

Chapter 90

Approach to Hemoptysis in the ICU



90.1 Introduction

Hemoptysis, the expectoration of blood originating from the respiratory tract, is a potentially life-threatening condition requiring rapid assessment and intervention in the ICU setting. Its prevalence and causes vary globally, reflecting differences between developed and developing countries. In developing nations, infectious diseases like tuberculosis are the most common causes of hemoptysis due to higher incidence rates and limited healthcare resources. Conversely, in developed countries, malignancies, bronchiectasis, and chronic inflammatory conditions are more prevalent etiologies [1].

Defining massive hemoptysis poses a significant challenge because of variability in volume thresholds and clinical consequences. Traditionally, massive hemoptysis has been described as bleeding exceeding 100–600 mL over 24 h. However, even smaller volumes can be life-threatening if they lead to airway obstruction or severe hypoxemia. Therefore, any hemoptysis that compromises ventilation or oxygenation warrants immediate medical attention [2, 3] [Ref: Algorithm 90.1].

90.2 Pathophysiology

Understanding the vascular origins of hemoptysis is crucial for effective management. Hemoptysis primarily arises from two circulatory systems:

- Bronchial Circulation: Originating from the systemic circulation, the bronchial arteries supply nutrients to the airways and are under systemic blood pressure. Hemorrhage from these vessels can be profuse due to the higher pressure, leading to significant bleeding.

- Pulmonary Circulation: This low-pressure system is responsible for gas exchange in the alveoli. Bleeding from the pulmonary arteries is less common but can occur in conditions like pulmonary embolism, arteriovenous malformations, or pulmonary hypertension.

Differentiating between these sources helps guide therapeutic interventions, as bronchial artery hemorrhages may respond well to bronchial artery embolization (BAE), while pulmonary artery bleeding may require alternative approaches [4, 5].

90.3 Etiology

Pulmonary: Bronchiectasis, infections (tuberculosis, fungal, necrotizing pneumonia, mycetoma, lung abscess), malignancy (bronchogenic carcinoma, bronchial adenoma), vascular (arteriovenous malformation, Dieulafoy lesions, aortic aneurysm erosion), iatrogenic (bronchoscopy, pulmonary artery catheter), trauma.

Immunological: Systemic lupus erythematosus, Wegener's granulomatosis, Goodpasture's syndrome, microscopic polyarteritis, amyloidosis, Bechets disease.

Cardiovascular: Mitral stenosis, endocarditis, pulmonary edema, bronchial artery aneurysm, pulmonary embolism.

Bleeding Disorders: Disseminated intravascular coagulation, thrombocytopenia.

90.4 Algorithmic Approach to Management

A systematic, algorithmic approach enhances the efficiency of diagnosing and treating hemoptysis. The workflow emphasizes airway management, hemodynamic stabilization, localization of bleeding, and definitive interventions.

Step 1: Assessing Airway Compromise

- Key Question: "Is the patient's airway compromised?"

This is the most critical step, as significant bleeding can obstruct the airway, leading to hypoxemia or aspiration.

- Indicators of Compromise: Stridor, respiratory distress, large volumes of blood in the oropharynx, inability to clear secretions, decreased oxygen saturation.
- Action Plan:
- Immediate Airway Management:
- Proceed with endotracheal intubation using a large-bore tube (≥ 8.0 mm) to facilitate suctioning of clots and secretions.

- In cases requiring lung isolation to prevent blood spillage into the unaffected lung, use a double-lumen endotracheal tube or bronchial blockers.
- Rigid Bronchoscopy:
- Employ rigid bronchoscopy in difficult cases for better airway control, suction capabilities, and removal of large clots.
- Ensure continuous monitoring of oxygenation and ventilation parameters.

Step 2: Evaluating Hemodynamic Stability

- Key Question: “Is the patient hemodynamically stable?”

Hemodynamic instability suggests significant blood loss, necessitating urgent resuscitation.

- Indicators of Instability: Hypotension, tachycardia, altered mental status, signs of shock, decreased urine output.
- Action Plan:
- Resuscitation Measures:
 - Initiate intravenous fluid replacement to maintain perfusion.
 - Transfuse blood products to correct anemia and restore oxygen-carrying capacity.
- Correct Coagulopathies:
 - Administer fresh frozen plasma, platelets, vitamin K, or procoagulant agents as indicated.
- Consider vasopressor support if hypotension persists despite fluid resuscitation.
- Implement invasive hemodynamic monitoring for ongoing assessment.

Step 3: Prioritizing Urgent Interventions

- Key Question: “If the patient is unstable, what urgent measures should be taken?”

For unstable patients, the focus shifts to rapidly identifying and stopping the bleeding source.

- Action Plan:
- Bronchoscopy:
- Flexible Bronchoscopy:
 - Provides direct visualization of the bleeding site.
 - Allows for suctioning of clots.
 - Facilitates therapeutic interventions, such as:
 - Application of topical vasoconstrictors (e.g., epinephrine), Nd:YAG laser or argon plasma coagulation.
 - Use of topical hemostatic agents like fibrin glue.
 - Balloon tamponade to compress bleeding vessels.
- Rigid Bronchoscopy:
 - Preferred in massive hemoptysis for better airway control and removal of large clots.

- Pharmacologic Interventions:
- Tranexamic Acid:
- Administer antifibrinolytic agents intravenously or via nebulization to promote clot stability.
- Topical Hemostatic Agents:
- Apply agents such as thrombin or fibrin sealants during bronchoscopy.
- Bronchial Artery Embolization (BAE):
- Coordinate with interventional radiology for urgent BAE to control bleeding from bronchial arteries.
- BAE is less invasive than surgery and has a high success rate in controlling hemorrhage.
- Surgical Intervention:
- If bronchoscopic and endovascular measures fail or are unavailable, consult thoracic surgery.
- Surgical options include lobectomy or pneumonectomy, depending on the bleeding source and patient stability [6, 7].

Step 4: Imaging and Localization of Bleeding Source

- Key Question: “Is the patient hemodynamically stable and the airway secure?”

Once stabilized, imaging studies are critical to guide further interventions.

- Imaging Modalities:
- CT Angiography (CTA):
- Importance:
- Preferred modality for accurately localizing the bleeding source.
- Identifies underlying pathologies (e.g., tumors, bronchiectasis, vascular anomalies).
- Detects both bronchial and non-bronchial systemic arteries involved in bleeding.
- Advantages over Bronchoscopy:
- Noninvasive.
- Visualizes areas beyond the reach of the bronchoscope.
- Provides a roadmap for interventional radiologists during BAE.
- Emerging Technologies:
- Multi-row detector CT scanners enhance image quality and diagnostic accuracy.
- Chest X-ray:
- Useful as an initial tool but less sensitive and specific.
- May reveal infiltrates, masses, or other structural abnormalities.
- Action Plan:
- Based on imaging findings, plan targeted interventions such as embolization or surgery.
- Investigations: Complete blood count, coagulation profile, renal function tests, liver function tests, sputum/endotracheal secretions for gram stain, culture, acid fast bacilli detection, CBNAAT (nucleic acid amplification—tuber-

culosis), fungal culture, cytology, blood grouping, and cross matching. Imaging and bronchoscopy (discussed below). One may also send disease-specific investigations if there is a suspicion (e.g., antinuclear antibody tests).

Step 5: Controlling the Bleeding

- Key Focus: Definitive control of the bleeding after localization.
- Interventional Radiology:
- Bronchial Artery Embolization (BAE):
 - First-line therapy for bleeding from the bronchial circulation.
 - Procedure:
 - Catheterization of the bronchial arteries under fluoroscopic guidance.
 - Embolization using materials like polyvinyl alcohol particles, coils, or gel foam.
 - Advancements:
 - Newer embolic agents and techniques have improved success rates and reduced complications.
 - Bronchoscopy:
 - Continue to utilize for therapeutic interventions if bleeding persists.
 - Repeat procedures may be necessary for ongoing management.
 - Pharmacologic Therapy:
 - Maintain antifibrinolytic therapy with agents like tranexamic acid.
 - Adjust medications based on coagulation profiles and bleeding status.
 - Surgical Options:
 - Indications:
 - Failure of bronchoscopic and endovascular interventions.
 - Anatomically localized disease amenable to resection.
 - Life-threatening hemorrhage requiring immediate control.
 - Procedures:
 - Lobectomy, segmentectomy, or pneumonectomy, depending on the extent of disease.
 - Risks:
 - High morbidity and mortality, especially in unstable patients.
 - Requires thorough evaluation of surgical risks versus benefits [8].

Step 6: Multidisciplinary Approach

Optimal management necessitates collaboration among various specialists to ensure comprehensive care.

- Team Members:
- Intensivists:
 - Coordinate critical care management.
 - Oversee hemodynamic support and ventilatory strategies.
- Pulmonologists:
 - Perform bronchoscopies.
 - Manage respiratory complications.
- Interventional Radiologists:

- Conduct imaging studies and perform BAE.
- Utilize advanced embolization techniques.
- Thoracic Surgeons:
 - Evaluate patients for surgical interventions.
 - Perform operative procedures when indicated.
- Benefits:
 - Enhances decision-making through shared expertise.
 - Improves patient outcomes by streamlining interventions [9].
 - Facilitates communication and coordination of care.

Step 7: Monitoring for Resolution

- Key Question: “Has the bleeding resolved post-treatment?”

Continuous assessment is essential to ensure effective control of hemoptysis.

- Indicators of Resolution:
 - Stabilized vital signs.
 - No new episodes of bleeding.
 - Improved respiratory function.
 - Normalizing laboratory values (e.g., hemoglobin, hematocrit).
- Action Plan:
 - Ongoing Monitoring:
 - Frequent reassessment of airway patency and breathing.
 - Serial blood tests to monitor hemoglobin and coagulation status.
 - Repeat Imaging:
 - Follow-up CT scans or chest X-rays to assess for recurrent bleeding or complications.
 - Adjust Supportive Care:
 - Modify ventilator settings as the patient improves.
 - Gradually wean off vasopressors and other supportive medications.

Step 8: Management of Recurrent Hemoptysis and Transition to Maintenance Therapy

- Recurrent Hemoptysis:
- Action Plan:
- Repeat Bronchial Artery Embolization:
 - Effective for recurrent bleeding due to revascularization or missed vessels.
- Evaluate for Underlying Conditions:
 - Investigate for diseases like aspergillosis, vasculitis, or bronchiectasis.
- Surgical Intervention:
 - Consider in cases where embolization is unsuccessful or not feasible.
 - Requires thorough risk assessment and patient optimization.
- Transition to Maintenance Therapy:
 - Address Underlying Etiology:
 - Infections:
 - Initiate or adjust antibiotics for conditions like tuberculosis or pneumonia.
 - Malignancies:

- Collaborate with oncology for chemotherapy, radiation therapy, or targeted treatments.
- Autoimmune Disorders:
- Implement immunosuppressive therapy for vasculitis or other inflammatory conditions.

90.5 Emerging Techniques and Innovations

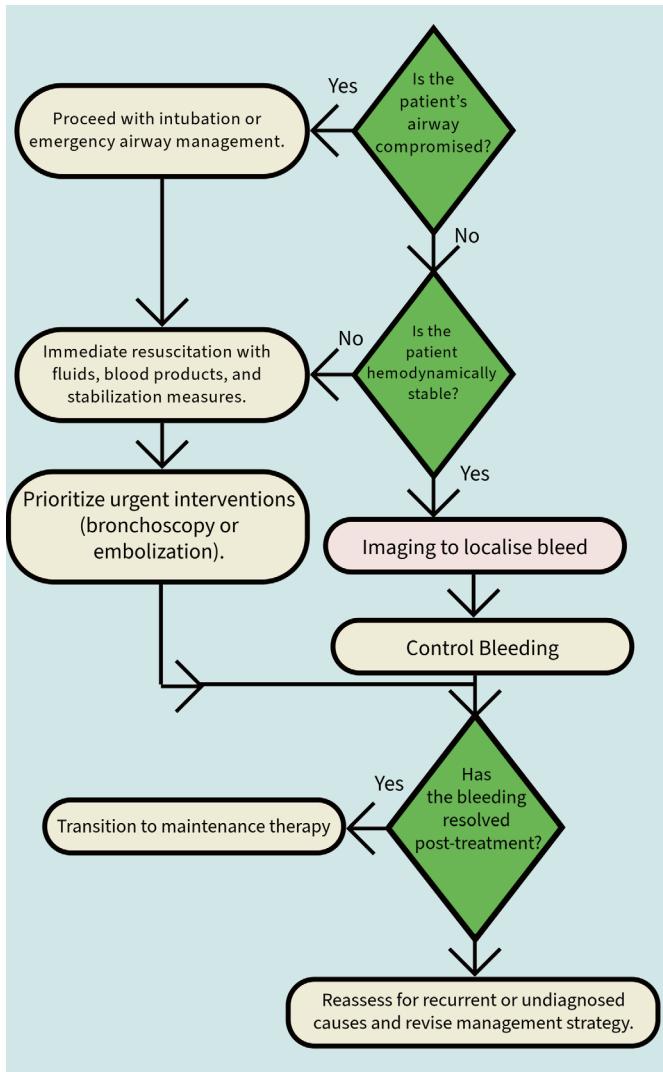
Advancements in technology have enhanced the diagnosis and management of hemoptysis:

- Multi-row Detector CT:
- Embolization Techniques:
- Development of new embolic materials improves the safety and efficacy of BAE.
- Use of calibrated microspheres and liquid embolic agents allows for targeted vessel occlusion.
- Innovations in catheter design enhance navigation and reduce procedure time.
- Minimally Invasive Surgical Approaches:
- Video-assisted thoracoscopic surgery (VATS) offers less invasive options for surgical intervention.
- Reduces postoperative pain and accelerates recovery compared to open surgery.
- Pharmacologic Advances:
- Research into novel antifibrinolytic agents and topical hemostatics may provide additional tools for controlling bleeding.

These innovations hold promise for improving patient outcomes and expanding the availability of effective treatments worldwide.

90.6 Conclusion

Managing hemoptysis in the ICU demands a systematic, multidisciplinary approach prioritizing airway protection, hemodynamic stabilization, precise localization of bleeding, and definitive interventions. Rapid assessment and timely decision-making are critical to prevent catastrophic outcomes. The use of bronchoscopy and CT angiography serves as the cornerstone for diagnosis and initial management, while advanced therapies like bronchial artery embolization and surgical interventions address more severe cases. Collaboration among intensivists, pulmonologists, interventional radiologists, and thoracic surgeons is essential for optimizing patient care. Addressing global disparities in healthcare access remains a pivotal challenge, emphasizing the need for continued innovation and resource allocation to reduce the burden of hemoptysis worldwide.

Algorithm 90.1: Approach to hemoptysis in the ICU

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Part VIII

Miscellaneous