Evaluation of the role of bronchoscopy in the intensive care units

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Objectives The aim of this study was to evaluate the role of bronchoscopy in the intensive care units (indications, advantages, disadvantages, results, and complications).

Patients and methods Bronchoscopy (rigid or fibroptic) was performed in Ain shams University hospital and Ain Shams University Specialized Hospitals on 80 ICU patients requiring diagnostic and/or therapeutic indication. The patients were grouped into ventilated and nonventilated.

Results A total of 50 (62%) fibroptic bronchoscopies and 30 (37%) rigid bronchoscopies were performed on 30 (37.5%) ventilated patients and 50 (62.5%) nonventilated. Overall, 90% of flexible bronchoscopies were done for ventilated patients and 54% of rigid bronchoscopies was done in nonventilated patients (54%). Moreover, 80% of the procedures were done for diagnostic purposes using fibroptic bronchoscopies in 98%, whereas 36.7% of bronchoscopies were done for combined indications and 13.3% of therapeutic indications bronchoscopies were done with rigid bronchoscopy. In addition, 51.25% of the procedures that were done with bronchoscopies were lavage followed by stent insertion (25%). In 83.3% of ventilated patients, lavage was done, whereas stent insertion was more in nonventilated patient group. Overall, 26.25% of the patients were diagnosed as having malignant disease and 20% had infections of lower respiratory tract. Complications occurred in 21.25%, with mortality rate of 0.0%, and hypoxia was the most common.

Conclusion Safety is one of the most important issues when deciding to perform bronchoscopy in the ICU, which depends on the accuracy of selection of the patients for the procedure and the experience of the bronchoscopist and facilities available.

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Introduction

The high-risk group for most invasive procedures includes critically ill patients [1]. Hypoxia, electrolyte disturbances, clotting abnormalities, and arrhythmias are often present [2]. Critically ill patients in the ICU are common to have respiratory involvement, with 30–50% of the admissions requiring the use of mechanical ventilation [3]. Advances in technology improve the ability to perform minimally invasive, accurate evaluations of the tracheobronchial tree and to perform increasing array of diagnostic, staging, therapeutic, and palliative interventions [3].

Thirty years ago, the main instrument for the direct examination of the tracheobronchial tree was the rigid bronchoscope and today is considered the procedure of choice in only two emergencies, hemoptysis and removal of foreign bodies. Flexible fiberoptic bronchoscopy has become the procedure of choice in most examinations of the tracheobronchial tree [4].

In ICU, bronchoscopy is increasingly being used because it is easy to perform at the bedside, with few complications being described [4]. Safety and usefulness, with appropriate precautions, have led to its increasing use even in unstable and mechanically ventilated patients [5].

The study aimed to evaluate the role of bronchoscopy in the intensive care units (indications, advantages, disadvantages, results, and complications).

Patients and methods

During the period between August 2014 and August 2017, we prospectively recruited 80 patients admitted to the Respiratory Intensive Care Units at Ain Shams University Hospital and Ain Shams University Specialized Hospitals, with indications for bronchoscopy (rigid or fibroptic).

All patients were admitted to ICU with indication for bronchoscopy (rigid or flexible). The indications were diagnostic, therapeutic, or combined.

Diagnostic indications were pneumonia (unresolved nosocomial, ventilator associated pneumonia), diffuse or focal lung lesions, tracheoesophageal fistula, and tracheal tear. Therapeutic indications/combined indications included atelectasis (roentgenographic)

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and excess airway secretions, massive or undiagnosed hemoptysis, obstructing endobronchial neoplasms, and strictures or stenosis (dilatation and stents).

Patients were grouped into one of the two groups: ventilated and nonventilated.

All patients or their relatives provided written informed consent for being subjected to the procedures, which were performed as part of the regular prebronchoscopic assessment. It consisted of history, medications, physical examination, laboratory tests (complete blood count, erythrocyte sedimentation rate, kidney functions test, liver functions test, and bleeding profile before bronchoscopy), radiology (CXR or computed tomography chest), pulse oximetry or arterial blood gases before and after bronchoscopy, pulse oximetry monitoring of oxygen saturation during bronchoscopy, electrocardiography monitoring, and anesthesiologist evaluation when needed.

Anesthesia

Fibroptic bronchoscopy was done under local anesthesia using lignocaine with total dose limited to 8.2 mg/kg in adults, with intravenous general anesthesia (patients with abscess or endobronchial lesion with risk of massive bleeding) with insertion of endotracheal tube or laryngeal mask airway or anesthesia under sedation by Midazolam (ventilated patient or after local anesthesia owing to patient irritability during bronchoscope).

In case of rigid bronchoscopy, general anesthesia was established by the anesthesiologist in all cases using total intravenous anesthesia and controlled ventilation through the ventilation port of the rigid bronchoscope (RB).

Bronchoscopic procedure

Flexible bronchoscopes (model EB-1530T3 and FB-18X pentax, video bronchoscope; Asahi Optical Co. Ltd, Japan) were used, and accessory equipment (forceps brush, needles) were used whenever indicated. Technical procedures used during bronchoscopy included bronchoalveolar lavage, bronchial wash, endobronchial biopsy, or transbronchial needle aspiration biopsy, which were performed whenever indicated.

Bronchoscopy in mechanically ventilated patients is performed through the endotracheal or tracheotomy tube by a specially adapted valve that facilitates the introduction of the bronchoscope into the airway without disconnection of mechanical ventilation. Patients were on volume control mode, FIO_2 of 100% (DRAGER EVITA 2).

Rigid bronchoscopy was performed using the proper-sized tube of RB using a Bryan-Dumon RB (Bryan Corp., Woburn, Massachusetts, USA). Procedures were performed using one or more of the following modalities whenever indicated: mechanical debridement with bevel of the RB or optical forceps, electrocautery (Erbe, Tubingen, Germany), bougie with successively larger RB, argon plasma coagulator (HF-Unit Tekno TOM 212A; Tekno Medical Optik Chirurgie GmbH, Tuttlingen, Germany), and Dumon silicone stent (Tracheobronxane; Novatech, La Ciotat, France).

Statistics

The data were revised, coded, and introduced into a PC using statistics for the social sciences (SPSS 15.0.1 for Windows, 2001; SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were performed. Parametric numerical data were presented as mean±SD and range, whereas nonparametric numerical data as median and interquartile range. Non-numerical data were presented as frequency and percentage. Analytical statistics was performed, and Student's *t*-test was used to assess the statistical significance of the difference between the two study group means. The χ^2-test was used to examine the relationship between two qualitative variables. Fisher's exact test was used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells. A *P* value of more than 0.05 was considered as nonsignificant, *P* value of less than 0.05 as significant, and *P* value of less than 0.01 as highly significant.

Results

A total of 80 patients were included. There were 53 (66.3%) male and 27 (33.8%) female patients. The demographics of the studied patients are shown in Table 1.

A total of 50 (62.5%) flexible bronchoscopy and 30 (37.5%) rigid bronchoscopy procedures were done. Overall, 90% of flexible bronchoscopy procedures were done for ventilated patients compared with 46% in nonventilated patients. However, rigid bronchoscopy was done in 54% of nonventilated patients as compared with 10% of ventilated patients ($P<0.001$), as shown in Table 2. Complications occurred in 17 (21.25%) patients with no mortality.

Bronchoscopies were done for diagnostic purpose (80%), therapeutic (5%), or combined (15%). Overall, 98% of diagnostic bronchoscopies were done with fibroptic bronchoscope (FOB), 36% of the combined bronchoscopic indications were done with rigid bronchoscope, and all therapeutic bronchoscopies were done with rigid bronchoscopy, as shown in Table 3.

Most common indication of bronchoscopy was stridor in 20 (25%) patients followed by suspected lower respiratory tract infection or malignancy (20%), collapse owing to secretions or endobronchial lesion (18.75%), bilateral lung infiltrates and hemoptysis (12.5% for each of them), and suspected tracheoesophageal fistula, tracheal tear, or tracheomalacia in 5%.

Most common procedure done was lavage (51.25%) to obtain lower respiratory tract sample with suspected infection or malignancy, followed by stent insertion or cleaning in 25%, and then biopsy and lavage in 12.5%. In 83.33% of the ventilated patient, lavage was done, whereas biopsy and stent insertion or cleaning were seen more in the nonventilated patient group (P=0.039; Fig. 1). Lavage was done with flexible bronchoscopy in 82%, whereas stent, debulking, and cautery were done only with rigid bronchoscopy (P<0.001), as shown in Fig. 2.

Bronchoscopy results are shown in Table 4. In 36% of the ventilated patients, lower respiratory tract infection was diagnosed (*Pseudomonas aeruginosa*, *Acinetobacter* spp., and *Staphylococcus aureus*) and 31.25% of malignant results were seen in nonventilated patients (P<0.001; Table 5).

Table 1 Baseline characteristics of patients before bronchoscopy

Characteristics	*n* (%)
Age	
Range	15–85
Mean±SD	
Ventilated	55.63±17.28
Not ventilated	51.10±17.52
Sex	
Males	53 (66.3)
Females	27 (33.8)
Ventilation state	
Ventilate	30 (37.5)
Not ventilated	50 (62.5)

Discussion

In the study of respiratory diseases, bronchoscopy is a fundamental technique [6]. In the ICUs, it is easy to perform at the bedside, and few complications have been described with its use [4].

Bronchoscopy was studied in ventilated and nonventilated patients in ICU as proposed by other authors such as Christopher and Udaya [7], where among 198 FFBs, 150 (76%) were done in patients who were on ventilators, whereas 48 (24%) were done in nonintubated patients and Lucena *et al.* [8], who examined FOB in respiratory intensive care unit, where 73 of the 107 FBS procedures were carried out in patients with mechanical ventilation, and 34 in patients with oxygen therapy. In the present study, bronchoscopies were done for diagnostic, therapeutic, or combined indications, which agreed with the studies of other authors, such as the study by Lucena *et al.* [8], where bronchoscopy for diagnostic purposes was done in 88 (82%) cases, and for therapeutic in 19 (18%) cases. The clinical diagnostic indication mostly was diagnosis of pulmonary infiltrates and then post-tracheostomy management [8].

Table 2 Comparison between ventilated and nonventilated groups regarding the type of bronchoscopy

	n (%)			χ^2	*P* value
	Nonventilated	Ventilated	Total		
Type of bronchoscopy					
Flexible	23 (46.0)	27 (90.0)	50 (62.5)	15.488	<0.001**
Rigid	27 (54.0)	3 (10.0)	30 (37.5)		

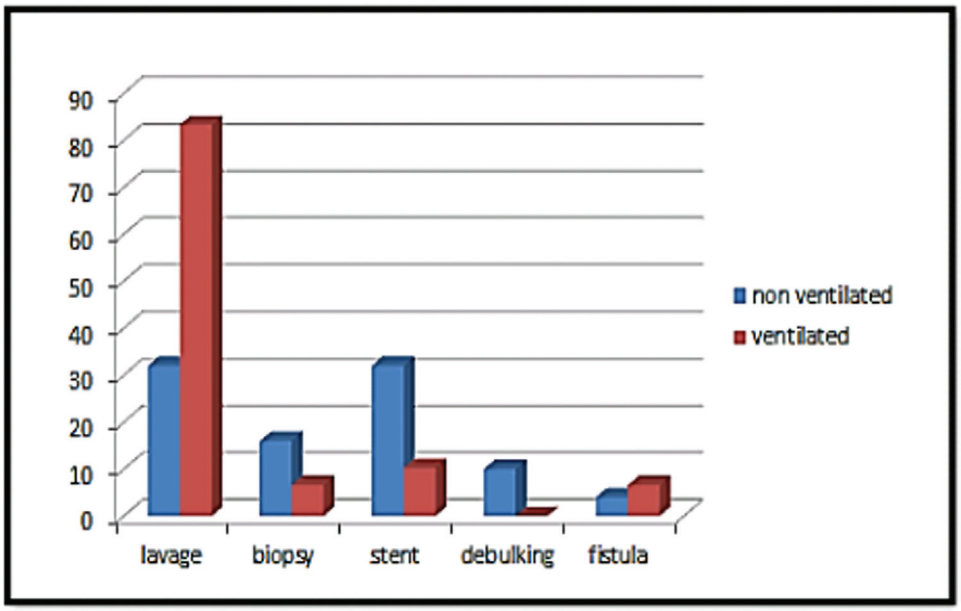
P<0.01, highly significan.

Table 3 Comparison between flexible and rigid bronchoscopy regarding indications of bronchoscope

Indication	*n* (%)			χ^2	*P* value
	Flexible (*N*=50)	Rigid (*N*=30)	Total (*N*=80)		
Diagnostic	49 (98.0)	15 (50.0)	64 (80.0)	27.089	<0.001**
Therapeutic	0 (0.0)	4 (13.3)	4 (5.0)		
Combined	1 (2.0)	11 (36.7)	12 (15.0)		

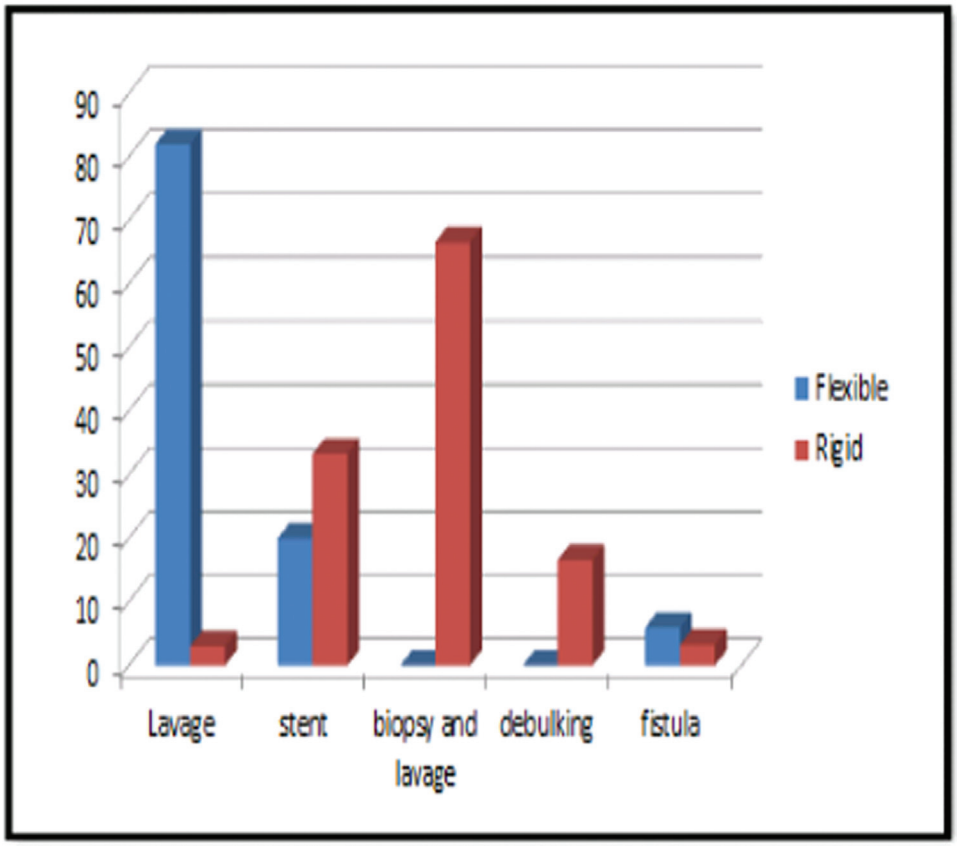
P<0.01, highly significan.

Figure 1



Comparison between group of patients and type of procedure.

Figure 2



Comparison between flexible and rigid bronchoscope as regard procedures.

Flexible bronchoscopy is most common for ventilated patients, mostly for lavage (bacteriology for suspected lower respiratory tract infection as ventilator acquired pneumonia (VAP) and abscess, and cytology for suspected malignancy), whereas in nonventilated patients, more rigid bronchoscopy was done for stent insertion, cautery, and debulking of malignant airway tumor. This coincides with the study done by Charles

and Eric [9], which reports of FFBs performed, where the major diagnostic indications were obtaining lower respiratory tract samples for suspected infection, evaluating lung lesions of unknown etiology accidentally discovered on chest radiography, investigation of hemoptysis, and assessment of airway patency. Moreover, in the study by Hyun *et al.* [10], most common diseases for rigid bronchoscopy performance were tracheal stenosis after endotracheal intubation.

Malignancy is the most common result obtained with bronchoscopy procedure (lavage and biopsy), such as squamous cell carcinoma in 10 (41.6%) and adenocarcinoma in five (23.8%), which were seen more in the nonventilated group of patients. This is comparable with the study of Kaparianos *et al.* [11], where cytological results collected from either bronchial wash, bronchial brushing or biopsy from 535 patients with endobronchial lesions showed that the majority proved to be adenocarcinomas (37.9%) and squamous cell carcinoma (34.2%). The next common result obtained was infection (bacteriology from bronchial lavage or bronchoalveolar lavage), which was more diagnosed in the ventilated patient group. This coincides with the study of other investigators, such as Christopher and Udaya [7], where diagnostic BAL was done in 37 FFB, and of these BAL cultures, 15 (41%) were positive, and eight (22%) of these led to a change in patient management.

Complications occurred in 17 (21.25%) patients. Mortality rate was 0%. The significant number of complicated patients was with oxygen desaturation, tachyarrhythmia (more with flexible bronchoscopy), and bradycardia (more with rigid bronchoscopy). Those complications were studied by other author. The study by Amir *et al.* [12], reported that the most common complications of bronchoscopy were hypoxemia 4%, and the study by Pablo *et al.* [13], reported that from a total of 102 FOBs performed in RICU, the most common event is a drop in SpO_2, with a drop of greater than 5% observed in 65% of patients during FOB.

Table 4 Results of bronchoscopies

Results	*N*=80 [*n* (%)]
Infection	16 (20)
Malignancy	21 (26.25)
Airway stenosis diagnosis/stent insertion or cleaning	20 (25)
Tracheomalacia or tracheoesophageal fistula	4 (5)
Diagnosis cause of hemoptysis/intervention	5 (6.25)
Sarcoid	1 (1.25)
Diagnosis of bilateral infiltrates	6 (7.5)
Nonconclusive for bilateral infiltrates	4 (5)

Conclusion

FFB is a safe procedure to perform in critically ill patients. The safety of the bronchoscope and the mortality obviously depend on the accuracy of selection of the patients for the procedure and the experience of the bronchoscopist and facilities available.

FFB is frequently used in the RICU, in most cases for diagnostic purposes, whereas rigid bronchoscope, which is the instrument of choice in most bronchoscopic therapeutic procedures in ventilated patients, can compromise hemodynamics and gas exchange, but its diagnostic role must be measured against hazards.

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Nil.

Conflicts of interest
There are no conflicts of interest.

Table 5 Comparison between ventilated and nonventilated groups regarding the results of bronchoscopy

	n (%)			χ^2	*P* value
	Nonventilated (*N*=50)	Ventilated (*N*=30)	Total (*N*=80)		
Results					
Infection	5 (10.0)	11 (36.66)	16 (20.0)	24.957	<0.001**
Malignancy	16 (32)	5 (16.66)	21 (26.25)		
Resolved collapse	3 (6.0)	0.0 (0.0)	3 (3.75)		
Airway stenosis diagnosis/stent	17 (34)	3 (10.0)	20 (25)		
Tracheomalacia or tracheoesophageal fistula	1 (2.0)	3 (10.0)	4 (5)		
Diagnosis cause of hemoptysis/intervention	3 (6.0)	2 (6.5)	5 (6.25)		
Sarcoid	1 (2.0)	0 (0.0)	1 (1.25)		
Diagnosis of bilateral infiltrates	2 (4.0)	4 (13.33)	6 (7.5)		
Nonconclusive for bilateral infiltrates	4 (8)	0 (0.0)	4 (5)		

P<0.01, highly significan.

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