Med Intensiva. 2012;36(9):644–649

medicina intensiva

www.elsevier.es/medintensiva

SPECIAL ARTICLE

Current status of fiberoptic bronchoscopy in intensive care medicine☆

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Received 3 July 2012; accepted 13 September 2012
Available online 21 December 2012

KEYWORDS
Bronchoscopy;
Competency;
Accreditation;
Consensus

Abstract Flexible bronchoscopy (FB) has been of great help in the management of critically ill patients. Its safety and usefulness in the hands of experienced professionals, with the required measures of caution, have resulted in the increasingly widespread use of the technique even in unstable critical patients subjected to mechanical ventilation and with high oxygen demands. The Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC), through its Acute Respiratory Failure (GT-IRA) and Infectious Diseases (GT-EI) Work Groups, aims to promote knowledge and standards of quality in the use of FB among all specialists in Intensive Care Medicine. Through an expert committee, the SEMICYUC has established the objective of accrediting such training, with the preparation of a curriculum and definition of those Units qualified for providing training in the different techniques and levels. The accreditation process seeks to stimulate good learning practice and quality in training. Both specialists in Intensive Care Medicine and other specialists, and the patients, will benefit from the commitment and control afforded by such accreditation, and from the learning and training which the mentioned process entails.

☆ Please cite this article as: Martin-Loeches I, et al. Situación actual de la realización de fibrobroncoscopias en los Servicios de Medicina Intensiva. Med Intensiva. 2012;36:644–9.

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2173-5727/$ – see front matter

PALABRAS CLAVE
Broncoscopia;
Competencia;
Acreditación;
Consenso

Situación actual de la realización de fibrobroncoscopias en los Servicios de Medicina Intensiva

Resumen La fibrobroncoscopia (FBC) flexible en el campo de la Medicina Intensiva ha supuesto la introducción de una técnica de gran ayuda para el manejo de pacientes críticamente enfermos. Su seguridad y utilidad, en manos de un profesional adecuadamente entrenado y con las debidas precauciones, ha derivado en un uso cada vez más extendido, incluso en pacientes críticos inestables ventilados mecánicamente y con requerimientos elevados de oxígeno. La Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias (SEMICYUC) mediante el Grupo de Trabajo de Insuficiencia Respiratoria Aguda (GT-IRA) Y Enfermedades Infecciosas (GTEI), tiene como objetivo promover el conocimiento y los estándares de calidad de la práctica de la FBC en todos los especialistas en Medicina Intensiva. La SEMICYUC se ha propuesto como objetivo, a través de un comité de expertos, acreditar la formación aportando para ello un curriculum, así como las unidades con capacidad para formar en las distintas técnicas y niveles. El proceso de acreditación busca estimular las buenas prácticas de aprendizaje y de calidad en la formación. Tanto el especialista en Medicina Intensiva, como otros especialistas médicos y los pacientes se beneficiarán del nivel de compromiso y de control que la acreditación conlleva y del aprendizaje y el entrenamiento que involucra este proceso.

Introduction

Flexible bronchoscopy (FB) in Intensive Care Medicine has been of great help in the management of critically ill patients. Provided the necessary precautions are taken, the technique is extremely safe.[1] A study published a few years ago reported a mortality rate of 0.01% and an incidence of complications of over 0.08% in a series of 24,521 FB procedures,[2] while another registry[3] of about 48,000 cases reported a mortality rate of 0.02% and a complications rate of over 0.3%. A more recent European multicenter registry documented a mortality rate of 0.04% and an incidence of complications of over 0.12% in close to 40,000 procedures.[4] In these three aforementioned studies, the analysis was conducted on a retrospective basis. Small prospective studies have reported somewhat higher rates.[5,6] However, in a more recent study of 4000 cases involving more than 2000 bronchoalveolar lavage (BAL) procedures, along with other invasive techniques, no fatality was recorded, and the incidence of major and minor complications was low (0.5% and 0.8%, respectively).[7]

Indications

Diagnostic and therapeutic applications in the Department of Intensive Care Medicine (Table 1)

Flexible or fiberoptic bronchoscopy has become an essential tool for the adequate management (diagnostic and therapeutic) of patients admitted to the Department of Intensive Care Medicine (DICM).[8] In the hands of adequately trained professionals, and adopting the necessary precautions, the safety and usefulness of FB has caused it to become increasingly used even in unstable critical patients subjected to mechanical ventilation (MV) and with high oxygen demands.[9] Based on the recommendations of the British Thoracic Society, the DICM should be adequately equipped to perform FB for diagnostic and therapeutic procedures on both a programmed basis and in emergency situations.

One of the most common and useful applications of FB in mechanically ventilated patients is the diagnosis and treatment of lobar collapse refractory to the usual management measures such as for example postural changes and respiratory physiotherapy. The success rate in such situations is reportedly 79–89%.[10–13] FB is probably less effective in patients with subsegmental atelectasis or air bronchogram on the chest X-rays.[14,15]

Table 1 Diagnostic indications of flexible bronchoscopy.

1. Investigation of the origin of the hemoptysis
2. Chest X-ray alterations such as localized increases in density, atelectasis or localized enhanced transparencies
3. Localized wheezing or stridor
4. Unilateral diaphragmatic paralysis of unexplained cause
5. Superior vena cava syndrome or vocal cord paralysis of unexplained cause
6. Airway injury secondary to the inhalation of toxic gases
7. Suspected airway rupture following chest trauma
8. Suspected bronchopleural fistula
9. Postoperative follow-up of pulmonary and cardiopulmonary transplant patients
10. Microbiological study of suspected opportunistic infections and (in selected cases) of pneumonia due to common pathogens
11. Immunocompromised patients with new lung infiltrates, and follow-up of the resolution of lung infection
12. Obtainment of material in the study of diffuse interstitial pulmonary disease
13. Problems associated with the endotracheal tube (tube damage or obstruction, malpositioning, etc.)
14. Evaluation of the evolution of prolonged intubation and tracheotomy

The appearance of retained bronchial secretions can obstruct the main airway and increase the risk of infection. Guided suctioning, together with saline solution lavage, can be very effective in dealing with this complication. Likewise, certain foreign bodies, such as impacted food following bronchoaspiration, or tooth fragments, can be easily removed with the accessories adapted to the flexible bronchoscope.

Minimum endotracheal bleeding is common during routine tracheal suctioning in the ventilated patient, and can be a consequence of tracheal epithelial erosion. If bleeding proves persistent or excessive, FB can be used to identify the origin and extent of the hemorrhage and contribute to define a management strategy. In situations of massive bleeding, visualization with the flexible bronchoscope can prove very difficult, however, and other techniques are then preferred, such as rigid bronchoscopy and/or the interventional vascular radiology, which require the intervention of other specialists such as thoracic surgeons, pneumologists and/or radiologists.

Nosocomial pneumonia is the most frequent in-hospital infection in Intensive Care. Flexible bronchoscopy is very useful in ventilated patients for guided microbiological sampling of the airway with diagnostic intent. An early diagnosis, particularly in immune depressed and neutropenic patients, is important in relation to treatment response following identification of the causal pathogen. FB allows us to establish an etiological diagnosis through the obtainment of non-contaminated secretions directly from the most distal airway of the affected area. Processing of the samples in quantitative cultures in turn allows differentiation between colonization and infection. The main diagnostic techniques are bronchoalveolar lavage (BAL) and protected specimen brush sampling. In performing BAL, we generally instill physiological saline solution at room temperature (typically 150–200 ml in boluses of 20–50 ml). The volume varies among the different publications and depends on the particular clinical conditions of the patient. In general, over 40% of the instilled volume is recovered. Bronchial protected catheter brush sampling is another option, and in some cases can offer greater specificity than BAL, since the risk of contamination is minimized–though the sample is collected from a more localized area. In contraposition, BAL is comparatively more sensitive, since it encompasses a much larger area of lung parenchyma–though there is a risk of contamination of the operating canal. A way to avoid or reduce such contamination is to insert the flexible bronchoscope without suctioning.[16] The use of guided techniques compared with direct sampling remains subject of controversy, and it is important to underscore that the obtainment of microbiological samples by BAL or protected specimen brush sampling appears to be relatively safe and rapid, and in most cases causes no complications.[17–19] Furthermore, the direct visualization of the secretions can help in the diagnosis and differentiation of ventilator associated pneumonia and/or tracheobronchitis.[20]

In some cases, a transbronchial biopsy may be needed to establish a histological diagnosis of lung parenchymal disorders of uncertain etiology.[21] In the ventilated patient there is a significant risk of pneumothorax (10%) and bleeding (approximately 5%), and a definitive histological diagnosis can only be established in about one-third of the cases.

In the diagnosis of lesions caused by smoke inhalation–a relatively common condition seen in the DICM–emergency FB detects mucosal hyperemia and edema, inflammation of the subglottic region, and the presence of carbon particles in the airway, indicative of severe injury and anticipating the need for intubation.

Orotracheal intubation

Flexible bronchoscopy is very useful in situations characterized by difficult intubation in which the presence of anatomical variants, obstruction of the upper airway, limited mobility of the head and neck, protection in cervical fractures and severe bleeding tendency make it unadvisable to perform conventional intubation with the laryngoscope.[22] Nevertheless, FB is only necessary in a small proportion of patients (0.07–3.4%) admitted to the DICM.[9,23]

The oral route is the preferred option for tracheal intubation, since it allows us to place a larger diameter endotracheal tube.[7,22] The outer diameter of most flexible bronchoscopes varies between 1.8 mm (ultrafine) and 6.4 mm–the majority of adult bronchoscopes having an outer diameter of about 6.0 mm. Most of the existing bronchoscopes pass through a 7.5-mm endotracheal tube, which is the preferred option in the intubation in adult patients.[24] Pediatric bronchoscopes can also be used for nasotracheal intubation, since they are more flexible–though this lack of stiffness implies that the instrument is often directed into the esophagus by mistake.

Facilitation of percutaneous tracheotomy

Flexible bronchoscopy is a safety measure that has been recommended for performing percutaneous tracheotomy.[25] The use of FB helps prevent complications such as damage to the posterior wall of the trachea, pneumothorax, subcutaneous emphysema or false insertions that have been reported with blind percutaneous methods.[26,27] One of the principal advantages of the endoscopic guide is that it allows direct visualization of tracheal puncture, facilitating correction of the position of puncture during the paramedial puncture procedures.[28,29] This technique moreover allows us to detect any anomalous position of the tracheotomy cannula, and the lesions that can be caused during its insertion – as well as the existence of problems such as edema, tracheal erosion or tracheomalacia following intubation.

Evaluation of airway trauma

Tracheobronchial lesions are present in 2.8% of all penetrating chest wounds and accidental deaths. The clinical manifestations of tracheobronchial lesions are fundamentally dependent upon the extent and location of the air leakage. The clinical and radiological findings are suggestive, but FB is the fastest and safest way to diagnose airway damage secondary to chest injuries. The use of FB for the early diagnosis and follow-up of such injuries in cases where a conservative approach is adopted proves essential for adequate patient management.

Precautions and safety controls

Patients admitted to the DICM must be regarded as presenting a high risk of complications during the performance

of FB, as established by the British Thoracic Society, with grade B recommendation.

In order to perform FB, it is essential to know the physiology of ventilation and its modifications as a result of the application of positive pressure during mechanical ventilation. Likewise, it is essential for the physician to know the different types and models of ventilators used, as well as the patient-ventilator inter-connections. Most of the modern microprocessors included in the current ventilator systems control tidal volume and minute-ventilation. The reduction in tracheal diameter upon inserting the flexible bronchoscope can cause hypoxemia as the most serious phenomenon, accompanied by alveolar hypoventilation and air trapping due to the rise in intrinsic positive end-expiratory pressure (auto-PEEP). Flexible bronchoscopy can generate intratracheal pressures of between 10 and 20 cm H_2O, with reductions in arterial oxygen pressure (PaO_2) of up to 40% below the basal values, due to the decrease in tidal volume and PEEP. This drop in PaO_2 is usually transient and quickly reverts in most cases. When FB is performed during mechanical ventilation, the inner diameter of the endotracheal tube must be at least 2.0 mm greater than the outer diameter of the bronchoscope in order to ensure an adequate volume supply and minimize auto-PEEP.[30]

Pre-oxygenation of the patient subjected to mechanical ventilation can be achieved through the inhalation of 100% oxygen during 5 min prior to performing FB. It is also important to maintain fractional inspired oxygen (FiO_2) at 100% during the procedure and the immediate recovery period. Devices are available for connecting the bronchoscope to the endotracheal tube with a perforated diaphragm allowing continuous ventilation together with the maintenance of PEEP. This is particularly important when FB is performed in patients with severe hypoxemia secondary to acute lung injury (ALI) or acute respiratory distress syndrome (ARDS).

Flexible bronchoscopy can induce a rise in intracranial pressure in some patients with head injuries. However, brain perfusion pressure remains within acceptable limits in most cases.[31] A systematic review involving 132 patients showed the use of FB to imply low risk in patients with intracranial hypertension.[32]

Accreditation and competence

The Spanish Society of Intensive and Critical Care Medicine and Coronary Units (*Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias*, SEMICYUC), through its Acute Respiratory Failure (GT-IRA) and Infectious Diseases (GT-EI) Work Groups, aims to promote knowledge and quality standards in the performance of flexible bronchoscopy among all specialists in Intensive Care Medicine. After case consultation, and following the experience of other international Societies in these processes, the SEMICYUC has developed an accreditation system for all those who perform FB. By establishing standard and inviting specialists in Intensive Care Medicine and related disciplines to obtain this accreditation, the Society aims to promote learning and to elevate the quality standards of clinical practice in critically ill patients.

We are aware of the differences in training and performance of FB among different centers, and do not aim to establish rigid learning and practice criteria; rather, with a hope to implement the essential minimum requirements for training and performance of FB in critical patients, and to propose these capacities to the different medical Societies.

Such accreditation is voluntary and seeks to promote a standard defining norms referred to training in FB and to the quality of the DICM in promoting such skills. Through an expert committee, the SEMICYUC aims to accredit professional training in FB and the Units that request inclusion in the accreditation process. The latter aims to stimulate good learning practice and training quality. Both specialists in Intensive Care Medicine and other specialists, as well as patients, stand to benefit from the level of commitment and control afforded by such accreditation, and from the learning and training implied by this process. The accreditation will be recognized by the SEMICYUC and other specialties.

Training in flexible bronchoscopy in the critical patient

At present there are no specific training programs referred to FB in the critical patient. However, a full list of the competences in FB required by intensivists has recently been established and published through the CoBaTrICE project (Competency-Based Training in Intensive Care Medicine in Europe), under the leadership of the European Society of Intensive Care Medicine (ESICM), and with participation of the SEMICYUC. The mission of the project is to develop a training program at European level, based on the development of competences, and with the fundamental purpose of harmonizing training.[33]

The objective of the CoBaTrICE project is to homogenize skills and capacitation among specialists in Intensive Care Medicine, and to guarantee a common standard referred to clinical competences. The program encompasses the global knowledge, skills, behaviors and attitudes required for each of the 102 CoBaTrICE competences, divided into 13 sections: 12 domains plus the basic sciences. Within each section, presentation is made of the program for each competence–the global program for each section in turn appearing after the corresponding section. In domain 5 (practical procedures), under section 5.6, a description is provided of the knowledge and indications for performing FB and for obtaining samples in patients subjected to mechanical ventilation.

Likewise, the American College of Critical Care Medicine (ACCM) has developed standards and recommendations referred to certain aspects of Intensive Care, including organizational, management and quality improvement issues.[34,35] More recently, in Europe, the HERMES (Harmonized Education in Respiratory Medicine for European Specialists) project has established the most relevant aspects referred to critical patients, and addresses levels of competence in FB.[36]

Lastly, a document on standards and recommendations has been drafted, to be applied in Intensive Care Units, and was published in the year 2010 by the Spanish Ministry of Health. This document is based upon a multidisciplinary design comprising different scientific Societies, and establishes competences in the use of FB by intensivists.[37]

Thus, it is considered that intensivist competence should include not only learning of the indications of FB in the critical patient but also the skills and aptitudes required for performing and interpreting FB. This poses problems

in terms of education and training, accreditation, cumulative experience and continued or ongoing evaluation.[38] The knowledge must be acquired through training directed by a competent professional, independently of his or her specialty, but with experience in the technique and in specific clinical situations.

Through an expert committee, the SEMICYUC aims to acknowledge the training or contribute a curriculum, and accredit those Units qualified for providing training in the different techniques and levels. At present there is no clear evidence in the literature indicating the way in which the necessary skills for performing FB must be acquired or maintained on an independent basis by specialists in Intensive Care Medicine. Capacitation must be carried out under the direct supervision of an expert bronchoscopist.

According to different scientific Societies,[39–41] the number of procedures recommended during training varies. In acquiring the mentioned skills, the needs may differ from one person to another. The time required to gain the necessary skills can vary among different professionals, but in general, the greater the number of procedures carried out under the supervision of expert professionals, the better the results obtained. It is therefore advisable to perform as many procedures as possible in the course of the training period.

Likewise, in order to ensure that trained bronchoscopists retain their competence, they must continue to actively perform FB procedures. Ideally, the recommendation is 20–50 procedures annually in order to maintain professional competence, though according to different sources, 12 procedures yearly is regarded as the minimum for maintaining the necessary skills.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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