HEMOPTYSIS

Prof. G. Zuliani

HEMOPTYSIS

- Hemoptysis is the expectoration of blood, that can range from *blood-streaking of sputum* (Hemoptoe) to the presence of *gross blood* in the absence of any accompanying sputum.
- The term ***massive hemoptysis*** is reserved for potentially life-threatening bleeding; it has been defined by a number of different criteria, more often as ***more than 600 ml of blood over a 24 hour period.***

HEMOPTYSIS

- 1000 ml of blood in the alveolar space is sufficient to cause significant hindrance to the oxygen transfer.
- Massive hemoptysis accounts for only 1.5% of all hemoptysis.
- The majority of hemoptysis originates from the ***bronchial arteries*** (about 90%)

VASCULAR ORIGIN OF HEMOPTYSIS

- Blood traversing the lungs can arrive from:
  - **pulmonary arteries**
  - **bronchial arteries**
- Virtually, the entire ***cardiac output*** courses through the *low-pressure* pulmonary arteries and arterioles to be oxygenated in the pulmonary capillary bed
- In contrast, the ***bronchial arteries*** carry only a small portion of the cardiac output, but are under much *higher systemic pressure*

VASCULAR ORIGIN OF HEMOPTYSIS

- Despite the quantitatively smaller contribution of the bronchial circulation to pulmonary blood flow, the ***bronchial arteries*** are generally a much more important source of hemoptysis than the pulmonary circulation

- In addition to being perfused at a higher pressure, they also *supply blood to the airways and to lesions within the airways*

HEMOPTYSIS

- The total mortality rate related to hemoptysis is influenced by:

1. ***Malignant etiologies***
2. ***Bleeding rate***

- The coexistence of hemoptysis over 1000 ml/24hr and malignancy in the same patient brought the mortality rate to about **80%.**

DIFFERENTIAL DIAGNOSIS OF HEMOPTYSIS

- Before assuming a *lower respiratory source* of the bleeding, it is always important to consider whether the blood may be coming from a *non-pulmonary source*, such as the *upper airways* or the *gastrointestinal tract*

- ***Alkaline pH, foaminess, or the presence of pus*** may sometimes suggest the lungs as the primary source of bleeding rather than the stomach.

1. Airways diseases

- The most common source of hemoptysis is airways disease:
  - **Inflammatory diseases**: such as acute bronchitis or bronchiectasis
  - **Neoplasms:** including primary bronchogenic carcinoma, endobronchial metastatic carcinoma or bronchial carcinoid
  - **Foreign body & Airway trauma**
  - **Kaposi's sarcoma:** in patients with AIDS, involving the airways and/or the pulmonary parenchyma
  - **Fistula** between a vessel and the tracheo-bronchial tree:
    - fistulas between the aorta and the airway are associated with **aneurysms of the thoracic aorta;** are fatal if not diagnosed and surgically treated

1. Airways diseases

- Bronchitis
- Bronchiectasis
- COPD
- Bronchogenic carcinoma

are common causes of hemoptysis.

2. Pulmonary parenchymal diseases

- **Infections:** especially tuberculosis, pneumonia, aspergilloma, and lung abscess
  - Hemoptysis, which can be life-threatening, complicates the course of 50-85 percent patients with an **Aspergilloma**
- **Tuberculosis** can cause massive hemoptysis through multiple mechanisms
  - ***Active cavitary or non-cavitary*** lung disease can cause small or large amounts of bleeding
  - Active disease can cause sudden ***rupture of a Rasmussen's aneurysm*** (aneurysm of the pulmonary artery that slowly expands into an adjacent cavity because of inflammatory erosion of the external vessel wall until it bursts)

2. Pulmonary parenchymal diseases

- **Inflammatory or immune disorders**
  - Goodpasture's syndrome, Wegener's granulomatosis, pulmonary hemosiderosis, lupus pneumonitis,
- **Coagulopaties**
  - ***thrombocytopenia or use of anticoagulants***
- **Iatrogenic:** percutaneous or transbronchial lung biopsy. Hemoptysis, which is usually minor and transient, occurs in five to 10% of percutaneous lung biopsies (but massive hemorrhage and death have also been reported)

2. Other cause of pulmonary parenchymal hemorrhage

- **Cocaine-induced pulmonary hemorrhage**
  - Hemoptysis has been described in about 6% of habitual smokers of free-base cocaine ***("crack")*** and has been associated with *diffuse alveolar hemorrhage*

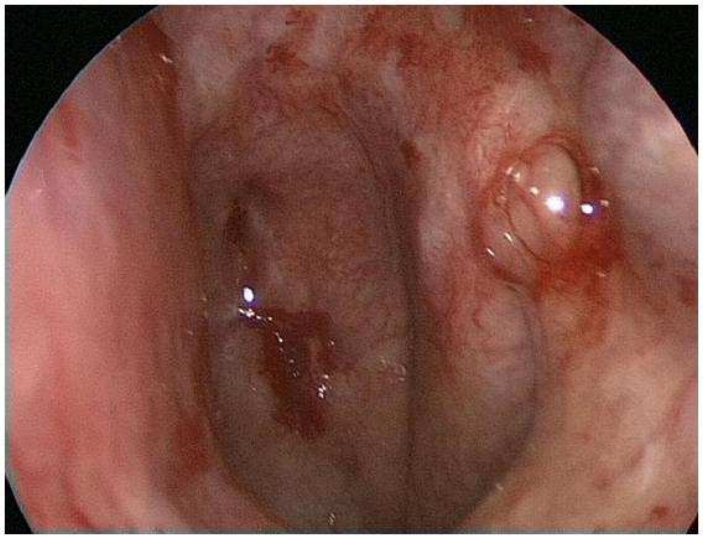
- **Catamenial hemoptysis**
  - Hemoptysis, in women, that is recurrent and coincident with menses. The cause is intra-thoracic *endometriosis*, usually involving the pulmonary parenchyma but occasionally affecting the airways

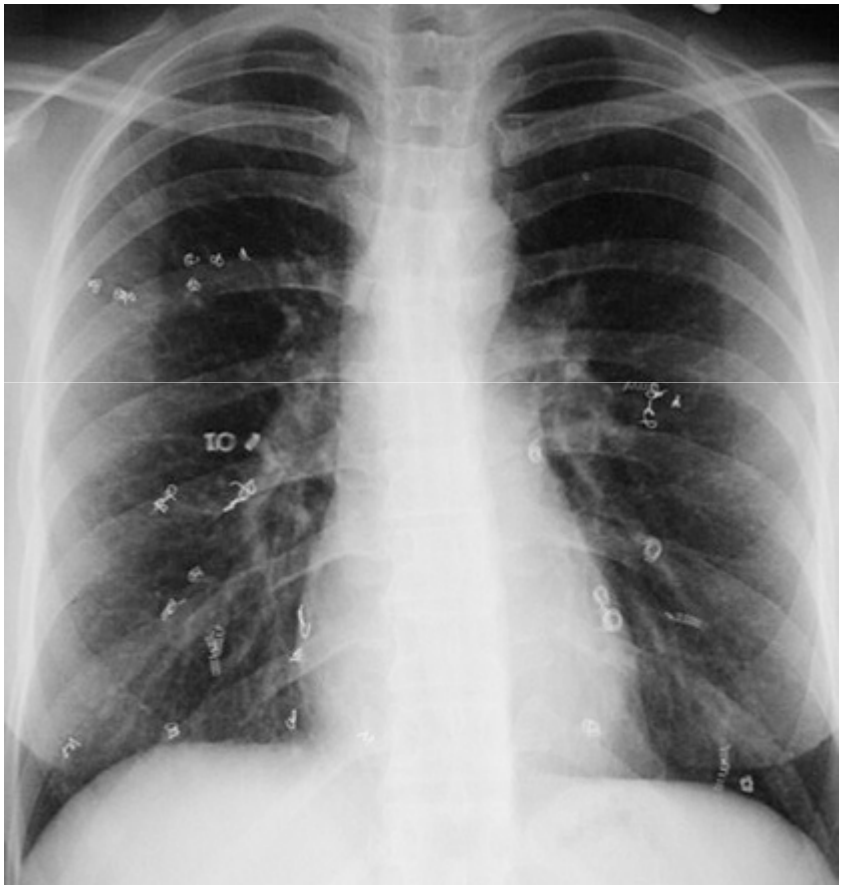
3. Pulmonary vascular disorders

- **Pulmonary embolism (infarction)**
- **Pulmonary A-V malformation,** either with or without underlying ***Rendu-Osler-Weber*** syndrome
- **Elevated pulmonary capillary pressure**
  - ***mitral valve stenosis***
  - *significant left ventricular failure*
  - *congenital heart diseases*
  - ***severe pulmonary hypertension***
- **Iatrogenic**
  - pulmonary artery perforation from a Swan-Ganz catheter

Hereditary hemorrhagic telangiectasia: ROW

Fig. 2. Telangiectasia en mucosa labial.





4. Cryptogenic hemoptysis

- Depending upon the study, up to **30%** of patients with hemoptysis have NO cause identified even after careful evaluation

- In a series of patients with “cryptogenic” hemoptysis, the prognosis was generally good, and most patients had resolution of bleeding within six months of evaluation

Adelman M et al. Cryptogenic hemoptysis. Clinical features, bronchoscopic findings, and natural history in 67 patients. Ann Intern Med

TABLE 1
Differential Diagnosis of Hemoptysis

Source other than the lower respiratory tract

Upper airway (nasopharyngeal) bleeding

Gastrointestinal bleeding

Tracheobronchial source

Neoplasm (bronchogenic carcinoma, endobronchial metastatic tumor, Kaposi's sarcoma, bronchial carcinoid)

Bronchitis (acute or chronic)

Bronchiectasis

Broncholithiasis

Airway trauma

Foreign body

Pulmonary parenchymal source

Lung abscess

Pneumonia

Tuberculosis

Mycetoma ("fungus ball")

Goodpasture's syndrome

Idiopathic pulmonary hemosiderosis

Wegener's granulomatosis

Lupus pneumonitis

Long contusion

Primary vascular source

Arteriovenous malformation

Pulmonary embolism

Elevated pulmonary venous pressure (especially mitral stenosis)

Pulmonary artery rupture secondary to balloon-tip pulmonary artery catheter manipulation

Miscellaneous and rare causes

Pulmonary endometriosis

Systemic coagulopathy or use of anticoagulants or thrombolytic agents

Adapted with permission from Weinberger SE. Principles of pulmonary medicine. 3d ed. Philadelphia: Saunders, 1998.

Table 2 – Distribution of the infectious causes of hemoptysis in 50 patients admitted to the pulmonology ward of the Otávio de Freitas General Hospital between July of 2005 and February of 2006.

Underlying diagnosis	n	%
ABPA	1	2.6
Lung abscess	1	2.6
Bronchiectasis	19	48.7
Upper respiratory tract infection	1	2.6
Lower respiratory tract infection	2	5.2
Mycetoma	8	20.5
Community-acquired pneumonia	3	7.7
Active pulmonary tuberculosis	4	10.3
Total	39	100

ABPA: allergic bronchopulmonary aspergillosis.

EVALUATION OF HEMOPTYSIS

- The evaluation should begin with the initial history and ***physical examination*** supplemented by ***chest radiograph***

- Important features of the history include: ***age, smoking history, duration of hemoptysis, and association with symptoms of acute bronchitis or exacerbation of chronic bronchitis***

TABLE 3

Diagnostic Clues in Hemoptysis: Physical History

Clinical clues	*Suggested diagnosis**
Anticoagulant use	Medication effect, coagulation disorder
Association with menses	Catamenial hemoptysis
Dyspnea on exertion, fatigue, orthopnea, paroxysmal nocturnal dyspnea, frothy pink sputum	Congestive heart failure, left ventricular dysfunction, mitral valve stenosis
Fever, productive cough	Upper respiratory infection, acute sinusitis, acute bronchitis, pneumonia, lung abscess
History of breast, colon, or renal cancers	Endobronchial metastatic disease of lungs
History of chronic lung disease, recurrent lower respiratory track infection, cough with copious purulent sputum	Bronchiectasis, lung abscess
HIV, immunosuppression	Neoplasia, tuberculosis, Kaposi's sarcoma
Nausea, vomiting, melena, alcoholism, chronic use of nonsteroidal anti-inflammatory drugs	Gastritis, gastric or peptic ulcer, esophageal varices
Pleuritic chest pain, calf tenderness	Pulmonary embolism or infarction
Tobacco use	Acute bronchitis, chronic bronchitis, lung cancer, pneumonia
Travel history	Tuberculosis, parasites (e.g., paragonimiasis, schistosomiasis, amebiasis, leptospirosis), biologic agents (e.g., plague, tularemia, T2 mycotoxin)
Weight loss	Emphysema, lung cancer, tuberculosis, bronchiectasis, lung abscess, HIV

HIV = human immunodeficiency virus.

**—Arranged from most to least common diagnosis for each clinical clue.*

Information from references 4, 5, 17, and 18.

Physical examination

- **Telangiectasias** suggests **R-O-W** disease
- **Skin rash** may be suggestive of **vasculitis**
- **Splinter hemorrhages** suggest **endocarditis or vasculitis**
- **Clubbing** is non-specific
- **Cardiac murmurs** raise the question of congenital heart disease, endocarditis with septic emboli, or, when a diastolic rumble or opening snap is present, mitral stenosis
- The legs should be examined carefully for possible **deep venous thrombi (eco-doppler)**

EVALUATION OF HEMOPTYSIS

- **NO immediate further work-up is indicated** if the clinical picture IS NOT suggestive of a lung carcinoma:
  - ***negative chest radiograph***
  - ***age <40 years***
  - ***no smoking history***
  - ***hemoptysis < 1 week duration***
  - ***suggestive of acute bronchitis (blood streaking superimposed upon purulent sputum)***

- The patient should be treated for bronchitis and observed for recurrence of hemoptysis following improvement in purulent sputum production

EVALUATION OF HEMOPTYSIS

Low-risk patients with normal chest radiographs can be treated on an outpatient basis with close monitoring and appropriate oral antibiotics, if medication is clinically indicated.

TABLE 2

Differentiating Features of Hemoptysis and Hematemesis

Hemoptysis	*Hematemesis*
History	
Absence of nausea and vomiting	Presence of nausea and vomiting
Lung disease	Gastric or hepatic disease
Asphyxia possible	Asphyxia unusual
Sputum examination	
Frothy	Rarely frothy
Liquid or clotted appearance	Coffee ground appearance
Bright red or pink	Brown to black
Laboratory	
Alkaline pH	Acidic pH
Mixed with macrophages and neutrophils	Mixed with food particles

Information from references 4, 17, and 18.

Diagnostic Studies

1. Sputum Examination
2. Chest Radiography
3. Bronchoscopy
4. CT - HRCT
5. Angiography

TABLE 5

Diagnostic Clues in Hemoptysis: Chest Radiograph

Chest radiograph finding	*Suggested diagnosis**
Cardiomegaly, increased pulmonary vascular distribution	Chronic heart failure, mitral valve stenosis
Cavitary lesions	Lung abscess, tuberculosis, necrotizing carcinoma
Diffuse alveolar infiltrates	Chronic heart failure, pulmonary edema, aspiration, toxic injury
Hilar adenopathy or mass	Carcinoma, metastatic disease, infectious process, sarcoid
Hyperinflation	Chronic obstructive pulmonary disease
Lobar or segmental infiltrates	Pneumonia, thromboembolism, obstructing carcinoma
Mass lesion, nodules, granulomas	Carcinoma, metastatic disease, Wegener's granulomatosis, septic embolism, vasculitides
Normal or no change from baseline	Bronchitis, upper respiratory infection, sinusitis, pulmonary embolism
Patchy alveolar infiltrates (multiple bleeding sites)	Bleeding disorders, idiopathic pulmonary hemosiderosis, Goodpasture's syndrome

**—Arranged from most to least common diagnosis for each clinical clue.*

Information from references 4 and 17.

EVALUATION OF HEMOPTYSIS

- **Further evaluation is indicated** if the patient has ***risk factors for carcinoma*** or if the hemoptysis ***does not occur in the setting of acute bronchitis***

- **Bronchoscopy** is the preferred next procedure in those patients with risk factors for tumor or chronic bronchitis

- On the other hand, **HRCT** is the preferred next procedure in patients at lower risk for tumor or chronic bronchitis, but with a history or radiograph suggestive of bronchiectasis or an arteriovenous malformation.

DIAGNOSTIC PROCEDURES

- **Bronchoscopy**
  - often considered in patients with hemoptysis and normal or non-localizing CXR to rule out endobronchial malignancy
  - performed *early in the evaluation*, while the patient is still bleeding, provides the highest yield for localizing the bleeding site
- Risk factors predicting those individuals most likely to have **tumor** found on bronchoscopy include:
  - *Male sex*
  - *Older age, greater than 50 years*
  - *Smoking history greater than 30 pack/year*
  - *Duration of hemoptysis greater than one week*

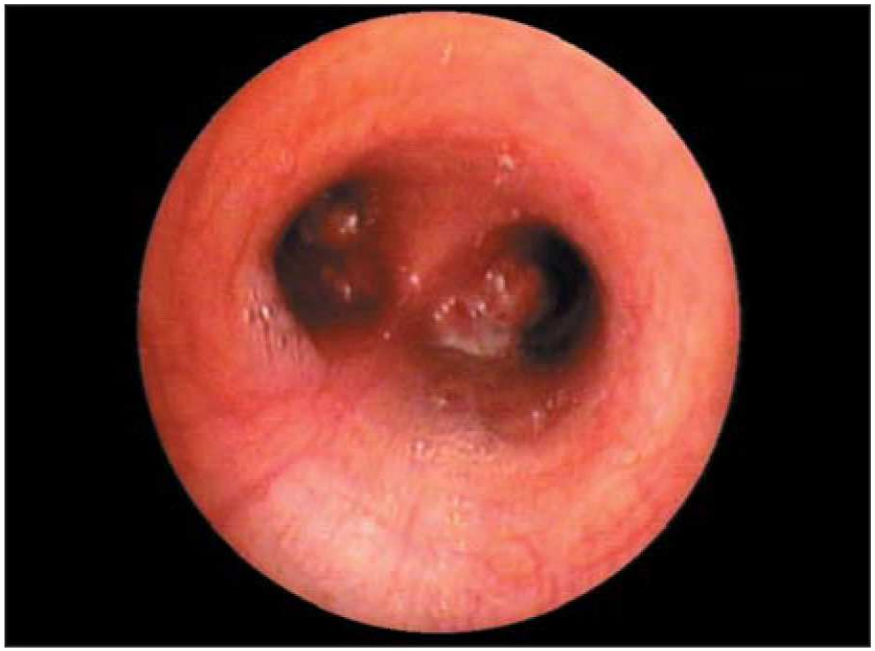
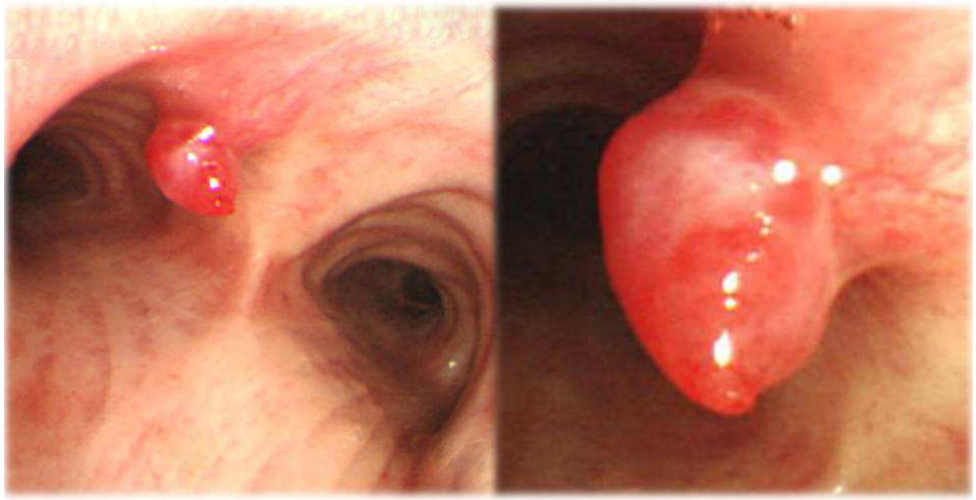


Figure 3. Bronchoscopic image of the main carina and the bilateral polypoid lesions throught both left and right main bronchus.



A pink polypoid mass on the bronchial musosa

Arteriography

- If the patient continues to bleed and the source is still unknown, ***Arteriography*** should next be performed, since it may be useful for diagnosis and therapy too
- Since the majority of massive bleeds arise from the bronchial circulation, ***bronchial arteriography*** has a higher yield than arteriography of the pulmonary or systemic arterial beds
- When the *pulmonary arterial circulation* is the source, the most common underlying conditions are pulmonary A-V malformations, Rasmussen's aneurysms or iatrogenic pulmonary artery tears

CT scan of the chest

- Use of early chest CT has been advocated to help localize the bleeding site and diagnose the cause
- CT scan may suggest one of several diagnoses such as: ***bronchiectasis, lung abscess, and mass lesions including cancer, mycetomas, and A-V lesions***
- It may also help in the acute setting to *guide arteriography or bronchoscopy* to the regions of highest yield
- The disadvantage of chest CT is that it may require temporary movement of an unstable patient

Bronchoscopy versus HRCT

- Bronchoscopy and HRCT are, in many ways, **complementary studies,** each with specific advantages in certain clinical situations
- In one study of 91 patients with hemoptysis, HRCT demonstrated all tumors seen by bronchoscopy as well as, several which were beyond bronchoscopic range. On the other hand, HRCT *could not detect bronchitis or subtle mucosal abnormalities* which could be seen by Bronchoscopy
- In another report of 57 patients, HRCT was particularly useful in diagnosing *bronchiectasis and aspergillomas*, while Bronchoscopy was diagnostic of *bronchitis and mucosal lesions* such as Kaposi's sarcoma

TABLE 6

Diagnostic Clues in Hemoptysis: Laboratory Tests

Test	*Diagnostic findings*
White blood cell count and differential	Elevated cell count and differential shifts may be present in upper and lower respiratory tract infections
Hemoglobin, hematocrit	Decreased in anemia
Platelet count	Decreased in thrombocytopenia
Prothrombin time, International Normalized Ratio, partial thromboplastin time	Increased in anticoagulant use, disorders of coagulation
Arterial blood gases	Hypoxia, hypercarbia
D-dimer	Elevated in pulmonary embolism
Sputum Gram stain, culture, acid-fast bacillus smear and culture	Pneumonia, lung abscess, tuberculosis, mycobacterial infections
Sputum cytology	Neoplasm
Purified protein derivative skin test	Positive increases risk for tuberculosis
Human immunodeficiency virus test	Positive increases risk for tuberculosis, Kaposi's sarcoma
Erythrocyte sedimentation rate	Elevated in infection, autoimmune disorders (e.g., Wegener's syndrome, systemic lupus erythematosus, sarcoid, Goodpasture's syndrome), may be elevated in neoplasia

Acute management of hemoptysis

- Initial priorities are insuring adequate airway protection, ventilation, and cardiovascular function **(ABC)**
- Possible ***coagulation disorders*** should be rapidly reversed (PT, aPTT, platelet count)
- Patients with poor gas exchange, rapid ongoing hemoptysis, hemodynamic instability, or severe shortness of breath should be ***orally intubated*** with a large bore endotracheal tube (size 8.0 or greater)

Use of bronchoscopy in acute management of hemoptysis

- A bronchoscopic option for protecting the non-bleeding lung is ***Balloon Tamponade*** of the bleeding site, involving placement of a ***Fogarty balloon catheter*** in the segmental or sub-segmental bronchus leading to the bleeding site
- The balloon is left inflated for 24 to 48 hours, and the patient is then observed for rebleeding with the balloon deflated for several hours
- There is a potential risk of ischemic mucosal injury and post-obstructive pneumonia, but these complications have not been reported

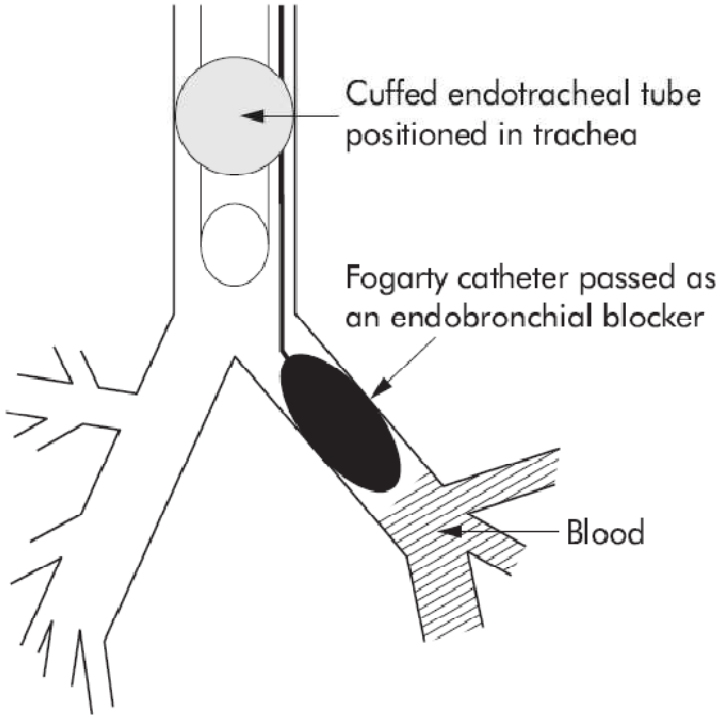


Figure 5 Control of left sided massive haemoptysis by tracheal intubation, placement, and inflation of a Fogarty catheter in the left main bronchus.

Use of bronchoscopy in acute management of hemoptysis

- Bronchoscopic techniques used to slow or stop bleeding have included ***lavage with saline*** and application of ***topical epinephrine*** (1:20.000), ***vasopressin, thrombin or a fibrinogen-thrombin combination***
- None of these methods has been tested in controlled trials (!)
- If bronchoscopy visualizes a localized bleeding mucosal lesion, ***laser therapy or electrocautery*** may be considered, if available

Protection of the non-bleeding lung

- If the location or side of bleeding is known, placing the bleeding lung in a dependent position may prevent blood spillage into the non-bleeding lung: ***place the patient on lateral decubitus toward the site of bleeding***

- **Selective intubation:** an alternative strategy involves placement of a typical, ***single lumen endotracheal tube*** into either the right or left mainstem bronchus. This approach is less practical when the right lung is bleeding, because selective intubation of the left mainstem bronchus may be quite difficult
- A third alternative is the placement of a ***double lumen endotracheal tube*** specially designed for selective intubation of the right or left mainstem bronchi

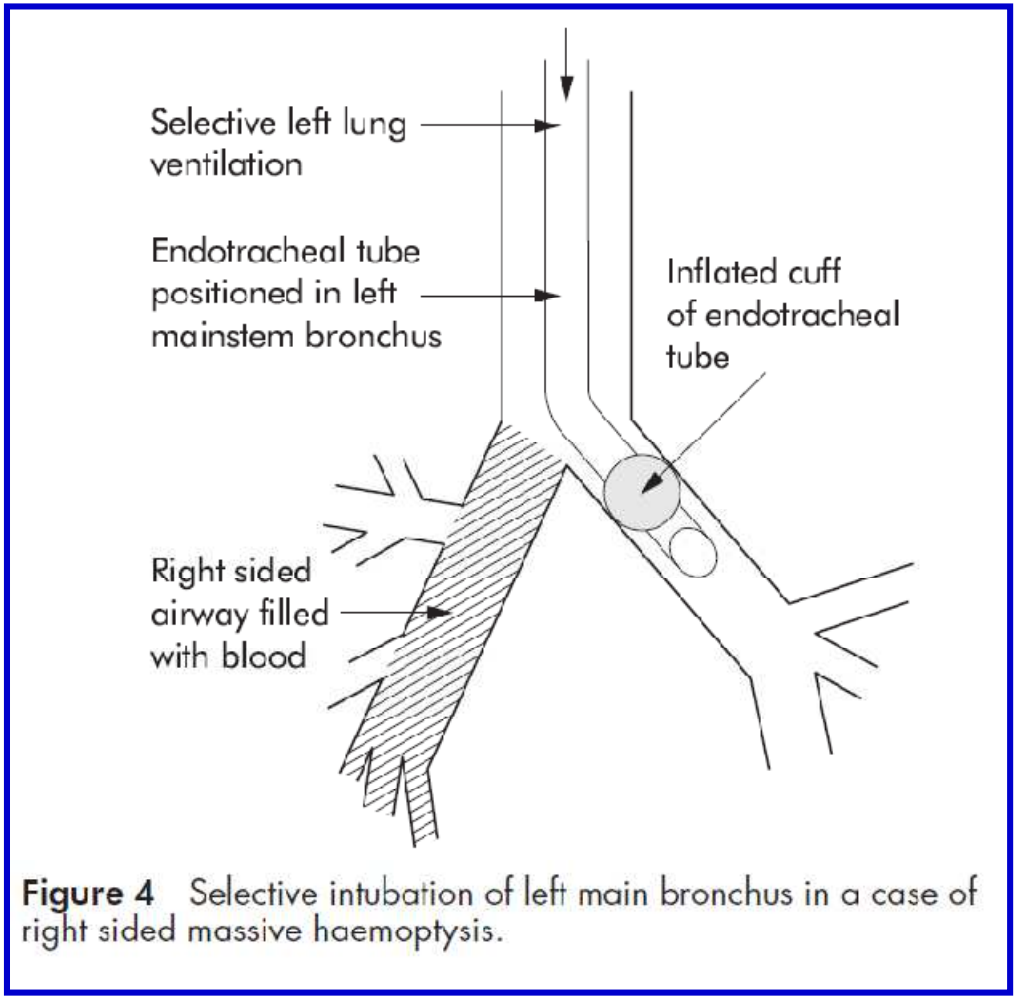


Figure 4 Selective intubation of left main bronchus in a case of right sided massive haemoptysis.

Arteriographic embolization

- The other option for the patient who continues to bleed is ***Arteriographic Embolization***, either as "semi-definitive" treatment or as a bridge to elective surgery
- ***In the hands of experienced angiographers, embolization successfully stops bleeding more than 85% of the time***
- Unfortunately, embolization is only "semi-definitive," because ***re-bleeding occurs in 10-20%*** of patients over the next 6-12 months
- Late re-bleeding may be due to incomplete embolization, revascularization, or recanalization.

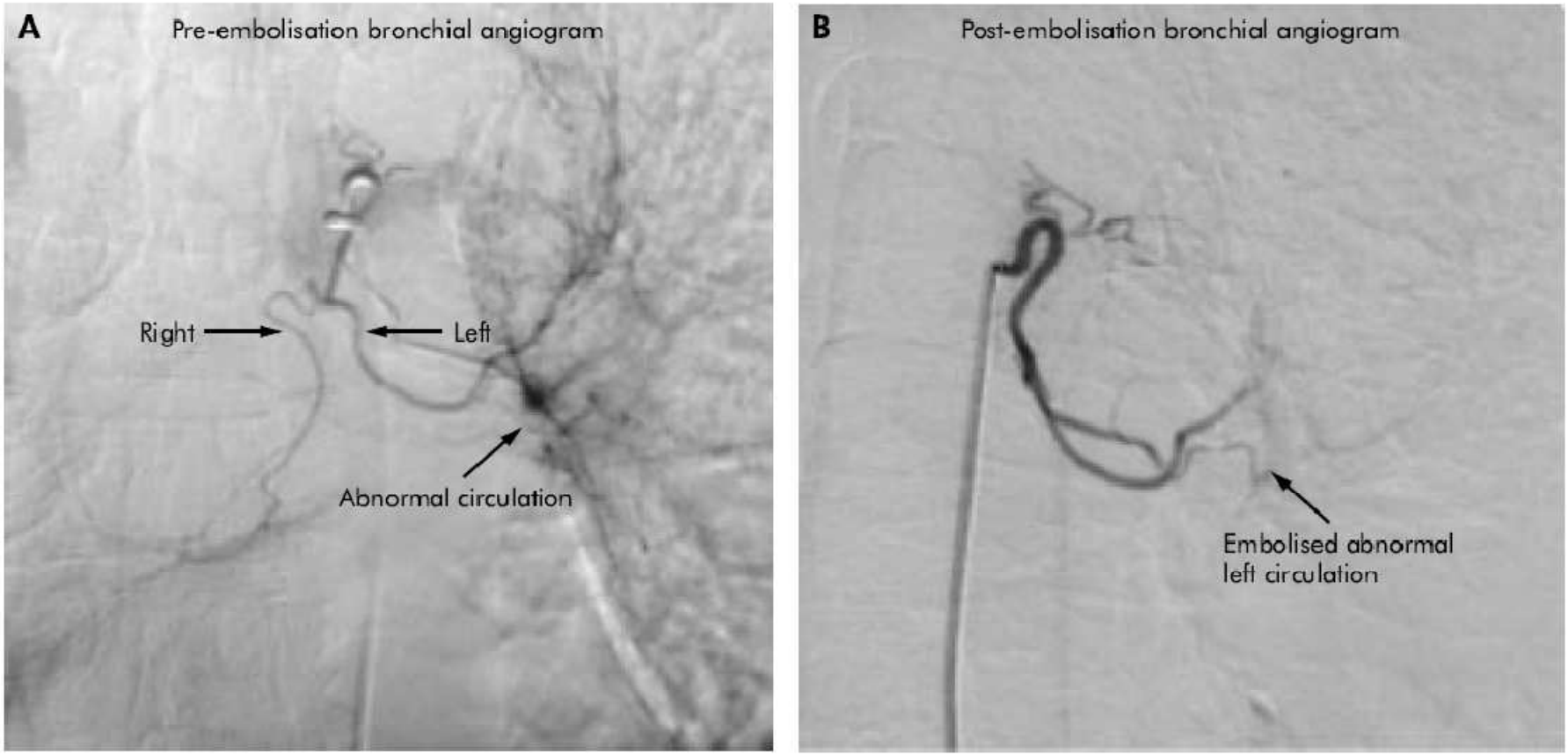
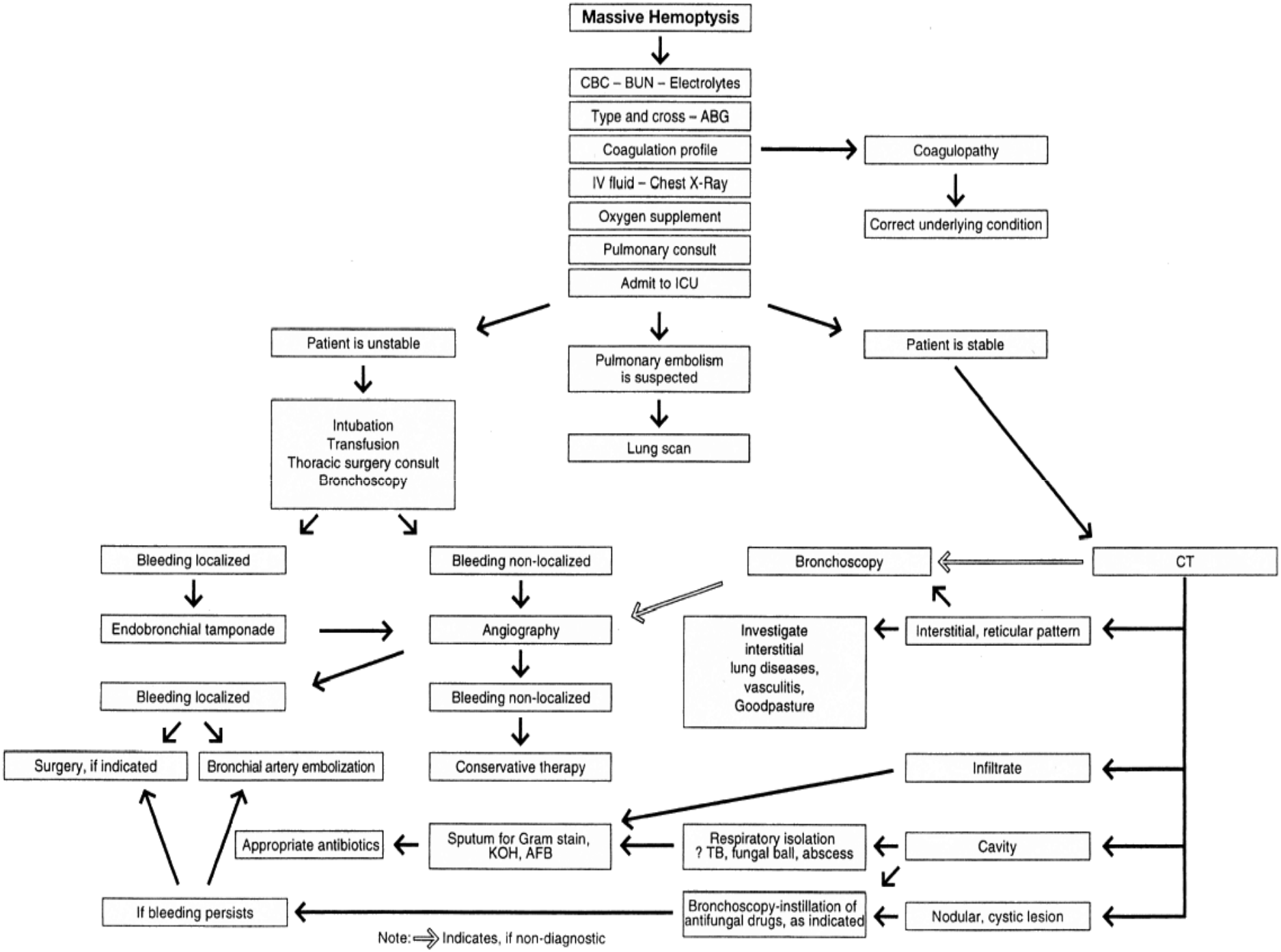


Figure 2 Use of selective bronchial artery embolisation to control massive haemoptysis. (A) Bronchial angiogram showing common trunk and left sided abnormal circulation pre-embolisation, and (B) post-embolisation angiogram showing the left bronchial artery and successful embolisation of abnormal vessels.

Surgery

- Patients with lateralized uncontrollable bleeding should be assessed early for possible surgery
- ***Contraindications*** to surgery include: severe underlying pulmonary disease (advanced K), active TBC, diffuse underlying lung disease (cystic fibrosis, multiple A-V Ms, multifocal bronchiectasis), and diffuse alveolar hemorrhage
- Morbidity and mortality are significantly greater with emergent surgery for persistent massive bleeding compared with elective surgery
- *In most series of emergent therapy, surgical mortality for treatment of massive hemoptysis is high (approximately 20%)*


Massive Hemoptysis
CBC – BUN – Electrolytes
Type and cross – ABG
Coagulation profile
IV fluid – Chest X-Ray
Oxygen supplement
Pulmonary consult
Admit to ICU
Coagulopathy
Correct underlying condition
Patient is unstable
Intubation
Transfusion
Thoracic surgery consult
Bronchoscopy
Pulmonary embolism is suspected
Lung scan
Patient is stable
Bleeding localized
Endobronchial tamponade
Bleeding localized
Surgery, if indicated
Bronchial artery embolization
Bleeding non-localized
Angiography
Bleeding non-localized
Conservative therapy
Bronchoscopy
CT
Investigate interstitial lung diseases, vasculitis, Goodpasture
Interstitial, reticular pattern
Infiltrate
Cavity
Nodular, cystic lesion
Appropriate antibiotics
Sputum for Gram stain, KOH, AFB
Respiratory isolation ? TB, fungal ball, abscess
If bleeding persists
Bronchoscopy-instillation of antifungal drugs, as indicated
Note: ⇒ Indicates, if non-diagnostic