Recommended Principles Relative to the Use of Bronchoscopy and Tracheotomy in Infants and Children

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This report consists of a summary of somewhat divergent views relative to endoscopy and tracheotomy in pediatric patients. It represents the discussions of a combined meeting of two committees of the American College of Chest Physicians; namely: (a) The Committee on Pulmonary Diseases in Children and (b) the Committee on Bronchoesophagology, held initially in conjunction with the Annual Meeting of the American College of Chest Physicians in Chicago, Illinois in 1962, and in the other sites of annual meetings in 1963, 1964 and 1965.

A. BRONCHOSCOPY IN INFANTS AND CHILDREN

I. Attitudes towards the procedure:
A marked variance in attitude towards endoscopy in infants as to its risks, value and indications was expressed. Discussions by committee members from New York City revealed that in many major hospitals, infant endoscopy was rarely performed, considered extremely hazardous and associated with a high complication rate. In contradistinction to this were the remarks of Dr. Edith Lincoln on whose service the procedure is frequently performed and considered of such minimal risk that it is frequently carried out for periodic evaluation of the therapeutic response and progress of combined tuberculous endobronchial disease with peribronchial lymphadenitis. This discussion led to the obvious conclusion that risk decreased markedly with (a) improved technical ability of operators resulting from more frequent application of the procedure, (b) lower risk and complication rate when better risk patients were subjected to endoscopy and (c) specific technical measures used to avoid so-called “subglottic edema.”

The fundamental difference in attitude towards risk inherent in such endoscopy significantly affected different individuals’ concepts concerning the indications for and value of the procedure. In other words, in those areas where there is a significant fear of the risks involved, the procedure was prone to be utilized only as a late, desperation type measure in moribund patients. In similar manner, in those areas where the general attitude was frequent early use of endoscopy in bronchopulmonary disease, such physicians were prone to be almost unduly liberal in their recommendations for endoscopy.

II. Indications for endoscopy:
(A) Foreign bodies: There was uniform agreement that endoscopy was indicated in all patients presenting with foreign bodies in the tracheobronchial tree. Some distinct enthusiasm for the use of magnets for extraction of magnet-sensitive metal foreign bodies was expressed. A uniform emphasis was placed on the value of and need for chest fluoroscopy in evaluating the possibility of foreign body inhalation.

(B) For the purpose of diagnosis:
1. Obstructive phenomena. Patients presenting with evidence of persistent, localized or unilateral bronchial obstruction, such as (a) wheezing, (b) roentgenographic evidence of mediastinal shift (albeit constant or phasic with respiration), (c) localized emphysema or (d) localized atelectasis were considered candidates for endoscopy.

Special consideration was given to vascular rings due to aortic anomalies or “pulmonary sling,” when present as the cause for tracheobronchial obstruction. Several discussors remarked on the possible harm of endoscopy in such patients with tracheal or bronchial compression resulting from such

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vascular abnormalities. Therefore, it was recommended that appropriate esophagograms and in some instances, tracheograms, be performed prior to endoscopy whenever such anomalies were suspected.

Lobar emphysema (better termed "idiopathic localized pulmonary emphysema of infancy") was also considered as a possible indication for endoscopy. Here it was stressed that the diagnosis is most prone to be considered when roentgenograms showed localized or unilateral ischemia of the lung often with concomitant plethora of non-involved lung tissue. In view of such ischemia, the discussion considered the role of pulmonary angiography in this disease. The general consensus of opinion was that such studies were recommended. However, it was agreed that pulmonary ischemia could be produced either by "localized distensive emphysema of infancy" or by partial bronchial obstruction due to various causes.

It was, therefore, recommended that endoscopy could be of true value in idiopathic emphysema especially inasmuch as the classic form of the disease provides a bronchoscopic study which appears to be completely negative. In some of the disease states imitating localized distensive emphysema of the idiopathic type, bronchoscopy may reveal significant mucopurulent secretion or mucous plugs which would thus present evidence against the presence of true "congenital lobar emphysema."

Besides the above seemingly negativistic value of endoscopy in localized idiopathic emphysema, many committee members considered that endoscopy might occasionally reveal (a) the rare instance of localized agenesis of bronchial rings, surgical correction of which could prove curative and (b) that endoscopy (if it be combined with trans-endoscopic instillation of contrast material) may reveal (1) localized obstruction from redundant mucosal folds (again potentially curable without loss of lung tissue) or (2) suggest the more common type of localized emphysema of the newborn wherein the lung tissue is unsalvageable as the result of malunion of ectodermal and endodermal lung elements.

Tuberculosis: - Considerable difference of opinion was expressed in regard to the use of endoscopy in infant or childhood tuberculosis. Dr. Edith Lincoln considers the procedure of diagnostic value and useful in evaluation of therapeutic response. In the latter category this procedure may lead toward change in therapeutic regimen, such as the type of drug therapy combination used, or even lead one towards earlier surgical excisional measures. Other commentators noted that secretions obtained at, or subsequent to, endoscopy may reveal tuberculous organisms in patients upon whom other sputa or gastric washing studies had proved negative. Some members were quite strongly opposed to endoscopy in tuberculosis of the child or infant considering it to be unnecessary, potentially harmful to the disease process, and a procedure of high risk.

Atelectasis: - Again opinion varied. The majority of the joint committee members considered that patients with a major clinical response to atelectasis such as dyspnea, fever or cyanosis, deserved endoscopy if medical treatment fails, including positive pressure (24 hour limit). The limited value of roentgenograms in defining the degree and severity of atelectasis particularly in its earlier stages was stressed.

It was emphasized by some, and generally agreed, that special safety measures are needed prior to and in conjunction with endoscopy of the severely ill infant with atelectasis. The frequency of experience of cardiac arrest attendant to endotracheal suction in the cyanotic infant was stressed. Vagus terminal response is seriously enhanced by the presence of a high pCO₂ and a low arterial pH. Therefore, in such instances, the general recommendation is that the infant should undergo preliminary hyperventilation with a high oxygen concentration followed by endotracheal intubation. Further hyperventilation should then be carried out prior to further aspiration through the endotracheal tube. When one
feels that the basic defect in blood gases is satisfactorily corrected, then bronchoscopy can be performed with minimal or no risk. Preliminary atropine is strongly indicated. In less severe states, useful aspiration can be accomplished by (a) preliminary mask hyperventilation and (b) direct vision laryngoscopy with insertion of a fine rubber-tipped bronchoscopic suction tube under direct vision into the tracheobronchial tree without preliminary local or general anesthesia. This is a method previously described and popularized by Dr. Cameron Haight in the immediate postoperative management of tracheoesophageal fistulae in infancy (Fig. 1A, B).

**Pneumonia:** There was general agreement that endoscopy is rarely indicated in the early stages of this disease. Furthermore, it was noted that it is more prone to need consideration (i.e. for endoscopy) sometime during the course of staphylococcal disease than in other bacterial pneumonias. The main reason for considering endoscopy in pneumonia were for (a) delayed resolution, (b) secondary pneumatoceles, (c) tendency to abscess formation, and (d) as a concomitant to tracheostomy in extremely ill patients unable to control their secretions.

When endoscopy is used in pneumonia patients, it was the general feeling that the acute cellulitic stage of the disease was a phase of the illness wherein endoscopy should be avoided. Endobronchial instrumentation in acute pneumonic processes prior to 24 or 48 hours of adequate antibiotic therapy is considered (a) capable of augmenting or disseminating the disease process and, (b) being associated with a
higher incidence of postinstrumentation bacteremia. The value of endoscopy later in the course of pneumonias (i.e. after 10-14 days of persistent disease) was considered to be of potential value in (1) allowing direct application of shrinking agents upon edematous areas of bronchial obstruction, (2) permitting local irrigation with saline to release mucopurulent impactions, (3) producing a marked expectorant response, and (4) in occasionally revealing an unsuspected foreign body or other type of obstruction.

Chronic Lung Disease Processes: - Here the predominant matter for discussion was the value of endoscopy in the management of mucoviscidosis. It was uniformly agreed to be of no diagnostic value in this disease. Marked divergence of opinion as to its therapeutic value was expressed. This was flavored by (a) the knowledge of the irreversibility of this disease process and (b) the susceptibility of these lungs to secondary bacterial invasion. The final consensus was that the procedure was relatively rarely indicated in mucoviscidosis, but occasionally is a life-saving measure. Consideration of the need for endoscopy should be decreased by the earlier advent of better physiotherapy (chest and drainage exercises), more adequate expectorant therapy, appropriate chemotherapy and antibiotics, and overall therapeutic program. It was stressed that should endoscopy become necessary that particular care in sterilization of equipment to eradicate Pseudomonas pyocyaneus should be given; by this it was meant that cold sterilization methods, other than the use of gas (ethylene oxide) sterilization, are known to be incapable of eradicating this organism so commonly involved in the terminal phases of mucoviscidosis. Therefore, only complete sterility of instruments and operative procedure are considered adequate when bronchoscopy is employed in this disease.

Tracheomalacia: - Considerable divergence of opinion was expressed as to the need for, and the value of, endoscopy in this disease. Some observers felt that simple observation of the epiglottis digitally or by direct vision would often suffice. Others felt that endoscopy was essential for the diagnosis of the disease. There was general agreement that a patient with tracheomalacia presenting persistent troublesome secretions from acute or chronic tracheobronchitis was a candidate for endoscopic assistance.

Miscellaneous: - The need for endoscopy in patients with asthmatoid behavior who do not fit the true pattern of bronchial asthma was stressed. It was considered that such patients may harbor pedunculated or sessile adenomata, unsuspected bronchial stenosis, neoplasms or foreign bodies.

There was no uniformity of opinion as to the need for, or frequency of, bronchoscopy in true bronchial asthma in its earlier or less severe stages. All agreed that unilateral asthma should not be considered bronchial asthma, but due to organic obstruction until proved otherwise and thus deserved early endoscopy. The value of bronchoscopy in status asthmaticus also appeared to be a controversial point, drawing some very strong proponents and a few strong antagonists towards the institution of this procedure in this state of the disease.

The value of bronchoscopy in chronic tracheobronchitis was also mentioned. The otolaryngologists and thoracic surgeons of the joint committees emphasized the need for one or more bronchoscopies prior to bronchography in bronchiecstatic patients.

III. Technical Considerations: - (1) Anesthesia: - Two basic attitudes towards this aspect were expressed. Dr. Paul Holinger and other otolaryngologists from the Chicago area and some from the Philadelphia area prefer no anesthetic (either general or topical) in patients up to the age of 10-12 years. In such patients preoperative sedation and occasional atropine was recommended. In the older children, these surgeons would prefer to institute topical anesthesia. In contradistinction to this attitude were the groups representing the Mayo Clinic and Emory University School of Medicine, both of whom were very en-
thusiastic about the use of fluothane plus topical lidocaine (Xylocaine). Apparently excellent results were reported by both groups. Those utilizing general anesthesia stressed the lesser degree of psychologic trauma incurred plus the bronchodilating capacity of bromochlorotrifluoromethane (Fluothane). Those using no anesthesia or purely topical anesthesia expressed a fear of the risk of anesthesia and their feeling that this was making a relatively simple procedure unduly complicated.

2) Instruments: - There was general enthusiastic agreement that the smallest useful size bronchoscope should be used whenever possible and that the Holinger modification of the Jackson bronchoscope presented the least traumatic outer surface. Considerable enthusiasm was expressed for the new No. 2.5 Holinger-Jackson bronchoscope for infants in the newborn weight group.

(3) Technique of Insertion (Fig. 2): - The marked variance in reported risks and complications of bronchoscopy in infants revealed a rather remarkable lack of understanding throughout this continent relative to the special techniques required in infants and children. It was initially stressed by Dr. Abbott and enthusiastically reported by others that proper use of the Jackson infant laryngoscope was the major element in prevention of so-called subglottic edema. It was stressed that this instrument should be placed on the posterior surface of the tongue, just anterior to the epiglottis and any actual contact with the epiglottis should be avoided. It was the general feeling that the posterior inferior surface of the epiglottis adjacent to the larynx was that area prone to produce edema and that thus so-called “subglottic edema” might be considered “epiglottic trauma or edema.” By appropriate downward pressure and forward traction with the laryngoscope towards the lips of the patient, the epiglottis would thus be drawn forward without actually even having encountered direct pressure from the operative instruments. This will allow adequate exposure of the vocal cords, and gentle introduction of an appropriate size bronchoscope can then be performed in a truly atraumatic manner.

It was further emphasized that once the bronchoscope had been passed through the larynx that any unnecessary movement of the instrument capable of producing laryngeal trauma, must be avoided at all costs. The need for elevating the patient's head in a position parallel to the operating table with the face thus pushed considerably upward in relation to the anterior surface of the sternal area, was emphasized as being that position most beneficial towards exposing the larynx without incurring posterior displacement by the hyoid structures. This was considered the “Chevalier Jackson head position,” and considered far preferable to the more commonly used hyperextension or dorsiflexion of the head commonly seen during endotracheal intubation. This latter position was condemned.
as being conducive to unnecessary trauma to the anterior portion of the larynx, and potentially capable of "coning the medulla" in patients with intracranial pressure. At the completion of the operative procedure just before final removal of the bronchoscope it was generally recommended that the head be re-positioned to again simulate the "Chevalier Jackson head position," thus allowing withdrawal of the bronchoscope without pressure upon the anterior laryngeal and epiglottic areas. Some enthusiasm was actually expressed that we should urge that the term "subglottic edema" be changed and replaced by the words "anterior laryngeal edema" or "epiglottal-laryngeal edema."

IV. Complications:-- There was general agreement that the vast majority of complications attendant to bronchoscopy in infants leading to tracheotomy or suffocation was the result of improper understanding of the above traumatic technique for endoscopy. The committee expressed a sincere desire that this aspect of their report be strongly emphasized and if such report is published that it be amply illustrated by drawings which have already been made by the Emory University Department of Medical Illustrations. Difficult intubation should be followed by immediate intravenous dosage of steroid equivalent to 1 mg dexamethasone per kg body weight.

The possibility of producing bacteremia during endoscopy was mentioned, as was trauma due to improper size of instruments used. Trauma due to lack of qualifications of the operator were also commented upon. Special emphasis was placed upon adequate sterilization of instruments and the maintenance of a more sterile atmosphere during the operative procedure in the area of operation.

V. Postoperative Care:-- The intensity of postoperative care needed varies markedly with (a) the technique used for the procedure, (b) the duration of the operation and (c) the preoperative state of the patient and his laryngotraechobronchial tree. Close observation with hospitalization is required for the first 24-48 hours. Adequate high humidity, such as provided by tent or by other modern apparatus is satisfactory. The general feeling was that warm humidification was better than cold humidity. If the procedure is properly performed there should be (1) no hoarseness, (2) no respiratory difficulty or retraction, (3) minimal, if any, discomfort and (4) liquid diet should be well tolerated as soon as topical anesthesia has worn off (approximately two hours). However, if the procedure has been traumatic or previous laryngeal trauma has occurred, as evidenced by hoarseness, then initial attempts at swallowing water must be cautiously observed for fear of aspiration. It is only in such cases that a tracheotomy set need be kept at the bedside and a stormy convalescent period feared. The majority of committee members considered high humidity (warm) and steroids the only useful medical measures for prevention of "laryngeal edema." Others suggested that steroid therapy could play a role in decreasing edema when present. There was uniform opinion that the best treatment for this complication was prevention by utilizing appropriate technique.

Should a tracheotomy be performed, the general recommendation was that the patient should be primarily intubated either with an adequate-sized bronchoscope to permit ventilation or with an endotracheal tube. Such will allow an elective type of tracheotomy procedure to be performed and minimize the chances of post-tracheotomy unilateral or bilateral pneumothorax.

VI. Summary:-- The foregoing discussion emphasizes the value of the "atraumatic technique" in prevention of complications. In institutions utilizing this technique the procedure is very liberally used and basically free of complications. The catastrophe of vago-vagal reflex cardiac arrest is considered to be avoidable if one uses the appropriate hyperventilation techniques as the initial therapeutic approach for patients presenting with cyanosis or any
evidence of significant hypoxia and hypercarbia prior to actual introduction of the bronchoscope. Infections resulting from endoscopy reflect inappropriate sterilization techniques relative to instruments, inappropriate regard to aseptic measures in the operating room during the operative procedure or improper timing of the procedure insofar as blood level of antibiotics for active pneumonitis is concerned.

Dissemination of infection can be produced by instrumentation in the early phases of pneumonia. There may be some danger in bronchoscopy of the patient who is severely distressed by vascular anomalies, such as vascular ring or "pulmonary sling" syndrome.

VII. Problems requiring solution: - The committee was unable to arrive at uniform recommendations relative to indications for bronchoscopy. The members from clinics in which complications were extremely rare were liberal in their "recommended indications." The opposite was equally true from clinics where infant endoscopy is rarely used and associated with high complication rate (either because of late institution of the procedure in highly moribund patients or because of inappropriate understanding of the atraumatic technique). It is hoped that with more widespread acceptance of this "atraumatic technique" that more uniform recommendations concerning indications for infant endoscopy may evolve.

There is a continuing problem of training of endoscopists for children. In institutions wherein the procedure is liberally used, the residents are allowed sufficient training; whereas, in other institutions utilizing rare endoscopy, independent endoscopy by the resident trainee is almost unheard of. It is felt that infant endoscopy does require special training, care and understanding of the problem. As such, it should be performed only by adequately trained otolaryngologists or thoracic surgeons and not by general surgeons, pediatricians, anesthetists, or general practitioners.

Improved visibility is a continuing desire of endoscopists and it is hoped that the new fiberglass lighting and other instrumental improvements will live up to initial promises and expectations. Continued development in this field is required.

The committee uniformly agreed that (1) the understanding of pediatricians and general practitioners relative to the potential value of infant endoscopy, and (2) its appropriate timing and application in the disease are not adequate. The American College of Chest Physicians and its appropriate committees are urged to continue and further stress their efforts in this regard.

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