Control of Massive Hemorrhage During Bronchoscopy

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INTRODUCTION

There are few things as terrifying as the onset of massive bleeding during bronchoscopy. Suddenly, vision through the bronchoscope is gone. Blood pours into and from the bronchoscope, perhaps in a steady stream. Since the patient's cough reflex has been abolished, either by topical or general anesthesia, the tracheobronchial tree fills rapidly with blood and spontaneous or assisted respiration is no longer possible. The onset of anoxia is within moments. Hypoxic cardiac arrest and death will ensue if prompt action is not effectively taken.

There are few experienced endoscopists who have not faced this problem. Conversations with colleagues indicate that death from hemorrhage and asphyxia is too often the result. The literature is remarkably sparse on this subject. Jackson, when discussing hemoptysis in 1922, stated that "it is mechanically easy to pack off one bronchus with the author's packs introduced through the bronchoscope, but the advisability of doing so requires further clinical tests." Boyer in 1939, reported a death due to massive hemorrhage following a carefully considered biopsy of a mass in the left lower lobe "branch bronchi." Kernan in a discussion of Boyer's work stated that "as to hemorrhage during bronchoscopy, it is by far the most dangerous complication that can occur. It is probably best, if bleeding starts during biopsy, to keep the bronchoscope in place and suck away the blood till the bleeding stops." Hamilton and Walker in 1956, stated that "massive hemorrhage occurring as a complication of bronchoscopy is fortunately an uncommon occurrence. However, it does occur and usually ends fatally within a few minutes." They reported the treatment of bleeding following biopsy of a left lower lobe lesion. Their "treatment" consisted of removing the bronchoscope and inserting a cuffed endotracheal tube into the right main bronchus. An emergency nonsterile left pneumonectomy was done. The patient died during the early postoperative period. They recommended this technique although they had used it once unsuccessfully. Pecora reported successful treatment of a patient by packing the involved bronchus with a long strip of narrow gauze through the bronchoscope, maintaining both the gauze and the bronchoscope in place for about one-half hour. He stated the "method had been successfully employed by others.‖ Wilkins, Darling, Souther and Sniffen in a clinical survey of adenomas of the trachea and bronchus in 1963 reported two fatalities from hemorrhage following biopsy. Goldman and Harris reported a "series of patients demonstrating the protean nature of hemoptysis and the spectrum of diseases which represent the pathologic substrate for hemoptysis." They reported one death in endoscopy and pointed out the pitfalls of emergency pulmonary resection in that a source of bleeding may never be identified in the resected specimen or at autopsy. They also reported cases of continuing hemoptysis following resection. While their paper did not deal with the control of massive hemorrhage occurring during bronchoscopy, they did report control of bleeding during bronchoscopy in one case by "packing with an Adrenalin soaked sponge."

Certainly, massive hemorrhage during bronchoscopy does occur more often than these few entries in the literature would lead the neophyte to believe. As with most surgical emergencies, a consistently successful conclusion depends upon routinely having an adequate number of trained personnel, an adequate and proper setup of instruments and supplies, and a plan of action. For this reason it is felt worthwhile to review the author's experience.
with four cases of massive hemorrhage during bronchoscopy over the past 12 years and to outline the routine preparations and techniques which make control of this deadly emergency possible.

**Personnel**

Some find it possible to perform "adequate" diagnostic endoscopies with little help, even holding the patient's head themselves. Certainly a better examination is possible with a trained person (called "second assistant" by Jackson) to hold the head and a trained person to pass instruments as well as at least one other to circulate. We consider this the absolute minimum in personnel for adequate and safe endoscopies. In an emergency situation inadequate staff can court disaster. This assumes use of the Boyce position which Jackson had repeatedly stressed is best for transbronchoscopic procedures requiring exposure, precision, and avoidance of loss of time plus best possible drainage of secretions (or blood). These are all certainly of paramount importance in handling massive hemorrhage.

**Proper Equipment**

Having adequate equipment available and properly set up with standard positions for personnel and equipment is of utmost importance in facilitating bronchoscopic examinations and handling emergencies. Our routine room arrangement is illustrated in Figure 1.

**Figure 2.** Instrument table setup and minimum instrumentation for peroral bronchoscopies. (1) Surgeon's gloves; (2) straight Mayo scissors; (3) medical glass containing 1 ml of 1:1000 Adrenalin diluted to 10 ml with normal saline. (4) Bronchial washings collection tubes. (5) tonsil suction tip (above) and Morrison flexible tip suction, straight and curved (below). (6) Medicine cups for biopsies. (7) Syringes—two 10 ml Luerlok; (8) Jackson laryngoscope (16 cm), two light carriers, suction tip. (9) Right angle telescope; (10) 2 safety pins. (11) 2-18 gauge needles (1-½" long); (12) 2 Coolidge or Jackson sponge carriers; (13) 2 foreign body forceps. (14) Clerf specimen collector; (15) biopsy forceps, straight and sidebiting. (16) Extra light carriers. (17) Bronchoscopes (7 mm x 40 cm) and (8 mm x 40 cm) for adults or a selection of appropriate sizes for children. (18) Open-end suction tip; (19) suction tubing; (20) emesis basin with warm normal saline. (21) Towel clips; (22) sponges. (23) Towels.

Other assorted forceps, bronchoscopes, suction tips and other spare equipment and supplies are available in the room. These include topical thrombin, sparse suction tubing, battery boxes and battery cords for bronchoscopes and right angle telescope.
The minimum instrument table setup for bronchoscopy is illustrated in Figure 2.

A PLAN OF ACTION

When massive bleeding starts during bronchoscopy, procedures for control, for assuring continuity of the patient’s airway and providing adequate oxygenation are the same whether the bronchoscopy is conducted under topical or general anesthesia. In fact, if under topical anesthesia the patient becomes frantic or overly anxious or if the topical anesthesia becomes inadequate, induction of general anesthesia, once initial control of hemorrhage is obtained, may make complete control of the emergency safer and easier.

For bronchoscopy under general anesthesia, we prefer the anesthesiologist to intubate the adult patient with a 5 to 6 mm, noncuffed tube. The bronchoscope is passed anteriorly to the tube. The patient is ventilated with an anesthetic-oxygen mixture. Ventilation is periodically augmented by the endoscopist who obstructs the end of the bronchoscope in unison with the anesthesiologist’s squeezing the bag of the anesthesia machine.

A. Do Not Withdraw the Bronchoscope!

This is the cardinal rule for controlling hemorrhage occurring during a bronchoscopy. When blood obscures the light and pours from the bronchoscope, this may be the neophyte’s first reaction. If the bronchoscope is withdrawn and bleeding is extensive, proper position of the instrument for control may never be recovered.

B. Put Table in Trendelenburg Position

The trachea courses dorsally from the larynx. Placing the operating table in about 15° headdown position helps drainage of blood and secretions through and about the bronchoscope. An assistant may remove blood from the mouth and pharynx by using the tonsil tip suction with a separate suction source.

C. Attach Oxygen Tube to Sidearm of Bronchoscope

Under topical anesthesia ventilation may be assisted or oxygen “insufflated” as described by Jackson.1 When necessary to induce general anesthesia with the bronchoscope in place, general anesthesia may be maintained by ventilating the patient with an oxygen-gas mixture by “thumbing” the bronchoscope. If hemorrhage occurs under general anesthesia, a tube from an oxygen source is attached to the sidearm or “branch tube” of the bronchoscope to augment the anesthesiologist’s efforts with this periodic ventilation technique.

D. Start Intravenous

An assistant performs either a venipuncture with a large gauge needle or a venous cutdown in order to replace blood loss and to administer intravenous medications as needed.

E. Draw Blood Clot

The clot is drawn as the intravenous is started so that the patient’s blood may be typed and crossmatched for replacement.

F. Apply Suction

The open-end suction tip is introduced and positioned to the side of the bronchoscope and a strong vacuum applied in an attempt to visualize the source of bleeding to allow direct application of diluted adrenalin packs.

G. Apply Adrenalin and Pressure

Diluted Adrenalin is applied with the Jackson bronchoscopic sponge in a sponge carrier. This may be held in contact with a small bleeding area for several minutes and may stop moderate bleeding.

H. Pack the Bronchus

If the above measures do not serve to control the hemorrhage, the bronchus must be packed without hesitation. Generally the bronchi are semirigid structures and ideal for packing. Bleeding from the smaller bronchi such as segmental or middle lobe may often be stopped by occluding the bronchial orifice with one or two Jackson bronchoscopic sponges introduced with the sponge carrier or foreign body forceps. Larger lobar or main bronchi may be packed with part or all of an opened laparotomy sponge using foreign body forceps.

Once the pack is in place the bronchoscope may be moved to aspirate blood and clot from the remaining tracheobronchial tree.

I. Lavage the Bronchi

After aspirating the majority of blood and clots and ventilating the patient well, the unpacked portion of the tracheobronchial tree should be repeatedly irrigated with 10 ml aliquots of warm sterile saline which are aspirated to remove clots from smaller branch bronchi.

J. Remove or Replace the Pack

Blood clots quickly in the lung. After replacing the lost blood with blood and/or fluids, assuring a clear airway and good oxygenation, and allowing the patient’s condition to stabilize, one may approach removing the pack.

Another suitable pack should be in readiness in case bleeding should recur. We have found it useful to make a thick paste of topical thrombin and to coat the replacement pack with this paste. This paste seems to hasten clotting and results in a firmer clot.

When the pack is teased out of the bronchus, a careful inspection should be made to assure that bleeding has stopped. The area may be washed with warm saline which may be aspirated, but vigorous suction to the immediate area from which bleeding occurred should be avoided. Only after assuring that bleeding is stopped, the airway is clear, and the patient’s condition is good should the bronchoscope be removed.

The following cases are presented to illustrate the use of these techniques in various situations. While these methods have been utilized to control lesser bleeding, it is felt that these four instances have provided a real test.

REPORT OF CASES

CASE 1

This 54-\text{yr-old} white woman was hospitalized in September, 1956, with a 13-year history of an estimated 24 episodes of hemoptysis.

The day of admission she began to cough up large amounts of blood and continued to do so for three days. She was treated with bedrest, sedation, and multiple whole blood transfusions. She was seen in consultation and bronchoscopy recommended to control the bleeding if possible.
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and to determine the source of bleeding in case emergency resection should be necessary.

Chest roentgenograms revealed scattered infiltrates bilaterally but primarily on the left with some loss of volume of the left lower lobe.

Under topical tetracaine (Pontocaine) anesthesia, a No. 7–40 Jackson bronchoscope was passed with ease. The tracheal mucosa, carina, and right-sided bronchi appeared normal except for flecks of old blood in the right lower lobe and basilar segmental bronchi.

The bronchoscope was passed on to the left side and bright red blood was seen rolling from the orifice of one or more segmental bronchi of the left lower lobe making visualization of the left lower lobe difficult. A roughened, fungating area was noted on the anterolateral aspect of the left lower lobe bronchus just proximal to the take-off of the basilar segmental bronchi. A biopsy was taken. Even brisker bleeding ensued with obliteration of the light. After suctioning, the area was sponged with 1:10,000 Adrenalin solution. Bleeding continued actively and two bronchoscopic sponges in a single bronchoscopic sponge carrier were wedged into the lower lobe bronchus. With this pack in place the right bronchial tree was lavaged with warm saline and aspirated until clear. The original pack was removed and replaced with two bronchial sponges coated with topical thrombin. These were left in place for five minutes and then gingerly removed. No further bleeding occurred. The right tracheobronchial tree was again lavaged and aspirated. The bronchoscope was withdrawn. Approximately 550 ml of blood was in the suction bottle at the end of the procedure with additional blood on the surgeon and the floor.

The biopsy proved the fungating area to be bronchial adenoma. The patient underwent a successful left lobectomy two days later without further bleeding.

Case 2

This 52-year-old colored woman was seen in the outpatient clinic in April, 1959, with a febrile illness and a cough productive of large amounts of greenish sputum. Chest roentgenograms revealed no aerated lung on the left. Broad spectrum antibiotics were prescribed because the patient refused hospital admission. She returned six weeks later still febrile with a productive cough. The past history revealed that she had been treated for syphilis seven years previously. Atelectasis of the entire left lung persisted. Bronchoscopy was recommended.

The thoracic surgical resident administered topical Pontocaine anesthesia after appropriate premedication and passed a No. 7–40 Jackson bronchoscope without difficulty. The carina was shifted to the right but the right-sided bronchi appeared normal. Just below the carina on the left he encountered a lesion nearly completely obstructing the left main bronchus. A suction tip was passed beyond the obstruction and a large amount of pus followed by some bright red blood was aspirated. The bronchoscope was withdrawn approximately 1.0 cm and massive bright red hemorrhage occurred. When the author entered the room there were approximately 1,500 ml of blood in the suction bottle. The resident, the floor and the wall were liberally coated. Fortunately, the resident had not withdrawn the bronchoscope.

A standard laparotomy sponge was opened to its greatest length and the left main bronchus quickly packed. With oxygen attached to the sidearm, the bronchoscope was then withdrawn into the trachea and the blood and blood clots removed by lavage and aspiration. When the right bronchial tree was clear, general anesthesia was administered. After giving 1,500 ml of lactated Ringer's solution intravenously, the patient's blood pressure stabilized. The left main bronchus was quickly repacked with another laparotomy sponge soaked in a thick topical thrombin solution, using foreign body forceps. The second pack was left in place for approximately ten minutes and then removed. No bleeding occurred.

The patient refused surgery for the obvious aneurysm of the aorta with erosion of the main bronchus and was discharged against advice three days later.

Case 3

This 26-year-old white man was admitted to the hospital in June, 1963, with a history of moderately severe hemoptysis of 16 hours' duration. He had coughed up "at least a cup" of blood on two occasions during this period.

Five years previously he had been shot at close range in the right chest with a 30/30 rifle. He had been treated conservatively with debridement of the wound and tube drainage. That admission was followed by an empyema and temporary bronchopleuro-cutaneous fistula which resolved without thoracotomy. Follow-up studies revealed small metal fragments and rib fragments in the pulmonary parenchyma.

He had coughed up a small piece of bone and some blood-streaked sputum 2½ years later. This subsided spontaneously.

Physical examination revealed a small pulmonary hernia in the area of the sixth and seventh ribs. Chest roentgenograms revealed absence of the anterior and lateral portions of the sixth and seventh ribs and deformities of the fifth and eighth ribs on the right, and an infiltrate in the middle lobe. Pieces of bone were noted in the right middle and lower lobes.

Bronchoscopy was planned in an attempt to remove a foreign body (probably old rib fragment) from the middle lobe bronchus and to control hemorrhage. If this was not successful, a thoracotomy and resection were planned.

Under ECG monitoring, general anesthesia was introduced and a No. 8–40 Jackson bronchoscope passed with ease anteriorly to the small endotracheal tube. There was evidence of chronic inflammation of all segmental bronchi of the right lower lobe. The anterior basilar segmental bronchus was narrowed and there was old bloody mucus present.

The middle lobe bronchial orifice was occluded with blood clot. This clot was removed by suction. Its removal was followed by brisk bleeding. The end of the bronchoscope was wedged about the middle lobe orifice. The middle lobe bronchus was sponged with diluted Adrenalin solution and approximately 600 ml of blood aspirated with no evidence of abatement of the hemorrhage. A bronchoscopic sponge on a sponge carrier was wedged into the middle lobe orifice in order to prevent further bleeding. The tracheobronchial tree was lavaged and aspirated.

Two bronchoscopic sponges were tied securely together with a long piece of No. 1 black silk suture and wedged into the middle lobe bronchus with foreign body forceps in place of that held by the sponge carrier. The tracheobronchial tree was then thoroughly irrigated with warm sterile saline and aspirated to remove all remaining blood. The bronchoscope was withdrawn and the small endotracheal tube replaced with a large, cuffed endotracheal tube by the anesthesiologist after first passing the external, free end of the long silk ligature through the larger endotracheal tube.

A saphenous vein cutdown was performed and blood

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transfusion started. The patient was positioned in the left lateral decubitus position and right lower and middle lobe lobectomies were performed. The sponges in the middle lobe bronchus were drawn up through the endotracheal tube by the anesthesiologist just before the middle lobe bronchus was divided.

Pathologic examination of the resected lobes revealed "chronic inflammation and ulceration with bronchial cysts secondary to trauma and foreign bodies (osseous tissue) of the right middle and lower lobes." The bleeding apparently arose from erosion of one of the bone spicules into the middle lobe bronchus. The patient has had no recurrence of hemoptysis.

CASE 4

This 61-year-old white man was admitted to the hospital in October, 1966, because of thoracic back pain of 2½ weeks' duration. He gave a history of having smoked up to three packages of cigarettes a day for 48 years. He had had a chronic cough for years which had become progressively worse and productive of yellowish mucus over the previous few months.

Studies by the referring physician included a chest roentgenogram (Fig 3) which showed an apparent infiltrate in the posterior subsegment of the apical posterior segment of the left upper lobe. In addition, stratigraphs and spot films showed a compression fracture of the lateral aspect of the fifth dorsal vertebra. It was not possible to determine if this was recent or old. The admitting diagnosis was bronchogenic carcinoma of the left upper lobe with probable metastases to the fifth dorsal vertebra and mediastinal lymph nodes.

The day following hospital admission he was scheduled for a bronchoscopy and a cervicomediastinal exploration.

Under general anesthesia with a small endotracheal tube in place, a No. 8-40 Jackson bronchoscope was passed without difficulty. Inflammatory changes of the vocal cords and trachea were noted. The carina was slightly blunted anteriorly but in normal position. On the right side diffuse chronic inflammatory changes of the bronchial mucosa were noted.

There seemed to be an increase in the inflammatory changes on the left side. The proximal lower lobe bronchus was slightly and concentrically narrowed as if by extrinsic pressure. The mucosa was reddened but intact.

The bronchoscope was positioned to inspect the orifice of the left upper lobe bronchus, which appeared normal except for inflammatory changes. As viewed through the right angle telescope, there was marked narrowing of the apical-posterior segmental orifice due to tumor. Immediately after the biopsy there was a massive hemorrhage with full lumen flow of blood from the bronchoscope as well as around the bronchoscope filling the pharynx and mouth. The patient's condition deteriorated rapidly. The bronchoscope was left in place and the left main bronchus was quickly packed with a gauze surgical sponge. After oxygen had been added to the sidearm of the bronchoscope, the remaining blood was aspirated and the right bronchial tree lavaged and aspirated. During the period of brisk bleeding there was a measured loss of over 1,200 ml of blood.

With administration of intravenous fluids the patient's condition improved. Prior to withdrawing the bronchoscope, when no further bleeding was noted, the sponge pack was removed from the left side and the left side gingerly irrigated and aspirated.

It was elected to proceed with the cervicomediastinal exploration because it was felt that the lesion was a bronchogenic carcinoma with metastases and thoracotomy was to be avoided if possible. A node removed from the superior mediastinum yielded a diagnosis of "undifferentiated squamous cell carcinoma" on frozen section. As the supraclavicular wound was being closed in layers, massive subcutaneous emphysema developed. Auscultation revealed a mediastinal click.

A portable chest roentgenogram revealed consolidation of the left lower lobe and marked mediastinal and subcutaneous emphysema.

The bronchoscope was reintroduced and a long rent was noted in the membranous and lateral portion of the left main and lower lobe bronchi. There was no further bleeding. Since the bronchial tear jeopardized the patient's life immediately, thoracotomy was thought necessary in spite of the fact that it had been demonstrated that the bronchogenic carcinoma had metastasized.

A large, cuffed endotracheal tube was introduced and advanced to the right main bronchus. While it had been hoped that a left upper lobe lobectomy with bronchoplasty or repair of the bronchial tear could be performed, it was found that the small primary tumor of the posterior subsegment of the apical-posterior segment of the left upper lobe had metastasized widely to hilar and mediastinal lymph nodes. These lymph nodes involved the main bronchus, the extra-pericardial portion of the left pulmonary artery, and the vagus nerve. There was a large hematoma in this area. A radical intrapericardial pneumonectomy was necessary.

Examination of the resected specimen revealed that large lymph nodes surrounding the bronchus were replaced with carcinoma and largely necrotic. They had eroded a long portion of the bronchial wall including the cartilaginous rings, leaving the bronchial mucosa intact. The tumor had also replaced a good portion of the wall of the pulmonary artery in this area. It was through this neoplasm that the
bronchial tear had occurred into the pulmonary artery.

The patient's postoperative course was uneventful. Follow-up revealed that he died from metastatic bronchogenic carcinoma 1½ months following discharge from the hospital.

**DISCUSSION**

We have made no attempt to define “massive hemorrhage” but do not feel that it is germane to the subject. Certainly in each of these cases bleeding was sufficient to cause asphyxiation and death if not promptly and effectively treated.

We admit to having sanctioned emergency bronchoscopy under less ideal conditions. We do feel, however, that routine diagnostic or therapeutic bronchoscopies should not be performed without the minimum preparations and equipment presented here. Not only will they make for more thorough and productive diagnostic and therapeutic bronchoscopies, but will make it possible to handle successfully the rare emergency such as massive hemorrhage.

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**GEOGRAPHIC DETERMINISM**

Anthropogeography, as developed by Ratzel of Germany and interpreted by Semple of the United States, consists, in essence, of a classification or systematization of natural environment, based on the influence which the different types of environment exercise on human activities. Their approach is being regarded as being definitely determinative and not permissive. The emphasis is thus laid on the side of physical circumstances, and the fixed character of, and the inevitability of, the control exercised in any given set of natural conditions, is dogmatically asserted. To the views of the Ratzelian school the term geographic determinism has been applied. The Ratzelian view may be criticized on the ground that it prejudices that which it purports to investigate and that the facts adduced are insufficient to support the dogma of generalizations. Further, it is clear that man is in many cases the active agent molding nature to his will.


**THE TRAGIC SENSE OF LIFE**

A book with the above title was published by Miguel de Unamuno (1864–1936) in 1912. In it he sees man, the real man, the individual, not the abstract figure of progress report and statistics, as being forever aware of death, and hungering down to the remotest depth of his being for immortality. Man's analytic intellect, his critical reason, only strengthen the denial of what his essential individuality demands against all argument, the conquest of death, eternal life. It is terrible division in him, this endless war between reason and faith, that brings a man a tragic sense of life, and on this dark but secure foundation he can begin to build, despair and agony rising to compassion, compassion to a love of all who share the same hunger and suffering, love to a God who must return it.