ATS TECHNICAL STANDARDS: SUMMARY FOR CLINICIANS

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Flexible Airway Endoscopy in Children

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The American Thoracic Society previously published standards for flexible airway endoscopy (FAE) in children in the *American Review of Respiratory Diseases* in 1992 (1). Since that time there have been significant advances in the field with expansion in the use of FAE for diagnostic and therapeutic purposes. The American Thoracic Society formed a multidisciplinary committee of international experts to develop new technical standards. The standards are based largely on the experience of committee members, as there is minimal evidence related to pediatric FAE available from clinical trials and controlled observational studies. The technical standards describe the equipment, personnel, competencies, and procedures necessary for pediatric FAE. This summary is prepared for practicing clinicians.

Equipment and Setting

The decision to perform FAE is based on a patient's clinical condition. Primary concerns should be prioritization of patient safety, timely completion of the procedure, and infection control. Optimal airway examination requires an appropriately sized flexible bronchoscope. Currently available sizes range from an outer diameter of 2.2 mm to 6.3 mm and an internal channel of 1.2 mm to 3.2 mm.

Infection Control

The flexible bronchoscope generally comes into contact with intact mucous membranes without penetrating sterile tissue. Therefore, it is considered a semi-critical medical device. Between uses the minimum standard for bronchoscope reprocessing includes fastidious manual cleaning and high-level disinfection. All centers should follow manufacturer recommendations and established guidelines for inspection, maintenance, storing, cleaning, and reprocessing (2).

Training

Proficiency of a provider to perform FAE requires mastery of the core competencies including indications, contraindications, and identification of airway pathology. Competency is not dependent on performing a specific number of procedures.

Common Reasons for Performing FAE

The clinical presentation is the primary consideration when deciding whether or not to perform a diagnostic or therapeutic FAE. The procedure should be performed when it is the easiest, safest, and most effective way to obtain information or provide an intervention. For example, unexplained

stridor is a common indication for FAE, especially when there might be concern for subglottic stenosis. The risks and benefits must be considered on an individual basis. The only absolute contraindication is parental refusal (3).

Preprocedure Evaluation

Before FAE, it is important to recognize preexisting conditions that may impact the safety of the procedure including hemodynamic instability, bleeding diatheses, bronchial hyperresponsiveness, pulmonary hypertension, upper or central airway obstruction, or immunodeficiency. Infectious risk to the team, such as potential tuberculosis, should also be assessed. An inhaled short-acting β -agonist before the procedure should be considered in patients with history of asthma or bronchial hyperresponsiveness.

Sedation and Monitoring

The level of sedation required for FAE is determined by the clinical status of the patient and the indications for the procedure. Considerations include patient comfort, providing satisfactory conditions for the desired therapy or diagnostic procedure, and maintenance of both adequate gas exchange and hemodynamic stability.

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Airway Management and Examination

The flexible bronchoscope can be introduced into the airway via six techniques: transnasal, transoral, face mask, laryngeal mask airway (LMA), endotracheal tube (ETT), or tracheostomy tube. The goal of FAE is often evaluation of airway dynamics and anatomy. A transnasal FAE approach may be considered if the patient's history and examination suggest symptoms of abnormal airway dynamics or anatomy, such as stridor. Use of an LMA or ETT bypasses the upper airway and can then interfere with optimal viewing of laryngeal anatomy and dynamics. Therefore, an ETT or LMA can be inadequate to visualize airway pathology including laryngomalacia.

The Role of the Rigid Bronchoscope

FAE is useful for evaluating all levels of airway anatomy and dynamics, performing bronchoalveolar lavage (BAL), and removing peripheral airway mucous plugs. There are particular situations in which rigid bronchoscopy is preferable, however. These include when ventilation through the bronchoscope is needed for assessment of the posterior larynx and cervical trachea, when there is brisk pulmonary hemorrhage, and for foreign body extraction. Multiple instruments may be placed via the rigid bronchoscope.

Bronchoalveolar Lavage

Performance

Bronchoscopic and nonbronchoscopic BAL (where a sample is obtained via a suction catheter inserted into the ETT) have similar sensitivity, specificity, and predictive values. The location of the BAL should be based on clinical, radiologic, and bronchoscopic findings.

Processing

It is not standard practice to correct for dilution of the epithelial lining fluid. Proposed methods for correction have included measurement of secretory component, urea concentrations, total protein, or albumin in BAL fluid. However, there has been minimal validation of these tests, and significant methodological uncertainties remain. Situations wherein

there are alterations in alveolar-capillary permeability, such as certain inflammatory conditions, may affect the results.

Diagnostic Utility of Bronchoalveolar Lavage in Infection

Intubated patients are at risk for ventilator-associated pneumonia (VAP). When addressing common bacterial organisms in adults, VAP diagnostic criteria from the CDC/National Health Safety Network include: (1) greater than or equal to 10^4 cfu/ml from BAL; (2) protected specimen brushing greater than or equal to 10^3 cfu/ml from BAL; and (3) BAL-obtained cells containing greater than or equal to 5% intracellular bacteria on direct microscopic examination. In pediatric VAP diagnosis, equivalent investigations have not been performed to specify pediatric values. Quantitative bacterial cultures for VAP diagnosis have increased specificity. When assessing immunocompromised children, active infection may be suggested with fewer organisms on quantitative culture.

Bronchoalveolar Lavage in Cystic Fibrosis

The practice of directing cystic fibrosis (CF) treatment based on BAL continues to be controversial. In adults with CF, cultures from BAL or protected brush sampling correlate well with culture from expectorated sputum. In contrast, bacterial cultures from the oropharynx do not accurately represent the flora in lower airway BAL. In asymptomatic young children newly diagnosed with CF, BAL can identify organisms that might otherwise go undetected.

Bronchoalveolar Lavage in the Diagnosis of Pulmonary Aspiration

There is no gold standard for diagnosis of aspiration in the pediatric population, and results have varied from study to study. Factors such as what is aspirated, the volume of aspirate, and the amount of time between the aspiration event and the BAL sampling all affect the results. Lipid-laden alveolar macrophages may be present in any BAL and are especially common in patients with lung disease. They have been used as a potential marker of aspiration, but this finding is nonspecific as there can be both exogenous and endogenous sources of lipid. The lipid-laden macrophage index and other quantitative scoring systems remain controversial.

Bronchoalveolar Lavage in Other Disorders

In patients with Langerhans cell histiocytosis, BAL cytology will most commonly reveal immunostaining for S-100, CD1a, and langerin. In pulmonary alveolar microlithiasis, the cytology typically shows microlith staining with periodic acid-Schiff stain or von Kossa stain. Patients with chronic lipoid pneumonia typically demonstrate oil red O staining with evidence of lipid-laden macrophages. The BAL fluid in patients with pulmonary alveolar proteinosis will reveal periodic acid-Schiff stain-positive, diastase-resistant amorphous material. Patients with alveolar hemorrhage will have evidence of hemosiderin-stained macrophages.

Specialized Procedures

Transbronchial and Endobronchial Biopsy

Transbronchial biopsies can be performed with pediatric FAE for a number of conditions, including nodules, infections, and infiltrative lung disease, and for evaluation of patients after lung transplantation. Endobronchial ultrasound can be used to localize peripheral lung nodules and guide the biopsy to the lesions of interest. It can be performed in pediatric patients as long as a bronchoscope with a minimum of a 2.0-mm working channel can be used. Endobronchial biopsies can also be performed when assessment of the pediatric airway surface is required. Indications for endobronchial biopsies include ciliary dyskinesia, infection, granulomatous disease, airway lesions/tumors, and airway fibrosis. The efficacy of endobronchial biopsy will be significantly greater if large 2.0-mm biopsy forceps are used, but to accommodate them the patient must have a large enough ETT.

Bronchoscopic Dilatation and Airway Stenting

Tracheal dilatation is indicated in situations in which there is severe stricture of the large airways. Malacic lesions and airway narrowing caused by external compression are generally not amenable to airway dilatation. Bronchoscopic dilatation should be performed while carefully considering the diameter of the native bronchus. To ensure

that one does not traumatize the airway, a balloon should be chosen that is the same size or only slightly bigger than the involved bronchus. Narrowing in the trachea, left and right mainstem bronchi, and the bronchus intermedius are generally amenable to stenting. It is ideal to have the shortest stent possible to traverse the affected area, and the diameter of the stent should be slightly larger than the airway on either side of the lesion.

Atelectasis

FAE can be used in the diagnosis and treatment of atelectasis. It is suggested that FAE can assist in determining the cause of atelectasis in 62 to 100% of patients. Although some providers will use bronchoscopically instilled mucolytics, there are no data to support that they are more effective than the standard technique using sterile saline washes.

Documentation

The procedure note should include the provider's rationale, findings, and tracking information. It may be used to communicate results as well as for quality control, internal auditing, and medical research.

For qualifying remarks related to the summary above, see the full clinical practice guideline (4). ■

Author disclosures are available with the text of this article at www.atsjournals.org.

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