Deaths and Complications Associated with Fiberoptic Bronchoscopy*

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A questionnaire was sent to 1,041 owners of fiberoptic bronchoscopes requesting data about complications of bronchoscopic examination; 323 (31 percent) of the questionnaires were returned. From approximately 48,000 procedures, ten deaths were reported and are described. Information about two additional deaths not obtained from data on the questionnaires is also included. All patients who died had either myocardial disease, severe chronic pulmonary disease, serious pneumonia, or cancer. Two deaths were associated with evidence on necropsy of fresh myocardial infarctions that had been unsuspected prior to the procedure. Two deaths occurred after administration of local anesthesia prior to bronchoscopic examination. Two were patients who previously had slowly hemorrhaging tumors that hemorrhaged massively following, respectively, forceps biopsy and saline lavage. Four brushes broke off in bronchi. Ten cardiac arrests and 41 life-threatening reactions to anesthesia also occurred.

Fiberoptic bronchoscopy has been in use in this country since 1969. Since it is better tolerated by patients and permits more extensive visualization of the tracheobronchial tree than does rigid bronchoscopy, fiberoptic bronchoscopy has become a widely used procedure. While this procedure has been the subject of many enthusiastic reports dealing with its advantages, only one report which was based on a questionnaire has dealt exclusively with its complications. Because fiberoptic bronchoscopy is still a relatively new procedure, another questionnaire was devised to review a large number of bronchoscopic examinations.

**MATERIALS AND METHODS**

A new questionnaire was sent to 1,041 known owners of fiberoptic bronchoscopes. Information was solicited regarding the number of procedures and biopsies performed, the anesthetics employed, the method of cleaning the fiberoptic bronchoscope, and the life-threatening complications encountered. Follow-up letters were sent to physicians if a death, broken bronchial brush, or pneumothorax was reported. In addition, two deaths that were not disclosed by data from the questionnaires are also included. All deaths are reported separately because of the multiplicity of risk factors in some patients. Cases included under deaths are not included in the results of other specific complications.

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RESULTS

Of 1,041 questionnaires sent, 323 (31 percent) were returned. Approximately 48,000 bronchoscopic examinations and 6,300 biopsies were reported by the replying physicians. Since the exact number of bronchoscopic examinations could not be verified, incidences of complications were not calculated.

Twelve deaths were reported by 11 physicians, including the two that were not obtained from data on the questionnaires. Of the 12 deaths, two that occurred after the administration of anesthetics but prior to bronchoscopic examination are also included. All data regarding deaths are summarized in Table 1.

Twenty-seven life-threatening cardiovascular complications were reported by 22 doctors, excluding those reported as complications of anesthesia. There were ten cardiac arrests, four hypotensive episodes, three episodes of supraventricular tachycardia, one episode of T-wave changes, one episode of syncope, and eight unspecified reactions.

Fifty-two episodes of life-threatening airway complications were reported by 31 physicians. Bronchospasm was the most common problem and was found in 17 instances. Laryngospasm was reported in seven patients. Eight instances of hypoxia occurred. Hemorrhage was reported to interfere with the airway in five patients. Fifteen unspecified reactions occurred.

Life-threatening reactions to anesthesia were reported in 41 patients by 27 physicians. There were 18 episodes of hypoventilation from excessive premedication that necessitated four instances of intubation and ventilation. There were six episodes of
Table 1—Deaths Associated with Fiberoptic Bronchoscopic Examination

<table>
<thead>
<tr>
<th>Patient, Sex Age (yr)</th>
<th>Source of Data*</th>
<th>Case Description**</th>
<th>Technical Aspects</th>
<th>Circumstances at Death</th>
<th>Pathologic Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, Q</td>
<td>COPD; PaO2, 45 mm Hg; PaCO2, 80 mm Hg; bronchoscopy attempted to remove secretions</td>
<td>Diazepam; tetracaine</td>
<td>Cardiac arrest when bronchoscope inserted into nostril</td>
<td>Unsuspected 2-day-old MI</td>
<td></td>
</tr>
<tr>
<td>2, Q</td>
<td>...</td>
<td>&quot;Uneventful bronchoscopy and brushing&quot;</td>
<td>Died 15 min after bronchoscopic procedure</td>
<td>MI; lung cancer; multiple pulmonary emboli</td>
<td></td>
</tr>
<tr>
<td>3, Q</td>
<td>...</td>
<td>Thiopental general anesthesia</td>
<td>After procedure, hyperventilated and developed bigeminy and cardiac arrest</td>
<td>Severe coronary atherosclerosis; possible MI</td>
<td></td>
</tr>
<tr>
<td>4, M, 70 Q</td>
<td>Hilar mass; MI 2½ mo previously; COPD; VC, 34%; FEV1, 44%; tissue diagnosis needed for radiation therapy</td>
<td>Morphine, 10 mg; Phenobarbital, 50 mg; atropine, 0.6 mg</td>
<td>Hypotension during procedure; died 5 hr later; believed to have MI</td>
<td>Bronchial biopsy: squamous carcinoma</td>
<td></td>
</tr>
<tr>
<td>5, M, 70 Q</td>
<td>Streaking hemoptysis; atelectasis in left upper lobe</td>
<td>...</td>
<td>Slowly hemorrhaging tumor; massive hemorrhage after 30-ml saline lavage and suctioning; died despite introduction of open bronchoscope</td>
<td>Oat cell carcinoma</td>
<td></td>
</tr>
<tr>
<td>6, M, 52 Q</td>
<td>Streaking hemoptysis</td>
<td>...</td>
<td>Slowly hemorrhaging tumor; after forceps biopsy, patient expectorated blood and died</td>
<td>Forceps biopsy: squamous carcinoma</td>
<td></td>
</tr>
<tr>
<td>7, M, 94 Q</td>
<td>Severe pneumonia; &quot;reasonable preoperative blood gases&quot;</td>
<td>Atropine; oxygen via face mask; ECG monitoring</td>
<td>Bradycardia progressing to cardiac arrest</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>8, M, 70 Q</td>
<td>Advanced emphysema; old thoracoplasty; atelectatic lobe</td>
<td>Dyclone (Dyclone)</td>
<td>Cardiac arrest</td>
<td>Epidermoid cancer; advanced emphysema; coronary atherosclerosis; cor pulmonale</td>
<td></td>
</tr>
<tr>
<td>9, ... Q</td>
<td>...</td>
<td>General anesthetic; fiberoptic bronchoscope inserted through open bronchoscope</td>
<td>Died in recovery room</td>
<td>Advanced carcinoma involving heart and major vessels</td>
<td></td>
</tr>
<tr>
<td>10, ... Q</td>
<td>&quot;Patient in extremis&quot;</td>
<td>...</td>
<td>Cardiac arrest</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>11, M, 67 NQ</td>
<td>Mass in right lung; COPD: dyspeptic at rest; sinus tachycardia; no blood gas analysis</td>
<td>Tetracaine</td>
<td>Cardiac arrest after tetracaine, before bronchoscopy</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>12, M, 86 NQ</td>
<td>Chronic respiratory disease; &quot;aspirated chestnut&quot;; gasping, acutely ill; while receiving oxygen at 2 L/min: PaO2, 53 mm Hg; PaCO2, 31 mm Hg; and pH, 7.41</td>
<td>Lidocaine</td>
<td>After bronchoscopy, patient became combative and was given 8 mg of morphine intramuscularly; cardiac arrest 5 min later</td>
<td>Voluminous mucus; severe pneumoniosis and emphysema; cor pulmonale; no chestnut</td>
<td></td>
</tr>
</tbody>
</table>

*Q, Questionnaire; and NQ, Nonquestionnaire sources.

**COPD, Chronic obstructive pulmonary disease; MI, myocardial infarction; VC, vital capacity; FEV1, forced expiratory volume in one second.

convulsion, all felt to be secondary to topical anesthesia. Tetracaine and lidocaine were each implicated in three instances. One cardiac arrest occurred that was attributed to an overdose of tetracaine.

Four brushes broke off in bronchi. Three were reusable brushes of uncertain age; the type and all...
specific data about the fourth are unknown. The three for which specific data are available broke off, respectively, in the right upper lobe, the left upper lobe, and the left lower lobe. One brush was left in place in the left upper lobe for 18 months without complications. Another brush was removed during an exploratory thoracotomy investigating a mass which was subsequently found to be inflammatory. The third broken brush was moved proximally with a biopsy forceps (Olympus) but could not be extracted with it. Full suction adhered the brush and surrounding mucus to the suction channel. The brush was then removed with the bronchoscope.

Twenty-three instances of pneumothorax were reported by 14 physicians. The pneumothoraces occurred with both brush biopsies and biopsies using endobronchial and transbronchial forceps, regardless of whether the instrument was directed under direct visualization, under fluoroscopic control, or blindly. Potentially life-threatening hemorrhage with forceps or brush biopsies occurred in 11 instances. Two other unspecified complications were reported.

A wide variety of agents was used to clean the fiberoptic bronchoscope (Table 2). Iodine and alcohol, separately and in combination, were used most frequently. Water or soap, or both, were used exclusively by 11 physicians. Glutaraldehyde was used by a total of 27 physicians. Sterilization with ethylene oxide gas was used by 38 physicians, of which only 21 used it consistently after each procedure.

DISCUSSION

There have been few reports of deaths associated with fiberoptic bronchoscopic examination. Credle et al. reported four deaths occurring in 24,521 procedures. One death was associated with excessive tetracaine anesthesia; another occurred in a patient with metastatic carcinoma who developed a cardiac arrest. The third death occurred while a seriously ill patient underwent bronchoscopic examination through an 8-mm endotracheal tube, and the fourth was related to an unspecified ancillary procedure. Flick et al. reported a death associated with a transbronchial biopsy in a patient with malignant lymphoma and chronic lymphocytic leukemia. Despite a platelet count of 85,000/cu mm, and a normal prothrombin and partial thromboplastin time, the patient hemorrhaged massively after the biopsy and died.

In this study, all patients who died had at least one of the four following serious underlying illnesses: cardiovascular disease, severe chronic pulmonary disease, pneumonia, or cancer.

Heart disease was known to be present in at least five of the patients who died (cases 1 to 4, and 8). Of the six cases in whom data from necropsies were available (cases 1 to 3, 8, 9, and 12), four had serious underlying coronary atherosclerosis. Patients 1 and 2 were found to have fresh myocardial infarctions at autopsy, indicating that infarctions had occurred at least 12 hours prior to the procedure. Cardiovascular complications were frequently reported in patients who did not die; these included cardiac arrest, hypotension, supraventricular tachycardia, and T-wave changes.

These data demonstrate that a careful evaluation of the patient's cardiovascular status should be performed prior to bronchoscopic examination. The finding of two unsuspected myocardial infarctions indicates that one should be very cautious about performing bronchoscopic examinations in the presence of myocardial ischemia. Since cardiac arrests, arrhythmias, and T-wave changes may occur, patients with cardiovascular disease should be monitored electrocardiographically during the procedure.

Hypoxia was demonstrated in only two patients who died (cases 1 and 12) but was suspected clinically in three others (cases 4, 8, and 11). It is known that determinations of blood gas levels were not obtained in patient 11. The physician of patient 11 candidly stated that had he realized how hypoxic the patient was, he probably would not have performed the bronchoscopic examination.

Hypoxia is a precipitating cause of many cardiac arrests and may be produced by fiberoptic bronchoscopic examination. Therefore, analysis of blood gas levels should be performed prior to bronchoscopic examination in most cases and certainly in all patients where hypoxia is suspected. If the PaO2 is less than 70 mm Hg, supplemental oxygen should be administered through a face mask or through nasal prongs. If the bronchoscope is inserted through an endotracheal tube, oxygen can be administered through a sides-arm adaptor. Patients receiving mechanical ventilation can undergo bronchoscopic examination readily through various adaptors and with little risk, providing the endotracheal tube or tracheostomy is 8 mm or greater in diameter and the patient's tidal volume is maintained.

Although excessive sedation during fiberoptic bronchosopic examination has been reported to cause respiratory depression, it has not been associated with deaths. In this study, excessive sedation may have contributed to the death of three patients (cases 1, 4, and 12). Patient 1 had an arterial carbon dioxide tension (PaCO2) of 80 mm Hg, was given an unspecified amount of diazepam, and died while the fiberoptic bronchoscope was still in his nostril.
Patient 4, a 70-year-old man with severe chronic obstructive pulmonary disease, received 10 mg of morphine and 50 mg of phenobarbital; he was noted to be hypotensive during bronchoscopic examination. The use of morphine in patient 12, when he became agitated after the bronchoscopic examination, was temporally related to the patient's death a few minutes later. Oversedation leading to life-threatening hypoxemia was noted in 18 other instances. In hypoxic and particularly hypercapnic patients, it may be necessary to omit sedation during the procedure. The two senior authors of this report have each undergone transnasal fiberoptic bronchoscopic examination without sedation and found the procedure only mildly uncomfortable.

Credle et al. reported that topical anesthesia used in fiberoptic bronchoscopic procedures caused three respiratory arrests, two seizures, one case of methemoglobinemia, and one death that was mentioned earlier. In our study, tetracaine and lidocaine were the most frequently used topical anesthetics and were responsible for several complications. Tetracaine may have contributed to the death of patients 1 and 11. Both patients died after administration of tetracaine, before bronchoscopic examination began. Tetracaine was specifically implicated in one cardiac arrest and three seizures. Although tetracaine is a very effective anesthetic, it has a very narrow range of safety and has been previously implicated in several deaths. Syncope and cardiovascular collapse may be the first sign of its toxicity. Lidocaine is a safer, though slightly less effective, anesthetic. Seizures, the most common manifestation of this drug's toxicity, were reported in three instances.

Broken brushes constitute an infrequent and hitherto unrecognized problem. Three of the four broken brushes were of a reusable variety; it is not known how often each had been used prior to breakage. One of the brushes had been bent and restraightened prior to the procedure. A manufacturer's representative has told us that if a brush is bent, it should be discarded and not reused, since a bent brush is likely to break if straightened (Mr. Harry Cherin, Service Manager, Olympus Corp. of America, oral communication, fall of 1974). It is apparent that repeated use of brushes is hazardous and that they should be discarded at regular intervals.

One lost brush was left in place for 18 months without complications. Whether other lost brushes would be equally innocuous is unknown. One broken brush was removed by thoracotomy, one by a biopsy forceps and suction, and one by an unknown procedure. There are several devices available for removing foreign bodies with a fiberoptic bronchoscope which could possibly be used to recover a broken brush. Two patients died from sudden hemorrhage following manipulation of an endobronchial carcinoma. The precipitating event was saline lavage in one and forceps biopsy in the other. Both tumors were noted to be hemorrhaging slowly prior to the manipulation but otherwise did not have a characteristic appearance. It is noteworthy that neither tumor was a bronchial adenoma, the tumor usually associated with massive hemorrhage after biopsy.

Life-threatening hemorrhage does not often occur after endobronchial biopsies using the fiberoptic bronchoscope. From among 500 fiberoptic bronchoscopic examinations, Zavala reported six episodes of brisk hemorrhage following forceps biopsies, some of which were transbronchial. Massive hemorrhage is a dreaded complication and is difficult to manage. Since a large volume of blood cannot be rapidly removed through a 2-mm fiberoptic bronchoscopic channel, the fiberoptic bronchoscope should be removed immediately, and an open bronchoscope or endotracheal tube should be inserted. If an endotracheal tube is in place, Zavala suggests rotating the patient so that the hemorrhaging side is down, aspirating blood with a large suction catheter, and administering oxygen through nasal and endotracheal routes simultaneously. If the hemorrhaging persists, he recommends insertion of a rigid scope and gauze packing of the segmental bronchus.

Pneumothoraces occurred with brush, endobronchial, and transbronchial biopsies whether the biopsy instrument was directly visualized, with fluoroscopic guidance, or blindly. Data are insufficient to correlate the relative incidence of pneumothorax with each technique. Pleuritic pain indicates that the biopsy instrument is in contact with the pleura. If this occurs, the instrument should be withdrawn and reinserted. Using this technique coupled with fluoroscopic guidance, Schoenbaum et al. encountered no pneumothorax in 350 transbronchial forceps biopsies on 160 patients.

A surprisingly wide variety of agents was employed to clean the fiberoptic bronchoscope (Table 2). Sackner has recently reviewed various methods of cleaning this instrument. Ethylene oxide gas is the most effective method but requires 8 to 12 hours. Sterilization performed by soaking the bronchoscope in a number of agents has produced cultures that were negative for ordinary pathogens but does not sterilize the handle. Glutaraldehyde is a very effective germicide but is reported to damage the fiberoptic bronchoscope if there is a leak in the outer sheath (Mr. Harry Cherin, Service Manager,
Olympus Corp. of America, oral communication, fall of 1974).

Although fiberoptic bronchoscopic examination is a relatively safe procedure, deaths and other serious complications can occur. A careful cardiovascular and pulmonary evaluation prior to bronchoscopic examination is essential. Blood gas analyses should be obtained in most cases and certainly in all patients where hypoxia is suspected. Patients with cardiovascular disease should be monitored electrocardiographically; those with a PaO₂ of less than 70 mm Hg should receive supplemental oxygen.4 Sedatives and local anesthetics should be employed judiciously, particularly tetracaine. Resuscitative equipment must be readily accessible. Repeated use of biopsy brushes is hazardous, and a brush with a bent tip should be discarded. If a patient experiences pleuritic pain during a biopsy, the biopsy instrument should be withdrawn and reinserted. Use of these simple precautions should minimize serious complications associated with fiberoptic bronchoscopic examination.

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REFERENCES

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