

Manifestations of hemoptysis

How to manage minor, moderate, and massive bleeding

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CME learning objectives

- To review the differential diagnosis of hemoptysis
- To understand the pathophysiology of hemoptysis in common diseases
- To become familiar with diagnosis and management of minor and massive hemoptysis

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This page is best viewed with a browser that supports tables.

Preview: Hemoptysis is frightening for the patient and worrisome to the physician because it may be a sign of serious pulmonary or systemic disease. In this article, Dr Johnson discusses the differential diagnostic considerations in hemoptysis as well as the treatment of nonmassive and massive types.

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Hemoptysis can have many causes, including infection, cardiovascular disease, cancer, and vasculitis (table 1). The amount of blood expectorated is important because the rate of bleeding is a major determinant of morbidity. Massive hemoptysis has been arbitrarily defined as the expectoration of more than 100 to 600 mL of blood in 24 hours (1). Massive hemoptysis is a medical emergency that places the patient at high risk for asphyxiation and death. Primary care physicians are most likely to encounter nonmassive hemoptysis but also should be familiar with massive hemoptysis.

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Table 1. Common causes of hemoptysis**Infectious**

Chronic bronchitis
 Bronchiectasis
 Tuberculosis
 Nontuberculous mycobacteria
 Lung abscess
 Necrotizing pneumonia
 Mycetoma
 Cystic fibrosis

Cardiovascular

Severe left ventricular heart failure
 Mitral stenosis
 Pulmonary embolism or infarction
 Septic pulmonary embolism or right-sided endocarditis
 Aortic aneurysm or bronchovascular fistula

Neoplastic

Lung cancer
 Bronchial adenoma
 Metastatic disease (osteogenic sarcoma, choriocarcinoma)

Vasculitic

Wegener's granulomatosis
 Systemic lupus erythematosus

Miscellaneous

Idiopathic pulmonary hemosiderosis
 Aspirated foreign body
 Pulmonary contusion or trauma
 Posttransthoracic needle biopsy or transbronchial lung biopsy
 Cocaine ("crack") lung
 Factitious hemoptysis

Pathophysiologic factors

The lungs have a dual blood supply. The pulmonary arterial circulation, a high-compliance, low-pressure system that terminates in the pulmonary capillary bed, is responsible for gas exchange. In addition, the lungs are supplied by the bronchial arteries, branches of the aorta that bring nutrients to the lung parenchyma and major airways. The bronchial arteries, like all systemic arteries, are a high-pressure system. Most cases of hemoptysis result from disruption of branches of the bronchial arterial tree.

Causes

In a recent US series that included HIV-infected adults (2), the most common causes of hemoptysis were bronchitis (26%), lung cancer (23%), pneumonia (10%), and tuberculosis (8%). In a study of 123 patients from South Africa (3), the most common causes, in descending order, were tuberculosis, bronchiectasis, necrotizing pneumonia, lung abscess, bronchovascular fistula, invasive fungal infections, and bleeding disorders. Tuberculosis is a leading cause of hemoptysis in developing countries and should be a differential diagnostic consideration in patients who are immigrants from countries with a high prevalence of this disease.

Bronchitis and bronchiectasis

Bronchitis usually causes mild hemoptysis. Inflammation of the airways leads to mucosal hyperemia, and disruption of small mucosal vessels produces blood-streaked sputum. Conditions such as bronchiectasis are associated with chronic inflammation of the lung, with local bronchial arterial proliferation and increased blood flow. Inflammation leading to erosion of these bronchial vessels can result in severe hemorrhage.

Lung cancer

Hemoptysis due to lung cancer is usually mild, resulting in blood-streaked sputum. Rarely, it is massive. The usual cause of minor hemoptysis is erosion of small, friable mucosal vessels in airways involved by tumor. Massive hemoptysis in patients with lung cancer is typically caused by malignant invasion of central pulmonary vessels by large central tumors.

Tuberculosis

Hemoptysis in patients with tuberculosis can result from several mechanisms. Endobronchial tuberculosis may cause local airway bleeding. Advanced chronic tuberculosis commonly causes hemoptysis through the previously described mechanisms. Calcified tuberculous lymph nodes can compress and erode lobar and mainstem bronchi, causing local bleeding and expectoration of gritty calcified debris called broncholiths in the sputum. Large cavitory lesions in patients with advanced tuberculosis often do not fully close despite successful antituberculosis treatment; these lesions sometimes are colonized by *Aspergillus*. Bronchial arterial bleeding from inflammation in the walls of cavities containing aspergillomata can be massive.

Cystic lesions in patients with chronic pulmonary sarcoidosis also often become colonized by *Aspergillus*, resulting in hemoptysis. Finally, massive fatal hemoptysis in patients with chronic cavitory tuberculosis can result from rupture of a pulmonary artery aneurysm (Rasmussen's aneurysm) in the walls of a tuberculous cavity.

Other causes

Hemoptysis can be caused by chronically elevated pulmonary venous pressure. The classic example is mitral stenosis, an uncommon condition in the United States today because of the decline in rheumatic heart disease. Nevertheless, mitral stenosis should be considered in patients with a history of rheumatic fever and those from regions with a high prevalence of rheumatic heart disease. Hemoptysis also can result from inflammation in areas of necrotizing pneumonia, such as invasive aspergillosis, and in immunologically mediated alveolar hemorrhage syndromes, such as Goodpasture's syndrome, Wegener's granulomatosis, systemic lupus erythematosus, and pulmonary hemosiderosis.

Diagnostic evaluation

The most important initial step in diagnosis is to differentiate between minor and massive hemoptysis. Through careful questioning of the patient, the amount of bleeding can be quantified. Massive hemoptysis is a true medical emergency and requires prompt diagnosis and treatment. Patients who have had more than 30 to 50 mL of blood loss in the previous 24 hours are at increased risk for death and should be hospitalized for evaluation. Massive hemoptysis is likely to be a sign of serious underlying disease (table 2) and requires immediate workup.

Table 2. Causes of massive hemoptysis

Common

Bronchiectasis (including cystic fibrosis)
 Tuberculosis
 Nontuberculous mycobacteria
 Lung abscess
 Mycetoma (aspergilloma, or fungus ball)
 Pulmonary contusion or trauma

Uncommon

Invasive aspergillosis or mucormycosis
 Mitral stenosis
 Pulmonary arteriovenous malformation
 Bronchovascular fistula (eg, tracheobrachiocephalic artery fistula in patients with chronic tracheostomy)
 Bleeding diathesis
 Foreign body
 Idiopathic pulmonary hemosiderosis
 Necrotizing bacterial pneumonia
 Bronchial adenoma
 Pulmonary embolism with infarction
 Septic embolism from tricuspid endocarditis
 Pulmonary-renal syndromes (Goodpasture's syndrome, systemic lupus erythematosus, Wegener's granulomatosis)
 Pulmonary artery rupture due to pulmonary arterial (Swan-Ganz) catheterization

History taking

Patients should be asked about episodes of severe childhood pneumonia, recurrent pneumonia, and chronic cough and sputum production, which are important clues to bronchiectasis. Blood streaking or gross blood in purulent sputum suggests pneumonia or lung abscess. Hemoptysis in the setting of dyspnea and pleuritic chest pain suggests the possibility of pulmonary embolism or infarction. Age is an important consideration; lung cancer is rare in patients younger than 40 years. Patients should also be asked about a history of tuberculosis or exposure to known cases of tuberculosis; occupational exposures; use of certain medications, especially anticoagulant drugs such as warfarin sodium (Coumadin); use of recreational drugs such as crack cocaine; and other chronic medical conditions, such as rheumatic heart disease and pulmonary thromboembolism.

Physical examination

The oropharynx and nasopharynx should be carefully inspected under adequate illumination to detect sources of bleeding in the upper airway. Cervical, supraclavicular, or axillary adenopathy suggests intrathoracic malignancy. Auscultation of the chest may indicate rales due to pneumonia or aspirated blood; it may also reveal localized wheezes due to focal endobronchial lesions, such as lung cancer. A thorough cardiovascular examination should be performed to detect S₃ gallops, cardiac murmurs, jugular venous distention, and dependent edema suggesting valvular heart disease or congestive heart failure. Clubbing of the fingers may be seen in patients with lung cancer, bronchiectasis, and lung abscess.

Laboratory evaluation

Standard posteroanterior and lateral chest radiographs should be obtained in all patients with hemoptysis. Important findings include fibrocavitary disease (ie, tuberculosis, necrotizing bacterial or fungal pneumonia), segmental or lobar atelectasis (from obstruction due to lung cancer, bronchial adenoma, or a foreign body), fungus balls in

cavitary lesions (aspergillosis), left atrial enlargement, Kerley's B lines (mitral stenosis), thickened bronchial walls (bronchiectasis), lymphadenopathy, and infiltrates. Up to 30% of patients with hemoptysis have a normal chest radiograph (4). A complete blood cell count, coagulation studies, and urinalysis to detect urinary abnormalities that suggest pulmonary-renal syndromes also should be performed routinely. Additional studies should be obtained, depending on the amount of hemoptysis and patient characteristics.

Minor hemoptysis

Minor hemoptysis is not immediately life-threatening. The goal of further evaluation is to determine the origin, provide effective specific treatment (if available), and rule out serious underlying disease (figure 1). In patients with a normal chest radiograph and a history consistent with bronchitis, treatment with a mild cough suppressant and an oral broad-spectrum antibiotic, with follow-up in 1 or 2 weeks, may be considered. Sputum cytologic testing should be performed if indicated.

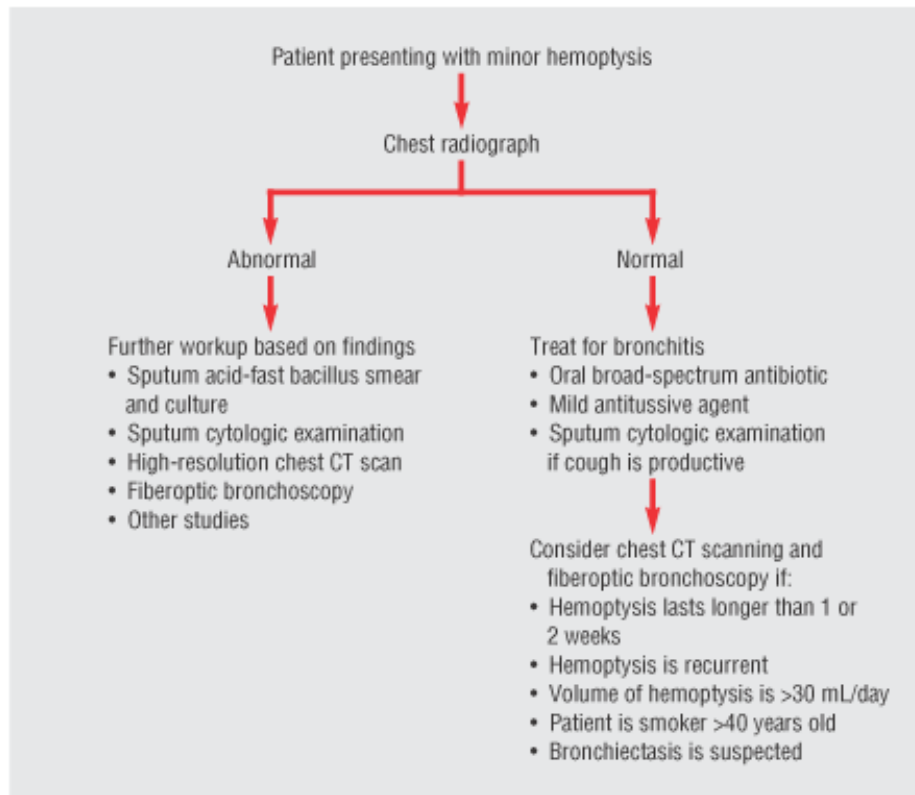


Figure 1. Management of minor hemoptysis. CT, computed tomographic.

Bronchoscopy should be considered on a case-by-case basis in this group of patients. Fiberoptic bronchoscopy is preferable to rigid bronchoscopy in patients with minor hemoptysis because of its ability to visualize the upper-lobe bronchi and distal airways. The diagnostic yield is higher when bronchoscopy is performed within a few days after the bleeding stops (5).

Some authorities recommend diagnostic bronchoscopy in all smokers older than age 40 with hemoptysis because of the higher prevalence of lung cancer in this group. Early tumors in large central airways can manifest as hemoptysis with a normal chest radiograph. Lung cancer was found in 3% to 6% of patients with minor hemoptysis and normal or nonlocalizing chest radiographs in three US referral hospital series (6-8). Age older than 50 years, a smoking history of greater than 40 pack-years, and male sex were important predictors of cancer in the largest of these studies (8).

In patients with an abnormal chest radiograph, further evaluation should be guided by clinical and radiographic findings. Mass lesions suggestive of cancer should be evaluated by sputum cytologic examination, transthoracic needle aspiration, bronchoscopic examination, or open-lung biopsy. Apical cavitory disease with surrounding infiltrates suggestive of tuberculosis should be evaluated by sputum acid-fast bacillus smears and cultures. Physicians need to look carefully for evidence of a meniscus (crescent) sign (air surrounding a mycetoma in a pulmonary cavity) consistent with aspergilloma. Lateral decubitus views or chest computed tomographic (CT) scanning to better visualize such lesions, as well as serum aspergillus precipitin testing, also may be indicated.

High-resolution CT scanning and fiberoptic bronchoscopy have complementary roles in the evaluation of patients with minor hemoptysis. High-resolution chest CT scanning is of greatest value for the detection of bronchiectasis and undiagnosed lung cancer. Because of the procedure's high sensitivity in detection of bronchiectasis, parenchymal masses, and cavitory disease such as mycetomas, some authorities recommend that it be performed prior to bronchoscopy in all patients with hemoptysis (9,10).

Moderate hemoptysis

Patients with moderate hemoptysis should be hospitalized for observation and further evaluation. They should be kept at bed rest in the semisitting position when awake and with the radiographically abnormal lung down when recumbent. Cough suppression with codeine may be useful; however, oversedation should be avoided. Adequate oxygenation should be ensured. The suspected source and rate of bleeding determine the timing of and the tests used in further workup. Bronchoscopic examination is often the next step.

Massive hemoptysis

Fewer than 5% of all cases of hemoptysis are massive. However, massive hemoptysis is a medical emergency that requires immediate evaluation and treatment (figure 2). The principal risk to life is asphyxiation, not exsanguination. The rate of bleeding is the most important prognostic factor (1). Patients with underlying lung disease are less able to tolerate spillage of blood into other portions of the lung before acute respiratory failure develops.

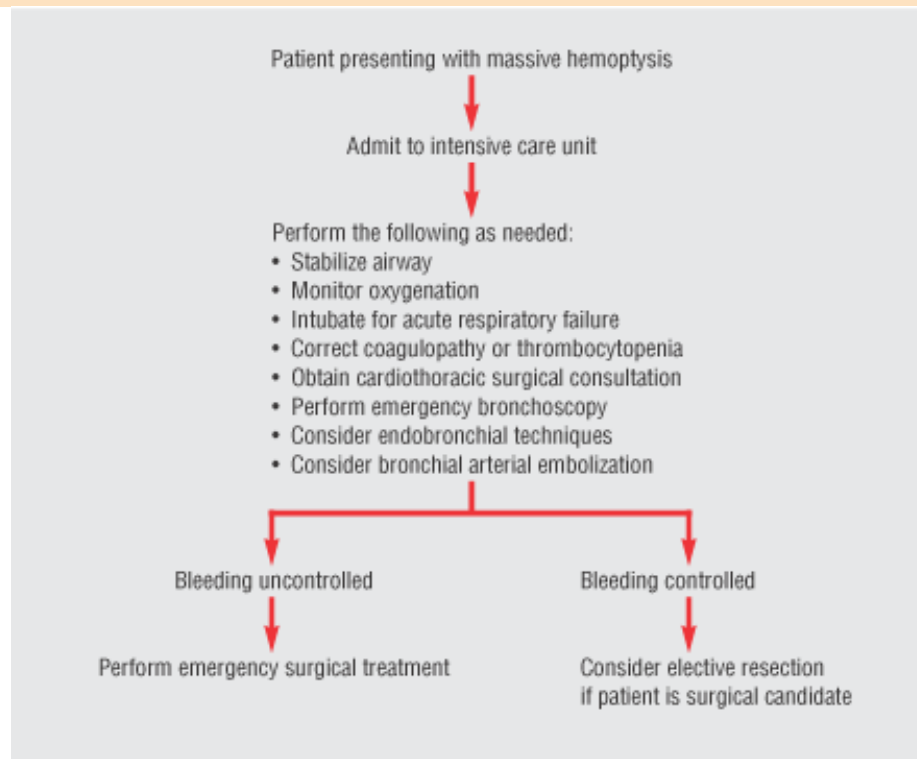


Figure 2. Management of massive hemoptysis.

Optimal diagnosis and treatment of massive hemoptysis continue to be controversial because few adequately controlled studies have been done. Infiltrates from aspirated blood may prevent localization of the bleeding site on chest radiographs. For similar reasons, chest CT scanning in patients with massive hemoptysis may not be very helpful.

The role of flexible versus rigid bronchoscopy in massive hemoptysis has been debated, as has the role of medical versus surgical therapy. Many case series comparing medical and surgical treatment have had serious selection biases. Some authorities advocate resection in all operable cases with localized lesions; others favor more conservative management. Management should be individualized on the basis of the rate of hemoptysis, the patient's underlying medical condition, the suspected source of the bleeding, and whether the patient is a good surgical candidate. Good candidates for surgical treatment have a localized site of bleeding, focal lung disease, adequate pulmonary function reserve, and a reasonable prognosis from other underlying medical conditions. Therapy for chronic suppurative lung diseases, such as cystic fibrosis and bilateral bronchiectasis, should be targeted toward preservation of functioning lung tissue.

Initial management: Treatment of massive hemoptysis is directed toward airway management, oxygenation, and localization of the bleeding site. Most deaths are due to asphyxia and hypoxemia from aspiration of blood into other areas of the lung. Management of massive hemoptysis requires a team approach involving appropriate pulmonary, anesthesia, thoracic surgical, and interventional radiology consultation. Patients should be admitted to an intensive care unit (ICU) for observation and kept at bed rest.

The condition may be managed expectantly with supplemental oxygen and cough suppression with codeine if bleeding has slowed or ceased. Patients should remain in a semisitting position or recumbent with the radiographically normal (presumably nonbleeding) lung up. All expectorated blood and respiratory secretions should be collected and

the volume and rate of blood loss estimated. Intubation should be performed if any signs of acute respiratory failure appear. Large-bore endotracheal tubes (>7.5 mm in diameter) are recommended to facilitate suctioning. Rigid bronchoscopy and selective intubation and ventilation of the nonbleeding lung with single- or double-lumen endotracheal tubes may be required.

Selective intubation: Intubation of the right or left main bronchus with standard single-lumen endotracheal tubes is generally the best option. Placement of double-lumen endotracheal tubes and care of patients who have them are technically challenging and require the attention of experienced medical, anesthesia, and surgical staff.

Bronchoscopy: If severe bleeding continues, additional diagnostic studies and therapeutic measures should be urgently considered. Bronchoscopy, the key method for localizing the source of bleeding and determining further treatment, should not be delayed. Localization of the bleeding site to the level of the bleeding lung or lobe is necessary for proper medical or surgical management.

Whether to use rigid or flexible fiberoptic bronchoscopy or a combination of both is controversial. Rigid bronchoscopy has the advantages of superior suctioning capacity of blood and clots, excellent visualization of the major airways, and adequate ventilation and airway control. However, it must be performed in the operating room. Few US pulmonologists are trained in rigid bronchoscopy. For lesser degrees of hemoptysis, flexible bronchoscopy can be done at the bedside or in the ICU; this method allows better visualization of upper-lobe orifices (from which most cases of massive hemoptysis arise) and subsegmental anatomy.

Alternatives to surgical management: Alternatives include endobronchial techniques, such as balloon catheter tamponade, instillation of thrombin or fibrinogen-thrombin glue (11), iced saline lavage (12), and bronchial arterial embolization. None of these techniques has been evaluated in controlled clinical trials. Endobronchial therapies may be useful in short-term stabilization by controlling bleeding until other diagnostic or definitive treatment measures can be performed.

Bronchial arterial embolization: This technique is now available in many large medical centers. Initially used mainly in cystic fibrosis patients with hemoptysis who were not surgical candidates, bronchial arterial embolization has now been used successfully for control of hemorrhage in other lung diseases. This angiographic technique involves cannulation of the bronchial artery that supplies the area of hemorrhage and embolization with polyvinyl alcohol particles or absorbable gelatin powder (Gelfoam). The main risk is ischemic spinal cord injury due to embolization of the anterior spinal artery that originates from a bronchial artery in about 5% of patients. This risk has been decreased by superselective embolization techniques using smaller catheters that can be placed distally (13).

Bronchial arterial embolization is about 90% effective for short-term control of hemoptysis. Early rebleeding is usually due to incomplete embolization in lesions with many feeding vessels. Late rebleeding occurs in 10% to 20% or more of patients by 1 year and is due to proliferation of collateral vessels. Patients with early or late rebleeding may undergo repeated bronchial arterial embolizations. This method is useful to control hemoptysis, especially in patients with diffuse lung disease or those who are not surgical candidates. Because of the significant recurrence rate, it should not be considered definitive treatment in patients with lesions that are appropriate for surgical

resection.

Definitive treatment for massive hemoptysis must be individualized, depending on the patient's underlying medical condition and prognosis, pulmonary function reserve, and source of the massive hemoptysis. Massive hemoptysis often recurs--many times suddenly and without warning--and may be fatal (14). For patients with localized lesions and adequate pulmonary function reserve, surgical resection is the most effective therapy.

Summary

Hemoptysis is a frightening symptom for patients and often is a manifestation of significant underlying disease. The chest radiograph, history and examination findings, comorbid illnesses, and demographic factors guide evaluation of patients with minor hemoptysis.

Massive hemoptysis occurs in less than 5% of patients with hemoptysis and is almost always due to serious pulmonary or systemic illness. Massive hemoptysis is a life-threatening event that requires ICU admission and urgent bronchoscopic evaluation for lateralization or localization of the bleeding site. Management should be individualized and requires prompt consultation with appropriate cardiothoracic surgery, pulmonary medicine, anesthesia, and interventional radiology staff. The availability of endobronchial techniques and bronchial arterial embolization has enhanced our ability to control massive bleeding short-term and decreased the need for emergency surgical treatment. Massive hemoptysis may recur without warning. Prompt workup and treatment are required for all patients.

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