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Diverse etiologies and management strategies in a case series of Hemoptysis: Lessons learned and multidisciplinary approaches

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Abstract
Hemoptysis, the expectoration of blood from the respiratory tract, poses a significant clinical challenge, particularly in regions where tuberculosis (TB) remains prevalent. This case series explores four patients presenting with hemoptysis, each with distinct etiologies and management strategies. Patient A, a case of relapsed pulmonary tuberculosis, was successfully managed using bronchial artery embolization (BAE) to control massive bleeding. Patient B, with post-TB pulmonary destruction, underwent fluoroscopy-guided arterial embolization for hemostasis. Patient C, experiencing recurrent hemoptysis due to saccular aneurysms, required emergent pulmonary angiography and embolization. Patient D, diagnosed with drug-resistant TB after an initial episode of hemoptysis, responded well to a modified all-oral drug regimen following BAE.
The series highlights the complex and diverse causes of hemoptysis, ranging from TB sequelae to vascular anomalies and drug resistance. A multidisciplinary approach, incorporating advanced diagnostic imaging, interventional radiology, and tailored pharmacological management, was crucial to achieving favorable outcomes. Early recognition, timely intervention, and individualized treatment strategies are essential in managing hemoptysis effectively, reducing mortality, and improving patient prognosis.

Keywords: Hemoptysis, post-TB sequalae

Introduction

Massive hemoptysis, defined as the expectoration of more than 300 ml of blood within a 24-hour period, is considered a medical emergency. In India, where pulmonary TB remains prevalent, hemoptysis resulting from TB sequelae is a common etiology. Left untreated, massive hemoptysis can lead to high mortality rates, often due to asphyxiation rather than bleeding itself.

1. Epidemiology and statistics

- Approximately 5–14% of patients presenting with hemoptysis will experience life-threatening hemoptysis.
- The reported mortality rate for life-threatening haemoptysis ranges between *9% and 38%*.
- Factors predicting poor outcomes include rapid bleeding rates, aspiration of blood into the contralateral lung, and life-threatening bleeding requiring single-lung ventilation [1].

2. Clinical Manifestations

- Life-threatening hemoptysis (also known as massive hemoptysis) is variably defined based on criteria such as volume per hour of bleeding, total volume of bleeding per 24 hours, or abnormal gas exchange and hemodynamic instability.
- In general, bleeding rates exceeding 100 mL/h or total volumes exceeding 500 mL in 24 hours are considered life-threatening.
- Smaller volumes (around 50 mL) may also be life-threatening depending on the patient's underlying cardiopulmonary status [1].

3. Etiology [3]

- The causes of life-threatening hemoptysis are diverse and include conditions such as: Bronchiectasis, Lung cancer, Tuberculosis, Aspergillosis, Pulmonary arteriovenous malformations, Trauma, Inflammatory condition, Coagulopathies
- Bronchial arteries are responsible for hemoptysis in approximately 90% of cases [1].

4. Diagnosis [2]

- There is no consensus on the optimal diagnostic approach for life-threatening hemoptysis.
- A practical approach involves utilizing: Chest radiography, Computed tomography (CT), Bronchoscopy
- These modalities help localize the bleeding site based on patient stability.

5. Management [2]

- **Treatment options include:** Angiography and embolization, Bronchoscopy techniques, surgical interventions, Bronchial artery embolization is effective for recurrent haemoptysis.

6. Prognosis and Way Forward:

Early recognition and prompt management are crucial, Multidisciplinary collaboration involving pulmonologists, interventional radiologists, and thoracic surgeons is essential for optimal outcomes.

Hemoptysis: Hemoptysis is defined as coughing out of blood originating in the lower respiratory tracts that is trachea, bronchi and lungs. It includes coughing out of blood and blood-streaked sputum. It is a symptom of a disease and not a disease. If the coughed-up blood is more than 600-800 ml in 24 hours, urgent medical treatment may be needed. Massive hemoptysis, defined as the expectoration of more than 300 ml of blood within a 24-

hour period, is considered a medical emergency. In India, where pulmonary TB remains prevalent, hemoptysis resulting from TB sequelae is a common etiology. Left untreated, massive hemoptysis can lead to high mortality rates, often due to asphyxiation rather than bleeding itself.

Post-tuberculosis sequelae and Hemoptysis: An overview

Post-TB sequelae are anatomical and pathophysiological changes in the chest that can occur even after treatment for tuberculosis (TB). These sequelae can be caused by complications from primary or secondary pulmonary TB.

Background: Post-tuberculosis sequelae refer to chronic respiratory abnormalities that persist after successful treatment of pulmonary tuberculosis (TB). These sequelae can significantly impact patients' quality of life and long-term respiratory health [4, 5].

Epidemiology and Statistics

- Lung impairment is a common outcome in patients treated for TB, affecting up to 87% of individuals [8].
- The burden of post-TB sequelae varies across geographic locations and time of publication [4].
- In Europe, bronchiectasis, malignancies, post-TB sequelae, and idiopathic bleedings are recognized as the most frequent causes of hemoptysis [4].
- No specific guidelines exist for optimal work-up of hemoptysis symptoms, and diagnostic data are limited [4].

Clinical manifestations

- Hemoptysis, characterized by coughing up blood, accounts for 10–15% of all pulmonology consultations [4].
- Common causes of hemoptysis include bronchiectasis, malignancies, post-TB sequelae, and idiopathic bleedings [4].

Management

The severity of hemoptysis determines the management approach:

- **Mild:** Drops of blood up to 20 mL in 24 hours.
- **Moderate:** 20–500 mL in 24 hours.
- **Severe:** More than 500 mL in 24 hours [4].
- Diagnostic tests may include sputum cultures, chest radiography, multi-detector chest computed tomography (CT), bronchoscopy, and angiography [7].

Diagnosis and Treatment

- Clinical evaluation, pulmonary function tests, and chest radiographs help assess lung function and severity of dyspnea [8].
- Quality of life assessment using standardized questionnaires (e.g., St. George's Respiratory Questionnaire and Seattle Obstructive Lung Disease Questionnaire) provides insights into patients' well-being [8].

Prevention and prognosis

- Preventive strategies focus on early detection, effective TB treatment, and monitoring for sequelae.
- Prognosis varies based on individual factors, severity of sequelae, and timely intervention [8].

The way forward

- Continued research is essential to improve understanding, prevention, and management of post-TB sequelae, especially in high-, middle-, and low-income countries [9, 10].

Common causes of Hemoptysis

1. **Infections**
   - Bronchitis and Pneumonia are frequent culprits. In these conditions, inflammation and infection in the airways or lung tissue can lead to blood in the sputum.
   - Tuberculosis (TB) is another infectious cause. TB damages lung tissue, resulting in bleeding.
   - Bronchiectasis, characterized by dilated and damaged airways, can also lead to hemoptysis.
   - Lung abscesses (localized pockets of infection) may cause bleeding.

2. **Lung Cancer:** Lung tumors, especially malignant ones, can cause hemoptysis. Early diagnosis is crucial for better outcomes.

3. **Trauma or injury**
   - Chest trauma, such as rib fractures or lung contusions, can lead to bleeding.
   - Foreign bodies accidentally inhaled (common in children) can cause irritation and bleeding.

4. **Other causes**
   - **Blood Clotting Disorders:** Conditions affecting blood clotting (like hemophilia) can lead to spontaneous bleeding.
   - **Vascular Malformations:** Abnormal blood vessels in the lungs may rupture and cause hemoptysis.
   - **Autoimmune Diseases:** Some autoimmune conditions (e.g., granulomatosis with polyangiitis) can damage blood vessels.
   - **Heart Failure:** Severe heart failure can cause blood to back up into the lungs, leading to bleeding.
   - **Medications:** Certain drugs (e.g., anticoagulants) may increase bleeding risk.

5. **Evaluation and management**
   - If you cough up a large amount of blood, seek emergency medical attention.
   - Even if the blood is small in quantity, consult your doctor promptly. Early diagnosis improves prognosis.
   - Other symptoms (such as cough, chest pain, fever, wheezing, or breathlessness) may provide clues to the underlying cause.
   - Diagnostic tests (like chest X-rays, CT scans, bronchoscopy, or blood tests) help identify the source of bleeding.
   - Treatment depends on the specific cause and may involve addressing infections, managing underlying conditions, or surgery if necessary.

Remember, any unexplained hemoptysis warrants medical evaluation. It's essential to determine the cause promptly and initiate appropriate management [11, 12, 13, 14].

Post Pulmonary TB sequalae with Hemoptysis is a condition where patients who have been treated for pulmonary tuberculosis (TB) experience chronic lung damage and coughing up blood. The pathology, pathophysiology and pathogenesis of this condition are as follows:

- **Pathology:** TB causes inflammation and necrosis of lung tissue, leading to cavities, bronchiectasis, fibrosis, and scarring. These structural changes impair lung function and increase the risk of bleeding from damaged blood vessels [15, 16].

- **Pathophysiology:** TB triggers an immune response that involves various cells and molecules, such as macrophages, T cells, cytokines, and matrix metalloproteinases. These factors can either help control the infection or contribute to tissue damage, depending on the balance between pro- and anti-inflammatory signals [17]. Some patients may have genetic or environmental factors that predispose them to excessive inflammation and lung injury [15, 16].

- **Pathogenesis:** TB is caused by the bacterium Mycobacterium tuberculosis, which is transmitted through respiratory droplets. The bacteria can survive inside macrophages and evade the immune system. The bacteria can also spread to other parts of the lung or the body through the lymphatic system or the bloodstream. The bacteria can reactivate after a period of latency, especially in immunocompromised individuals [18].

Prevention

- **Avoid Smoking:** Smoking is a major risk factor for lung diseases, including hemoptysis. Quitting smoking significantly reduces the chances of developing respiratory conditions.

- **Infection Control:** Proper management of respiratory infections (such as tuberculosis, bronchitis, and pneumonia) can prevent complications leading to hemoptysis.

- **Protective Measures:** If you work in environments with dust, chemicals, or other respiratory irritants, use appropriate protective gear to prevent lung damage.

- **Regular Check-ups:** Regular visits to a healthcare provider can help detect and manage underlying conditions early.

Material and methods

Case series

1. Patient A

- A 38-year-old male presented with a massive bout of hemoptysis, expelling over 400 ml of blood. His history included anti-tubercular treatment two years prior for sputum-positive pulmonary TB, and he was declared cured. Recently, he was diagnosed with a relapse of pulmonary TB and was undergoing intensive phase of 4FDC Fixed Dose Combination with Rifampicin Isoniazid, Ethambutol and Pyrazinamide treatment. BAE effectively controlled his hemoptysis.

2. Patient B

- Another case involved a patient with post-pulmonary TB destruction who experienced massive hemoptysis. Fluoroscopy-guided arterial embolization successfully achieved hemostasis, highlighting the need for various diagnostic and therapeutic approaches[2].

3. Patient D

18 years male H/o Hemoptysis, X ray chest Right upper zone infiltration, GenXpert MTB not detected, clinically diagnosed and 4FDC started responded to treatment. After 1 year similar episode of Hemoptysis, Bronchial Artery Embolization done BAE and through bronchoscope specimen collected was send for GenXpert and Culture AFB with DST, MTB detected with Rifampicin resistance, started on all oral longer regimen, patient responded clinically with weight increased by 10 kg in six months.

Discussion

The presented case series underscores the diverse etiologies and management strategies for hemoptysis, a potentially life-threatening symptom. Patient A exemplifies the recurrence of hemoptysis in individuals with a history of pulmonary tuberculosis (TB), despite previous anti-tubercular treatment. This highlights the importance of vigilant follow-up and management, as well as the efficacy of bronchial artery embolization (BAE) in controlling massive hemoptysis associated with TB relapse. Patient B emphasizes the necessity for a multidisciplinary approach, utilizing fluoroscopy-guided arterial embolization to achieve hemostasis in cases of post-TB pulmonary destruction.

Patient C presents a unique case of recurrent hemoptysis due to saccular aneurysms, illustrating the diverse anatomical abnormalities that can underlie this symptom. The emergent pulmonary angiogram and subsequent embolization underscore the critical role of timely intervention in managing life-threatening hemoptysis secondary to vascular anomalies. Lastly, Patient D highlights the evolving nature of TB management, with the emergence of drug-resistant strains necessitating comprehensive diagnostic evaluation and tailored treatment regimens. The successful outcome, characterized by clinical improvement and weight gain, underscores the importance of early detection of drug resistance and appropriate therapeutic adjustments.

In conclusion, this case series emphasizes the complex nature of hemoptysis and the importance of a multidisciplinary approach in its management. From relapsed TB cases to vascular anomalies and drug-resistant strains, each patient necessitates tailored diagnostic and therapeutic interventions to achieve favorable outcomes and mitigate the risk of morbidity and mortality associated with this life-threatening symptom.

Conclusion

In conclusion, the presented case series highlights the diverse etiologies and management approaches for hemoptysis, emphasizing the need for a comprehensive understanding and multidisciplinary collaboration in its management. From cases of relapsed pulmonary tuberculosis necessitating bronchial artery embolization for hemostasis to the emergent intervention for vascular anomalies causing recurrent bleeding, each patient underscores the critical role of timely diagnosis and

intervention in mitigating the potentially life-threatening consequences of hemoptysis.

Furthermore, the emergence of drug-resistant tuberculosis poses additional challenges, necessitating thorough diagnostic evaluation and tailored treatment regimens to ensure optimal outcomes. The successful management of these cases underscores the importance of a holistic approach, integrating clinical expertise, advanced diagnostic modalities, and interventional techniques to address the underlying pathology and achieve hemostasis effectively.

Overall, this case series underscores the complexity of hemoptysis and the importance of individualized management strategies tailored to the underlying etiology, highlighting the need for ongoing research and collaboration to further refine diagnostic and therapeutic approaches in optimizing patient outcomes.

Summary

The case series presented encompasses four patients with hemoptysis, each illustrating different etiologies and management strategies. Patient A, a relapsed tuberculosis case, was successfully managed with bronchial artery embolization (BAE). Patient B, with post-TB pulmonary destruction, underwent fluoroscopy-guided arterial embolization. Patient C suffered from recurrent hemoptysis due to saccular aneurysms, necessitating emergency embolization. Patient D, diagnosed with drug-resistant TB after initial treatment, responded well to a modified drug regimen following bronchial artery embolization.

Overall, the series highlights the importance of tailored interventions based on the underlying pathology of hemoptysis. From tuberculosis relapse to vascular anomalies and drug resistance, each case required a multidisciplinary approach integrating diagnostic imaging, interventional radiology, and infectious disease management. Successful outcomes in these cases underscore the significance of timely intervention and individualized treatment plans in managing hemoptysis effectively.

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