American Thoracic Society
MEDICAL SECTION OF THE AMERICAN LUNG ASSOCIATION®

404

FLEXIBLE ENDOSCOPY OF THE PEDIATRIC AIRWAY

Reprinted from AMERICAN REVIEW OF RESPIRATORY DISEASE,
Vol. 145, No. 1, January 1992, pp. 233-235

THIS OFFICIAL STATEMENT OF THE AMERICAN THORACIC SOCIETY WAS ADOPTED BY THE ATS BOARD OF DIRECTORS, JUNE 1991.

Introduction

Flexible bronchoscopy in infants and small children was first described in 1978 (1). The use of this technique has increased greatly in the past decade. The indications, diagnostic utility, safety, and methodology of this procedure have been described (2, 3) and continue to evolve.

This statement is intended to provide guidelines for pediatric flexible bronchoscopy. Flexible bronchoscopy includes examination of the nose, pharynx, larynx, and tracheobronchial tree. Therefore, this statement addresses flexible endoscopy of the entire pediatric airway.

Although guidelines are available for flexible bronchoscopy in adults (4, 5), there are significant age- and size-related differences in the approach to infants and children. These guidelines should benefit practitioners of pediatric flexible bronchoscopy by outlining principles that enhance the safety and effectiveness and clarify the indications for the procedure. The guidelines should aid training programs in providing an optimal training experience.

Equipment

The necessary equipment should consist of a flexible bronchoscope of appropriate size for the patient and a light source. Photographic equipment such as a still or video camera is highly desirable. A teaching attachment or a video system is essential during the supervision of a bronchoscopist in training. Additionally, intravenous equipment, anesthetic agents, an adequate suction apparatus, a system for delivery of oxygen, and appropriate specimen collection containers are needed.

Resuscitation equipment must include bag and masks appropriately sized for infants and children and a source of oxygen capable of delivering adequate positive-pressure ventilation (6). Appropriately sized resuscitation equipment and medications for resuscitation should be immediately available.

Monitoring

Monitoring of the patient should include continuous evaluation of heart rate, respirations, color, and head (airway) position. Assessment of gas exchange by continuous oximetry is strongly recommended (6–11). At no time should a sedated patient be left alone or unobserved by trained personnel.

The pediatric patient must be adequately monitored following flexible bronchoscopy until awake. If supplemental oxygen is used during the procedure, it should be maintained after the procedure until adequate oxygenation on room air is documented. When the procedure is performed on an outpatient, the child should be tolerating oral intake prior to discharge.

Setting and Assistants

The preferred location for performance of pediatric flexible bronchoscopy is determined by the patient's clinical condition, the technical and clinical abilities of the bronchoscopist, and the nature of the available equipment and personnel. The procedure may be safely performed in an appropriate outpatient facility, at the bedside in the intensive care unit, or in the operating room. Unless specially equipped, hospital treatment rooms and general ward patient rooms are not adequate settings for flexible bronchoscopy.

The bronchoscopist should be supported by personnel qualified to assist in the following: (*1*) patient monitoring; (*2*) resuscitation; (*3*) specimen handling; (*4*) equipment care.

The required number of personnel depends upon the complexity of the procedure to be performed and the degree of patient sedation. It is recommended that one person observe and monitor the patient and another help administer medications and assist the bronchoscopist as needed.

Preprocedure Evaluation

Before performing flexible bronchoscopy on a pediatric patient, pertinent history and physical examination should be carried out. The history should include risk factors such as obstructive sleep apnea, previous anesthetic difficulties, or previous head and neck surgery.

The patient's vital signs and weight should be obtained and reviewed prior to the procedure. Radiographic studies, when appropriate, should be available for review during the bronchoscopy.

Although there are no data specific to antibiotic prophylaxis for flexible bronchoscopy, current American Heart Association guidelines state that antibiotic prophylaxis for bacterial endocarditis is not recommended before flexible bronchoscopy. However, physicians may choose to use prophylaxis in patients at a high risk for bacterial endocarditis (12).

Infection Control

Flexible bronchoscopes must be thoroughly cleaned and disinfected after each use. Appropriate measures, as recommended elsewhere (13, 14), should be used to prevent the spread of infection from patient to patient or to staff. Universal precautions are recommended for all staff who may be exposed to body secretions (15).

Indications

Diagnostic flexible bronchoscopy is indicated whenever the information desired can best be obtained by flexible bronchoscopy. Specific examples include but are not limited to the following (2, 16–18): (*1*) stridor; (*2*) persistent atelectasis; (*3*) wheezing; (*4*) recurrent/persistent pulmonary infiltrates; (*5*) lung lesions of unknown etiology; (*6*) chronic cough; (*7*) hemoptysis; (*8*) selective bronchography; (*9*) equivocal tracheobronchial foreign body (19); (*10*) to assess position, patency, or airway damage related to endotracheal or tracheostomy tubes; (*11*) to assess injury from toxic inhalation or aspiration; (*12*) to obtain samples of lower airway secretions and/or cells by bronchoalveolar lavage; (*13*) brush biopsy and transbronchial biopsy; little data are available on the use of these techniques in pediatric patients.

Additional indications for therapeutic flexible bronchoscopy include (18, 20, 21): (*1*) to aid in difficult intubations; (*2*) therapeutic bronchoalveolar lavage (22); (*3*) removal of airway secretions and mucous plugs. Under most circumstances, removal of foreign bodies and abnormal tissue should be carried out with the rigid bronchoscope.

Contraindications

Flexible bronchoscopy should only be performed when the relative benefits outweigh the risks. Situations that present a serious risk of complications during bronchoscopy include: (*1*) coagulopathy or bleeding diathesis that cannot be corrected; (*2*) massive hemoptysis; (*3*) severe airway obstruction; (*4*) severe refractory hypoxemia; (*5*) Unstable hemodynamics including dysrhythmias. Appropri-

ate measures to optimize the patient's condition should be taken to minimize risk. Although the patient may not have a condition that presents an increased risk or relative contraindication to flexible bronchoscopy, the procedure should *not* be performed by inexperienced personnel without adequate supervision or be performed in a setting without appropriate equipment and emergency capabilities. Clinical judgement and appropriate assessment of each individual situation is mandatory when considering a patient for flexible bronchoscopy. All bronchoscopy and emergency equipment should be appropriately sized for the individual patient examined.

Sedation

Procedures should always be performed under conditions which ensure the physical and emotional well-being of the patient. A quiet, reassuring atmosphere in the endoscopy suite will minimize the need for pharmacologic sedation. Sedation and topical anesthesia are usually indicated. Sedative doses and agents vary widely depending upon the age and medical condition of the patient and the preference of the bronchoscopist. In selected circumstances, general anesthesia may be preferable to sedation.

Comprehensive guidelines for the use of sedation in pediatric patients are available (6, 23). The goal of sedation for pediatric flexible bronchoscopy is to allow the patient to remain comfortable while maintaining adequate ventilation and oxygenation despite the presence of the bronchoscope in the airway. Significant findings of abnormal airway dynamics may be missed if spontaneous ventilation and muscle tone are excessively depressed by heavy sedation. Conversely, inadequate sedation is traumatic to the patient and precludes an optimal examination.

Consideration should be given to the placement of an intravenous line for pediatric patients undergoing flexible bronchoscopy. The intravenous route for sedation has the advantage of allowing titration of the sedative effect, rapid reversal of narcotics, and a shorter duration of action than with intramuscular or enteral routes. Patients undergoing sedation should have an intravenous line in place, or a person skilled in the placement of intravenous lines in children should be present (23).

Sedation is administered with the patient in a recumbent position to avoid hypotension. An accurate record should be maintained of sedative doses.

Topical Anesthesia

Effective topical anesthesia of the airway is essential for patient comfort and to abolish gag and laryngeal reflexes. Examinations confined to an artificial airway or emergency intubations are possible exceptions. A record of the delivered anesthetic dose should be kept.

The topical anesthetic selected should have minimal toxicity. A 1% or 2% lidocaine solution is currently the most commonly used topical anesthetic agent.

Complications

Complication of pediatric flexible bronchoscopy can generally be divided into two areas: (*1*) adverse effects of medication used before and during the bronchoscopic procedure and (*2*) adverse effects related to the bronchoscopic examination itself. Adverse reactions to medications account for at least half of the complications associated with flexible bronchoscopy (3).

Hypoxemia complicating flexible bronchoscopy may occur requiring the use of supplemental oxygen during the procedure (11, 24–27). Increased airway resistance, excessive sedation, and disturbance of ventilation–perfusion relationships are important causes of hypoxemia.

Other possible complications that the bronchoscopist should guard against are related to medications used for the procedure. Inadequate use of topical anesthesia may result in adverse reactions such as laryngospasm, bradycardia, or other vagally mediated phenomena (3). Inadequate sedation may lead to patient discomfort. On the other hand, excessive use of sedation may result in depression of respiration.

Infections complicating flexible bronchoscopy are uncommon. Proper cleaning of the instrument is required in order to prevent nosocomial infection. Post bronchoscopy fever may occur, especially following bronchoalveolar lavage.

Mechanical complications of bronchoscopy may include epistaxis, pneumothorax, and hemoptysis (3, 28). Transbronchial biopsy is the most common cause of bronchoscopy-related hemoptysis.

Training

Developing skills in flexible bronchoscopy should be incorporated into a comprehensive program whereby trainees develop expertise in airway anatomy, physiology, and pathophysiology as well as the necessary manual skills. Such a program should focus attention on principles of developmental anatomy and physiology of infants, children, and young adults.

Bronchoscopy skills are best taught over an extended period of time so that newly acquired skills can be practiced under the direct supervision of a trained bronchoscopist. Training of physicians to perform flexible bronchoscopy in pediatric patients must include four major areas.

Manual Skills

Competent bronchoscopists must know how bronchoscopes operate and how to manipulate the bronchoscope safely in the airways. Because the rate of mastering manual skills varies among trainees, it is unlikely that any specific number of procedures will guarantee competence. A training program should have enough cases to provide trainees with a broad exposure to common pediatric airway problems. Therefore, training programs should establish an organized and well-supervised program that will ensure adequate training and experience.

Physicians should practice using airway or lung models before attempting to bronchoscope patients. Trainees should not attempt to do bronchoscopy in patients until they have demonstrated that they know the airway anatomy. Small animals may serve as valuable resources to teach observation of airway dynamics (29) and nontraumatic manipulation of the bronchoscope.

Bronchoscopy training should be done only in an environment where supervisory personnel may intervene immediately if difficulties arise. Initial procedures on humans should be done on patients who are at a low risk for significant airway obstruction from the procedure. Subsequently, trainees should advance to examination of more complicated patients.

Training programs should retain documentation of procedures that a trainee has performed. Such documentation should help training programs determine whether a trainee has developed sufficient skills to perform flexible bronchoscopy independently in pediatric patients. Once learned, bronchoscope skills must be maintained.

Interpretation of Findings

Learning how to manipulate the bronchoscope is useless unless the bronchoscopist can interpret what he or she sees. Interpretation of findings requires an understanding of pulmonary physiology and developmental anatomy and pathology. Trainees should be taught and then demonstrate an adequate grasp of both static findings and dynamic changes in the airways and to what degree dynamic changes are normal. Before proceeding to independent work, the bronchoscopist should have sufficient experience with a variety of patient problems so as to recognize both normal variants and pathologic conditions. It is strongly recommended that training programs use a video system to supervise trainees and record endoscopic procedures for review and training discussion.

Learning Indications

One of the most important aspects of bronchoscopy is learning the indications for this procedure. Training programs must teach trainees how to determine when a patient may benefit from bronchoscopy and how to assess the risk–benefit ratio. Trainees must also understand the limitations of flexible bronchoscopy.

Sedation and Topical Anesthesia

Bronchoscopists must have experience with sedation and topical anesthesia in children of various ages and with a variety of disease processes.

This statement was prepared by a subcommittee of the Scientific Assembly on Pediatrics. Members of the committee are:
CHRISTOPHER G. GREEN, M.D., *Chairperson*
JAY EISENBERG, M.D.
ALBIN LEONG, M.D.
IAN NATHANSON, M.D.
BRUCE M. SCHNAPF, D.O.
ROBERT E. WOOD, PH.D, M.D.

References

1. Wood RE, Fink RJ. Applications of flexible fiberoptic bronchoscopes in infants and children. Chest 1978; 73:737.
2. Wood RE. The diagnostic effectiveness of the flexible bronchoscope in children. Pediatr Pulmonol 1985; 1:188–92.
3. Wood RE. Spelunking in the pediatric airways: explorations with the flexible fiberoptic bronchoscope. Pediatr Clin North Am 1985; 31:785–99.
4. Sokolowski JW, Burgher LW, Jones FL, Patterson JR, Selecky PA. Guidelines for flexible fiberoptic bronchoscopes in adults. Am Rev Respir Dis 1987; 136:1066.
5. Bone RC, Aviles A, Faber LP. Guidelines for competency and training in fiberoptic bronchoscopy. Chest 1982; 81:6.
6. Committee on Drugs, Section on Anesthesiology. Guidelines for the elective use of conscious sedation, deep sedation, and general anesthesia in pediatric patients. Pediatrics 1985; 76:317–21.
7. Anderson JA, Vann WF Jr. Respiratory monitoring during pediatric sedation: pulse oximetry and capnography. Pediatr Dent 1988; 10:94–101.
8. Cohen DE, Downes JJ, Raphaely RC. What differences does pulse oximetry make? (editorial) Anesthesiology 1988; 68:181–3.
9. Cote C, Goldstein EA, Cote M, *et al.* A single-blind study of pulse oximetry in children. Anesthesiology 1988; 68:184–8.
10. Fanconi S. Pulse oximetry for hypoxemia: a warning to users and manufacturers. Int Care Med 1989; 15:540–2.
11. Schnapf BM. Oxygen staturation during fiberoptic bronchoscopy in pediatric patients. Chest 1991; 99:591–4.
12. Committee on Rheumatic Fever Endocarditis and Kawasaki Disease of the Council on Cardiovascular disease in the Young. Prevention of bacterial endocarditis. JAMA 1990; 264:2919–22.
13. Rutala WA. The APIC guidelines for selection and use of disinfectants. Am J Infect Control 1990; 18:99–117.
14. Society of Gastrointestinal Assistants. Recommended guidelines for infection control in gastrointestinal endoscopy. Rochester NY, 1988.
15. Hanson PJ, Collins JV. AIDS, aprons, and elbow grease: preventing the nosocomial spread of immunodeficiency virus and associated organisms. Thorax 1989; 44:778–83.
16. Fitzpatrick SB, Marsh B, Stokes D, *et al.* Indications for flexible bronchoscopy in pediatric patients. Am J Dis Child 1983; 137:595–7.
17. Vigneswaran R, Whitfield JN. The use of a new ultrathin bronchoscope to determine endotracheal tube positions in the sick newborn infant. Chest 1981; 80:174–177.
18. Wood RE, Postma D. Endoscopy of the airway in infants and children. J Ped 1988; 112:1–6.
19. Wood RE, Gauderer M. Flexible fiberoptic bronchoscopy in the management of tracheobronchial foreign bodies in children: the value of a combined approach with open tube bronchoscopy. J Pediatr Surg 1984; 19:693–8.
20. Fan LL, Sparks LM, Fix EJ. Flexible fiberoptic endoscopy for airway problems in a pediatric intensive care unit. Chest 1988; 93:556–60.
21. Wood RE. Pitfalls in the use of the flexible bronchoscope in pediatric patients. Chest 1990; 97:199–203.
22. McKenzie B, Wood RE, Bailey A. Airway management for unilateral lung lavage in children. Anesthesiology 1989; 70:550–3.
23. Committee on Drugs, Section on Anesthesiology. Guidelines for the elective use of conscious sedation, deep sedation and general anesthesia in pediatric patients. Pediatrics 1986; 77:754.
24. Albertini RE, Harrell JH, Kurihara N, Moser KM. Arterial hypoxemia induced by fiberoptic bronchoscopy. JAMA 1974; 230:1666–7.
25. Karetzky MS, Garvery JW, Brandstetter RD. Effect of fiberoptic bronchoscopy on arterial oxygen tension. N Y State J Med 1974; 74:62–3.
26. King EG. Hypoxemia during fiberoptic bronchoscopy. (editorial) Chest 1984; 65:117–8.
27. Nussbaum E. Flexible fiberoptic bronchoscopy and laryngoscopy in children under 2 years of age: diagnostic and therapeutic applications of a new pediatric flexible fiberoptic bronchoscope. Crit Care Med 1982; 10:770–2.
28. Fan LL, Flynn JW. Laryngoscopy in neonates and infants: experience with the flexible fiberoptic bronchoscope. Laryngoscope 1981; 91:451–6.
29. Wood RE, Pick JR. Model systems for learning pediatric flexible bronchoscopy. Pediatr Pulmonol 1990; 8(3):168–71.

AMERICAN LUNG ASSOCIATION®
The Christmas Seal People®

#4033 Published by the American Lung Association® 6/92