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Indications, results and complications of flexible fiberoptic bronchoscopy: a 5-year experience in a referral population in Greece

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Abstract. – The aim of this study was to retrospectively review the indications, results and complications of flexible fiberoptic bronchoscopy (FFB) in an University teaching Hospital. Also, we present the radiological findings for the major causes according to computed tomography of the chest performed within 48 h of fiberoptic bronchoscopy.

A total of 4,098 FFBs were performed from January 1, 2003 to December 30, 2007. For diagnostic purposes, 3769 FFBs performed (92%) and for therapeutic purposes 329 FFBs (8%) performed.

Haemoptysis was the most common indication for FFB (21%), followed by fever/suspected infection (19%) and chronic cough (18%). The most common results of the diagnostic workup was nonspecific inflammation of the tracheobronchial tree (31% for haemoptysis, 38.7% for fever and 48.5% for chronic cough), with malignancy ranking second (17%, 26.1% and 26% respectively). The cytological results showed adenocarcinoma to be the most common lung cancer in both sexes (37.3% for men and 39.7% for women). The mortality rate was 0.04% and the frequency for major and minor complications was 0.56% and 0.33%, respectively.

In conclusion, flexible fiberoptic bronchoscopy is a safe procedure and can play a major role in both diagnosis and treatment, as long as the requisites of preparation and supervision are followed.

Key Words:

Chronic cough, Complications, Flexible fiberoptic bronchoscopy, Haemoptysis, Indications, Malignancy.

Abbreviatons

apt = activated partial thromboplastin time
BAL = Bronchoalveolar lavage
FFB = Flexible fiberoptic bronchoscopy
PT = Prothrombin time
SEER = Surveillance epidemiology and end results
CT = Computed tomography
HRCT = High-resolution computed tomography

Introduction

To our knowledge, there has not been a recent review that summarizes the major diagnostic indications for bronchoscopy or the CT findings associated with the most common causative aetiologies that lead a patient to be bronchoscopied. Also we mention the most common complications that we encountered. The aim of this study is a retrospective review of the above mentioned queries. A total of 4,098 consecutive flexible fiberoptic bronchoscopies (FFB) were performed at a large University teaching Hospital.

Materials and Methods

Data Collection

This retrospective study reviewed 4,098 consecutive bronchoscopy reports of FFBs performed in the tertiary University Hospital in Patras in Southwest Greece between January 1, 2003 and December 30, 2007. Each FFB report, completed by the attending physician and the bronchoscopy technician, contained the indication, anesthesia, findings, and complications. For each and every one of our patients, a bronchoscopy report was created and also the patient

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was under constant supervision for post-bronchoscopy complications including death, for 4 h following the procedure.

We did not document the incidence of fever, hypotension, or arrhythmias in this study. We did document the number of patients unable to complete the examination due to various reasons (lack of cooperation, high blood pressure, low oxygen tension, etc.). Most (82%) of the FFBs were performed by a pulmonary fellow in training under the supervision of an attending pulmonologist. The remainder of the procedures were performed by the attending staff of the Pulmonary Division.

Procedure Protocol

Informed consent was obtained from all patients in a written form. They were maintained without oral intake for at least 6h prior to the procedure. Platelet count >60,000/μL was ensured, along with normal prothrombin time (PT) and activated partial thromboplastin time (aPTT) were required if transbronchial biopsy, endobronchial biopsy, or brushings were performed. Subjects were premedicated with 0.4 mg IM atropine 30 to 45 minutes prior to the procedure, except patients with contraindications. Oxygen saturation was monitored via a continuous pulse oximeter, and supplemental oxygen was provided to maintain oxygen saturation >90%. Selected patients (for instance, those with coronary disease or known history of arrhythmias) were monitored with continuous electrocardiogram tracings. For conscious, spontaneously breathing patients, anesthesia was initiated with 4% atomized lidocaine hydrochloride until the gag reflex was extinguished. Just before insertion of the bronchoscope, 2 to 3 mL of 2% viscous lidocaine was applied to the nose. Midazolam (0.07 mg/kg) was administered intravenously in incremental doses to achieve conscious sedation, before and after the insertion of the bronchoscope. The bronchoscope was introduced via the transnasal route or rarely through the transoral route in those patients that had obstructed nasal passages. Additional anesthesia was administered via the bronchoscope by directly spraying 2-mL aliquots of 1% lidocaine on the endobronchial tree. The total dose of lidocaine was kept less than 600 mg. The maximum permissible dose of lidocaine was decreased 20% for patients under 50 kg and increased 20% for patients over 70 kg.

Bronchoalveolar lavage (BAL) was performed by wedging the bronchoscope in the desired lung segment and performing serial lavage and suctioning of 20 mL aliquots of sterile saline solution up to a total of 100 mL.

Transbronchial biopsy was performed under fluoroscopic guidance. The bronchoscope was wedged in the desired segment and maintained in that position throughout the biopsy. The biopsy forceps was then passed through the suction channel and extended to the lung periphery. If the patient reported pain, the forceps was immediately withdrawn several cm. Once the forceps was in proper position, the patient was asked to exhale completely. As the patient exhales, the forceps was advanced 1 to 2 cm in an open position, closed, and then removed from the bronchoscope to obtain the specimen. This procedure was repeated three to five times to obtain adequate samples.

HRCT scans were performed on a Siemens Somatom Plus (Siemens, Erlangen, Germany) scanner during breathholding at full inspiration. A set of scan images consisted of nine HRCT slices from the sternoclavicular joint down to the bottom of the lungs. The 1 mm collimation scans were performed at 10 mm intervals. Intravenous contrast was administered only as needed to assess equivocal mediastinal and/or hilar abnormality.

Results

Indications

A total of 4,098 bronchoscopies were performed of which 3769 (92%) were performed for diagnostic purposes and the remaining 329 (8%) were performed for therapeutic purposes. From these patients, 2412 (64%) were hospitalized in our ward while the remaining 1686 (36%) were examined as outpatients. We divided our patients according to their sex and age (<40 years old or >40 years old). The major diagnostic indications included haemoptysis (21%), fever/suspected infection (19%) and chronic cough (18%). Dyspnoea and chest pain represented 6% and 5% of the total, respectively. Those that bronchoscopied for suspicious/abnormal lesions on a chest radiograph represented about 14% of the total. Those with a history of malignancy to another site were bronchoscopied because of lesions found inside the lung parenchyma and was deemed necessary

Table I. Most common indications for performing flexible fiberoptic bronchoscopy.

Causes for bronchoscopy	Men		Women		Total	% of total
	< 40 years old	*> 40 years old*	*< 40 years old*	*> 40 years old*		
Haemoptysis	108	516	56	116	796	21.12%
Chronic cough	48	416	14	208	686	18.20%
Fever	60	420	14	224	718	19.05%
Abnormal radiological findings of unknown aetiology	23	337	17	146	523	13.88%
Lobectomy stump check	4	108	4	20	136	3.61%
History of malignancy to another organ	4	128	6	28	166	4.40%
History of tuberculosis	12	68	25	24	129	3.42%
Dyspnoea	40	120	12	40	212	5.62%
Chest pain	8	120	23	48	199	5.28%
Other causes (positive Mantoux reaction, hoarseness, etc.)	28	92	28	56	204	5.41%
Total	**335**	**2325**	**199**	**910**	**3769**	**100.00%**

to clarify whether they had metastatic disease or had newly developed lung carcinoma. They represented about 4% of the total. Those with a history of tuberculosis were bronchoscopied because they presented with fever, dyspnoea, or had developed new lesions in a routine chest CT as part of a follow-up. They accounted about 3% of the total. Finally, 5% of our patients were bronchoscopied for other causes such as vocal cord paralysis, unexplained pleural effusion, positive Mantoux reaction and need for corticosteroid therapy, superior vena cava syndrome along with the presence of a mediastinal mass, inhalation injury (Table I).

Concerning the FFBs done for therapeutic purposes, 5.8% of all FFBs were done to restore airway patency and treat atelectasis from mucous plugs and retained secretions with a small number of them (2.6%) done during general anesthesia through an endotracheal tube due to respiratory insufficiency, under the surveillance of an experienced anesthesiologist. The remaining 2.3% of all FFBs involved removal of foreign bodies and assistance in difficult intubations (Table II).

A total of 796 patients were bronchoscopied for haemoptysis, with 624 being men and 172 women (male:female ratio = 3.6:1) The length of the tracheobronchial tree was inspected for endobronchial lesions and bronchial washings as well as post-bronchoscopy sputa were sent for microbiological and cytological studies. Where indicated, protected-specimen brushing of the endobronchial mucosa or endo- or transbronchial biopsy was performed. The most common cause identified was non-specific inflammation of the tracheobronchial tree (31%), compatible with infection. Pneumonia (compatible clinical and radiological profile) represented 18.2% of the total, while tuberculosis about 8%. It is striking that about 17% of our patients were found to have endobronchial lesions that proved to be malignant (almost 1 in every 5 patients) (Table III).

Table II. Indications for performing therapeutic bronchoscopy.

Therapeutic FFBs	Number	Frequency	Of all FFBs
Restore airway patency/treat atelectasis	237	72.04%	5.80%
Removal of foreign bodies	56	17.02%	1.36%
Assistance in difficult intubations	36	10.94%	0.87%
Total	**329**	**100.00%**	**8.03%**

Table III. Most common bronchoscopical findings in patients presenting with haemoptysis.

Causes for haemoptysis	Men		Women		Total	% of total
	< 40 years old	*> 40 years old*	*< 40 years old*	*> 40 years old*		
Inflammation of the tracheobronchial tree	56	156	5	30	247	31.03%
Tuberculosis	6	50	5	5	66	8.29%
Malignancy	2	116	1	17	136	17.09%
Pneumonia	14	92	17	22	145	18.22%
Failure to cooperate	18	29	10	20	77	9.67%
Without gross pathological findings	12	73	18	22	125	15.70%
Total	**108**	**516**	**56**	**116**	**796**	**100.00%**

Also, we present the radiological findings of chest computed tomography done within 48 h of performing fiberoptic bronchoscopy. It can be shown, bronchiectasis was the identified cause in almost 20% of patients (Table IV and Figure 1).

A total of 686 patients were bronchoscopied for chronic cough (more than 12 weeks duration). There were 464 men and 222 women (the male:female ratio was 3:1). The length of the tracheobronchial tree was inspected for endobronchial lesions and bronchial washings as well as post-bronchoscopy sputa were sent for microbiological and cytological studies. Where indicated, protected-specimen brushing of the endobronchial mucosa or endo- or transbronchial biopsy was performed. Again, the most common cause was inflammation of the tracheobronchial tree (48.5%). It is important to notice that endobronchial findings compatible with malignancy were noted to 26% of our patients i.e. about 1 in every 4 patients. About 17.3% of our patients had no gross pathological findings that could explain their chronic cough (Table V).

Next, we present the radiological findings obtained by performing chest CT within 48 of FOB (Table VI & Figure 2). As we can see, in 28% of patients, computed tomography proved to be normal or non-diagnostic.

There were 718 patients bronchoscopied for fever due to suspected pulmonary infection with 480 being men and 238 women (male:female ratio 2:1). Inflammation of the tracheobronchial tree represented 38.7%, while 26.1% (more than 1 in every 4 patients) had endobronchial lesions that upon gross inspection and cytological examination proved to be malignant (Table VII).

All patients that were subsequently bronchoscopied, had a chest CT prior to the procedure, within 48h apart. We can see that computed tomography proved to be normal or non-diagnostic

Table IV. Computed tomography findings in patients presenting with haemoptysis.

CT findings in patients with haemoptysis	Number	Frequency
Bronchiectasis	159	19.97%
Atelectasis	104	13.07%
Nodules/mass	143	17.96%
Consolidation	167	20.98%
Hilar/mediastinal lymphadenopathy	72	9.05%
Cavities/thin-walled cysts	40	5.03%
Pleural effusion	40	5.03%
Normal/non-diagnostic	71	8.92%
Total	**796**	**100.00%**

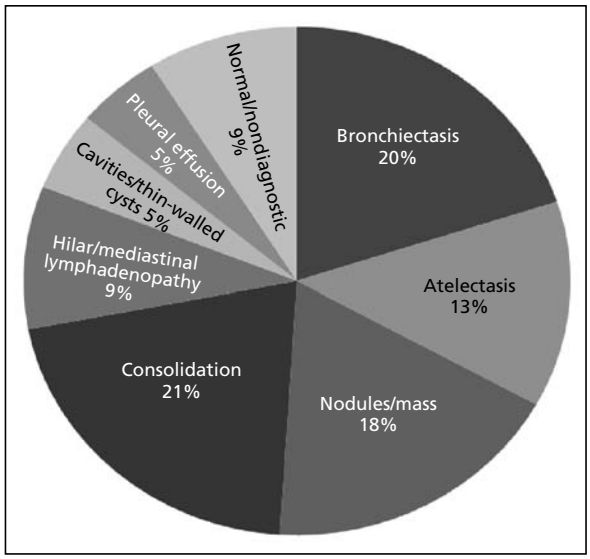

Figure 1. CT findings in patients with haemoptysis.

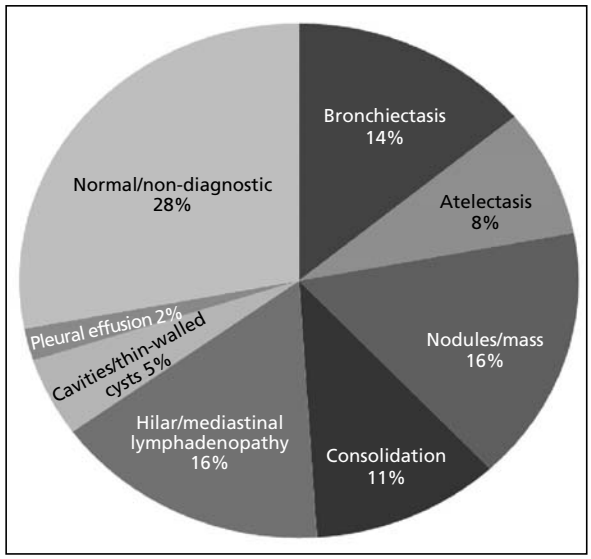

Figure 2. CT findings in patients with chronic cough.

in only 3% of patients, identifying many causes that FOB characterized as "non-specific inflammation of the tracheobronchial tree" (Table VIII and Figure 3).

Finally, we present the cytological results collected either from bronchial washings, bronchial wall brushing or biopsy for 535 patients found to have endobronchial lesions. Also, we mention their smoking habits. We already presented that 17% of the patients presented with haemoptysis, 26% with fever and 26% with chronic cough. The rest (31%), presented with dyspnoea (18%) and chest pain (13%). The majority proved to be adenocarcinomas (37.9%) and second in line was the squamous cell carcinoma (34.2%). Small cell carcinoma type represented 17.9%, while the other less common types (large cell, undifferentiated etc.) represented 9% of the total (Table IX).

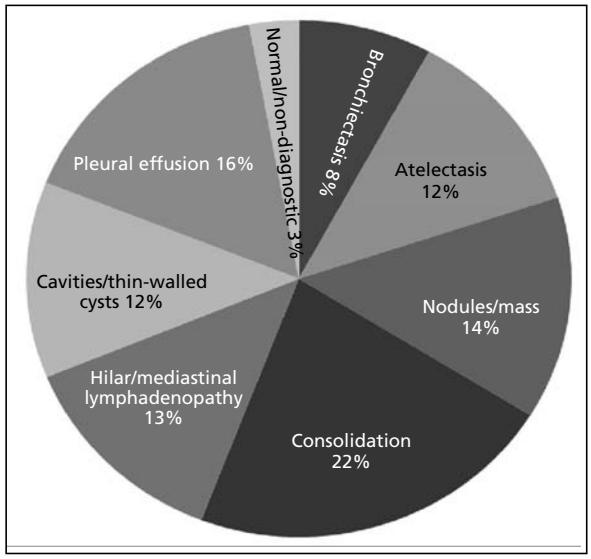

Figure 3. CT findings in patients with fever.

Table V. Most common bronchoscopical findings in patients with chronic cough.

Causes of chronic cough	*Men*	*Women*	*Total*	*% of total*
Inflammation of the tracheobronchial tree	217	116	333	48.54%
Malignancy	131	51	182	26.53%
Without gross pathological findings	83	36	119	17.35%
Failure to cooperate	33	19	52	7.58%
Total	**464**	**222**	**686**	**100.00%**

Table VI. Computed tomography findings in patients presenting with chronic cough.

CT findings in patients with chronic cough	Number	Frequency
Bronchiectasis	96	13.99%
Atelectasis	55	8.02%
Nodules/mass	110	16.03%
Consolidation	75	10.93%
Hilar/mediastinal lymphadenopathy	110	16.03%
Cavities/thin-walled cysts	34	4.96%
Pleural effusion	14	2.04%
Normal/non-diagnostic	192	27.99%
Total	**686**	**100.00%**

Men were outnumbering women (394 men over 141 women, male:female ratio = 2.8:1). It is interesting here to note that among men, about 79.1% (312 men) were smokers with 33.2% of them (131 men) being heavy smokers (>40 packs/year). As for women, 46.8% (66 women) were smokers, and 18.1% (12 women) were heavy smokers (>40 packs/year).

Complications

There were two fatalities associated with FFB (0.04%). One was due to hypoventilation and cardiac arrest and the other due to sudden hemorrhage. Major complications included 3 cases of pneumothorax (0.07% of all FFBs), 7 cases of pulmonary hemorrhage (0.17% of all FFBs) and 13 cases of respiratory failure (0.31% of all FFBs). They comprised less than 1% (0.56%) of the total FFBs and 2.65% and 6.19% of the 113 transbronchial biopsies performed, respectively. Minor complications included 9 episodes of bronchospasm (0.22%), 3 episodes of epistaxis (0.07%) and 2 episodes of laryngospasm (0.04%). They comprised 0.33% of the total FFBs performed (Table X).

Discussion

In the ACCP survey done by Prakash et al.[1], where the participants were asked to list the five most common indications for bronchoscopy in their personal practice, an abnormal chest radiograph was the most common indication for bronchoscopy (96.4%), along with haemoptysis (81,1%), pneumonia (65.1%) and diffuse/interstitial disease in the immunocompromised host. Chronic cough represented 23.4% of the total. In the study by Pue and Pacht[2], suspected infection was the most common cause for bronchoscopy (52%), while an abnormal radiograph ranked second with 17% of the total. Haemoptysis and chronic cough represented 4% and 1%, respectively. In our study, haemoptysis was the most common indication for bronchoscopy (21%), next was fever/suspected infection (19%) and chronic cough (18%). An abnormal chest radiograph ranked fourth (14%). We can see that there is a general agreement as to which are the most common indications for bronchoscopy. What is striking in our study though was the high percentage of malignancy involved in most of these cases. While other studies men-

Table VII. Most common bronchoscopical findings in patients with fever.

Causes of fever	*Men*	*Women*	*Total*	*% of total*
Inflammation of the tracheobronchial tree	175	103	278	38.72%
Malignancy	130	58	188	26.18%
Without gross pathological findings	110	44	154	21.45%
Failure to cooperate	65	33	98	13.65%
Total	**480**	**238**	**718**	**100.00%**

Table VIII. Computed tomographic findings in patients with fever.

CT findings in patients with fever	Number	Frequency
Bronchiectasis	57	7.94%
Atelectasis	86	11.98%
Nodules/mass	100	13.93%
Consolidation	158	22.01%
Hilar/mediastinal lymphadenopathy	93	12.95%
Cavities/thin-walled cysts	88	12.26%
Pleural effusion	115	16.02%
Normal/non-diagnostic	21	2.92%
Total	**718**	**100.00%**

tioned a percentage of underlying malignancy around 2.5%-5% in those bronchoscopied for haemoptysis[3,4] and around 0-2% for those bronchoscopied for chronic cough[5,6], in our study the percentages were 17% and 26%, respectively. Another 26% of them present with fever. Unfortunately, the smoking habits of the indigenous population (a substantial percentage of them, especially of the male sex, being heavy smokers) and the fact the most of them come from rural areas where they are exposed due to their work in agriculture to various chemicals known for their carcinogenic potential, can be held responsible for this. Due to the above data, we have become more cautious and less "stringent" when it comes to a man in middle-fifties or sixties who presents with an unexplained cough, who has a smoking history and the classic "dirty-lung" chest x-ray appearance. Doing that, we have managed to diagnose the presence of malignant tissue at its early stages (with no other metastases after total body CT and bone scan) and schedule surgery. Male sex, present and past smoking history and age >40 years old continue to be major epidemiologic risk factors for lung cancer.

The complications involved with the practice of bronchoscopy and their relative incidence have been well summarized. Credle et al[7] first reviewed them in 1974 by a questionnaire sent to 250 physicians. Seventy-eight percent (78%) responded with a total of 24,521 procedures reported. The mortality rate was 0.01% and the incidence of major complications was 0.08%. In a similar study, Suratt et al[8] surveyed 1,041 owners of flexible fiberoptic bronchoscopes. Thirty-one percent responded for a total of 48,000 procedures. Mortality rate was 0.03% and the incidence of major complications was 0.3%. Both studies may have underestimated the percentage of complications due to under-reporting by the responding physicians. Pereira et al[9] reported a higher prevalence of complications in the first prospective study involving 908 patients who had undergone FFB. The mortality rate was 0.1% and the percentage of major complications was 1.7%. In 1978, Dreisin et al[10] reported a prospective study of 205 consecutive FFBs performed in an university teaching hospital. The rate of complications was significantly higher than that reported in the previous studies. The mortality rate was 0.5% and the rate of major and minor complica-

Table IX. Cytological results for malignancy according to type.

Results for malignancy	*Men*	*Women*	*Total*	*% of total*
Squamous cell carcinoma	140	43	183	34.21%
Adenocarcinoma	147	56	203	37.94%
Small cell carcinoma	69	27	96	17.94%
Other types	38	15	53	9.91%
Total	**394**	**141**	**535**	**100.00%**

Table X. Most common complications that occurred during flexible bronchoscopy.

Complications of FFBs	Number	Frequency of total FFBs
Death	2	0.04%
Major		
Pulmonary hemorrhage (>50 ml)	7	0.17%
Pneumothorax	3	0.07%
Respiratory failure	13	0.31%
Total	**23**	**0.56%**
Minor		
Bronchospasm	9	0.22%
Epistaxis	3	0.07%
Laryngospasm	2	0.04%
Total	**15**	**0.33%**

tions was 5% and 6%, respectively. The major complications included bronchospasm, laryngospasm, pneumothorax, and haemoptysis. The minor complications included infiltrates, dyspnoea, epistaxis, subcutaneous emphysema, maxillary sinusitis, and an acute hysterical reaction. In 1979, Burgher[11] reported the complications associated with transbronchial lung biopsy. In 78 patients, the mortality rate was 1.3%. The frequency of pulmonary hemorrhage and pneumothorax was 30.2%. Finally, Pue and Pacht[2], reported the mortality rate to be 0% and that of major complications to be 0.5% in 4,273 FFBs.

We reported a mortality rate of 0.04% due to 2 deaths. One of the patients developed hypoventilation and cardiac arrest after the end of the procedure while the other died from sudden hemorrhage after manipulation of an endotracheal carcinoma, although all the available resuscitating equipment and trained personnel are always present and readily available. They were patients with comorbid conditions (chronic obstructive pulmonary disease, hypertension, diabetes mellitus) and was deemed necessary to perform a high-risk bronchoscopy due to major atelectasis from a mucous plug in the former patient and to establish a diagnosis in the latter. The rate of major complications was 0.56%. From the 7 cases of pulmonary hemorrhage, the 3 resolved by using topical epinephrine installation. From the 13 cases of respiratory failure, 5 necessitated intubation. The 3 documented pneumothoraces required no intervention. As already said, minor complications constituted <1% of total FFBs performed.

The cytological results are compatible with that mentioned in SEER (Surveillance Epidemiology and End Results, period 2001-2004) [http://seer.cancer.gov] in that adenocarcinoma was the leading type of lung cancer. Adenocarcinoma in white males has a frequency of 34.6% and in white females 42.3%. We documented frequencies of 37.3% and 39.7%, respectively. Squamous cell type in white males has a frequency of 23.2% and in white females 15,4%. Our data showed frequencies of 35.5% and 30.4% respectively. Small cell lung cancer in white males and females has frequencies of 12.6% and 14.8% respectively, while our data showed frequencies of 17.5% and 19.1% for white males and white females.

The above mentioned data are compatible with other (even larger) tertiary hospitals and even lower than those mentioned in previous series. Possible explanations are that the faculty is quite experienced and the pulmonary fellows attend the works of the bronchoscopy lab shortly after the beginning of their fellowship. Continuous transcutaneous oxygen saturation monitoring as well as cardiac rhythm monitoring is ensured. Where necessary, there is continuous oxygen supplementation. Patients with clotting disorders or with low platelet count <60,000/μL are excluded as well as those with severe hypoxia. Resuscitation equipment and trained personnel were always immediately available if a complication occurred although sometimes the need to do the best for a patient's health can go awry.

One can conclude though that apart from certain cases where the need to deal with a patient with deteriorating health can have unfortunate outcome, FFB can be performed with relative safety in a teaching hospital with appropriate preparation, supervision, and adherence to protocol.

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