# Chapter 63: Hemoptysis

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## INTRODUCTION AND EPIDEMIOLOGY

Hemoptysis is the expectoration of blood from the lungs or tracheobronchial tree. Severity ranges from mild to severe, and it can be difficult to stop. The challenge is to stabilize the patient while simultaneously determining the source and providing treatment. Most cases of hemoptysis are mild and resolve spontaneously; predicting which individual will develop large-volume bleeding is difficult. Determining the cause, location, and extent of hemoptysis requires a multidisciplinary approach.[1]

Assessing the amount of expectorated blood is difficult, because patients may either exaggerate or be unable to quantify the amount. The definition of **"massive" or "severe" hemoptysis** varies, with reported ranges from 100 mL per 24 hours to >1000 mL per 24 hours,[2,3] with a midpoint value of 600 mL per 24 hours accepted by many.[4] However, because even small volumes of blood can cause asphyxiation, any hemoptysis requires prompt attention.[5] Morbidity and mortality depend on the rate of bleeding, the ability of the patient to clear the blood, and the presence of underlying lung disease, which potentiates the effects of blood in the airways. We define **"minor" hemoptysis** as small-volume expectoration of blood in a patient with no comorbid lung disease, normal/stable oxygenation and ventilation, normal vital signs, and no risk factors for continued bleeding.

## PATHOPHYSIOLOGY

Hemoptysis results from disruption of blood vessels within the walls of the airways, from trachea to bronchi, bronchioles, and the lung parenchyma (**Table 63-1**). The pulmonary arteries account for 99% of the arterial blood flow to the lungs but are a low-pressure system and rarely the source of hemoptysis. The bronchial circulation accounts for only about 1% of the arterial blood flow to the lungs but 90% of the cases of hemoptysis because it is a high-pressure system.[6] The bronchial arteries typically branch off the thoracic aorta and are responsible for supplying oxygenated blood to the bronchi, pulmonary arteries and veins, and lung parenchyma. They follow the course

of bronchi along their tortuous paths. Once the bronchial arteries reach the level of capillaries, three anastomoses occur: the larger bronchial arteries can merge directly with the alveolar microvasculature; the smaller bronchial arteries can merge with the veins of the pleural and pulmonary drainage system; and bronchial capillaries can merge directly with pulmonary capillaries.[7] These connections produce a physiological right-to-left shunt comprising 5% of the total cardiac output.

TABLE 63-1

**Causes of Hemoptysis**

**Infectious**

Acute bronchitis

Tuberculosis

Lung parasites (paragonimiasis, echinococcus, schistosomiasis)

Mycetoma (aspergilloma)

**Structural**

Bronchiectasis (cystic fibrosis, organizing pneumonia, chronic bronchitis)

Tracheoarterial fistula (tracheostomy)

Aortobronchial fistula (aortic aneurysm erosion)

Hypersensitivity pneumonitis (occupational exposure)

**Vasculitides**

Goodpasture's syndrome (also known as antiglomerular basement membrane disease)

Granulomatosis with polyangiitis (formerly Wegener's granulomatosis)

Systemic lupus erythematosus

Behçet's syndrome

**Cardiovascular**

Pulmonary embolism with infarction

Pulmonary hypertension (mitral stenosis, congestive heart failure, left-sided endocarditis)

**Neoplastic**

Bronchogenic carcinoma

Bronchial adenoma

**Iatrogenic**

Bronchoscopy

Pulmonary artery catheter injury

**Traumatic**

Ruptured bronchus from deceleration injury

Lung contusion from blunt injury

Penetrating trauma

**Miscellaneous**

Nitrogen dioxide inhalation (ice arenas)

Cocaine inhalation

Catamenial (pulmonary endometriosis)

Many inflammatory and infectious processes can lead to hemoptysis. Coughing in the setting of transient airway inflammation (e.g., acute bronchitis) can lead to minor bleeding even in otherwise healthy lungs. In chronic inflammatory states like tuberculosis, cystic fibrosis, or chronic obstructive pulmonary disease (COPD), the bronchial arteries can proliferate and enlarge to enhance the delivery of blood to the alveoli. Such neoangiogenesis creates thin-walled, fragile vessels prone to rupture. Chronic disease states can lead to bronchiectasis (chronic bronchial wall inflammation), resulting in dilatation and destruction of the cartilaginous support, predisposing blood vessels to rupture. In the case of Aspergillus infection, there can be necrotic destruction of tissue, but more often there is a colonization of a previous area of pulmonary decay, resulting in cavitary **fungal balls**. Neoangiogenesis from bronchial artery branches occurs in the cavity walls.[5] A **Rasmussen's aneurysm** is a false aneurysm of dilated, tortuous branches of pulmonary arteries crossing the wall of a tuberculosis cavity. Although tumors can directly invade the bronchial and pulmonary arteries, they also promote neoangiogenesis. In particular, squamous cell carcinoma accounts for a large number of cases of massive hemoptysis.[5]

Traumatic causes of hemoptysis include deceleration injuries and penetrating trauma to the chest. Iatrogenic causes include direct arterial injury by pulmonary artery catheterization or biopsy of lung tissue during bronchoscopy. Biopsy of a carcinoid tumor can be associated with impressive hemoptysis.[5]

Hemoptysis secondary to fistulae between an aortic aneurysm or aortic inflammation and its primary branches can precipitate catastrophic hemoptysis. Tracheo-innominate fistulae result from erosion of a tracheostomy into the innominate artery that courses posterior to the upper sternum.

Arteriovenous fistulas forming between the low-pressure pulmonary arteries and pulmonary veins have thin walls that are easily ruptured. Osler-Weber-Rendu disease is associated with hemorrhagic telangiectasias of pulmonary arteriovenous fistulas as well as telangiectasias of the skin or mucous membranes.

Cardiac disease processes that elevate pulmonary pressure, such as mitral stenosis and congenital heart disease, can trigger hemoptysis. Distal pulmonary embolism can lead to infarction of lung tissue that results in edema and hemorrhage, which can be exacerbated by the use of anticoagulants.

Vasculitis and collagen vascular diseases such as Goodpasture's syndrome, systemic lupus erythematosus, and granulomatosis with polyangiitis (formerly Wegener's granulomatosis) damage the lung parenchyma predisposing to alveolar hemorrhage. Anemia can result from chronic diffuse alveolar hemorrhage.[9]

The cause of hemoptysis in up to 30% of the cases is undetermined.[1]

# CLINICAL FEATURES

First, identify if the condition is truly hemoptysis, and exclude hematemesis and epistaxis. Upper GI (UGI) bleeding is identified by a history of dark stools, nausea or abdominal pain, and positive stool guaiac test. Epistaxis can be identified on examination. Expectorated blood is bright colored if the source is the upper airway or lungs.

### HISTORY

If hemoptysis resolves prior to ED evaluation, history is then paramount for evaluation.

Patients give an accurate history regarding the source of bleeding about half the time. Ask about risk factors for hemoptysis; for example, smoking predisposes to chronic lung inflammation and vascular disruption and increases the risk of bronchogenic carcinoma. Tuberculosis is a leading cause of hemoptysis worldwide, so ask about a history of tuberculosis or emigration/travel from an endemic area. High-prevalence tuberculosis areas are Africa, inner-city New York, the Middle East, and Southeast Asia. Patients with previous venous thrombotic disease may have a pulmonary embolism as a cause. Ask about hematuria or known renal insufficiency given the link to Goodpasture's syndrome. Individuals with a connective tissue disease or suggestive symptoms such as arthralgias, myalgias, recurrent fevers, or rash may develop vasculitis and hemoptysis. Granulomatosis with polyangiitis is a more insidious vasculitis; look for s[redacted]oration. The lung fluke, Paragonimus spp., infects humans after eating infected crab and crayfish

and can cause hemoptysis in chronic infection. The tapeworm, Echinococcosis spp., can lead to hydatid cysts within the lungs. Cyclical hemoptysis coordinating with a woman's menstrual cycle could indicate a catamenial source from pulmonary endometriosis.

Cocaine and heroin inhalation can trigger diffuse alveolar hemorrhage. Nitrogen dioxide exposure in indoor ice arenas may cause hemoptysis in hockey players. Finally, ask about use of anticoagulants and recent procedures such as Swan-Ganz catheter insertion and bronchoscopy.

### PHYSICAL EXAMINATION

Examine the sputum to see if it is just blood-streaked or contains clots of blood. Patients often bring a sample of expectorated sputum to the ED, which helps assessment. Look for signs suggestive of major hemoptysis or underlying lung disease, such as tachypnea, tachycardia, hypotension, labored respirations, and hypoxemia.

If airway, breathing, and circulation are maintained, then focus on the physical exam. Evaluate the nares and posterior pharynx for evidence of epistaxis. Next, assess airway patency and potential difficulty of intubation. Auscultate the lungs for any wheezing suggesting airway inflammation or focally reduced breath sounds indicating a location of bleeding. Occasionally, crackles may be present, suggesting diffuse alveolar hemorrhage or heart failure. On the cardiac exam, auscultate for murmurs of valvular disease. Check for telangiectasia and petechiae on the skin exam.

## DIAGNOSIS

Most patients with minor hemoptysis need no specific tests unless on anticoagulation medication. For patients with massive hemoptysis or recurring hemoptysis, obtain a metabolic assessment including electrolytes and renal function studies, CBC, coagulation studies, and urinalysis. Baseline hemoglobin concentration is often falsely elevated in acute, rapid bleeding, as equilibration may not occur for 6 hours. Thrombocytopenia and coagulopathy increase recurrence risk and morbidity from hemoptysis. Urinalysis and renal function tests help narrow the differential diagnosis that includes Goodpasture's syndrome and granulomatosis with polyangiitis, and can also identify those at risk for contrast nephropathy if imaging is contemplated.

### IMAGING

Chest x-ray is the initial imaging modality and yields a diagnosis up to 50% of the time[1]; in massive hemoptysis, x-ray is rarely normal. [Loading [Contrib]/a11y/accessibility-menu.js] as scattered alveolar infiltrates on chest x-ray, whereas infiltrates, atelectasis, masses, and

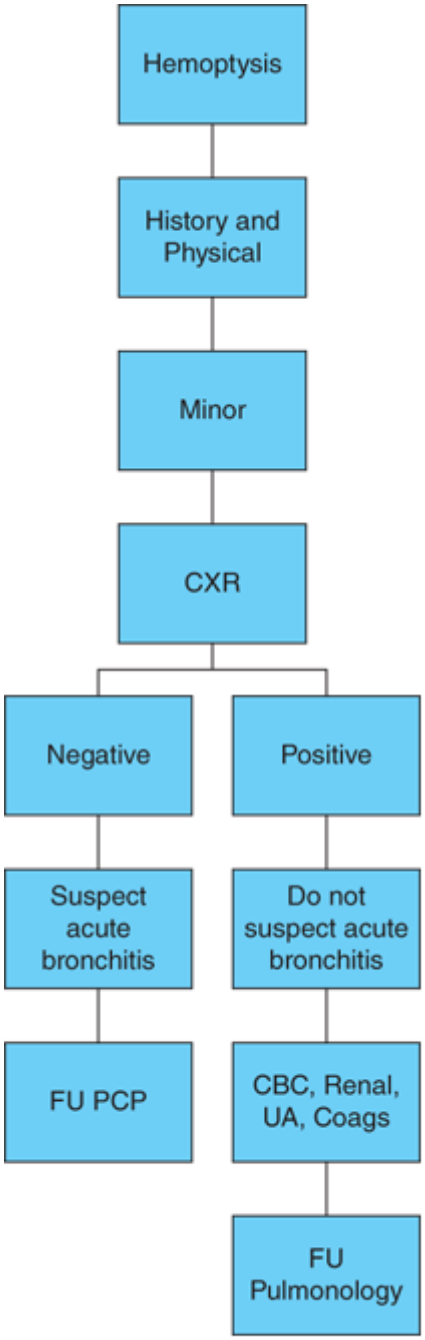
cavitation are localized as potential sources of hemoptysis.

Multidetector row CT delineates abnormal bronchial and nonbronchial arteries using reformatted images while limiting scan time and respiratory motion artifact. It can also identify bleeding from a pulmonary artery as in Rasmussen's aneurysm or from an anomalous vessel as in Dieulafoy's disease, a tortuous dysplastic artery within the submucosa. Bronchial arterial bleeding is almost always detected on multidetector row CT, whereas nonbronchial arterial sources can be identified more than half of the time.[10] Multidetector row CT is preferred over CT angiography. The limitation of CT evaluation for hemoptysis is that areas of bleeding can appear similar to infiltrate and tumor, and active bleeding can obscure a mass within the parenchyma.

## TREATMENT: MILD HEMOPTYSIS

Hemoptysis promotes anxiety in the patient and their family members, so the goal is to identify the cause, reassure those with minor features and no threat of imminent harm, and provide an appropriate ED disposition. The amount of blood expectorated, respiratory status, and risk factors for continued bleeding dictate the disposition. Patients with mild hemoptysis can be assessed as described in **Figure 63-1**.

**FIGURE 63-1.**
Diagnosis and management of minor hemoptysis. CXR = chest x-ray; FU = follow-up; PCP = primary care physician; UA = urinalysis.




Source: J.E. Tintinalli, J.S. Stapczynski, O.J. Ma, D.M. Yealy, G.D. Meckler, D.M. Cline: Tintinalli's Emergency Medicine: A Comprehensive Study Guide, 8th Edition

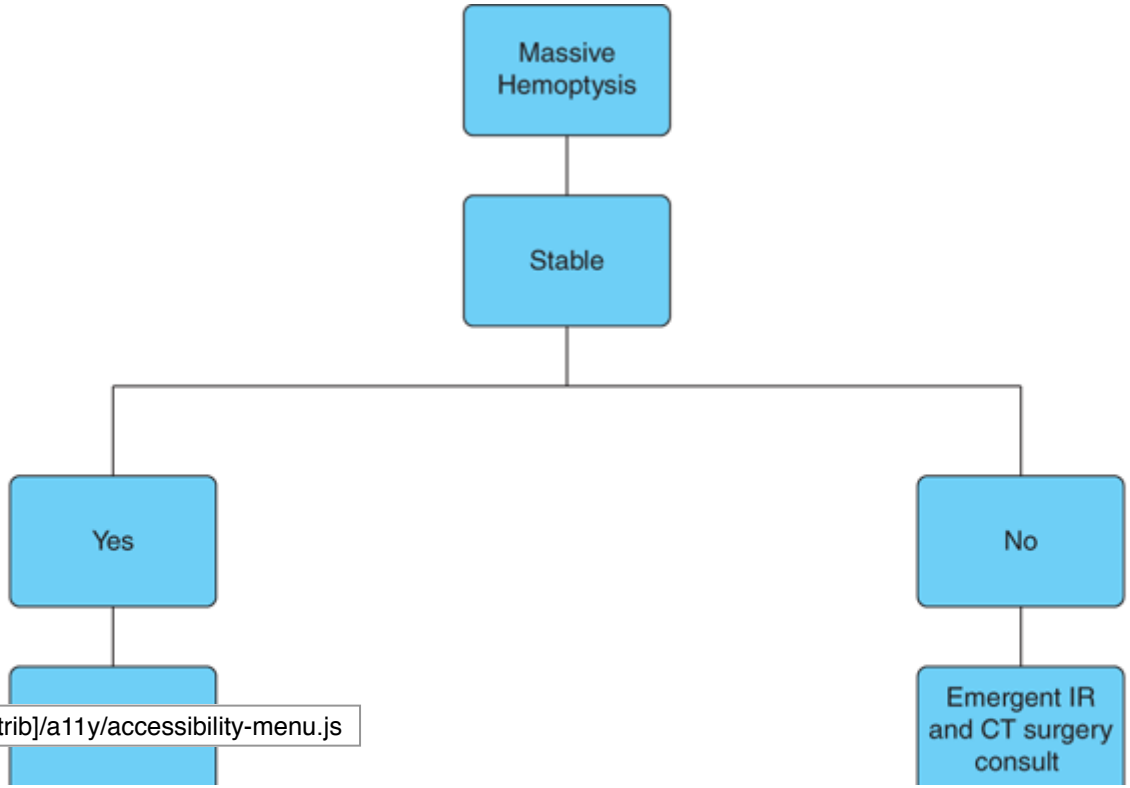
# DISPOSITION AND FOLLOW-UP

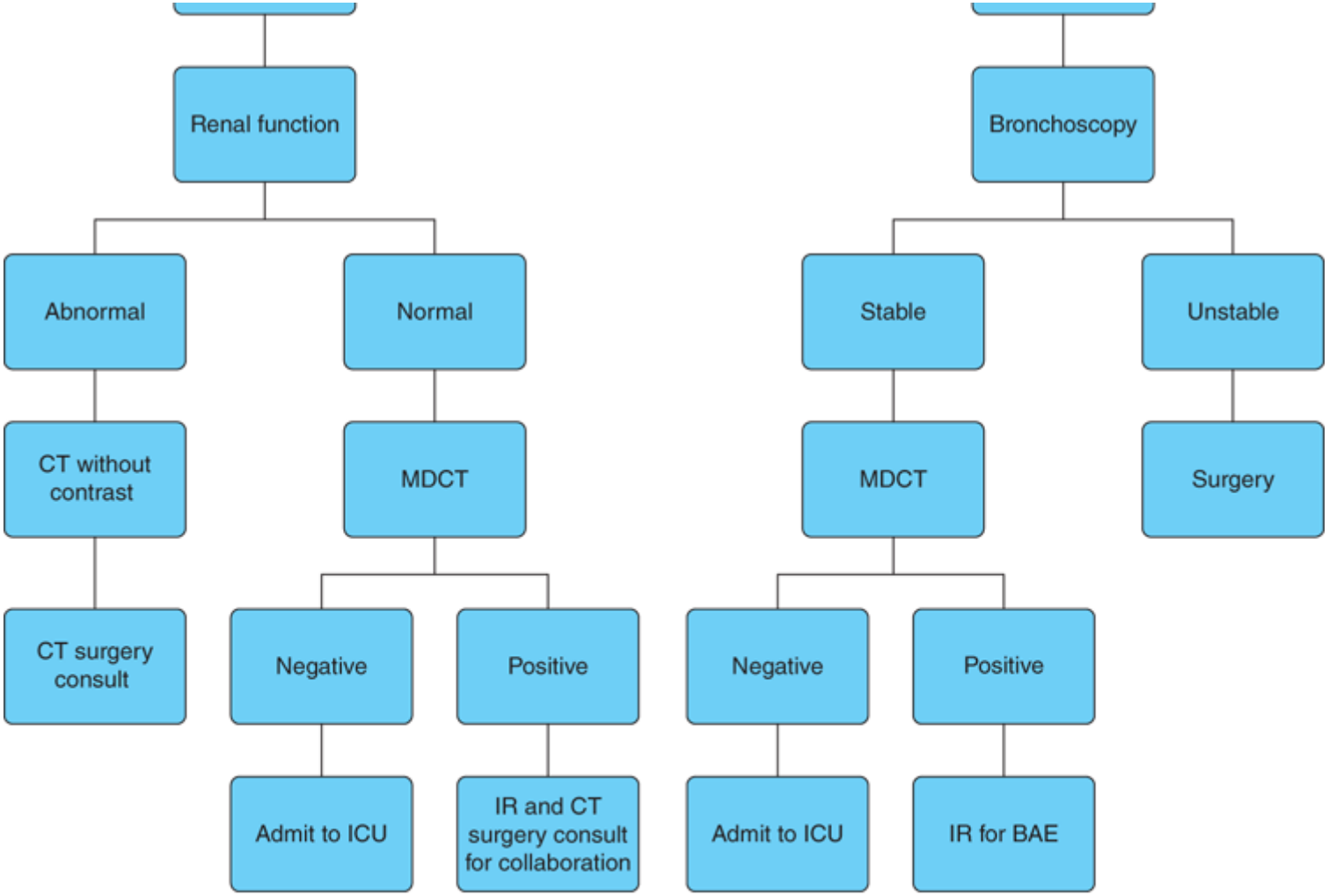
Most cases of hemoptysis are mild and self-limited. For mild hemoptysis, arrange follow-up with a primary care physician, otolaryngologist, or pulmonologist. Choose a pulmonologist if lung cancer or structural disease is suspected. Treat acute bronchitis with appropriate antibiotics.

# TREATMENT: SEVERE HEMOPTYSIS

Massive hemoptysis requires airway control and emergency broncho-scopy and often requires consultation with cardiothoracic surgery and interventional radiology (**Figure 63-2**) for definitive control of bleeding.

**FIGURE 63-2.**
Algorithm for massive hemoptysis. Determine whether patient is stable based on history provided by patient, rate of ongoing bleeding, ability of patient to clear the blood, and comorbidities. BAE = bronchial artery embolization; CT surgery = cardiothoracic surgery; CXR = chest x-ray; ICU = intensive care unit; IR = interventional radiology; MDCT = multidetector computed tomography.





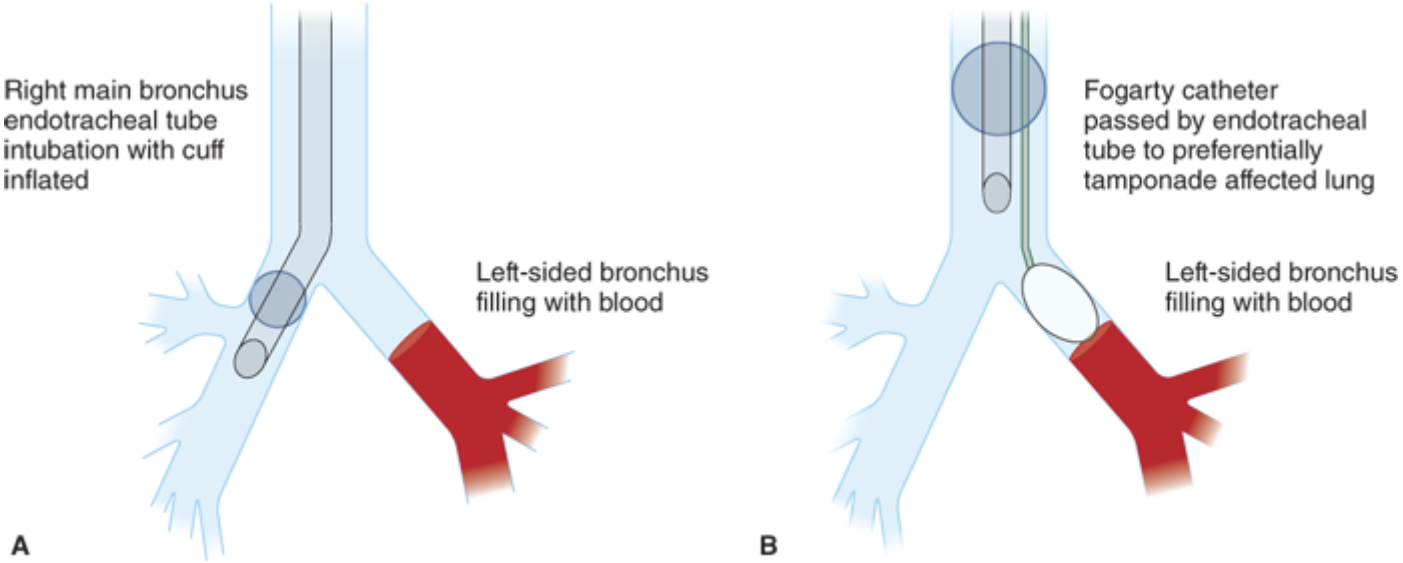



## AIRWAY CONTROL

In patients with more severe bleeding, assessing and ensuring the airway patency and ongoing oxygenation are key. If the patient has a tracheostomy, look for a trachea-innominate fistula; this can be controlled with direct digital pressure on the anterior portion of the trachea against the posterior aspect of the sternum using the tracheostomy as the point of access. If the patient does not have a t[Loading [Contrib]/a11y/accessibility-menu.js]trol, proceed immediately with rapid sequence intubation,[10] using a larger-diameter endotracheal

tube to allow for bronchoscopy. Once intubation is successful, place the patient so the affected lung is in a dependent position to prevent spilling of blood into the unaffected side. If bleeding is uncontrollable, you may preferentially intubate the main bronchus of the unaffected lung; and alternatively, to stop bleeding, some use a Fogarty catheter (14 French/100 cm) to tamponade the bronchus of the affected lung.[5] The latter can be accomplished by passing the Fogarty catheter adjacent to the endotracheal tube once the patient is intubated (**Figure 63-3**). If attempts at intubation fail, cricothyrotomy is an option.

**FIGURE 63-3.**
These are examples of techniques to control bleeding from the left lung. A. Selective right main bronchus intubation for left-sided massive hemoptysis. B. Using Fogarty catheter to direct control of hemoptysis coming from affected lung. The same techniques are used to control bleeding from the right lung. [Adapted with permission from Lordan JL, Gascoigne A, Corris PA. The pulmonary physician in critical care. Illustrative case 7: Assessment and management of massive haemoptysis. Thorax 2003; 58: 814-819. Copyright BMJ Publishing Group.]






Once the airway is stabilized, restore volume with crystalloid and transfusion of blood products to correct for anemia and coagulopathy as indicated.

Urgent bronchoscopy is needed in massive hemoptysis to identify the origin of bleeding and provide stabilizing treatment. Bronchoscopy may be performed in the ED by a consultant if the patient is unstable. Awake flexible, fiberoptic bronchoscopy provides visualization of the more peripheral and upper lobes but does not provide optimal suctioning and does not allow for local treatment. Rigid bronchoscopy usually requires general anesthesia but can be performed with deep sedation in skilled hands. Rigid bronchoscopy cannot fully view the upper lobes and peripheral lesions, but it offers greater suctioning ability than fiberoptic bronchoscopy and can provide treatment, such as the passage of Fogarty balloon catheters for tamponade of bleeding, epinephrine instillation, and ice water lavage. After rigid bronchoscopy, a flexible bronchoscope can be passed down the lumen of a rigid bronchoscope for more detailed inspection.

### DEFINITIVE BLEEDING CONTROL

Definitive bleeding control may involve consultation with a cardiothoracic surgeon or an interventional radiologist.[9,11,12] Emergency surgery is often reserved for massive hemoptysis resulting from leaking aortic aneurysm, iatrogenic pulmonary artery injury, thoracic trauma, or bleeding from a tracheo-innominate artery fistula at a tracheostomy site.[9,12] In other causes of hemoptysis or if cause is uncertain, bronchial artery embolization is a common treatment of massive and recurrent hemoptysis.[9] Even in cases of mycetoma from aspergillosis, adenoma, hydatid cyst, and active tuberculosis, where surgery is still indicated as the ultimate treatment, embolization can temporize bleeding and stabilize patients for elective surgery.[12] Risks of bronchial artery embolization include transverse myelitis due to spinal cord ischemia and pulmonary artery infarction from spread of embolic material beyond its intended site.[10]

## DISPOSITION

Admission to an intensive care setting or transfer to a tertiary care center is necessary for management of severe hemoptysis.

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