx.

Question 8: Which of the following adverse effects of bronchoscopy is probably most frequent ?

- A. Biopsy-induced pneumothorax
- B. Bronchoalveolar lavage induced hypoxemia
- C. Pain, discomfort or anxiety during insertion of the bronchoscope and passage into the lower airways
- D. Cardiac arrhythmias

Question 9: Which of the following statements about the trachea is incorrect?

- A. The cervical segment (extrathoracic) ends at the manubrium and encompasses about the first six tracheal rings.
- B. The U-shaped trachea is probably the most frequent shape found.
- C. A man's cross sectional tracheal area is usually about 40 percent larger than a woman's.
- D. Saber sheath tracheas have a small transverse diameter, which means that the distance between the left and right lateral walls of the trachea is short.
- E. In women, the lower limit of normal for transverse and sagittal diameters is about 10 mm.

Question 10: Which of the following statements about radiation exposure during fluoroscopy is correct?

- A. The patient's radiation exposure is increased as the anode tube is placed closer to the patient.
 - B. The bronchoscopist's radiation exposure makes wearing a protective lead garment unnecessary.
 - C. The patient's radiation exposure increase when the anode tube is further from the patient.
 - D. Radiation exposure is a measure of resolution, and can be adjusted by changing the size of the image on the fluoroscopy screen.
-

The Essential Flexible Bronchoscopist[®] Module II Post-test Questions

Question 1: Which of the following parts of a bronchoscope is most easily damaged?

- A. The universal cord
- B. The eyepiece or video control handle
- C. The insertion tube
- D. The control handle

Question 2: Which of the following drugs can be safely used for effective topical anesthesia in a patient with an allergy to Lidocaine?

- A. Atropine
- B. Fentanyl
- C. Tetracaine
- D. Glycopyrolate

Question 3: Dynamic bronchoscopy might be most helpful in patients with:

- A. Suspected tuberculosis and upper lobe infiltrates
- B. Suspected tracheobronchomalacia
- C. A large obstructing endobronchial lesion noted on computed tomography scan
- D. Ipsilateral lung mass and pleural effusion

Question 4: Which of the following best helps prevent obstruction by dried secretions in patients with indwelling Montgomery T-tubes?

- A. Placing the proximal part of the tube within 1 centimeter of the vocal cords
- B. Keeping the external limb of the T-tube capped, except for suctioning.

- C. Scheduling frequent and routine flexible bronchoscopy for suctioning
- D. Keeping the external limb of the T-tube uncapped.

Question 5: All of the following statements about flexible bronchoscopy in the intensive care unit setting are correct EXCEPT ?

- A. Bronchoscopy can be helpful to remove secretions in mechanically ventilated patents.
- B. Bronchoscopy can help resolve radiographic lobar atelectasis in mechanically ventilated patients.
- C. Bronchoscopy should be routinely used instead of chest percussion and tracheal aspiration to remove secretions in intubated patients.
- D. When scoping through the mouth, a bite block is essential to prevent scope damage, even in patients who are intubated orally.

Question 6: Which of the following anatomic descriptions is correct ?

- A. The trachea extends from C6 to T5, in a downward and backward direction, and, near the tracheal bifurcation, deviates slightly to right.
- B. The trachea extends from C6 to T5, in a downward and forward direction, and, near the tracheal bifurcation, deviates slightly to right
- C. The trachea extends from C6 to T5, in a downward and backward direction, with the thyroid gland surrounding the anterolateral portion between the fourth and sixth cartilage rings.
- D. The trachea extends from C6 to T5, in a downward and backward direction, with the thyroid gland surrounding the anterolateral portion between the first and third cartilage rings.

Question 7: Viewing the vocal cords from below might be useful in all of the following cases EXCEPT?

- A. To exclude a peristomal or subglottic source of bleeding in a patient with a tracheostomy.
- B. To fully evaluate laryngeal function in a patient with a tracheostomy being decannulated .
- C. To examine the subglottis and vocal cord function in a patient with suspected tracheal stenosis and a tracheostomy.
- D. To remove subglottic granulation tissue using laser

Question 8: Once in the airway, the flexible bronchoscope:

- A. Occupies less than 5% of the normal airway diameter
- B. Results in increased functional capacity, especially if there is also an endotracheal tube in place
- C. Decreases airway resistance, especially if there is also an endotracheal tube in place

D. Occupies more than 20% of the normal airway diameter

Question 9: High level disinfection does all of the following EXCEPT ?

- A. Inactivate all bacterial spores.
- B. Inactivate all fungi
- C. Destroy all viruses
- D. Destroy all vegetative organisms.

Question 10: Which of the following best describes a complex tracheal stricture?

- A. Circumferential narrowing 3 cm below the vocal cords, extending along a distance of 2, without associated tracheomalacia.
 - B. Partially circumferential web-like stricture 3 cm below the vocal cords along the anterior wall of the trachea in a site of previous and well healed tracheostomy.
 - C. Bottleneck stricture 2 cm below the cords with asymmetric narrowing of the trachea and a second partial web at the distal margin of the bottleneck stenosis.
 - D. Circumferential narrowing of the trachea to 3 mm by fibrous tissue 2 cm below the vocal cords, extending along a distance of 0.5 cm.
-

The Essential Flexible Bronchoscopist[®] Module III Post-test Questions

Question 1: Which of the following best describes Midazolam?

- A. Ten times more potent than diazepam
- B. Sedation and anxiolysis usually occurs within 2 minutes of administration
- C. Complete recovery of motor performance and consciousness often takes two hours
- D. Risk for apnea is greatest when used alone compared to when used with other sedating agents.
- E. Larger doses can cause seizures even in healthy patients

Question 2: Repeated trauma to the larynx during attempts at bronchoscopically-assisted endotracheal intubation most likely to cause which of the following?

- A. Laryngospasm, vomiting, and cardiac arrhythmias
- B. Hoarseness, vocal cord paralysis, and arytenoid luxation
- C. Laryngeal edema, aspiration, and fever
- D. Pain, gagging, and diarrhea

Question 3: When using Gluteraldehyde for high-level disinfection, a 10 minute immersion results in which of the following?

- A. 50% eradication of mycobacteria
- B. 85% eradication of mycobacteria
- C. 99.8% eradication of mycobacteria
- D. Complete eradication of mycobacteria

Question 4: All of the following statements about scattered radiation are correct EXCEPT?

- A. It is caused by increased voltage
- B. It can be reduced by decreasing the anode tube milliamperage
- C. It decreases the quality of the fluoroscopic image.
- D. It is caused by increased tissue thickness

Question 5: All of the following statements about topical Lidocaine are true EXCEPT ?

- A. The maximum dose recommended for flexible bronchoscopy is about 300 mg.
- B. Systemic effects include restlessness, seizures, numbness, and hypotension.
- C. It is less potent but longer acting than Tetracaine.
- D. Peak concentration is usually reached within 30 minutes of airway application.

Question 6: Which of the following statements best relates to patients with a saber-sheath trachea?

- A. It may be found in up to 5 percent of elderly men.
- B. The majority of patients with saber sheath trachea also have asthma
- C. It is characterized by an increased transverse distance and decreased sagittal diameter of the trachea..
- D. Differential diagnosis might include extrinsic compression, relapsing polychondritis, wegener's Granulomatosis, and Klebsiella Rhinoscleromata.

Question 7: All of the following statements describing the "proper" way to dictate or write a bronchoscopy note are correct EXCEPT?

- A. Consistently use the same concise and precise terminology.
- B. Tell a story that everyone can read and understand the same way .
- C. Consistently comment on airway patency, mucosal appearances, secretions, and location of specimens obtained.
- D. Referring to the amount and effects of conscious sedation can usually be avoided.

Question 8: The bronchus intermedius usually measures:

- A. Less than 1.0 cm.

- B. More than 2.5 cm.
- C. Between 1.0 and 2.5 cm.
- D. It is a misnomer because it immediately becomes the middle lobe and lower lobe bronchus.

Question 9: All of the following statements about bronchoalveolar lavage are true EXCEPT?

- A. Delayed onset fever, chills and myalgias are best treated with an antipyretic or other anti-inflammatory medication.
- B. Radiographic infiltrates in the area of lavage are rarely visible after the procedure.
- C. BAL may cause or increase hypoxemia
- D. Careful technique is essential to obtain a true alveolar sample rather than a simple bronchial wash.

Question 10: Which of the following statements about oral airways is MOST correct?

- A. They help keep the scope in the midline, facilitating exposure of laryngeal structures.
- B. They help maintain an open pharynx and larynx.
- C. They prevent the patient from biting the bronchoscope.
- D. They facilitate maneuverability of the scope and endotracheal intubation.

The Essential Flexible Bronchoscopist[®] Module IV Post-test Questions

Question 1: The average internal diameter of the left or right main bronchi, is about:

- A. 5 -10 mm
- B. 10-16 mm
- C. 14-18 mm
- D. 12-20 mm

Question 2: Endobronchial metastases are unlikely in which of the following illness?

- A. Colon cancer
- B. Malignant melanoma
- C. Gastric cancer
- D. Breast cancer
- E. Renal carcinoma

Question 3: LC-1 corresponds to which of the following?

- A. The minor carina between the lingula and the anterior segment of the upper division bronchus
- B. The minor carina between the lingual and the apical segment of the upper division bronchus
- C. The minor carina between the lingula and the lower lobe bronchus
- D. The minor carina between the superior segment and the lower lobe bronchus

Question 4: All of the following statements about bronchoalveolar lavage are true EXCEPT?

- A. Cellular and noncellular components from the epithelial surfaces of the lower respiratory tract are recovered.
- B. A 100 ml lavage samples approximately 10×10^6 alveoli
- C. Fluid return is decreased in smokers and in the elderly
- D. Procedures should be atraumatic, harmonious and result in no more than 10% bronchial squamous cells
- E. It is appropriate to call BAL a "bronchioloalveolar lavage".

Question 5: Generally accepted precautions for bronchoscopy in patients with thrombocytopenia include all of the following EXCEPT ?

- A. Administration of IVIG infusions for patients with Idiopathic Thrombocytopenic Purpura.
- B. Platelet transfusions to increase platelet count so that it is at least greater than 20,000, and higher if biopsies are being performed.
- C. Considering passage through the mouth (using a bite-block of course).
- D. Bronchoscopy, even without biopsy, should be avoided, especially if patients have severe thrombocytopenia (counts below 20,000 platelets)

Question 6: The nomenclature RC-2 corresponds to which of the following?

- A. The minor carina between RB 2 and the Bronchus Intermedius.
- B. The minor carina between RB 4, 5 and the lower lobe bronchus.
- C. The minor carina between RB 6 and the bronchus intermedius.
- D. The minor carina between RB 6 and the lower lobe bronchus.

Question 7: Which of the following airway abnormalities is least likely to be due to chronic bronchitis?

- A. Mucosal pitting.
- B. Band formation and traction of longitudinal fibers.
- C. Erythema and pallor.
- D. Raised red areas of mucosal thickening and edema.

Question 8: In a 62 year old patient with cough, weight loss, pleural effusion, volume loss, and a suspected history of tuberculosis, bronchoscopy might be helpful for which of the following?

- A. To discover possible bronchial strictures that might help explain the radiographic images.
- B. To obtain specimens for diagnostic purposes .
- C. To help exclude other potential diagnoses such as cancer.
- D. All of the above.
- E. None of the above. The patient should undergo thoracentesis or closed-needle pleural biopsy

Question 9: Which of the following endobronchial findings best describes early superficial invasive cancer ?

- A. Pale mucosa with lack of luster.
- B. Red or granular lesions with increased friability.
- C. Easy friability
- D. Answers a and b
- E. Answers a and c.

Question 10: Which of the following anatomic structures lies directly adjacent to the anterior wall of the bronchus intermedius at the level of the take off of the right upper lobe bronchus?

- A. The right pulmonary artery.
- B. The right pulmonary vein.
- C. The right pulmonary artery and pulmonary vein.
- D. The esophagus
- E. The thoracic duct.

The Essential Flexible Bronchoscopist[®] Module V Post-test Questions

Question 1: Which of the following nomenclatures pertain to the left lower lobe posterobasal segment, and the carina between the left upper lobe and left lower lobe bronchus?

- A. LB 8 and LC-2
- B. LB 10 and LC-2
- C. LB 9 and LC-2

D. None of the above

Question 2: A small malignant endobronchial abnormality is noted in the bronchus intermedius 0.5 cm beyond the right upper lobe bronchial orifice. Transcarinal needle aspirations are positive. CT scans reveal no other organ involvement. Which of the following best describes this patient's clinical TNM stage?

- A. T3 N1 M0
- B. T3 N2 M0
- C. T2 N2 M0
- D. T1 N2 M0
- E. None of the above

Question 3: Which of the following best describes the safety position during bronchoscopy?

- A. Turning the patient unto the left position to facilitate suctioning.
- B. Turning the patient onto the lateral decubitus position, bleeding side down in case of bronchoscopically-induced bleeding.
- C. Turning the patient unto the lateral decubitus position, left side down, in case of vomiting during bronchoscopy.
- D. Tilting the bed into the reverse Trendelenberg position in case of bronchoscopically-induced bleeding.

Question 4: Which of the following best explains why airway lacerations and tracheoesophageal fistulas are easily missed during bronchoscopic examination?

- A. Airway mucosa might swell and easily obliterate the lesion.
- B. The fistulous tract might be partially obliterated with esophageal wall mucosa
- C. The bronchoscopist has failed to perform a careful and diligent inspection
- D. The fistulous tract spontaneously opens and closes and can sometimes only be discovered after probing suppurative appearing areas using forceps.
- E. All of the above

Question 5: Which of the following best describes endobronchial abnormalities caused by sarcoidosis?

- A. Mucosal nodularity, bronchial strictures, or hyperemia.
- B. Mucosal edema, hypertrophy, or small raised whitish lesions.
- C. Both a and b
- D. Both a and b are correct, but airway abnormalities are nonspecific and can also be seen with other diseases.

Question 6: A procedure is appropriately considered "nondiagnostic" when ?

- A. Inspection and representative tissue samples and/or washings do not provide a diagnosis.
- B. Tissue samples are obtained, but are not representative (for examples, bronchoscopic lung biopsies reveal no pathology, and contain only bronchial mucosa, but no bronchioles or alveoli).

Question 7: Which of following statements about bronchoscopy-related pneumothorax (during bronchoscopic lung biopsy) is CORRECT?

- A. Pneumothorax occurs more frequently when large alligator forceps are used rather than small cup forceps.
- B. The overall incidence of bronchoscopy-related pneumothorax is about the same as that of percutaneous needle aspiration-related pneumothorax.
- C. The reported incidence is 1-4 %.
- D. Small-bore chest insertion is almost always warranted.

Question 8: The inflated balloon size of a 6 Fr balloon catheter is approximately:

- A. 6 mm.
- B. 7 mm.
- C. 10 mm.
- D. 12 mm.

Question 9: A transbronchial needle aspiration directed posteriorly and medially 1 cm beyond the origin of the right or left lower lobe bronchus risks entering which of the following anatomic structures ?

- A. The pulmonary veins.
- B. The pulmonary arteries.
- C. The esophagus
- D. The heart

Question 10: Bronchoscopic airway stents should be considered in each of the following settings EXCEPT?

- A. Severe extrinsic compression of the left main bronchus in a patient with fibrosing mediastinitis, dyspnea, and cough.
- B. Severe extrinsic compression of the trachea in a patient with thyroid cancer.
- C. Recurrent tracheal and right main bronchial obstruction in a patient with recurrent tumor three months after laser resection..
- D. Central obstruction but no known functional airways distal to the obstruction as evidenced longstanding complete atelectasis on chest radiographs and absence of ventilation on nuclear imaging studies.
- E. Complex benign tracheal stricture in a patient with significant comorbidities.

The Essential Flexible Bronchoscopist® Module VI Post-test Questions

Question 1: A 74 year old patient with subglottic tracheal stenosis and recent tracheal stent insertion (silicone stent 14 mm in diameter and 50 mm in length) presents with dyspnea and cough. A chest radiograph reveals distal migration. The patient is in severe and acute respiratory distress requiring intubation. All of the following are acceptable EXCEPT:

- A. Proceed with laryngoscopic intubation using a #6 cuffless endotracheal tube
- B. Proceed with bronchoscopy-assisted intubation. Select tube size dependent on airway caliber
- C. Proceed with an awake bronchoscopy-assisted intubation Select tube size dependent on airway caliber.
- D. Immediately paralyze the patient and proceed with laryngoscopic intubation using a #6 cuffless endotracheal tube

Question 2: Which of the following statements about airway stents is FALSE?

- A. In general, metal stents should be avoided in most settings of benign airway strictures.
- B. Silicone stents are prone to migration and obstruction by retained secretions
- C. Radiation therapy cannot be delivered because it has adverse effects on airway stents.
- D. A patient with an indwelling airway stent and new symptoms such as fever, cough, or dyspnea should be rapidly evaluated for possible stent-related complications.
- E. Stent-related granulation tissue formation is usually treated by laser or electrosurgical resection.

Question 3: Which of the following statements about photodynamic therapy is FALSE?

- A. Therapy has been FDA approved for treatment of early stage lung cancer.
- B. Patients must be protected from artificial light for up to 6 weeks after treatment.
- C. Tissue necrosis may cause airway obstruction and often necessitates flexible bronchoscopy for pulmonary toilet purposes.
- D. Skin photosensitivity should be avoided by wearing protective clothing and eyewear for up to 6 weeks after treatment.

Question 4: The esophagus usually lies:

- A. Within 3 mm behind the posterior wall of the trachea and left main bronchus.
- B. Directly behind the take off of the right main bronchus
- C. Directly behind the trachea but anterior to the origin of the left main bronchus
- D. Posterior and to the right of the distal third of the trachea.

Question 5: Increased yield from transbronchial needle aspiration is most likely to result from:

- A. Multiple passes and on-site examination by an expert cytopathologist.
- B. Luck.
- C. Applying suction while the needle is being removed from the lymph node.
- D. Using the jab and thrust techniques.

Question 6: Techniques of transbronchial needle aspiration are commonly referred to as all of the following, EXCEPT:

- A. Jabbing method.
- B. Piggy-back method
- C. Cough method
- D. Hub-against-the-wall method
- E. Blind-insertion method

Question 7: IASLC nodal station 4 R is accessed by:

- A. Transbronchial needle aspiration 2-4 intercartilaginous spaces posterolateral to the trachea.
- B. Transbronchial needle aspiration 2-4 intercartilaginous spaces anterolateral to the trachea.
- C. Transbronchial needle aspiration 2-4 intercartilaginous spaces lateral to the trachea.
- D. Transbronchial needle aspiration posterolateral to the trachea at the level of the carina.

Question 8: Which of the following anatomic structures lies immediately adjacent to the anterior wall of the left main bronchus and left upper lobe bronchus?

- A. Left pulmonary artery
- B. Aorta
- C. Left pulmonary veins
- D. Esophagus

Question 9: Transbronchial needle aspiration of IASLC station 7 is best performed by:

- A. Inserting the needle in a relatively horizontal fashion against the medial wall of the right main bronchus across from and just proximal to the take off of the right upper lobe bronchus.
- B. Inserting the needle in a relatively vertical fashion against the medial wall of the right main bronchus across from and just proximal to the take off of the right upper lobe bronchus.

- C. Inserting the needle through the posterior wall of lower third of the trachea at the level of the carina.
- D. Inserting the needle directly into the carina in a straight vertical direction.

Question 10: All of the following are important to prevent damage to the flexible bronchoscope during transbronchial needle aspiration, EXCEPT:

- A. Making certain that the needle has been withdrawn into its sheath before the sheath is withdrawn into the bronchoscope.
 - B. Straightening the bronchoscope before needle removal.
 - C. Practice.
 - D. Avoiding excessive flexion or extension of the tip of the bronchoscope at any time that the needle is being passed through the bronchoscope.
 - E. Avoid using the histology needle.
-

THE ESSENTIAL FLEXIBLE BRONCHOSCOPIST[®]

ANSWERS FOR POST TESTS MODULES I – VI

ANSWERS TO MODULE I POST-TEST

Answer 1: B
Answer 2: D
Answer 3: D
Answer 4: C
Answer 5: B
Answer 6: A
Answer 7: C
Answer 8: C
Answer 9: B
Answer 10: A

ANSWERS TO MODULE II POST-TEST

Answer 1: C
Answer 2: C
Answer 3: B
Answer 4: B
Answer 5: C
Answer 6: A
Answer 7: D
Answer 8: B
Answer 9: A
Answer 10: C

ANSWERS TO MODULE III POST-TEST

Answer 1: A
Answer 2: A
Answer 3: C
Answer 4: B
Answer 5: C
Answer 6: A
Answer 7: D
Answer 8: C
Answer 9: B
Answer 10: A

ANSWERS TO MODULE IV POST-TEST

Answer 1: B
Answer 2: C
Answer 3: A
Answer 4: D
Answer 5: D
Answer 6: B
Answer 7: D
Answer 8: D
Answer 9: D
Answer 10: A

ANSWERS TO MODULE V POST-TEST

Answer 1: B
Answer 2: C
Answer 3: B
Answer 4: E
Answer 5: D
Answer 6: B
Answer 7: C
Answer 8: D
Answer 9: A
Answer 10: D

ANSWERS TO MODULE VI POST-TEST

Answer 1: A
Answer 2: C
Answer 3: B
Answer 4: A
Answer 5: A
Answer 6: E
Answer 7: B
Answer 8: C
Answer 9: A
Answer 10: E

CONGRATULATIONS

You have now completed

The Essential Flexible Bronchoscopist

This is an important achievement on your journey to competency. We know that you will use what you have learned to enhance your bronchoscopy skills.

This reading assignment is complementary to other components of the Introduction to Flexible Bronchoscopy curriculum, just one part in your quest to become a more competent and knowledgeable bronchoscopist.

We encourage you to attend national and international professional medical society meetings around the world so that you may share your experiences with your colleagues. We also urge you to explore the Bronchoscopy International website (www.Bronchoscopy.org) for other learning materials, and to search instructional videos on the Bronchoscopy Academy YouTube site.

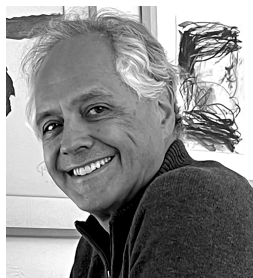
We look forward to receiving your comments regarding this and other components of The Bronchoscopy Education Project.

Please do not hesitate to contact your regional bronchology association, or email us at www.bronchoscopy.org

Thank you for participating in The Bronchoscopy Education Project!

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Henri Colt M.D. is an internationally recognized physician expert, leadership coach, award-winning medical educator and ethicist. In addition to his lectures, academic achievements, leadership positions in professional medical societies, and travels to more than one hundred countries, he has published numerous articles and book chapters on all aspects of interventional pulmonology. Results of his research in medical education, competency-oriented processes and procedures pertaining to bronchoscopy and other areas of pulmonary medicine are published in leading medical journals and textbooks. Colt has also served as a consultant to several large universities, governmental organizations, and national medical societies.

Professor Colt's team of certified and master instructors from Bronchoscopy International conduct faculty development programs around the world, in partnership with the World Association for Bronchology and Interventional Pulmonology and major regional medical associations. When he is not traveling, writing, or studying feature films that might be used for medical education, however, Colt's passions include mountaineering, tango, and watching the sunrise from his California home.

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The Essential Flexible Bronchoscopist[®] is the first of four volumes in The Essential Bronchoscopist[™] Series. In addition to module-specific competency-oriented learning objectives and post-tests, it contains 186 multiple choice question/answer sets pertaining to flexible bronchoscopy. Topics include anatomy, airway abnormalities, patient preparation, indications, contraindications, complications, techniques, solutions to technical difficulties, lung cancer, infections, tracheal stenosis, malignant and benign airway disorders, anesthesia and sedation, informed consent, patient safety, equipment maintenance, history, bronchioloalveolar lavage, endobronchial biopsy, washings, brushings, transbronchial needle aspiration, lung biopsy, and interventional techniques.

The aim of **The Essential Flexible Bronchoscopist[®]** is to prompt discussion among colleagues and to enrich the reader's experiential knowledge of this medical procedure*. Question/answer sets may be used in low-stakes continuing self-learning assessments, and to complement traditional apprenticeship style learning, thus contributing to the acquisition of cognitive and affective knowledge, as well as technical skill needed to become a competent flexible bronchoscopist.



The Essential Bronchoscopist[™] Series includes

- The Essential Flexible Bronchoscopist[®]
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*The Essential Bronchoscopist is officially endorsed by numerous professional medical associations, and is a recommended reading assignment of the Bronchoscopy Education Project.

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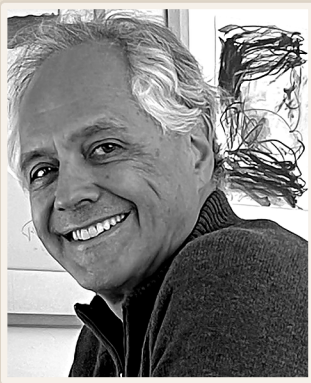
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A valuable resource of cognitive, technical, and experiential knowledge needed to become a competent bronchoscopist.



Henri Colt, MD

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The Essential Flexible Bronchoscopist is the first of several volumes of competency-oriented reading materials dedicated to the art and science of airway procedures such as bronchoscopy. This 186 multiple choice question/answer set contains six different modules with detailed explanations. A series of ten question post-tests helps learners reinforce their acquired knowledge of topics ranging from airway anatomy to mediastinal staging, technical aspects of BAL, biopsy, and TBNA, patient safety, informed consent, fluoroscopy, moderate sedation, procedural indications, complications, aspects of various airway disease processes, and solutions to technical problems. These modules are best used for continuing self-assessment, and to assure a uniform base of fundamental knowledge regardless of where bronchoscopists live or practice. Reviewed and revised by an international team of experts from Bronchoscopy International, this text has been translated into eighteen languages (www.Bronchoscopy.org). It is common reading among pulmonary and critical care practitioners around the world.

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