# Management of Hemoptysis in the Emergency Department

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Hemoptysis, defined as expectoration of blood originating from the lungs or bronchotracheal tree, is a serious and potentially lethal condition because of its unpredictable severity and course. Because patients with hemoptysis often present to the emergency department (ED), emergency physicians are frequently the first in line to assess and manage these patients. Investigating the cause and site of the hemoptysis and stopping the bleeding should be pursued simultaneously. A methodic examination (eg, chest radiograph, computed tomography [CT] scan) is essential to not only determine the etiology of the hemoptysis but also to select appropriate therapy for management of this condition. This article discusses clinical evaluation and management techniques that should be applied to patients with hemoptysis who present to the ED.

## GENERAL CONSIDERATIONS

The vast majority of hemoptysis events originate from the bronchial arteries (90%) as compared with the pulmonary arteries (5%).[1] Because of the high systemic pressure in the bronchial arteries, bleeding from this area has the propensity to be significant or even life-threatening. Patients with hemoptysis often experience great anxiety, even though the great majority of them display no hemodynamic disturbances.[2] Hemoptysis is massive in only 1.5% of cases.[3] Quantification of blood loss can be challenging; the amount of blood expectorated tends to be exaggerated by the patient, whereas the volume of blood engulfing the affected lobes, although significant can be underestimated and/or unmeasurable. The definition of massive hemoptysis varies from 200 mL to 1000 mL/24 h in the literature,[4,5] but most authors adopt 600 mL/24 h empirically to define hemoptysis in reported case studies.[6] Severe hypoxemia reportedly may occur with the presence of only 400 mL of blood in the alveolar space.[7]

The most frequent etiologies of hemoptysis in the United States are chronic inflammatory lung diseases and bronchogenic carcinoma, while tuberculosis remains the leading cause of hemoptysis in third world countries.[8,9] Most commonly encountered causes of massive hemoptysis are listed in the **Table**.

Therapeutic options depend on the etiology of hemoptysis. A conservative treatment approach is sufficient for patients with mild hemoptysis, as it is not life-threatening in the vast majority of these patients. Patients with massive hemoptysis should be treated with endobronchial tamponade, single- or double-lumen bronchial intubation, bronchial artery embolization, or surgery. Surgery also remains the treatment of choice for patients with hemoptysis caused by conditions in which bronchial artery embolization fails.

## CLINICAL MONITORING

Vital signs, including pulse oximetry, should be monitored closely throughout the process of evaluation. Blood pressure measurement should be recorded simultaneously with the pulse rate; early stage of shock may go undetected if only the blood pressure is measured. For example, a blood loss of 600 mL, which represents less than 15% of the total body volume in a 70-kg individual, is categorized as class 1 in the 4-stage hypovolemic shock classification by the American College of Surgeons.[10] At class 1 stage, the blood pressure and capillary refill remain normal, and only the pulse rate is elevated.

## CLINICAL ASSESSMENT

### History

A detailed history is important to obtain and will shed the first light on a probable etiology of hemoptysis. Patients previously diagnosed with tuberculosis may bleed from leaky dilated blood vessels within the cavity wall (Rasmussen's aneurysm).[11] Cavitary lesions, caused by fungal infections, tuberculosis, bullous disease, or sarcoidosis, may host aspergilloma, a common cause of hemoptysis.[12] Patients receiving anticoagulants are at risk of bleeding from internal organs, including the

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**Table.** Most Common Etiologies of Massive Hemoptysis

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|---|
| Neoplasms |
| Carcinoma |
| Adenoma |
| Metastatic lung cancer |
| Cavitary lesions |
| Tuberculosis |
| Fungal infection |
| Lung abscess |
| Hydatid cyst |
| Interstitial or reticular lesions |
| Goodpasture's syndrome |
| Wegener's granulomatosis |
| Bronchiectasis |
| Lymphangioleiomatosis |
| Infections |
| Behçet's disease |
| Systemic lupus erythematosus |
| Chronic bronchitis |
| Vascular etiologies |
| Mitral stenosis |
| Pulmonary infarct or embolism |
| Rupture of thoracic aneurysm |
| Arteriovenous malformation |
| Iatrogenic rupture of pulmonary artery by balloon-tipped catheter |
| Trauma |
| Coagulopathies |
| von Willebrand's disease |
| Hemophilia |
| Thrombocytopenia |

lungs.[13,14] Lung carcinoma should be the first consideration in a smoker older than 40 years presenting with hemoptysis.[15] Patients with mitral stenosis are predisposed to hemoptysis. Catamenial hemoptysis (pulmonary endometriosis) should be suspected when the development of hemoptysis coincides with the menstrual period.[16] In the event of a bioterrorist attack, certain conditions such as anthrax, plague, tularemia, and smallpox should be considered as differential diagnoses; they may cause hemoptysis either by direct lung involvement or by hemorrhagic complications, especially disseminated intravascular coagulopathy.[17]

### Signs and Symptoms

The symptomatology in hemoptysis varies with the etiology. Shortness of breath is not a usual symptom in mild hemoptysis except when the underlying conditions are associated with hypoxemia, reduced alveolar gas exchange, increased pulmonary capillary pressure (eg, pulmonary embolism), extensive parenchymal infection or disease, neoplasm, or severe mitral stenosis.[18,19] However, patients with massive hemoptysis exhibit moderate to severe dyspnea. Chest pain represents a cardinal sign in patients with dissecting aneurysm, pulmonary embolism, and pulmonary infarct.[20] Pleuritic pain may also be present in patients with necrotizing pulmonary infections. The presence of fever may indicate an infective cause for hemoptysis, but other conditions, such as vasculitis, neoplasm, or pulmonary embolism, may also manifest with fever.

Some clinical signs are helpful in the diagnostic search. Clubbing should raise the possibility of lung carcinoma or chronic inflammatory lung diseases (eg, bronchiectasis or suppurative lung diseases). If cutaneous purpura or ecchymosis are present, the clinician should suspect a possible blood dyscrasia. A rumbling diastolic murmur over the apex may be a sign of mitral stenosis. When aphthous oral or genital ulcers, uveitis, or cutaneous pustules are found in a patient with hemoptysis, Behçet's disease should be suspected; about 30% of the patients affected by this condition will bleed to death from a ruptured pulmonary artery aneurysm.[21] The coexistence of a saddle nose, chronic rhinitis, and nasal septal perforation in a patient with hemoptysis should heighten the suspicion of Wegener's granulomatosis.[22] Spontaneous hemoptysis in a previously healthy child with stridor should evoke the possibility of aspiration of a foreign body.[23] Bronchial adenoma can also cause hemoptysis in children. In fact, more than half of all bronchial tumors in children are bronchial adenoma.[24,25] In general, lung examination findings, such as rales or wheezing, are nonspecific or lacking in patients with hemoptysis. If present, they are usually the expression of the underlying conditions.[26]

### True Hemoptysis Versus Pseudohemoptysis

During the clinical assessment, bleeding from nasopharyngeal or gastrointestinal sources (pseudohemoptysis) should be excluded. Cough is a reflex mechanism that expels blood from the lungs and is always present with hemoptysis. While nasopharyngeal bleeds are usually not associated with cough, blood in the laryngeal area may provoke cough and may simulate hemoptysis. When the bleeding is suspected to originate from the nasopharyngeal space, laryngoscopic exploration should be done in the ED. Blood expectorated should be measured or estimated. It should also be considered that the amount of blood collected

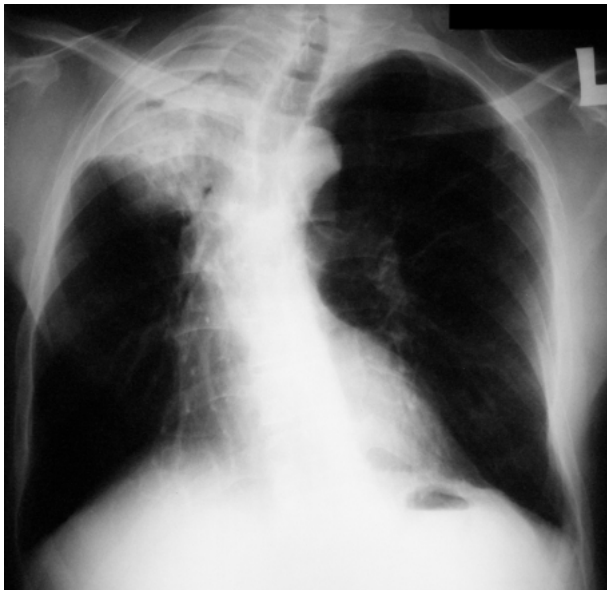

**Figure 1.** A fibrotic and cavitary lesion from old tuberculosis can be seen in the right upper lobe of a 47-year-old man with hemoptysis.


**Figure 2.** Computed tomographic imaging reveals a fungal ball in a patient with hemoptysis.

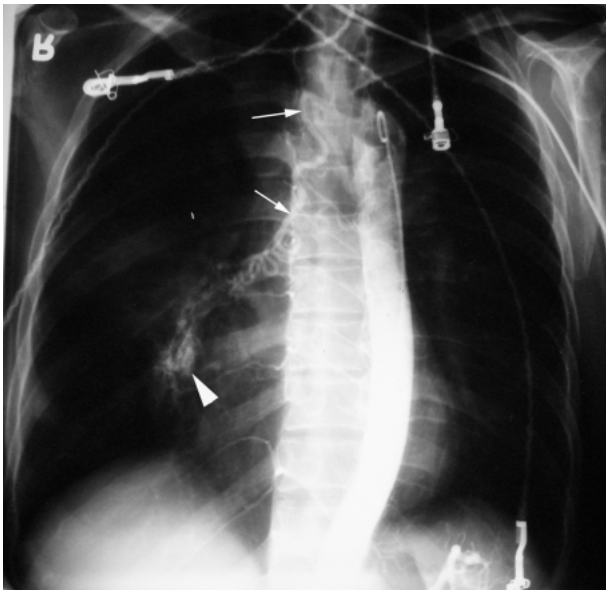

**Figure 3.** A selective angiogram of a patient with bronchiectasis and hemoptysis. Note a prominent right bronchial artery (*thin arrows*) and the extravasation of the blood into the alveolar space of the right lower lobe (*arrowhead*).

underrates the effective blood loss, because substantial quantities of blood may still be trapped in the alveolar space or swallowed.

## DIAGNOSTIC EVALUATION

Chest radiograph is very helpful in finding the cause of hemoptysis. The characteristics of the lung pathology (eg, tumors, cavities, or infiltrates) can be recognized on a plain chest radiograph (**Figure 1**). It should be cautioned that intra-alveolar bleeding may mimic an infiltrate because of its reticulonodular pattern.[27] Between 20% and 46% of patients with hemoptysis have a normal radiograph.[28]

A chest CT with contrast given intravenously helps to detect lesions not visible by chest radiograph. It is very sensitive in the diagnosis of bronchiectasis, small bronchogenic carcinoma, vascular pathologies, pulmonary embolism, and broncho-arterial fistula.[29] Fungal ball suspected on plain chest radiograph can be confirmed by CT (**Figure 2**). Despite the high sensitivity of CT, the cause for the hemoptysis remains unknown in 5% to 10% of patients evaluated with CT.[30] Selective bronchial angiography can not only identify the bleeding site but also the type of vascular pathology, such as aneurysm and arteriovenous malformation or fistula (**Figure 3**).

Sputum collection should be initiated early in the assessment of hemoptysis. Sputum specimens should be evaluated for presence of bacteria and fungi and must include Gram stain, acid-fast bacillus testing, potassium hydroxide preparation for fungal, and culture. Urinalysis should also be performed, and the presence of blood in the urine should raise the suspicion of Goodpasture's syndrome.

## MANAGEMENT

Maintaining an open airway should be the first priority in the management of hemoptysis. Large amounts of blood in the tracheobronchial tree may be a major impediment to gas exchange. The tissue oxygen saturation should be monitored by pulse oximetry,

and oxygen delivery should also be adjusted to oxygen saturation levels. Hypoxemic patients should be intubated as soon as possible. Two large-bore intravenous lines should be placed and blood drawn for complete blood count, blood urea nitrogen level, electrolyte level, arterial blood gases, coagulation profile, D-dimer, blood type and cross-match, and requisition for at least 6 U of packed erythrocytes. No time should be wasted waiting for cross-matched blood when the patient's condition is rapidly deteriorating; rather, transfusion with uncrossed O-positive blood should be started at once. However, O-negative blood should be given to women of childbearing age.[31] Complications of hemoptysis include hypoxemia due to reduced alveolar gas exchange and hypotension caused by excessive blood loss; hypotension will manifest when hemoptysis becomes massive. Unstable patients with hypoxemia and hypotension should not leave the ED for chest CT study; instead, they should be intubated and transfused. Pulmonary consultation should not be delayed in these situations.

It has been postulated that positioning the patient on lateral decubitus toward the bleeding site would spare the contralateral lung from blood aspiration, but there are no controlled studies to confirm this claim. Cough-suppressing medicines are not recommended because they potentially may cause blood retention in the lungs.

### Respiratory and Contact Precautions

Protection of other patients and medical personnel from airborne respiratory droplets and blood spills is mandatory. Respiratory and contact precautions should be implemented upon the patient's arrival in the ED. Medical personnel should wear long-sleeved protective apparel, goggles, mask, and gloves at every patient encounter. If possible, the patient should be placed in a single room or cubicle. All patients with hemoptysis should wear masks. Transmission of potentially lethal viral infections, such as hepatitis B and C and HIV, can be effectively prevented by avoiding direct blood contact and properly disposing of contaminated materials. Tuberculosis is a concern in every patient with hemoptysis.

### Interventions for Massive Hemoptysis

**Bronchoscopy.** Bronchoscopy should be performed by a pulmonologist after the patient has been intubated. Insertion of a large diameter endotracheal tube (at least 8 mm) can facilitate the bronchoscopic exploration. In the event of massive hemoptysis, many thoracic specialists prefer the rigid bronchoscope because of its greater suctioning ability and maintenance of airway patency. A rigid bronchoscope can only be used in the operating room, and patients will need either general anesthesia or conscious sedation. However, only the major bronchi can be visualized with a rigid bronchoscope; peripheral lesions and upper lobes are out of reach.[32] Conversely, flexible bronchoscopy allows the exploration of the fifth or sixth bronchial division and can be performed in the ED.[33]

Once the bleeding has been localized, an epinephrine solution diluted at 1:20,000 is injected through the fiberoptic channel in an attempt to constrict the bleeding vessel and stop the hemorrhage. This procedure may not be successful in presence of massive bleeding.

**Endobronchial tamponade.** This technique occludes the bleeding bronchus with a balloon-tipped catheter and has been refined since its introduction in the 1970s. Large catheters (eg, Foley catheter) only fit a rigid bronchoscope and can only reach the main stem bronchus. Therefore, the nonbleeding bronchi of the affected lung will not be protected from blood aspiration, and their alveolar space may be quickly invaded by the expanding hemorrhage when the main stem bronchus is occluded. Forgathy catheter is smaller (4-Fr diameter) and can be inserted into small bronchioles through a fiberoptic bronchoscope. The separation of the fiberoptic bronchoscope from the Forgathy catheter requires the ablation of the oversized proximal hub of the catheter. A pin should then be inserted at the proximal lumen of the catheter to maintain the balloon pressure; this maneuver will permit the bronchoscope to be sleeved out, leaving the catheter in place.[34] Another catheter introduced by Freitag in 1993 is easier to use than the Forgathy catheter. It has a detachable valve at the proximal end for balloon inflation. In addition, this catheter has another channel for instillation of vasoactive drugs. In a study by Freitag and colleagues, the success rate with this new catheter was high, with bleeding controlled in 26 of 27 treated patients.[35]

A new technique of blocking the bleeding bronchus by using a biocompatible sealant (N-butyl cyanoacrylate) was tested on 6 patients with hemoptysis.[36] The sealant was instilled via a catheter introduced through a fiberoptic bronchoscope and the catheter was then removed. Bleeding was controlled in all 6 patients with no complications, and there was no recurrence of the hemoptysis for at least 70 days.

**Double-lumen endotracheal intubation.** The urgent need to protect the nonbleeding lung from aspiration in case of life-threatening hemoptysis requires other therapeutic measures when bronchoscopic exploration or

endobronchial tamponade can not be performed promptly. Placement of a double-lumen endotracheal tube (Carlens or Robertshaw) allows proper ventilation of the nonaffected lung while suction is applied to the bleeding lung. Bronchial exploration with fiberoptic bronchoscope is still feasible after the double-lumen tube intubation; fiberoptic bronchoscopy also helps to verify the tube placement after a blind intubation.[37,38] Insertion of double-lumen endotracheal tubes should be done only by an anesthesiologist. The major disadvantage of this procedure is tube misplacement. In one series of 172 patients, misplacement was discovered in 74 patients (45%) after initial placement and 93 patients (54%) after patient positioning.[39] Another way to protect the nonbleeding lung from blood spill is selective intubation of the main bronchus with a single-lumen endotracheal tube, preferably done under bronchoscopic guidance. But blind intubation of the right mainstem bronchus must be attempted by the ED staff in the event of life-threatening bleeding from the left lung.[38] Selective bronchial intubation by either double-lumen or single-lumen endotracheal tubes is only palliative and temporary. Other steps to stop the bleeding should follow soon.

**Bronchial artery embolization.** This procedure should be not be performed until the patient has been transferred to the intensive care unit. It requires a selective angiographic study of the bronchial arteries. Once the bleeding bronchial artery is located, particles (polyvinyl alcohol foam, absorbable gelatin, pledgets of Gianturco steel coils) are infused into the hemorrhagic artery.[40,41] The success rate is generally excellent, varying from 85% to 98%.[42]

**Surgery.** The number of indications for surgery has decreased dramatically over the past 2 decades. Procedures such as lobectomy or pneumonectomy have been gradually replaced for those that are not as invasive (eg, bronchial artery embolization, endobronchial tamponade, or instillation of antifungal drugs via transbronchial or percutaneous catheters).[42–44] Surgical interventions carry tremendous risks; the surgical mortality rate varies widely among institutions. The institution's inclusion (or exclusion) criteria for surgical eligibility significantly influence mortality rates. Nevertheless, surgery remains the ideal treatment for hemoptysis from leaky thoracic aneurysm, chest trauma, and arteriovenous malformations.

### Conservative Treatment

Hemoptysis is mild in most patients; these patients may be managed with conservative treatment (correction of tissue perfusion, hypoxemia, and coagulopathy, if present). Also, when the bleeding site cannot be localized by bronchoscopy or selective angiography in unstable patients, only supportive treatment should be applied.[44]

## MORTALITY

Mortality is greatly influenced by the severity of bleeding and the nature of the lung pathology. In a retrospective review of 59 patients with hemoptysis, mortality rose significantly (58%) when the bleeding rate was above 1000 mL/24 h, but mortality was only 9% with blood loss less than 1000 mL/24 h.[45] Furthermore, mortality reached 59% in patients with malignancy and reached 80% when malignancy and bleeding rates above 1000 mL/24 h were concurrently present in the same patient. Certain conditions, such as necrotizing pneumonitis, lung abscess, and bronchiectasis, have an extremely low mortality rate (< 1%), and a conservative approach is generally sufficient.[46] An algorithm for the management of hemoptysis in the ED is shown in **Figure 4**.

## CONCLUSION

Physicians should be aware of the potential worsening of hemoptysis at any time and with no warning. Maintaining tissue perfusion and adequate oxygenation are of paramount importance when managing a patient with hemoptysis in the ED. Investigational efforts to establish the site of bleeding and diagnosis should be conducted without delay. Before diagnostic evaluation is complete, an intensive care unit bed should be secured for the patient. It is also imperative to recognize and correct coagulopathies in early stages of the clinical investigation. In stable patients, supportive treatment should be given; intubation is not necessary in patients with normal tissue perfusion and oxygenation.

Conditions such as hypoxemia and shock herald an impending catastrophic outcome, and these patients should not be transported out of the ED for CT. Pulmonary consultation should be requested for immediate bronchoscopy, and life-saving measures, such as intubation, transfusion, bronchoscopy, endobronchial tamponade, or single- or double-lumen endobronchial intubation, should be undertaken promptly in these unstable patients. **HP**

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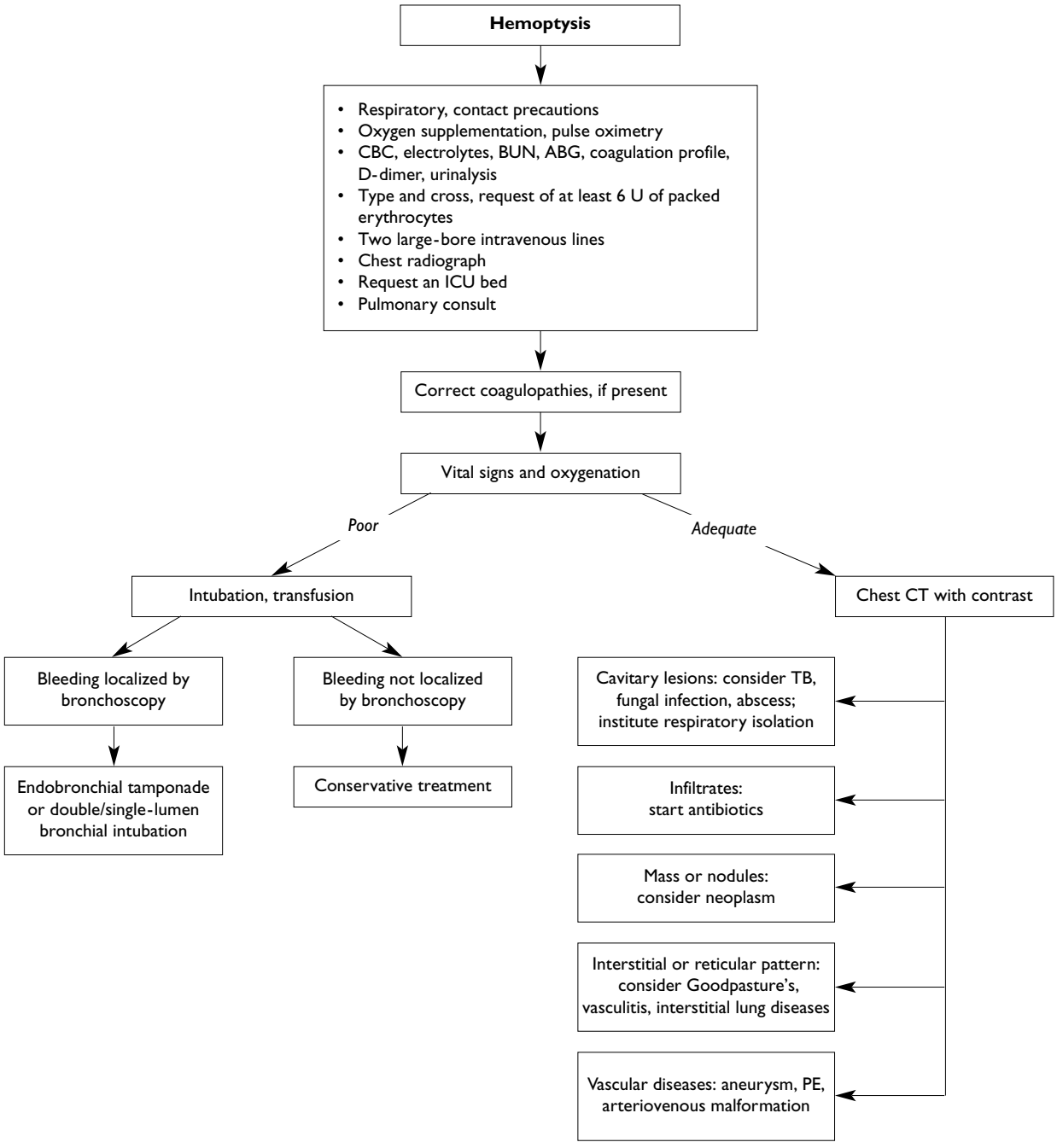


**Figure 4.** Algorithm for the management of hemoptysis in the emergency department. ABG = arterial blood gases; BUN = blood urea nitrogen; CBC = complete blood count; CT = computed tomography; ICU = intensive care unit; PE = pulmonary embolism; TB = tuberculosis.

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