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"A Study of Use and Safety of Fibre - Optic Bronchoscope in Critically Ill Patients in Intensive Care Units at Our Tertiary Care Hospital."

Dr. Anita A. Saibannavar,
Professor and Head, Department of Pulmonary Medicine, RCSMGMC, Kolhapur.
Corresponding Author: Dr. Anita A. Saibannavar,

Abstract:
Introduction: fibre-optic bronchoscopy (FOB) is one of the most important techniques in pulmonary medicine. The diagnostic and therapeutic uses of FOB, with less morbidity and mortality have led to its increase use in critically ill patients. As FOB allows direct inspection of airways under topical anaesthesia, it facilitates the early diagnosis and management of variety of pulmonary diseases.
Aims & objectives: We undertook this study at our institute to assess the yield of flexible fibre-optic bronchoscope in ICU, to look for complications associated with FOB in ICU and to judge the safety of FOB in ICU.
Material and methods: We included all adult patients admitted in ICU excluding patients with severe hypoxemia, bleeding disorders, unstable angina etc. All FOBs were done after informed, written and valid high risk consent. Pre procedure X-ray chest, ABG, bleeding time and clotting time was done. In ventilated patients, all precautions were taken as per guidelines.[34]. All procedures were followed by post procedure X-ray chest and ABG.
Result: FOB was performed in 42 patients on 105 occasions. Mean age of patients was 32.1 years. M:F ratio was 9:5. Among 105 bronchoscopies, 12 were done for diagnostic, 70 for therapeutic and 23 for combined indications. No death occurred during any of 105 procedures. Few complications observed were tachycardia, fever, minimal haemorrhage, hypoxemia and occasional arrhythmias.
Conclusion: Our study shows that the FOB is a safe procedure in critically ill ICU patients with proper monitoring. It is an extremely useful diagnostic and therapeutic procedure in critical ICU patients.
Key words: *Fibre-optic bronchoscope, critically ill, complications, Ventilators, safety.*

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I. Introduction

Fibre-optic bronchoscopy (FOB) was first introduced in clinical practice in 1967. It is one of the most important techniques in pulmonary medicine. The diagnostic and therapeutic utility of fibre-optic bronchoscopy, with minimal morbidity and mortality has led to its increased use in critically ill patients. FOB allows direct inspection of upper airways and lower airways, so it facilitates the diagnosis and management of variety of pulmonary diseases.

The critically ill patients in Intensive Care Unit (ICU) frequently require bronchoscopies for therapeutic as well as diagnostic purpose. The versatility of the flexible fibre-optic Bronchoscope has enabled the pulmonologist to utilize it frequently in the case of critically ill patients.[1] As a result, the flexible fibre-optic bronchoscope has become part of the standard equipment in most of Intensive care units. Gustav Killian reported his experience with the first bronchoscopy in 1838. Although a number of broncho-esophagologists contributed to refinement of the techniques based upon use of a rigid instruments, the advent of the flexible fibre-optic bronchoscopy, pioneered by Ikeda in 1967, opened new horizons to clinicians.[2]

It is a simple and safe bedside procedure with low morbidity. There are few complications associated with fibre-optic bronchoscopy especially, the risk being more in patients on the mechanical ventilators. But with proper monitoring of patient's hemodynamic status, if it is performed by bronchoscopists who are skilled and appropriately trained in the procedure, the risk of complications can be significantly reduced. Usefulness of fibre-optic bronchoscopy is increasing nowadays in intensive care units for diagnostic as well as therapeutic purpose. Improved knowledge and awareness of the anatomy and physiology of the procedure facilitates appropriate, safe and effective use of the bronchoscope.

We undertook this study with 42 patients admitted in our intensive care units at our institute to assess the yield, to look for complications associated and to judge the safety of FOB in intensive care unit.

II. Materials and Methods

We studied our experience with bedside FOB during one year period with 42 patients. We analysed the data about indication for admission in intensive care unit, underlying medical problems, indications for bronchoscopy, chest X-ray findings before and after bronchoscopy, arterial blood gas before and after bronchoscopy, complications during and after procedure and influence of the bronchoscopy findings on management of patients. [1]

All adult patients admitted in intensive care units requiring the therapeutic or diagnostic bronchoscopy were included in this study (Table 1, 2), excluding patients with severe hypoxemia, bleeding disorders, unstable arrhythmias etc. All FOBs were done under direct supervision, after taking written informed high risk consent.

Inj. Atropine 0.6 mg intramuscular was given 20 minutes prior to FOB as a premedication to prevent vasovagal attack and to decrease trachea-bronchial secretions. The procedure was performed under local anaesthesia in the form of 4% Lignocaine nebulisation for 10 minutes prior to procedure and SOS local instillation of 2% Lignocaine. Starvation was ensured 4 hours prior to procedure. No sedatives or general anaesthesia was employed. [34,3]

During all Intensive care FOB, monitoring of pulse, blood pressure, oxygen saturation and cardiograph was done. During the procedure, high concentrations of inspired oxygen was administered to maintain an arterial oxygen saturation of more than 90%. In case of all patients who were on mechanical ventilator, procedure of FOB was done with Fi02 100% during the procedure and 10 minutes post procedure. In patients on mechanical ventilator with Positive End Expiratory Pressure (PEEP), PEEP was reduced to avoid complications like barotroma with strict oxygen saturation monitoring. In all tube procedures, special type of catheter mounts or T piece were used to avoid disruption of oxygen flow and mechanical ventilation of patients. The shaft tip of the bronchoscope was well lubricated with Lignocaine jelly.

In patients who required therapeutic bronchoscopy, saline tracheal toilet was given to remove mucus plugs and secretions. In cases with tenacious thick secretions, diluted Sodabicarbonate [3] was used and in few patients N acetyl cystiene was also used with 1:2 dilution.

In patients with active haemoptysis which has failed to respond to conservative management, local instillation of haemostatic agent was done wedging the FOB into the segment with active bleeding. All FOBs were followed by chest radiograph and arterial blood gas to check for any complication and improvement post procedure.

III. Review Of Literature

Fibre-optic bronchoscope has been a part of standard equipment in many ICUs as it is extremely useful diagnostic and therapeutic tool. Shigeto Ikeda established standards for the Flexible bronchoscope first in 1964. Prototypes of bronchoscopes were completed by Machida Endoscopic Company Ltd. and Olympus Optical Company Ltd. in 1966. Ikeda presented FOB to annual meeting of American Bronchoesophagology Association in April 1970. In February 1987, Ikeda introduced prototype video bronchoscope.[2] Bronchoscopes have various sizes and are manufactured by various companies e g Olympus, Pentax.[2]

Mechanical ventilation is not a contraindication for either therapeutic or diagnostic FOB. With flexible bronchoscope, the patient's ventilation is assured by airflow around the bronchoscope between the external wall of device and the trachea-bronchial tree.

Table 1: Indications for Therapeutic Bronchoscopy[6]

1. Airway Clearance
   - Retained secretions
   - Mucous plugs (Asthma)
   - Blood clots
   - Foreign body
   - Haemoptysis/Haemorrhage
   - Obstructive neoplasm
2. Intrinsic Airway Problem
   - Effect of intubation
   - Stricture and Stenosis.
3. Airways Management
   - Endotracheal tube placement
   - Difficult intubation
4. Airway/Parenchymal Assessment
   - Broncho-pleural fistula
   - Broncho-esophageal fistula
   - Pulmonary alveolar proteinosis
5. Thoracic trauma.

Table 3: Contraindications of FOB

A) Cardiac
   - Recent MI
   - Unstable angina
   - Cardiac arrhythmia
   - Severe hypertension

B) Pulmonary
   - Severe hypoxemia
   - Severe bronchospasm
   - Active massive hemoptysis

C) Neurologic
   - Active seizures
   - Increased intracranial tension

D) Other Medical Conditions
   - Bleeding diathesis
   - Cirrhosis
   - Thrombocytopenia

Factors with increased risk of complications during FOB.[6]

- Lack of patients cooperation
- Lack of skilled personnel
- Lack of appropriate facilities
- Refractory hypoxemia
- Unstable Angina
- Hypercapnia
- Severe bronchospasm
- Severe debilitation/ co-morbidities
- Mechanical ventilation with PEEP
- Thrombocytopenia/coagulopathies
- Uraemia
- Pulmonary Hypertension
- Raised intracranial pressure

Table 2: Indications for Diagnostic Bronchoscope[6]

1. Stridor
2. Collapse or Atelectasis
3. Haemoptysis.
4. Assessment of position, patency or airway damage due to intubation/tubes.
5. Hoarseness with vocal cord palsy.
6. Broncho-pleural fistula.
7. Broncho-esophageal fistula

Physiological changes associated with brochoscopy[8]

FOB partially obstructs the airways increasing dramatically the airways resistance. It interferes with the gas exchange due to suction or BAL. BAL can lead to partial flooding of the alveoli washing out the surfactant thus increasing the possibility of atelectasis.

It is important to understand which derangement of the cardiovascular and respiratory systems associated with bronchoscopy, as these known derangements relate directly to the major complications of the procedure.

The most consistent derangement noted during and after bronchoscopy is arterial hypoxemia. The average change in PaO2, in healthy individuals is about 20 torr, but PaO_2 may drop by as much as 30-60% in compromised individuals.[9,12] The duration of procedure also affects de-oxygenation, with procedures exceeding 30 minutes resulting in greater decrease in Pa02. There is generally little change in PaCO2 during bronchoscopy. The decrease in PaO_2 may persist for several hours after completion of the procedure; thus post procedure monitoring is crucial.

Cardiac derangements, primarily arrhythmias are noted frequently. Although generally of little clinical significance, even minor degrees of tachycardia or other 'benign' arrhythmias can have important consequences in compromised patients. Arrhythmias are often noted during insertion of the bronchoscope or early in procedure, they are often most likely related to stimulation of vagus or irritant afferent in the airway. Patients with unstable angina or severe hypoxemia are at highest risk for complications.

Applications of Fibre-optic bronchoscope in ICUs

Fibre-optic bronchoscopy can be used for therapeutic as well as diagnostic purpose in ICUs for different indications (Table 1,2).

1. Assessment of Airway- Bronchoscopic examination generally permits evaluation and localisation of pathological changes in bronchial integrity such as
   - Broncho-pleural fistula
   - Tracheo or broncho-esophageal fistula
   - Post-intubation hoarseness of voice
   - Post-tracheostomy pressure changes on tracheal wall [4]
2. Evaluation of haemoptysis- FOB is useful in haemoptysis for diagnostic as well as therapeutic purpose.[3] For diagnostic purpose, the site of bleeding placed at peripheral branches also can be determined with FOB. For therapeutic purpose, Cold saline solution can be used along with haemostatic agent. The same effect can be achieved with bronchoscopic balloon catheters. Specially designed catheters have been developed for introduction through the working channel of the flexible fibre-optic bronchoscope, permitting subsequent removal of scope while the balloon remains in place.

3. Sampling of airway and alveolar constituents – Bronchoscopy provides easy and relatively safe access to materials in the trachea-bronchial tree and distal alveolar spaces. The most commonly employed bronchoscopic techniques for sampling of airways and alveolar spaces include bronchial washings,

bronchial brushings and broncho-alveolar lavage (BAL). BAL is safe even in critically ill patients, when biopsy or brushings are not recommended because of the risk of bleeding.

4. Endobronchial biopsies consist of tissue samples taken under direct visualisation of lesion in airways. Use of this procedure in critically ill patient is controversial. Each physician must determine the patients' risk-benefit ratio on a case to case basis. Complication rate for biopsy is high in critically ill patients. The serious complications of biopsies are bleeding and pneumothorax.

5. Mechanical ventilation with positive end expiratory pressure is relative contraindication for biopsy.[8]

6. Aspiration of secretions –

According to a survey of bronchoscopist conducted in the US, removal of retained secretions is cited as a leading indication for therapeutic bronchoscopy(4). Bronchoscopic aspiration of secretions may be indicated in patients presenting with weakness of respiratory muscles or disorders leading to recurrent aspirations. In critically ill or mechanically ventilated patients, removal of secretions and mucous plugs can be rapidly achieved with the flexible bronchoscope. Fibre-optic bronchoscope with a large diameter suction channel should be chosen for this procedure[4] The nature of the retained material, its consistency and viscosity may require frequent bronchoscopies to relieve segmental or lobar atelectasis due to thick mucus plugs. Bronchoscopic aspiration of secretions should not be considered routine in the postoperative period or other conditions where good chest physiotherapy and maintenance of adequate pulmonary toilet can be more effective.[4]

7. Closure of bronchial fistulae-

Fibre-optic bronchoscopy can be a useful intervention in confirming the diagnosis of suspected broncho-pleural fistula and specifying its precise location. Depending on location and the size of the fistula, it can be approached bronchoscopically and an attempt made to seal it. Many different techniques have been employed, including introduction of irritating substances e.g. silver nitrate which stimulate formation of granulation tissue. Several potentially useful agents have been described, including gel foam, autologous blood patch, cryoprecipitate, and thrombin injection to create fibrin clot. Small bronchial opening in an otherwise normal bronchus following thoracic surgery responds much better with a higher rate of success of bronchoscopic sealing It is much more difficult to achieve good obliteration of the fistula when the fistula is infected or is due to an underlying malignancy.[4]

8. Endobronchial intubation in critically ill patients or difficult intubation –

The role of fibre-scope in the management of difficult and failed intubations has been well established and the importance of learning this valuable skill has been emphasised. The fiberscope is under utilised in anaesthesia and critical care practice because of a high rate of intubation failure. The main cause of failure is lack of experience in maneuvering the fiberscope. Other technical causes of failure include clouding of the fiberscope's lens, drifting off the midline, and inability to advance the endotracheal tube or withdraw the fiberscope after completing the intubation. [4]

Expert use of the fiberscope can be a life saving measure through alleviating major airway complications and unnecessary tracheotomies. Bronchoscopy is a specialised procedure that requires extensive training. Familiarity with both the physiology and anatomy of the airways is essential. Any diagnostic or therapeutic manipulations should be considered in relation to the underlying condition of the patient, localisation of the area of investigation and other surrounding structures in the thorax. It is essential to develop good communication between the bronchoscopist and other members of the team. While the bronchoscopist concentrates on the field of work, other team members are responsible for monitoring the patient (i.e. oxygen saturation, blood pressure, heart rate etc.) and checking and maintaining the adequacy of ancillary equipments (e.g. suction, oxygenation, accessories like forceps, catheter, balloon).

Complications are generally due to inappropriate preparation of patients before bronchoscopy, effects of local anaesthesia and manipulations of various instruments. Appropriate training and experience of bronchoscopy and supporting team are crucial in reducing the rate of complications (Table 4).

Inadequate topical anaesthesia potentiates coughing, gagging and patient discomfort and increases the risk of injury during bronchoscopy. Topical anaesthetics such as Lignocaine, the most frequently used agent, are absorbed systematically through the respiratory mucosa, increasing the risk of cardiac or CNS toxicity. These complications are more likely to occur in patients with underlying low cardiac output, hepatic dysfunction and oropharyngeal candidiasis.[4]

Table No.4: Complications of FOB[4,15]

1.	Anaesthesia related	2.	Hypoxaemia
3.	Fever	4.	Pneumothorax.
5.	Haemorrhage.	6.	Cardiac Arrhythmias.
7.	Bronchospasm.	8.	Tachycardia.
9.	Subcutaneous emphysema.	10.	Sinusitis.
11.	Nasal bleeding	12.	post procedure pneumonia
13.	Death / Vasovagal reaction .		

Transient hypoxaemia is the most common abnormality observed. In patients with underlying chronic lung disease, severe hypoxemia may occur, triggering life threatening cardiac arrhythmias. Significant O_2 desaturation may occur during BAL. Use of supplemental oxygen during the procedure should be routine.
Appearance of transient fever after bronchoscopy is not unusual and generally does not require any therapy. However, persistent fever in the setting of progressive radiographic infiltrates necessitates antibiotic therapy. The incidence of fever is increased in the elderly, in those with underlying chronic pulmonary disease or documented endobronchial obstruction and in those with bronchoscopic interventions for malignancy. In most cases, these complications resolve spontaneously within 24 hours. The incidence of post bronchoscopic infection is higher in immune-compromised patients.

Pneumothorax is commonly seen with transbronchial biopsy procedure in 4% cases. The risk is also high in mechanically ventilated patients. For this purpose, a post-bronchoscopy expiratory chest radiograph is performed routinely.

One of the most frequently reported complications related to bronchoscopy is haemorrhage. Increase risk is seen in cases with uraemia, bleeding disorders, thrombocytopenia, mechanical trauma, vigorous suctioning, endobronchial brushing and biopsy may result in bleeding in 1-4% normal individuals.

Cardiac complications particularly arrhythmias, can be noted in association with bronchoscopy like sinus bradycardia, atrial fibrillation, supra ventricular tachycardia and premature ventricular contractions etc. But clinically significant major arrhythmias are rare. Mortality rate is very low i.e. <0.01%.

IV. Results

In this study, we have reviewed yield and safety profile of the Flexible Fibre-Optic Bronchoscopy in intensive Care Unit. Flexible fibre-optic bronchoscopy was performed in 44 patients on 105 occasions. The mean age of patients was 32.1 years (Range 13 years to 80 years). Nine patients were younger than 20 years. Male: Female ratio was 9: 5. The common indication for admission to ICU was respiratory failure (Table-5).

The 105 flexible fibre-optic bronchoscopies were done for diagnostic indication in 12 (11.3%), therapeutic in 70 (66.9%) and combined in 23 (21.8%) (Table 6).

Flexible fibre-optic bronchoscopy was performed once in 19 patients, twice in 10 patients, thrice in 8 patients, four times in 1 patient, two patients underwent FFB for seven times, one patient underwent bronchoscopy eleven times, one patient for thirteen times.

Seventeen patients underwent FFB through the transnasal route on 40 occasions, 7 patients underwent FOB through endotracheal tube on 8 occasions and 18 patients through tracheostomy tube on 57 occasions.

Among 17 patients who underwent FOB through transnasal route, desaturation was observed maximum when bronchoscope was at the vocal cord. This problem was overcome by supplemental oxygen.

Among 42 patients, 25 patients underwent FOB on 65 occasions when they were either intubated or with tracheotomy. During these 65 FOB procedures, 44 times patients were on mechanical ventilator and 12 times on mechanical ventilator with PEEP.

Three FOBs were done on patients who presented with stridor. Diagnosis was made in all three of them. Eight patients underwent fibre-optic bronchoscopy for acute collapse of lung detected on chest radiograph. Six among them i.e. 75% showed improvement post-procedure in the form of oxygenation and chest radiographic findings within 24 hours after bronchoscopy. There was no variation in response to FOB as per lobe involvement. Two patients amongst them not responded.

Four patients underwent FOB for haemoptysis. 100% good result was observed in these patients by local instillation of haemostatic agent e.g. Botropase or Hemlock. But in only one patient, exact site of haemoptysis was correctly diagnosed. Seven patients underwent FOB for hoarseness of voice post extubation or post decanulation, 5 among them had vocal cord palsy and 3 patients had granuloma formation at the site of tracheostomy cuff.

Among these FFB, two patients were diagnosed to have bronchial fistula with the help of FFB. Both of them were subjected for bronchoscopic closure of fistula. Positive result with documented improvement on post FOB X-ray chest was observed in one patient i.e. with broncho-pleural fistula. Only one patient was subjected for FOB guided difficult incubation transnasally in case tetanus with laryngeal spasm with trismus. It was unsuccessful.

Sixteen patients underwent FFB for copious amount of thick, viscid secretions for clearing airways i.e. therapeutic purpose. Among them in seven patients FOB was helpful in patient's management.

No death occurred due to FOB during all these 105 procedures. Tachycardia was observed with almost all procedures, but only 4 patients developed tachycardia more than 140/min and which settled within 2 hours post procedure. 19 patients developed post procedure fever. No patient developed pneumonia or septicaemia. Minimal haemorrhage occurred in 30% of patients. Mostly bleeding was minimal probably due to trauma and no treatment required. 13 patients developed increase in frequency of premature ventricular beats commonly in patients above the age of 45 years and during early phase of procedure. Hypoxemia post FOB was observed in 30% of patients predominantly seen in patients on mechanical ventilation.

TABLE-5: INDICATIONS FOR ADMISSION OF 42 PATIENTS TO THE ICU

Sr. No.	Indications	No.of Patients	Percentage
(1)	Acute Respiratory Failure	14	33.3%
(2)	Tetanus	07	16.06%
(3)	Neuromuscular Disorders	06	14.03%
(4)	Postsurgical Care	03	07.1%
(5)	Stridor	03	07.1%
(6)	Haemoptysis	02	04.8%
(7)	Hanging	02	04.8%
(8)	Bronchial Fistulas	02	04.8%
(9)	Others	03	07.1%
	Total	42	100.0%

TABLE – 7: COMPLICATIONS ASSOCIATED WITH FOB

Sr. No.	Complication	No.of Patients
1	Tachycardia	42
2	Haemorrhage	16
3	Fever	19
4	Hypoxemia	13
5	Arrhythmia	14
6	Death	00

TABLE – 6:INDICATIONS FOR 105 FLEXIBLE FIBER – OPTIC BRONCHOSCOPIC PROCEDURES IN 42 PATIENTS IN INTENSIVE CARE UNIT

Sr. No.	Indication	Diagnosis	No. Of Patients	No. Of FOB		Percentage
A	Diagnostic	• Stridor	03	11	12	11.3%
		• Hoarseness	08			
B	Therapeutic	• Retained Secretions	06	17	70	66.9%
		• Difficult Intubation	01			
C	Combined (D&T)	• Haemoptysis	04	14	23	21.8
		• Collapse of Lung	08			
		• Bronchial Fistula	02			

V. Discussion

Bronchoscopy is an extremely useful diagnostic and therapeutic tool in an intensive care unit setting. The critically ill patients or patients in the intensive care unit frequently require bronchoscopy for the removal of retained secretions, placement or change of endotracheal tubes, diagnostic bronchoalveolar lavage, and assessment of haemoptysis and other pulmonary problems (Table-1, 2).

Rigid bronchoscopy, when used in the intensive care unit, has been limited to situations where a flexible bronchoscope was unavailable or for patients with foreign bodies if required. Presently majority of bronchoscopies performed in the ICU use the FOB.[4]

The most common indications for FOB in the ICU have been retained secretions and a radiological abnormality with unexplained hypoxemia. In Mayo Clinic series of 129 patients who underwent 198 flexible bronchoscopies, 75% were mechanically ventilated patients. Bronchoscopy was performed for therapeutic indications in 47%, diagnostic purposes in 44% and both diagnostic therapeutic purposes in 9%. Of 90 FOBs for retained secretions, 41% showed mucous plugs on significant secretions but clinical improvement, as noted by

the improvement in oxygenation and improved chest roentgen logic findings upto 72 hours after FOB was noted in only 19%[1]

Lindholm and colleagues reported that of the 71 therapeutic bronchoscopies 81%, were successful in improving aeration as evaluated by chest x-ray.[16]

In the report by Stevens and colleagues[17], clinical improvement as determined by oxygenation and physical examination occurred in 44% of 70 FOB done for retained secretion. Snow and Lucas reported their experience with 67 bronchoscopies in 51 patients in surgical ICU, 58% of whom had radiologic improvement.

In comparison with these studies, our yield from therapeutic FOB for retained secretions was also good we in our study had seen improvement in roentgenogram in 75% of patients who had collapse due to mucous plug or blood clot prior to FOB (Table-6).

FOB is invaluable in assessing the placement of an endotracheal tube (ETT). Faulty placement of an endotracheal tubes was recognised in 14 of 92 diagnostic FOB performed by Stevens and colleagues[17] Kastanus and colleagues[19]. who used FOB to assess the pathogenic factors leading to laryngotracheal injury due to tracheal intubation in 19 critically ill patients, concluded that FOB is a useful procedure for assessment and prevention of such injuries Hovener and Henneberg [20] used FOB in a weekly basis to examine the larynx and trachea in an effort to prevent damage from the tracheal tube in intubated patient. FOB has also been helpful in replacing endotracheal tubes inpatients on mechanical ventilation.

By threading the new or larger ETT over the instrument, the distal half of the flexible bronchoscope is used as the guide stem and passes next to the existing endotracheal tube, while the latter is removed and the new tube is passed into the trachea over the bronchoscope. This technique was successful in 27 of 29 patients described by Halebian and Shires. [21]

We had used FOB for the assessment of damage caused by Endotracheal (ET) intubation or tracheostomy tube. In our series we have been able to diagnose the damage because of intubation or tracheostomy tube in 66% of patients, in the form of vocal cord palsy or granuloma formation.

In Mayo Clinic series, 75% FEB were done inpatients on mechanical ventilation. This proportion is higher than number of patients on mechanical ventilator in our series (43 6%). In our opinion, the fact that a patient is on a mechanical ventilator does not increases the risk of complications from FOB. The addition of positive end expiratory pressure may contribute to more complications, although this relationship was not observed in our study except for increase incidence of procedure hypoxemia (Table-4).

The yield of our study in managing patients with haemoptysis was 100% with use of only local instillation of haemostatic agents. Use of any other measures for e g. Fogarty balloon, as done in other series was not done in any of our patients.

There are reports of using a fibre-optic bronchoscope to identify Broncho- Pleural Fistula (BPF). It has been reported that once this has been identified adequately, it is possible to obliterate the BPF using tissue glue In our study we have tried closure of BPF in one patients successfully.

Fibre-optic bronchoscopy is a safe procedure even when performed in the ICU or critically ill patients. The safe performance of procedure does require the operator be well trained and familiar with potential adverse effects and complications of bronschoscopy. The commonly encountered complications listed in Table-7.[25,26]

The reported complications noted in our series had been mild. The most frequently seen complications are tachycardia, post FFB fever, hypoxemia and cardiac arrhythmias. It has been observed that more hypoxemia occurs with increase duration of procedure and inpatients who were on mechanical ventilators with peak end expiratory pressure. As seen in other series.[1]

In our study, no death had occurred. Three cases of cardiopulmonary arrest, all successfully resuscitated, were described by Barrett among 410 FOB done in ICU. [12]

With standard FOB the risk of major complications has been found to be 0.08%, and the risk of death, 0.01%.[27] The incidence of bleeding following transbronchial biopsy in mechanical ventilated patients may be as high as 20%.[27]

Clinical conditions that increase the risks associated with FOB include lack of cooperation by patients, severe debility, recent myocardial ischaemia, unstable angina and unstable cardiac arrhythmias, worsening asthma or status asthmaticus, mechanical ventilation with peak end expiratory pressure, thrombocytopenia, lung abscess, uraemia and pulmonary hypertension.

FOB has a central role in the diagnosis of major airway disruption after traumatic injuries to the chest wall. The safest, most expedient way to diagnose a tear or disruption in the trachea or main stem bronchi is to inspect the area visually via the FOB. [28] In our study we have diagnose one patient who had presented with left lung collapse following a railway accident as rupture left main stem bronchus which was confirmed later with the help of CT scan patient was referred for surgical management.

VI. Conclusions

Our study shows that the flexible fibre-optic bronchoscopy is a safe procedure to perform in critically ill patients with proper monitoring and care. We have done 105 FOBs out of which 85 FOBs are with positive results beneficial to patients, which is statistically significant ($P < 0.0001$). No patient had any major life threatening complications during our study. Few minor complications were seen like haemorrhage, hypoxemia, tachycardia. This signifies the safety and use of the procedure in the critically ill patients in intensive care unit. Bronchoscopy is an extremely useful and safe procedure in the critically ill ICU patients.

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