Study objectives: It is difficult to determine, in the child with a long-term tracheostomy, when bacterial airway colonization has progressed to a respiratory infection requiring antibiotic treatment. Our aim was to investigate whether there is a consensus regarding this and related chronic care issues among clinicians treating these patients.

Design and setting: A questionnaire asking about practices regarding use of tracheal aspirate cultures and antibiotics was distributed to 47 pediatric pulmonary centers.

Participants: Individuals representing 34 centers (72%), caring for 10 to 400 patients, responded.

Interventions: None.

Results: At 65% of centers, management is variable, dependent on the patient’s underlying condition. The most common indications to obtain a culture were change in secretions (91%) or fever without an obvious source (21 centers). Indications to treat with antibiotics included many leukocytes in secretions (21 centers) or a respiratory illness (18 centers). When treating, 97% prescribe antibiotics empirically, most often enterally; nine centers use inhaled antibiotics. In most centers (79%), management is often done by telephone.

Conclusions: Although pediatric pulmonologists tend to have similar approaches to assessment and management of suspected respiratory tract infections in tracheostomized children, no clear consensus exists, and much of current practice is empirical. To optimize care of these patients, studies should be conducted to develop criteria to objectively differentiate bacterial airway “colonization” from “infection.”

Key words: airway; bacterial colonization; children; pediatric pulmonologist; respiratory infection; respiratory secretions; tracheostomy

Despite the fact that many pediatric pulmonologists routinely care for a substantial number of children with a long-term tracheostomy, surprisingly little published information is available regarding many aspects of their chronic care, including assessment and management of suspected respiratory tract infections. In particular, it is often very difficult to determine when a child has developed a respiratory condition that may require treatment with antibiotics. In most, if not all, patients with a tracheostomy, the trachea becomes colonized with bacteria (most commonly Gram-negative organisms such as Pseudomonas aeruginosa) soon after placement of the artificial airway.1,2 It remains so indefinitely, as a result of disruption or bypass of the body’s usual defense mechanisms for clearing microorganisms, which include filtering by the upper airway and removal by effective mucociliary transport and cough mechanisms.1-3 Therefore, growth of bacteria in a culture of tracheostomy secretions will generally not allow the conclusion that an infection requiring antibiotics is present; even quantifying bacterial load may not be helpful.4 Furthermore, the presence of WBCs on a Gram’s stain of secretions or gross purulent appearance may not indicate need for antibiotics, because even in a patient in stable condition with a tracheostomy, secretions normally contain leukocytes, predominantly neutrophils.4,6 In addition, at least in adults with long-term tracheostomies, tracheal aspirate leukocyte concentrations may not correlate with quantitative bacterial counts.4

Thus, currently available basic laboratory testing or gross inspection of tracheal secretions may not be useful in determining when airway colonization, defined as innocuous presence of bacteria, has progressed to true infection, implying the presence of clinical or subclinical disease.7 When fever, respiratory distress, and cough accompany purulent tracheo-
ostomy secretions, antibiotics may prove to be beneficial. However, it is often not so clear, eg, in an otherwise well pediatric outpatient who has yellow tracheostomy secretions, whether antibiotics should be prescribed. Prescribing often-expensive antibiotics when they may not be indicated may place the child at risk for drug-related side effects, and theoretically, the development of antibiotic-resistant organisms.

Clinicians caring for children with tracheostomies must frequently make decisions about how to evaluate and manage suspected respiratory tract infections. Since even among the group of pulmonologists who practice at Children's Hospital of Wisconsin there is no absolute agreement on how to deal with these issues, we wondered how other caregivers approach these important decisions. We conducted a survey among academic pediatric pulmonary medicine centers in the United States to determine whether there is consensus about best practice. We were particularly interested in their approach to tracheostomized pediatric outpatients, because management of this group of children may be less straightforward than that of more seriously ill hospitalized patients. Outpatient management is particularly difficult because it often takes place over the telephone because (1) logistic difficulties often preclude a trip to the pulmonologist, and (2) most of these children are cared for at home by skilled medical personnel who can perform a thorough medical assessment.

**Materials and Methods**

**Questionnaire Distribution**

A three-page questionnaire was mailed early in 1994, along with a self-addressed, stamped envelope to the directors of the 46 accredited pediatric pulmonology fellowship programs listed in the January 1993 issue of *Journal of Pediatrics* and/or the October 1993 issue of the *American Review of Respiratory Disease*. An accompanying cover letter was sent, describing the survey, and our desire to assess the “standard of care” regarding management of children with tracheostomies at different institutions across the nation. It was not explicitly stated in this letter, or in the questionnaire itself, that responses should necessarily reflect the practice of all center caregivers. Attempts were not made to have the questionnaire completed by more than one person at each responding center. Respondents (centers) were given the option of remaining anonymous. A questionnaire was also given to our chief pediatric pulmonologist (T.B.R.).

**Questionnaire Content**

Responders were instructed to indicate who was filling out the survey, ie, physician, nurse, etc. Information gathered included the following: (1) number of patients with tracheostomies followed up by the center; (2) age range; (3) number receiving mechanical ventilation; (4) underlying diagnoses; (5) when tracheal aspirate cultures are obtained; (6) when antibiotics are prescribed; (7) whether a formal protocol exists to guide such management; (8) when follow-up cultures are obtained; (9) whether the center is thought to have a very aggressive approach to treatment; (10) whether management is dependent on underlying diagnosis, use of mechanical ventilation, or season; (11) whether concern exists regarding development of antibiotic resistance; and (12) whether a significant amount of management regarding these issues is done via telephone.

No attempt was made to internally or externally validate the questionnaire. In addition, attempts were not made to further define vague terms (eg, “ill,” “well,” “abnormal” or “normal” [regarding secretions], “positive” [regarding cultures], “respiratory illness,” “a virus,” and “aggressive” [regarding treatment]) or to determine if these held the same meaning for different respondents.

**Statistics**

Where appropriate, data are expressed as mean±SD.

**Results**

**Responses**

Completed questionnaires were returned by 34 centers (72% response rate), 4 of which desired to remain anonymous. Five questionnaires were completed by nurses or respiratory therapists; the rest were completed by physicians. Not all questionnaires that were returned contained responses to every question; when the number of responders to a question was <34, it is indicated below.

**Center and Patient Characteristics**

Respondents completing the questionnaire as center representatives (referred to in this “Results” section as “respondents,” “individuals,” or “centers”) reported caring for 48.5±77.0 patients (range, 10 to 400), age range approximately birth to at least 22 years. Almost half of patients receive some type of mechanical ventilation (a more precise value cannot be given because responses had a wide range). Underlying diagnoses that led to tracheostomy placement are listed in Table 1.

**Overall Approach to Management**

Only one respondent (2.9%) reported having a formal management protocol regarding when to obtain tracheal aspirate cultures and treat with antibiotics in these patients. Twenty of 31 respondents (65%) said that their approach to such management is specifically dependent on underlying diagnosis.

**Obtaining Tracheal Aspirate Cultures**

The vast majority of respondents (31/34, 91%) obtain a tracheal aspirate culture if there has been a
change in tracheostomy secretions, regardless of clinical condition. As can be seen in Figure 1, the most frequently reported change was secretions becoming green. Another frequently reported indication was presence of a fever without an obvious source in an ill patient.

Indications for Treating With Antibiotics

As shown in Figure 2, the most commonly reported indications for treating a tracheostomized child with antibiotics for respiratory-related reasons were presence of many WBCs on a Gram’s stain of tracheostomy secretions or presence of any respiratory illness. Most respondents, 61% (20/33), do not treat a child with abnormal tracheostomy secretions if he/she is well. Twelve respondents (35%) treat patients receiving mechanical ventilation more aggressively with respect to antibiotics. Fourteen respondents (41%) are more likely to prescribe antibiotics during the winter than during other seasons. Only two respondents (6%) place patients with tracheostomies on a regimen of long-term “prophylactic” antibiotics based on presence of a tracheostomy alone.

Utilization of Culture Results

Thirty respondents do not prescribe antibiotics if a culture grows organisms other than those described as “normal flora” if the patient is well and secretions are normal. Among respondents who do treat under such circumstances, the most frequently treated organisms include Pneumococcus (four respondents), and Staphylococcus aureus, group A streptococcus, Haemophilus influenzae type b, and Haemophilus nontypable (three respondents each).

Specifics of Antibiotic Therapy

When the decision has been made to treat with antibiotics, all respondents except one treat “empirically” without waiting for results of current culture and sensitivity analysis, although results of previous culture are often used to tailor therapy. As shown in Table 2, the most frequently prescribed antibiotics are enteral trimethoprim-sulfamethoxazole and amoxicillin-clavulanate potassium; relatively few respondents use inhaled antibiotics. Of 31 respondents, only 6 (19%) believe they treat positive tracheal aspirate cultures very aggressively.

Follow-up Cultures and Treatment

Four respondents (only 12%) routinely obtain a follow-up culture after treating with antibiotics, even if the patient is well. If the repeat culture grows the same organism present before treatment, only two of those individuals specifically responding (7%) consistently administer another course of antibiotics.

Antibiotic Resistance Issues

Eight respondents acknowledged concern about development of antibiotic resistance because of frequent antibiotic use; five respondents were not concerned. Seventeen respondents have had tracheal aspirate cultures grow methicillin-resistant S. aureus; five of these respondents report inability to eradicate this organism.

Management Logistics

Many issues regarding tracheostomy secretions and suspected respiratory tract infections for patients

![Figure 1. Indications for obtaining a tracheal aspirate culture. Responses are categorized as either “secretion-related,” referring to quality of tracheostomy secretions, or “illness-related,” referring to patient condition. “Sepsis w/n” signifies that culture is obtained as part of a “sepsis workup.”](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21767/ on 06/26/2017)
who do not sound ill are managed at most centers (79%, 27/34) over the telephone.

**DISCUSSION**

The survey results show that pediatric pulmonologists do not generally follow a formal protocol to guide management of possible respiratory tract infections in tracheostomized children; most center representatives (hereafter referred to as “centers”) vary their approach based on the patient’s underlying diagnosis. Most centers obtain a tracheal aspirate for culture and sensitivity analysis if there has been a change in usual secretions, even in a well patient; secretions becoming green was thought to be most indicative of need to obtain a specimen. Interestingly, however, most centers will not treat with antibiotics despite presence of abnormal secretions if the patient is well. Most centers do obtain a specimen in an ill patient with a fever without a source, and antibiotic treatment is often initiated in these children if any type of respiratory illness is present. Presence of many leukocytes in secretions was thought by most centers to indicate need for antibiotics, while rarely are antibiotics prescribed based solely on growth of a particular organism in secretions.

When pulmonologists decide to prescribe antibiotics, they rarely wait for results of the culture obtained during the “current” episode to choose the drug; the antibiotic, usually delivered enterally, is frequently chosen empirically or based on results of previous culture. Rarely is a routine follow-up culture obtained after antibiotic treatment. Although most centers do not believe they have a very aggressive approach to treatment of suspected respiratory tract infections, potential development of antibiotic resistance does concern some centers, and methicillin-resistant *S aureus* is seen not infrequently.

The survey found no clear consensus among pediatric pulmonologists regarding approach to suspected respiratory tract infections in tracheostomized patients. This is likely due, at least in part, to the lack of published literature regarding this topic in children. In a comprehensive book describing care of children with long-term tracheostomies, specific guidelines regarding need for antibiotics are not given, and the importance of the “entire clinical picture” is emphasized, without a more detailed explanation. Brook studied 27 tracheostomized pediatric inpatients with severe neurologic disorders and found bacterial colonization of the airway in all of them. Subjects were followed for 1 year, and 24 patients were described as having “chronic tracheobronchitis with recurrent episodes of pneumonia,” but the diagnosis of tracheobronchitis was made without strict criteria and was defined as being present when “purulent secretions appeared but when physical examination and chest x-ray films showed no evidence of pneumonia.” Only 2 positive blood cultures were found in 38 specimens from the 24 patients with pneumonia, and all patients were said to have responded favorably to therapy. Inter-

![Graph](image.png)

**Figure 2.** Indications for treating with antibiotics. “Many WBCs” refers to presence of many WBCs on Gram’s stain of tracheostomy secretions, and “resp illness” refers to presence of any respiratory illness. Subsequent criteria refer to quality of secretions; “any change” signifies change from usual baseline.

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>No. of Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteral</td>
<td></td>
</tr>
<tr>
<td>TMP-SMX*</td>
<td>18</td>
</tr>
<tr>
<td>Amox-Clav&lt;sup&gt;1&lt;/sup&gt;</td>
<td>18</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>8</td>
</tr>
<tr>
<td>Eryth-Sulfa&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>3</td>
</tr>
<tr>
<td>Cefixime</td>
<td>3</td>
</tr>
<tr>
<td>Cefuroxime axetil</td>
<td>3</td>
</tr>
<tr>
<td>Inhaled</td>
<td></td>
</tr>
<tr>
<td>Tobramycin</td>
<td>5</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>5</td>
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</tbody>
</table>

<sup>*TMP-SMX=trimethoprim-sulfamethoxazole.  
<sup>1Amox-Clav=amoxicillin-clavulanate potassium.  
<sup>2Eryth-Sulfa=erythromycin ethylsuccinate-sulfisoxazole acetyl.  

Table 2—Antibiotics Used Empirically to Treat Suspected Respiratory Tract Infections in Tracheostomized Children
estingly, anaerobic organisms, which are not routinely sought in tracheal aspirate specimens in some institutions, were thought to play a significant role in colonization and infection of the airway of these patients.

Another study of a small group of patients (16 adults) by Karnad and coworkers suggests that measurement of respiratory mucus pH in critically ill tracheostomized adults may help in predicting the development of pneumonia. In these patients, pH decreased generally at the time of or before the development of radiologically detectable pneumonia. In this study, 11 of 16 patients with known tracheobronchial colonization developed pneumonia, and 2 others developed pneumonia without prior colonization. No mention was made of tracheobronchitis, the vaguely defined entity we are attempting to characterize more specifically. Palmer et al recently reported a decrease in tracheal secretion soluble-intercellular adhesion molecule-1 burden in six adult patients with a long-term tracheostomy and ventilator dependence after treatment with antibiotics for "tracheobronchitis" (loosely defined as an increase in purulent secretions without associated radiographic findings), suggesting that this molecule might eventually have utility in following the course of possible respiratory infections. However, it appears that no comprehensive long-term investigation focusing on strict diagnosis, management, and outcome of respiratory tract infections, particularly those without clear radiographic findings (ie, tracheobronchitis), has been conducted in pediatric outpatients with long-term tracheostomies.

Due to the lack of published guidelines, most of current practice regarding suspected respiratory tract infections in these patients appears to be based on a compilation over time of empirical "hands-on" experience, as was implied by one pediatric pulmonologist completing our questionnaire. Some of the current practices are without scientific basis, and may lead to unnecessary expenses. For example, purulent secretions were thought by most to indicate need to obtain a tracheal aspirate culture, even in a well patient. Purulent appearance, however, implies only the presence of leukocytes/inflammation, or perhaps presence or overgrowth of pigment-producing Pseudomonas, and not necessarily infection. Airway secretions in a patient in stable condition with a tracheostomy normally contain leukocytes, generally mostly neutrophils, likely due to (1) an inflammatory response generated by the presence of colonizing bacteria, and (2) irritation by the tracheostomy tube, and intermittently, suction catheters. Since antibiotic treatment is often started before results of a current culture are available, with good success (personal observation), the utility of obtaining these expensive cultures on a frequent basis might be questioned. The cost of Gram's stain and culture and sensitivity analysis for a tracheal aspirate specimen at Children's Hospital of Wisconsin is dependent on the number of organisms isolated; for two isolates, which may be considered typical, the cost is $226. One might also question the logic of the common practice of obtaining such a culture as part of the workup of a patient with fever without a source, because, unlike the case with a normally sterile body fluid such as cerebrospinal fluid, growth of any organisms will not necessarily allow one to identify this as the source of the fever.

Although, as noted above, leukocytes in tracheal secretions are not at all unexpected even in the absence of infection, this was the most commonly reported criterion used to institute antibiotic therapy. The second most common reported indication was presence of any respiratory illness, although this term often lacks strict definition and is used very subjectively in this patient population. To our knowledge, none of the other most frequently reported criteria thought to signify need to start antibiotic therapy, all of which describe a change in tracheostomy secretions, has ever been found to necessarily imply presence of infection, eg, foul smell, which may simply signify bacterial overgrowth, and copious amount, which may not even be accurately assessed, even by trained personnel. Perhaps fortunately, however, most centers will not start antibiotic therapy based only on a change in secretions if the child is well.

When deciding whether to prescribe antibiotics in equivocal cases, one must weigh the potential benefits against the potential costs, such as high drug expense (eg, cephalosporins and aminoglycosides), drug side effects, and development of antibiotic resistance. Indeed, methicillin-resistant S aureus was reported by many centers as an organism recovered from tracheostomy secretions, although means of acquisition was not proven and may be nosocomial rather than related to antibiotic usage. Furthermore, a recent study, done in chronically tracheostomized adult outpatients, suggests that persistent colonization with S aureus, Pneumococcus, and Gram-negative enteric bacilli may actually protect against colonization by, and, theoretically eventual disease due to, more invasive strains of these bacteria. Therefore, it can be inferred that long-term prophylaxis or even liberal treatment with antibiotics might thus be harmful. Hence, it is perhaps fortunate that patients are rarely placed on a regimen of long-term prophylaxis, that most centers do not treat based only on growth of a particular organism in culture, and, that,
in general, most centers do not believe that they have a very aggressive approach to treatment.

Although our survey has allowed a semiquantitative description of the current practices regarding assessment and management of suspected respiratory tract infections in tracheostomized pediatric outpatients, we acknowledge several shortcomings: (1) not every center returned the questionnaire; (2) not all centers responded to every question; (3) the sample size; (4) the sample does not include otolaryngologists, who may care for many of these children; and (5) the practices of the person completing the questionnaire may not necessarily accurately reflect overall practice trends at that center, even though he/she is referred to as a “representative” of that center. Therefore, bias of unclear degree and significance may be present in the data. In addition, to make the questionnaire shorter and less time-consuming to complete, as noted above, important terms such as “respiratory illness” and “well” were not specifically defined, leaving related responses open to subjective interpretation.

In summary, our study sheds light on the current behavior of academic pediatric pulmonologists in the United States regarding suspected respiratory infections in tracheostomized pediatric patients. Although there are certain trends regarding practice, no clear consensus exists, probably because controlled studies have not been performed, and therefore, published guidelines do not exist. Therefore, much of current practice appears to be empirical. To optimize care of these patients, long-term controlled studies must be conducted with carefully defined outcome measures to determine when innocuous airway colonization has progressed to infection warranting antibiotic therapy.

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Pediatric Pulmonary Update
August 28 & 29, 1998
Alfred Soffer Educational Center
Northbrook, Illinois

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