Chapter 39: Hemoptysis

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INTRODUCTION

Hemoptysis is the expectoration of blood from the respiratory tract. Bleeding from the gastrointestinal tract (hematemesis) or nasal cavities (epistaxis) can mimic hemoptysis. Once established as hemoptysis, the degree of blood that is being expectorated (volume and frequency) is the next step as massive or life-threatening hemoptysis (>400 mL of blood in 24 h or >150 mL at one time) requires emergent intervention. This chapter will focus predominantly on non–life-threatening hemoptysis. The source of the bleeding as well as the cause are the next steps when approaching a patient with hemoptysis.

ANATOMY AND PHYSIOLOGY OF HEMOPTYSIS

Hemoptysis can arise from anywhere in the respiratory tract, from the glottis to the alveolus. Most commonly, bleeding arises from the bronchi or medium-sized airways, but a thorough evaluation of the entire respiratory tree is important.

The dual blood supply of the lungs makes it unique. The lungs have both the pulmonary and bronchial circulations. The pulmonary circulation is a low-pressure system that is essential for gas exchange at the alveolar level; in contrast, the bronchial circulation originates from the aorta and, therefore, is a higher-pressure system. The bronchial arteries supply the airways and can neovascularize tumors, dilated airways of bronchiectasis, and cavitary lesions. Most hemoptysis originates from the bronchial circulation, and bleeding from the higher-pressure system makes it more difficult to stop.

ETIOLOGY

Hemoptysis commonly results from infection, malignancy, or vascular disease; however, the differential for bleeding from the respiratory tree is varied and broad. In the United States, the most common causes are viral bronchitis, bronchiectasis, or malignancy. In other parts of the world, infections such as tuberculosis are the most common causes.

Infections

Most blood-tinged sputum and small-volume hemoptysis are due to viral bronchitis. Patients with chronic bronchitis are at risk for bacterial superinfection with organisms such as *Streptococcus pneumoniae, Haemophilus influenzae,* or *Moraxella catarrhalis,* increasing airway inflammation and potential for bleeding. Similarly, patients with bronchiectasis are prone to hemoptysis during exacerbations. Due to recurrent bacterial infection, bronchiectatic airways are dilated, inflamed, and highly vascular, supplied by the bronchial circulation. In several case series, bronchiectasis is the leading cause of massive hemoptysis and subsequent death.

Tuberculosis had long been the most common cause of hemoptysis worldwide, but it is now surpassed in industrialized countries by bronchitis and bronchiectasis. In patients with tuberculosis, development of cavitary disease is frequently the source of bleeding, but rarer complications such as the erosion of a pulmonary artery aneurysm into a preexisting cavity (i.e., Rasmussen's aneurysm) can also be the source.

Other infectious agents such as endemic fungi, *Nocardia,* and nontuberculous mycobacteria can present as cavitary lung disease complicated by hemoptysis. In addition, *Aspergillus* species can develop into mycetomas within preexisting cavities, with neovascularization to these inflamed spaces leading to bleeding. Pulmonary abscesses and necrotizing pneumonia can cause bleeding by devitalizing lung parenchyma. Common responsible organisms include *Staphylococcus aureus, Klebsiella pneumoniae*, and oral anaerobes.

Paragonimiasis can mimic tuberculosis and is another significant cause of hemoptysis seen globally; it is common in Southeast Asia and China,

although cases have been reported in North America from raw crayfish ingestion. It should be considered as a cause of hemoptysis in recent immigrants from endemic areas.

Vascular

Hemoptysis from a vascular cause can be associated with cardiac disease, pulmonary embolism, arteriovenous malformation, or diffuse alveolar hemorrhage (DAH). While the classic description of the sputum expectorated in pulmonary edema (from elevated left end-diastolic pressure) is "pink and frothy," a spectrum of hemoptysis including frank blood can be seen. This observation is particularly true now with the more widespread use of anticoagulants and antiplatelet medications.

Pulmonary embolism with parenchymal infarction can present with hemoptysis, but pulmonary emboli do not commonly cause hemoptysis. An ectatic vessel in an airway or a pulmonary arteriovenous malformation can be a source of bleeding. A rare vascular cause of hemoptysis is the rupture of an aortobronchial fistula; these fistulae arise in the setting of aortic pathology such as aneurysm or pseudoaneurysm and can cause small bleeding episodes that herald massive hemoptysis.

DAH causes significant bleeding into the lung parenchyma but, interestingly, is not often associated with hemoptysis. DAH typically presents with diffuse ground glass opacities on chest imaging. A range of insults cause DAH, including immune-mediated capillaritis from diseases such as systemic lupus erythematosus, toxicity from cocaine and other inhalants, and stem cell transplantation. The so-called "pulmonary-renal" syndromes, including granulomatosis with polyangiitis and anti-glomerular basement membrane disease, may lead to both hemoptysis and hematuria (though one manifestation may be present without the other). A recently identified cause of hemoptysis and DAH is vaping-induced lung injury.

Malignancy

Bronchogenic carcinoma of any histology is a common cause of hemoptysis (both massive and nonmassive). Hemoptysis can indicate airway involvement of the tumor and can be a presenting symptom of carcinoid tumors, vascular lesions that frequently arise in the proximal airways. Small cell and squamous cell carcinomas are frequently central in nature and more likely to erode into major pulmonary vessels, resulting in massive hemoptysis. Pulmonary metastases from distant tumors (e.g., melanoma, sarcoma, adenocarcinomas of the breast and colon) can also cause bleeding. Kaposi's sarcoma, seen in advanced acquired immunodeficiency syndrome, is very vascular and can develop anywhere along the respiratory tract, from the bronchi to the oral cavity.

Mechanical and Other Causes

In addition to infection, vascular disease, and malignancy, other insults to the pulmonary system can cause hemoptysis. Pulmonary endometriosis causes cyclical bleeding known as catamenial hemoptysis. Foreign body aspiration can lead to airway irritation and bleeding. Diagnostic and therapeutic procedures are also potential offenders: pulmonary vein stenosis can result from left atrial procedures, such as pulmonary vein isolation, and pulmonary artery catheters can lead to rupture of the pulmonary artery if the distal balloon is kept inflated. Finally, in the setting of thrombocytopenia, coagulopathy, anticoagulation, or antiplatelet therapy, even minor insults can cause hemoptysis.

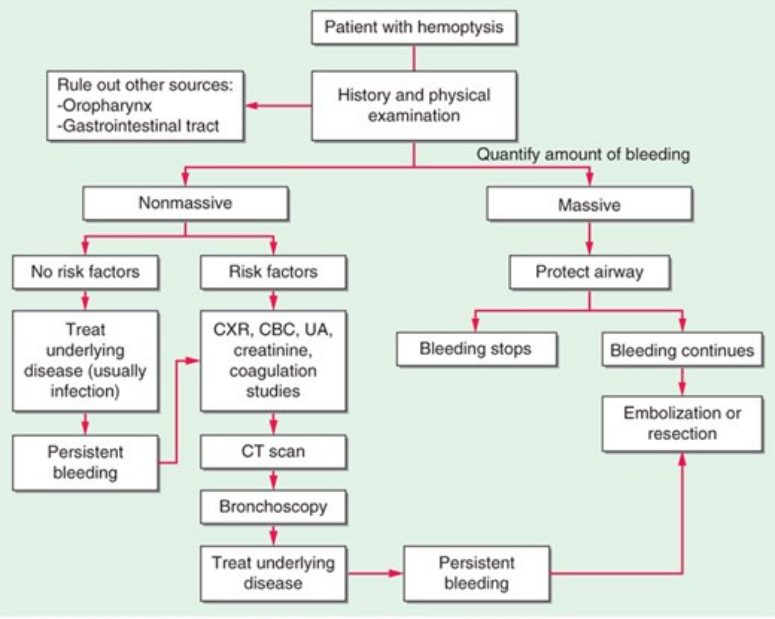
EVALUATION AND MANAGEMENT

History

The amount or severity of bleeding is the first step in assessing a patient with hemoptysis. A patient's description of the sputum (e.g., flecks of blood, pink-tinged, or frank blood or clot) is helpful if you cannot examine it. An approach to management of hemoptysis is outlined in **Fig. 39-1**.

FIGURE 39-1

Approach to the management of hemoptysis. CBC, complete blood count; CT, computed tomography; CXR, chest x-ray; UA, urinalysis.



Source: Joseph Loscalzo, Anthony Fauci, Dennis Kasper, Stephen Hauser, Dan Longo, J. Larry Jameson: Harrison's Principles of Internal Medicine, 21e

While there is no agreed-upon volume, blood loss of 400 mL in 24 h or 100–150 mL expectorated at one time should be considered *life-threatening hemoptysis*. These numbers derive from the blood volume of the tracheobronchial tree (generally 100–200 mL). Patients rarely die of exsanguination but, rather, are at risk of death due to asphyxiation from blood filling the airways and airspaces. Most patients cannot describe the volume of their hemoptysis in milliliters, so using referents like cups (one U.S. cup is 236 mL) can be helpful. Fortunately, life-threatening hemoptysis only accounts for 5–15% of cases of hemoptysis.

The history may point to the cause of hemoptysis. Fever, chills, or antecedent cough may suggest infection. A history of smoking or unintentional weight loss makes malignancy more likely. Patients should be asked about inhalational exposures, including vaping. A thorough medical history with careful attention to chronic pulmonary disease should be obtained, with evaluation of risk factors for malignancy and bronchiectatic lung disease (e.g., cystic fibrosis, sarcoidosis).

Physical Examination

Reviewing the vital signs is an important first step. Patients who have life-threatening hemoptysis can have hypoxemia, tachycardia, and hemodynamic instability. As the site of bleeding is important, evaluation of the nasal and oral cavities is imperative. In addition, auscultation of the lungs and seeking other relevant physical findings such as clubbing can point to a cause of the hemoptysis. A focal area of wheezing could suggest a foreign body aspiration. Other signs of a bleeding diathesis (e.g., skin or mucosal ecchymoses and petechiae) or telangiectasias may suggest other etiologies of the hemoptysis.

Diagnostic Studies

Initial studies should include measurement of a complete blood count to assess for infection, anemia, or thrombocytopenia; coagulation parameters; measurement of electrolytes and renal function; and urinalysis to exclude pulmonary-renal disease. Chest imaging is necessary for every patient.

A chest radiograph is usually obtained first, although it frequently does not localize bleeding and can appear normal. In patients without risk factors for malignancy or other abnormalities in the initial evaluation and with a normal chest radiograph, treating for bronchitis and ensuring close follow-up is a reasonable strategy, with further diagnostic workup.

In contrast, patients with risk factors for malignancy (i.e., age >40 or a smoking history) should undergo additional testing. First, chest computed tomography (CT) with contrast should be obtained to better identify masses, bronchiectasis, and parenchymal lesions. A CT looking for pulmonary embolism should be considered if the history and physical examination are consistent with that diagnosis. Following a CT, a flexible bronchoscopy should be performed to exclude bronchogenic carcinoma unless imaging reveals a lesion that can be sampled without bronchoscopy. Small case

series show that patients with hemoptysis and unrevealing bronchoscopies have good outcomes.

Interventions

When the amount of hemoptysis is massive or life-threatening, there are three simultaneous goals: first, protect the nonbleeding lung; second, locate the site of bleeding; and third, control the bleeding.

Protecting the airway and nonbleeding lung is paramount in the management of massive hemoptysis because asphyxiation can happen quickly. If the side of bleeding is known, the patient should be positioned with the bleeding side down to use gravitational advantage to keep blood out of the nonbleeding lung. Endotracheal intubation should be avoided unless truly necessary, since suctioning through an endotracheal tube is a less effective means of removing blood and clot than the cough reflex. If intubation is required, take steps to protect the nonbleeding lung either by selective intubation of one lung (i.e., the nonbleeding lung) or insertion of a double-lumen endotracheal tube.

Locating the bleeding site is sometimes obvious, but frequently, it can be difficult to determine. A chest radiograph, if it shows new opacities, can be helpful in localizing the side or site of bleeding, although this test is not adequate by itself. CT angiography helps by localizing active extravasation. Flexible bronchoscopy may be useful to identify the side of bleeding (although it has only a 50% chance of locating the site). Experts do not agree on the timing of bronchoscopy, although in some cases—cystic fibrosis, for instance—bronchoscopy is *not* recommended because it may delay definitive management. Finally, proceeding directly to angiography is also a reasonable strategy given that it has both diagnostic and therapeutic capabilities.

Controlling the bleeding during an episode of life-threatening hemoptysis can be accomplished in one of three ways: from the airway lumen, from the involved blood vessel, or by surgical resection of both airway and vessel involved. Bronchoscopic measures are generally only temporizing: a flexible bronchoscope can be used to suction clot and insert a balloon catheter or bronchial blocker that occludes the involved airway. Rigid bronchoscopy, done by an interventional pulmonologist or thoracic surgeon, may allow therapeutic interventions of bleeding airway lesions such as photocoagulation and cautery. Because most life-threatening cases of hemoptysis arise from the bronchial circulation, bronchial artery embolization is the procedure of choice for control of the bleeding. However, bronchial artery embolization can have significant complications such as embolization of the anterior spinal artery. However, it is generally successful in the short term, with >80% success rate at controlling bleeding immediately, although bleeding can recur if the underlying disease (e.g., a mycetoma) is not treated. Surgical resection has a high mortality rate (up to 15–40%) and should not be pursued unless initial measures have failed and bleeding is ongoing. Ideal candidates for surgery have localized disease but otherwise normal lung parenchyma.

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FURTHER READING

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