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Medical Progress

Hemoptysis: Diagnosis and Management

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Hemoptysis is one of the most important symptoms of cardiopulmonary disease—first, because bleeding even in small amounts may indicate the presence of such serious diseases as bronchogenic carcinoma or active tuberculosis, and second, because untreated massive hemorrhage is associated with a high mortality rate. The cause of hemoptysis may be suggested by the history, physical examination or chest x-ray findings, but often diagnostic procedures such as bronchoscopy, bronchography and pulmonary angiography are needed for definitive diagnosis. The importance of early localization of the bleeding site and surgical intervention in patients with massive hemoptysis is stressed.

HEMOPTYSIS IS A common symptom of cardiopulmonary disease, being reported by 7 to 15 percent of patients evaluated in chest clinics.[1-14] Although bronchitis is a very common cause of hemoptysis, a thorough evaluation is usually necessary to exclude the presence of more serious pathologic conditions such as tuberculosis or bronchogenic carcinoma. The amount of bleeding that a patient reports, even merely blood-streaked sputum, does not influence the need for full investigation since the quantity of blood may not be correlated with the seriousness of the underlying thoracic disease.[1-3,5]

Hemoptysis was concisely referred to in the Hippocratic aphorism "the spitting of pus follows the spitting of blood, consumption follows the spitting of this and death follows consumption."[2] For centuries, hemoptysis was considered pathognomonic of pulmonary tuberculosis. In 1936 Würtzen and Sjorslev noted, however, that a third of patients admitted to a tuberculosis sanitarium for hemoptysis did not have tuberculosis as previously assumed.[6] It has recently become quite clear that there are actually numerous causes of hemoptysis. The more common or well-known (or both) of these are given in Table 1. A more complete list was published by the American Thoracic Society in 1966.[7]

There are no recently collected epidemiologic data on the relative frequency of the various causes of hemoptysis. American studies, reported two to three decades ago, indicated that bronchitis or bronchiectasis (or both), lung carcinoma, and tuberculosis were the most common causes of hemoptysis (in that order), and accounted for over two thirds of the cases.[2,8] Lung carcinoma no doubt continues to be a major cause of hemoptysis in the United States, since a recent American Cancer Society study reports a 14-fold increase in lung cancer in the last 40 years.[9] A parallel increase in cigarette smoking implies the same is true of bronchitis.[9] In contrast, the incidence of tuberculosis has decreased in the United States, although in some other parts of the world it

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TABLE 1.—*Common or Well-Known Causes of Hemoptysis*

Arteriovenous aneurysm	Parasitic infection
Bleeding diathesis	Pneumoconiosis
Bronchial adenoma	Pneumonia (viral, bacterial, fungal)
Bronchial endometriosis	Polyarteritis nodosa
Bronchitis	Primary pulmonary hypertension
Bronchiectasis	Pulmonary edema due to left ventricular failure or mitral stenosis
Bronchoaortic artery fistula	Pulmonary infarction
Bronchogenic carcinoma	Systemic lupus erythematosus
Broncholithiasis	Trauma
Bronchopleural fistula	Tracheal-innominate artery fistula
Chronic granuloma of lung	Transthoracic and transbronchial lung biopsy
Congenital heart disease	Transtracheal aspiration
Cystic fibrosis	Tuberculosis
Cysts and blebs	Wegener granulomatosis
Foreign body	
Goodpasture syndrome	
Idiopathic pulmonary hemosiderosis	
Lung abscess	
Metastatic carcinoma	
Mycetoma	

remains poorly controlled and is still the main cause of hemoptysis.[3]

The percentages of patients with specific intrathoracic diseases having hemoptysis are shown in Table 2. Hemoptysis is most closely associated with aspergilloma, bronchiectasis, bronchial adenoma and bronchogenic carcinoma.

Pathophysiology of Hemoptysis

There are numerous pathophysiologic mechanisms that result in bleeding from the tracheobronchial tree. For example, inflammation of the mucosa (vascular engorgement, desquamation, atrophy and erosion) as in acute or chronic tracheobronchitis commonly results in bleeding. The mucosa of the tracheobronchial tree is well vascularized and quite friable. Mild trauma such as produced by suctioning during bronchoscopy is often sufficient to result in active bleeding.

Infarction of lung tissue often results in hemoptysis. Pulmonary infarction may be due to bland and septic pulmonary emboli; invasion of blood vessels by Pseudomonas aeruginosa, phycomycosis and Aspergillus fumigatus; pulmonary vasculitis such as polyarteritis nodosa, Wegener granulomatosis and systemic lupus erythematosus; and necrotizing staphylococcal, Gram-negative or fungal pneumonia.

In acute left ventricular failure or mitral stenosis, blood-streaked sputum is due to rupture of pulmonary veins or capillaries distended by elevated intravascular pressure. In addition, enlarged bronchial veins may be the source of bleeding in mitral stenosis.[15]

TABLE 2.—*Percentage of Patients With Specific Intrathoracic Diseases Having Hemoptysis**

Diseases	*Percent of Patients With Hemoptysis*
Aspergilloma	55-85
Bronchial adenoma	46-55
Bronchogenic carcinoma	37-53
Bronchiectasis	28-45
Lung abscess	11-15
Tuberculosis	6-19

*See References 3, 10-14, 23, 26, 27, 48.

Hemorrhage in Goodpasture syndrome is due to abnormalities in the alveolocapillary basement membrane, possibly due to antibody directed to the membrane.

Hemoptysis is associated with active tuberculosis. However, it may occur years after the disease has been adequately treated from any of the bronchopulmonary sequelae of previous tuberculous infection, including broncholithiasis (rupture of a calcified lymph node into a bronchus), development of a carcinoma (adenocarcinoma) in a tuberculous scar, bronchiectasis, and a residual cavity with or without a mycetoma.[16]

Bleeding from a tuberculous cavity, whether the infection is active or arrested, has been attributed to rupture of a Rasmussen aneurysm, a pear-shaped dilatation of a pulmonary or bronchial artery in the wall of the cavity.[17] However, Thompson studied 138 patients with tuberculosis dying of pulmonary hemorrhage and found only eight instances of aneurysmal dilatation of arteries lining the blood-filled tuberculous cavity.[18] Rather than being due to distinct aneurysmal dilatation of a bronchial or pulmonary artery, hemoptysis in patients with cavitary tuberculosis is more likely related to the development of a hypervascularized, dilated, tortuous bronchial circulation, and to anastamoses between the bronchial and pulmonary circulations. These vascular abnormalities have been well shown in autopsy specimens and by antemortem selective bronchial arteriography in patients with cavitary tuberculosis as well as in patients with other chronic pathological conditions including bronchiectasis, cystic fibrosis and lung abscess.[19-22] Hemoptysis, often massive, in these patients has been postulated to occur as a result of rupture of pulmonary capillaries (possibly due to entrance of high pressure bronchial blood into the low pressure pulmonary

TABLE 3.—*History in Patients With Hemoptysis*

Age of patient
Time of onset of hemoptysis in relation to duration of other symptoms
Chest pain
History of cardiopulmonary disease
History of cigarette smoking
History of hematuria
Appearance of sputum
Symptoms of nasal, oropharyngeal, laryngeal disease, or gastrointestinal disease

circulation) or dilated bronchial arteries that are adjacent to areas of chronic inflammation and infection.[21,22]

In cases of bronchogenic carcinoma, pathologic studies have shown an increase in the bronchial arterial supply to the region of the tumor.[20] Selective bronchial arteriography, however, has shown there to be abnormalities in the bronchial circulation in only five of 158 patients with lung carcinoma.[21] It is unlikely that hemoptysis in patients with bronchogenic carcinoma is due to rupture of large bronchial arteries or bronchopulmonary anastamosis since hemorrhage in these patients is usually mild, and rarely massive. Malignant tumors of the lung more likely produce hemoptysis by invasion of the mucosa or by necrosis of tumor tissue.

The pathogenesis of bleeding from a mycetoma (proliferation of a fungus such as aspergillus, nocardia or candida in an air-filled cavity) is not known. A number of pathogenic mechanisms have been suggested, including friction caused by movement of the mycetoma, and release of an anticoagulant and trypsin-like proteolytic enzyme from the fungus.[23]

Hemoptysis associated with closed chest trauma is usually due to contusion of the lung parenchyma; that is, exudation of blood and edema fluid into the intraalveolar spaces as well as interstitium.[24] Less frequently, bleeding following closed chest trauma, particularly to the anterior chest, results from fracture of the trachea just above the carina or of one of the mainstem bronchi just below the carina. Finally, hemoptysis following a penetrating bullet wound to the chest occurs when there is a communication between the missile track and the bronchial tree.

Clinical Evaluation of Hemoptysis

The evaluation and treatment of patients with hemoptysis depends on many factors, the most important of which is the rate of bleeding. There is generally ample time for evaluation of cause and management when bleeding is not massive. When hemorrhage is massive (200 to 600 ml of blood in 24 hours), localizing the site of bleeding and specific therapy (including maintenance of an airway, transfusion and surgical operation) should progress simultaneously with diagnostic studies to determine the cause of the bleeding or occasionally should precede them when necessary.

History

A thorough history may provide clues to the site of bleeding and the underlying disease. Table 3 lists some of the important points in the history.

The age of the patient at the onset of hemoptysis is helpful since some causes are age-related. Andosca and Foley pointed out that bronchiectasis and mitral stenosis were significant causes of pulmonary hemorrhage before age 40,[25] whereas bronchogenic carcinoma is more commonly the cause after age 40.[8]

The time of onset of hemoptysis in relation to the duration of other pulmonary symptoms may be of some diagnostic value. For example, hemoptysis is rarely the initial symptom in bronchogenic carcinoma[5,26,27] and, as a matter of fact, usually occurs late in the sequence of symptoms, being preceded by a change in cough pattern, fatigue and vague chest sensations.[27] Hemoptysis occurs earlier when a tumor arises in a major bronchus than when it is more peripheral.[8]

A patient may occasionally describe subjective chest sensations at the time of hemoptysis, including burning, heaviness, bubbling and vague chest pain. These sensations may localize the site of bleeding to one lung or even to a specific lobe.[5,27,28]

A history of hematuria in a patient presenting with hemoptysis suggests the presence of such diseases as Wegener granulomatosis, Goodpasture syndrome and polyarteritis nodosa.

The appearance of sputum may occasionally be of some value. Blood mixed in with gritty white material suggests the diagnosis of broncholithiasis. Frothy pink sputum is seen in pulmonary edema due to left ventricular failure. Rusty brown or prune juice colored sputum is seen in bacterial pneumonia. Blood mixed with pus is more likely to be due to lung abscess or pneumonia if the illness is acute or semiacute, whereas bronchiectasis is more likely if the illness is chronic. Blood streaking of mucoid sputum is not of diagnostic help, since it may be due to a variety

TABLE 4.—*Important Physical Findings in Patients With Hemoptysis*

Clubbing
Telangiectasia
Petechiae, ecchymosis
Ulceration of nasal septum
Diastolic rumble, opening snap
Adenopathy
Localized wheezes, rhonchi, rales

TABLE 5.—*Essential Laboratory Studies in Patients With Hemoptysis*

Complete blood count, differential, platelet count
Prothrombin time, partial thromboplastin time
Urinalysis
Sputum smear and culture for bacteria, acid fast bacteria, and fungus
Sputum cytology
Intermediate-PPD (coccidioidomycosis and histoplasmosis skin tests, serologies in endemic areas)
Aterial blood gases (in selected patients)
X-ray film of chest

of disorders including bronchitis, tuberculosis and bronchogenic carcinoma. Two conditions may be associated with sputum that contains no blood but may be confused with hemoptysis. Patients with pneumonia due to Serratia marcescens, a Gram-negative rod which is occasionally pigmented red, may produce red sputum which does not contain red blood cells and which is hematest negative. An amoebic abscess may rupture into a bronchus and cause the expectoration of "anchovy paste" sputum, resembling old blood.

It should be emphasized that bleeding may be from the nasal passages, nasopharynx, gums or larynx, rather than the lung. Laryngoscopy may be required to differentiate upper from lower respiratory tract bleeding. Hematemesis is occasionally reported as hemoptysis by patients. Suctioning blood or guaiaic positive material from the stomach via a nasogastric tube may not reliably differentiate gastrointestinal from tracheobronchial bleeding, since patients with hemoptysis frequently swallow coughed blood.

Physical Examination

Physical examination should include a specific search for the findings listed in Table 4. Telangiectasia on the lips or buccal mucosa is seen in Rendu-Osler-Weber disease. Clubbing is associated with bronchogenic carcinoma, bronchiectasis and lung abscess, as well as many other pulmonary and nonpulmonary disorders. A diastolic rumble and opening snap indicate the presence of mitral stenosis. Palpable cervical, scalene or supraclavicular lymph nodes suggest bronchogenic carcinoma. Ulceration of the nasal septum and other midline structures of the upper airway are seen in Wegener granulomatosis. Localized rales, wheezes, and ronchi should be interpreted with caution since these physical findings may represent pneumonitis due to aspirated blood rather than indicate the site of active bleeding.

Laboratory Studies

Table 5 lists laboratory studies that are most helpful in evaluating patients presenting with hemoptysis of unknown cause. Roentgenographic examination of the thorax should be obtained routinely in all cases of hemoptysis. Frequently, the pathologic process responsible for hemoptysis will have a typical roentgenographic appearance which is not obscured by aspirated blood. Examples are the enlarged left atria and Kerley B lines of mitral stenosis, an old tuberculous cavity containing a movable mass suggestive of an aspergilloma, or a central mass associated with loss of lung volume distal to the mass suggestive of a bronchogenic carcinoma. Great caution should be exercised in ascribing the site of bleeding to an abnormality, shown on x-ray study of the chest, that could be associated with hemoptysis. At bronchoscopy, the bleeding site has occasionally been identified elsewhere.[28]

The finding of no abnormalities on an x-ray film of the chest in a patient with hemoptysis should not preclude the consideration of additional diagnostic studies such as bronchoscopy and bronchography. Hemoptysis may occasionally be the only clinical indication of the presence of a bronchogenic carcinoma[30,31] or bronchiectasis.[30]

All expectorated sputum should be collected in a container placed at the patient's bedside. This will allow both qualitative examination of the sputum (such as for presence of pus) and measurement of the quantity of expectorated blood. The latter is particularly important since the patient's estimation of the amount of hemoptysis is often erroneous.

Special Procedures

Bronchoscopy

Hemoptysis is reported to be the most common indication for endoscopic examination of the tracheobronchial tree.[33] Although other studies are helpful in establishing the site and cause of the hemoptysis, bronchoscopy is often needed for both definitive diagnosis and localization. In patients with mild to moderate bleeding, bronchos-

copy has in our experience been used primarily to exclude bronchogenic carcinoma as the cause. In many cases of nonmassive hemoptysis, the cause is obvious and bronchoscopy is not necesary. Examples include active tuberculosis, pneumonia, pulmonary infarction, bronchiectasis and acute tracheobronchitis. However, even in these pulmonary disorders, if the bleeding is persistent or recurrent, a bronchoscopic evaluation may be required to exclude the presence of a tumor.

Bronchoscopy should be done in all patients with massive hemoptysis to identify the bronchial orifice from which active bleeding is coming; determination of the cause is often less important in the emergency management of the patient. Direct bronchoscopic visualization of the site of bleeding in patients with life-threatening hemoptysis cannot be replaced by the history, physical examination or x-ray film of the chest, which can only suggest the bleeding site,[29] or even by knowledge of a previously known cause and site of bleeding. If an emergency operation becomes necessary to control bleeding, knowledge of the exact site of bleeding is obviously essential.

Whether bronchoscopy should be done during the period of active bleeding has been controversial. Jackson and Diamond recommended that bronchoscopy be postponed until after hemoptysis has subsided for fear of reactivating bleeding.[26] However, the consensus is that bronchoscopy is both safe and highly informative during the period of active bleeding.[2,29,34] Pursel and Lindskog were able to visualize the site of bleeding with a rigid bronchoscope in 86 percent of a group of patients bleeding actively at the time of the procedure, while the bleeding site was identified in only 52 percent of patients in whom active hemoptysis was not present.[2] Using fiberoptic bronchoscopy during the period of active bleeding, Smiddy and co-workers located the source of bleeding in 66 of 71 patients;[29] Rath identified the site of bleeding in 21 of 31 patients.[34] Bronchoscopy did not produce deleterious effects in any of the patients in these three series. These data suggest that there is an advantage to bronchoscopy during active bleeding and that there is relatively little risk.

The fiberoptic bronchoscope has replaced the rigid bronchoscope for evaluation in patients with nonmassive hemoptysis since it is flexible and allows visualization of segmental and subsegmental bronchi, thus increasing the diagnostic yield. In patients with massive hemoptysis, Smiddy and associates successfully visualized the site of active bleeding by systematically lavaging segmental bronchi with a fiberoptic bronchoscope.[29] Despite this recent report, many bronchoscopists still favor the use of the rigid metal bronchoscope during massive hemoptysis,[33,35] since it is easier to maintain vision through the rigid bronchoscope because it has a large channel for aspirating blood. In addition to its diagnostic value, the rigid metal bronchoscope can be used to suction blood clots from the tracheobronchial tree, maintain an airway, provide mechanical ventilation and control hemorrhage (see section on massive hemoptysis, later in the article).

Tomography

Tomography may be of value in selected cases to better show the presence of lung cavities, solid masses, and mediastinal and hilar adenopathy. If broncholithiasis is suspected, tomography may be helpful in demonstrating the antomical relationship of a calcified lymph node to the bronchi.[5]

Ventilation-Perfusion Lung Scanning/Pulmonary Angiography

In patients presenting with the sudden onset of hemoptysis, dyspnea, and pleuritic chest pain, lung scanning or pulmonary angiography, or both, may be needed to diagnose pulmonary infarction. In addition pulmonary arteriovenous anastamoses, which may be responsible for hemoptysis in patients with or without Rendu-Osler-Weber disease, may be visualized by pulmonary angiography. The presence of a pulmonary arteriovenous communication is suggested roentgenographically by the appearance of a somewhat lobulated sharply defined round or oval homogeneous density which decreases in size during the Valsalva maneuver.

Bronchography

In patients with unexplained recurrent hemoptysis, a chronic cough productive of purulent sputum, and abnormalities shown on an x-ray film of the chest, bronchography should be considered to determine the presence and extent of bronchiectasis. A normal finding on an x-ray study or absence of a productive cough does not exclude bronchiectasis as a possible cause of hemoptysis. In one study 7 percent of patients with significant bronchiectasis had normal roentgenograms,[36] while in another study, 22 patients or 3 percent of all patients with bronchiectasis had no history

of a chronic productive cough or recurrent acute respiratory tract infection; that is, had so-called "dry bronchiectasis."[32] It is significant that in this group of patients with "dry bronchiectasis," hemoptysis was present in approximately half.

Bronchography should generally be done after active bleeding has subsided. During active bleeding or after recent bleeding, the procedure not only is technically difficult but results may be misleading, since clots within the bronchi may cause irregularities of contour or a failure of normal filling.[2,5,8] Furthermore, the injection of a bronchographic dye may produce additional respiratory embarrassment in a patient who is actively hemoptysizing and aspirating blood.[37,38]

Selective Bronchial Arteriography

Selective bronchial arteriography (SBA) was recently used in an attempt to identify the site of massive pulmonary hemorrhage in six patients with cystic fibrosis.[22] Extravasation of contrast medium was observed in one patient and in two others enlarged bronchial arteries were found in a single lobe. Findings on selective bronchial arteriography correlated well with bronchoscopic localization of the bleeding site. In the remaining three patients, SBA was normal or showed diffuse abnormalities of the bronchial vasculature.

Selective bronchial arteriography may be of value if bronchoscopy has failed to identify the site of massive bleeding. However, since experience with SBA is limited, it should not supplant bronchoscopy which remains the most reliable method of localizing pulmonary hemorrhage.

Hemoptysis of Unexplained Cause

The relative frequency of unexplained hemoptysis in various studies has ranged from 0.5 to 58 percent with most values in the range of 5 to 15 percent.[1,2,4,8,26] This variability is due to a number of factors, the most important of which are methods of patient selection and the diagnostic methods employed.

The clinical course of patients presenting with an episode of unexplained hemoptysis was investigated by Douglass and Carr.[39] Fifty-five patients who had hemoptysis for which no cause was found on x-ray films of the chest, bronchoscopy and bronchography were followed for five more years. Nineteen of the patients had additional episodes of bleeding, all but one less in quantity than during the initial episode. However, only one patient was subsequently found to have bronchogenic carcinoma, indicating that patients with unexplained hemoptysis after thorough evaluation have an excellent prognosis for having a benign lesion. These findings were confirmed by Barrett and associates who followed 81 patients with hemoptysis of unknown cause.[40] It is probable that most hemoptysis of unknown origin is due to minor inflammatory disease, such as bronchitis, which is present beyond the field of the bronchoscope, or less frequently to mild bronchiectasis not detected by bronchography.[39]

Massive Hemoptysis

Whether or not hemoptysis should be called massive has usually been arbitrarily based on the amount of blood expectorated. Critical amounts have ranged from 200 to greater than 600 ml in 24 hours.[2,5,41-43] This is a critical definition, since the diagnosis of massive hemoptysis has served as a guideline for the necessity for immediate surgical intervention. However, it is important to note that the mortality rate for pulmonary hemorrhage is more closely related to the severity of obstruction of the tracheobronchial tree than to the amount of blood loss.[5,44-46] For example, in an obtunded or debilitated patient or in a patient with underlying chronic pulmonary disease, the quantity of blood hemoptysized may be less than that defined as "massive" and yet still be life-threatening.

Chronic inflammatory pulmonary diseases can cause severe bleeding, especially when associated with destruction of pulmonary tissue. It is, therefore, no surprise that tuberculosis, both active and arrested, is the most frequent cause of massive hemoptysis[41,42] and together with bronchiectasis,[29,42] pulmonary abscess[47,48] and aspergilloma[23] account for most cases.[49] Less common causes of massive hemoptysis include rupture of an aortic aneurysm into a bronchus, Goodpasture syndrome, systemic disorders associated with a bleeding tendency (such as leukemia), cystic fibrosis,[28] localized pulmonary bullae,[50] acquired[51] and congenital[52] heart disease, bronchial adenoma, and iatrogenic causes such as percutaneous or transbronchial lung biopsy, tracheal-innominate fistula due to tracheostomy, transtracheal aspiration and anticoagulation therapy. Although bronchogenic carcinoma is a cause of massive hemoptysis, bleeding in this disease is characteristically minimal but persistent.[2,4]

Massive hemoptysis treated nonsurgically has been associated with a high mortality rate.[41,42]

In one series 54 percent of patients who had hemoptysis of 600 ml or more in 48 hours and who were managed nonsurgically died; among patients who bled more than 600 ml in 16 hours mortality exceeded 75 percent.[41] In view of this high mortality rate in patients treated conservatively, an aggressive surgical approach has been advocated in the management of massive hemoptysis. In a nonrandomized study, Crocco reported 81 percent survival of 32 patients treated surgically compared with survival of only 1 of 9 (12 percent) patients treated nonsurgically.[41] Similar data favoring early thoractomy in patients with massive bleeding has been reported by others.[5,35,43,46,53]

Rigid bronchoscopy under topical anesthesia should be done in all patients with massive hemoptysis, occasionally even before less invasive diagnostic studies have been completed, since immediate endoscopic localization of the bleeding site is essential. The procedure should preferably be carried out in the operating room in case emergency thoracotomy is necessary. Although Bahabozorghi and co-workers felt that bronchoscopy was dangerous in patients with massive hemoptysis, and therefore recommended resecting the area shown to be abnormal on an x-ray film of the chest,[46] most other surgeons agree that inability to locate the bleeding site by endoscopy is a contraindication to surgery.[35,41,42,54]

If the bleeding site can be found, the endoscopist can attempt to control the hemorrhage through the bronchoscopic lumen by applying a sponge with dilute adrenalin or topical thrombin to the area of bleeding. If this is unsuccessful, the bronchus can be packed with sponges,[55] or a Fogarty catheter can be placed through the lumen of the rigid bronchoscope into the bleeding bronchus and the balloon inflated to tamponade the area.[56,57] Recently, this catheter has also been successfully passed into a bleeding bronchus through the suction channel of the fiberoptic bronchoscope.[58,59]

After the site of massive bleeding is identified, and a surgical approach decided upon, the patient should be anesthetized and intubated in preparation for emergency thoracotomy. Although a double-lumen Carlens endotracheal tube has been designed to prevent blood spreading from one lung to the other, its use is no longer recommended because of the expertise required for its insertion and because of its small lumen.[46,53,56] A large bore endotracheal tube is more effective because it is better for aspirating blood clots and can be placed in the mainstem bronchus of the nonbleeding lung to protect that lung from further aspiration of blood during the operation.[5,54]

Not all patients with massive hemoptysis can be managed surgically. A patient with severe chronic obstructive pulmonary disease or far advanced cavitary tuberculosis may not have enough pulmonary reserve to survive a surgical procedure or may end up a respiratory cripple. Many criteria based on pulmonary function studies have been proposed for evaluating the risk of pulmonary resection. However, pulmonary function studies including simple spirometry may be difficult or impossible to carry out in patients with unrelenting hemoptysis. Furthermore, the validity of criteria used to exclude patients as surgical candidates is questionable following recent aspiration of large amounts of blood.

There are occasional cases of massive hemoptysis that are best treated by modalities other than pulmonary resection. Examples include massive hemoptysis due to mitral stenosis which should be treated by mitral commisurotomy or valve replacement;[51] pulmonary hemorrhage due to a bleeding disorder where therapy should be directed toward correction of the bleeding tendency when possible; the diffuse bleeding of Goodpasture syndrome which cannot be treated by localized surgical resection but which may respond to high dose steroids[60] or bilateral nephrectomy.[61] Finally, in patients with metastatic bronchogenic carcinoma surgical therapy for massive hemoptysis generally should not be carried out because of the very poor prognosis.[41,54]

Patients with massive hemoptysis who are not surgical candidates, such as those in whom the site of bleeding has not yet been identified, should be placed in a critical care unit and receive the following intensive medical management:

- Most important is the maintenance of the airway which may necessitate intubation or rigid bronchoscopy to suction blood.
- Proper positioning of the patient including slight Trendelenberg position to promote drainage, and the lateral decubitus position with bleeding side down (if known) to decrease the amount of blood spillage into the normal lung.
- Arterial blood gas studies as a guide to oxygen therapy and need for assisted ventilation.
- Small doses of sedatives to decrease anxiety; cough depressants such as codeine are contraindicated.

- Platelet count and coagulation studies; specific replacement therapy when possible.
- Serial hematocrits to determine need for transfusion.
- Bronchodilators for patients with chronic obstructive pulmonary disease to improve reversible airway narrowing; intermittent positive pressure devices to deliver bronchodilators should be avoided.

When an adequate airway and acceptable oxygen tension cannot be maintained because of massive pulmonary hemorrhage in a patient who is not a surgical candidate, extracorporeal membrane oxygenation should be considered in select cases. This procedure recently proved lifesaving in a patient with massive hemoptysis due to Goodpasture syndrome.[62]

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