Bacterial tracheitis is characterized by acute upper-airway obstruction and purulent secretions within the trachea. Historically, affected children were young, stridorous, and toxic-appearing and required tracheal intubation, and morbidity and mortality were significant. *Staphylococcus aureus* was the most common organism involved. During the 14 months of this retrospective study, 46 children were admitted to the pediatric intensive care unit because of this diagnosis, and their medical records were reviewed. Compared with those in previous reports, children in this study were older (mean ± standard error of the mean [SEM], 69.3 ± 6.8 months) and less toxic. Only 26 (57%) of 46 patients required tracheal intubation. Intubated patients were significantly younger than nonintubated patients (mean ± SEM, 46.9 ± 6.5 vs. 98.9 ± 9.9 months). *Moraxella catarrhalis* was identified in 12 (27%) of 45 bacterial respiratory cultures, while influenza A virus was recovered from 18 (72%) of 25 viral respiratory cultures. There were no major complications. This series represents the largest reported cohort of patients with this condition and suggests an epidemiological change toward a less morbid condition.

Between January 1995 and February 1996, a large number of children with bacterial tracheitis were admitted to the pediatric intensive care unit (PICU) at Children’s Hospital Medical Center (Cincinnati). This report describes the clinical characteristics of and therapeutic interventions for these children and compares and contrasts them to those described in previous reports.

**Methods**

The medical records of all patients admitted from January 1995 to February 1996 whose diagnoses were bacterial tracheitis were reviewed. The diagnosis of bacterial tracheitis was confirmed on the basis of standard criteria [3–6, 8, 9], which included clinical signs of upper respiratory tract obstruction and at least two of the following: (1) radiographic evidence of intratracheal membranes; (2) laryngotracheal inflammation and mucopurulent secretions noted by direct visualization during bronchoscopy; or (3) a tracheal aspirate positive for leukocytes on gram staining and a positive bacterial culture. Patients with tracheostomies were excluded.

All medical records were reviewed for demographic, clinical, laboratory, and radiographic features of bacterial tracheitis. Tracheal leak tests were performed by the respiratory therapists and PICU physicians by means of standard technique during spontaneous ventilation [12]. Categorical data were analyzed with χ² or Fisher’s exact testing. Continuous data were analyzed with the Student’s *t* test. Significant *P* values were set at <.05.

**Results**

Forty-six patient records noting a discharge diagnosis of bacterial tracheitis were identified. The mean (±SEM) age of
these patients was 69.3 (±6.8) months (range, 7–168 months); there were 23 males and 23 females. Chronic disease was present in one of the 46 patients. The mean (±SEM) duration of symptoms prior to admission was 2.5 (±0.3) days, and they were predominantly upper respiratory in nature. The mean (±SEM) PICU length of stay was 2.8 (±0.3) days, and the mean (±SEM) hospital length of stay was 5.4 (±0.4) days. Most diagnoses were made between August and December 1995 (figure 1).

Presenting symptoms in the emergency room were cough in 40 of the 46 (86%) and stridor in 25 of 46 (54%). Acute onset of symptoms or an acute change in the course of the illness was noted in 11 (24%) of the 46 patients (6 of 26 intubated patients [23%] and 5 of 20 nonintubated patients [25%]). High temperature (≥40°C) was reported in 8 (17%) of the 46 patients, 4 in each group. Table 1 lists the more common signs and symptoms on admission. Other symptoms noted at the time of admission included choking episodes, orthopnea, dysphagia, and neck pain, in two (4%) each and syncope, dysphonia, and agitation, in one (2%) each. Emergency room management included the use of inhaled racemic epinephrine in 12 patients (26%), dexamethasone in 9 (20%), aerosolized saline in 4 (9%), subcutaneous epinephrine in 1 (2%), and inhaled albuterol in 1 (2%).

Airway radiographs were obtained for 44 (96%) of the 46 patients. Tracheal irregularities or membranes were seen in 36 of 44 radiographs (82%) (figure 2). One or more chest radiographs were obtained for 28 (61%) of the 46 patients. Persistent pulmonary infiltrates were noted in 7 of these 28 (25%), atelectasis in 7 (25%), hyperinflation in 2 (7%), and pulmonary edema in 2 (7%).

Laryngoscopy and bronchoscopy were performed on all 46 patients, 44 in the operating room and 2 at the bedside. Tracheal intubation was required in 26 (57%) of the 46 children. Decisions regarding placement of an endotracheal tube were made during the procedure by the bronchoscopist in 24 of 26 cases (92%), on the basis of the degree of obstruction associated

<table>
<thead>
<tr>
<th>Characteristic of patient group</th>
<th>Nonintubated (n = 20)</th>
<th>Intubated (n = 26)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mo)*</td>
<td>98.9 ± 9.9 (range, 7–168)</td>
<td>46.9 ± 6.5 (range, 7–132)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sex (M/F ratio)</td>
<td>11/9</td>
<td>12/14</td>
<td>.56</td>
</tr>
<tr>
<td>Preadmission length of illness (d)*</td>
<td>2.8 ± 0.5</td>
<td>2.3 ± 0.3</td>
<td>.38</td>
</tr>
<tr>
<td>Cough</td>
<td>19/20 (95)</td>
<td>21/26 (81)</td>
<td>.21</td>
</tr>
<tr>
<td>Stridor</td>
<td>6/20 (30)</td>
<td>19/26 (73)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Rhinorrhea</td>
<td>6/20 (30)</td>
<td>11/26 (42)</td>
<td>.54</td>
</tr>
<tr>
<td>Hoarseness</td>
<td>5/20 (25)</td>
<td>7/26 (27)</td>
<td>.88</td>
</tr>
<tr>
<td>Drooling</td>
<td>0/20 (0)</td>
<td>5/26 (19)</td>
<td>.06</td>
</tr>
<tr>
<td>Toxic appearance</td>
<td>4/20 (20)</td>
<td>3/26 (12)</td>
<td>.68</td>
</tr>
<tr>
<td>Severe retractions</td>
<td>1/20 (5)</td>
<td>4/26 (15)</td>
<td>.37</td>
</tr>
<tr>
<td>T&lt;sub&gt;max&lt;/sub&gt; on first PICU day (°C)*</td>
<td>39.3 ± 0.4</td>
<td>39.1 ± 0.3</td>
<td>.54</td>
</tr>
<tr>
<td>Improvement after racemic Epi</td>
<td>2/4 (50)</td>
<td>4/8 (50)</td>
<td>1.0</td>
</tr>
<tr>
<td>Tracheal irregularities on radiograph</td>
<td>18/20 (90)</td>
<td>18/24 (75)</td>
<td>.26</td>
</tr>
<tr>
<td>WBC count (×10&lt;sup&gt;3&lt;/sup&gt;/mm&lt;sup&gt;3&lt;/sup&gt;)*</td>
<td>9.9 ± 1.0</td>
<td>13.6 ± 1.2</td>
<td>.03</td>
</tr>
<tr>
<td>PICU length of stay (d)*</td>
<td>1.1 ± 0.1</td>
<td>4.2 ± 0.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital length of stay (d)*</td>
<td>3.3 ± 0.1</td>
<td>7.0 ± 0.5</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

NOTE. Epi = epinephrine; PICU = pediatric intensive care unit; T<sub>max</sub> = maximum temperature.
* Mean ± SEM.

Figure 1. Distribution of patients with bacterial tracheitis in the period from January 1992 to February 1996. The data from 1992 through 1994 represent the total number of patients and are indicated by the white bars. The data for 1995 and 1996 are representative of patients requiring intubation (black bars) and those not requiring intubation (gray bars).

Figure 2. Radiographic appearance of the lateral neck in a study patient with bacterial tracheitis, before tracheal intubation. The arrow indicates the presence of an intratracheal membrane.
with secretions and/or edema. For the remaining two children the initial diagnosis was croup; they were admitted to a general pediatric ward and intubated emergently because of acute respiratory failure. Patients requiring tracheal intubation were younger, had a higher incidence of stridor at the time of presentation, had a higher WBC count on admission, and had a longer PICU and hospital stay than did nonintubated patients (table 1). Other signs and symptoms at presentation were not significantly different between intubated and nonintubated patients.

The mean (±SEM) length of tracheal intubation was 3.2 (±0.2) days. The mean (±SEM) endotracheal tube size used was 1.7 (±0.1) mm smaller than that normally required for age. Positive-pressure ventilation was required by 23 (88%) of the 26 intubated patients. Two children did not need positive airway pressure, but one patient required continuous positive airway pressure. Tracheal leak tests were performed on the day of extubation in 14 (54%) of the 26 patients. A tracheal leak of <25 cm of H₂O was present in 12 of 14 patients (86%), while 2 of 14 (14%) had a leak of ≥25 cm of H₂O (figure 3).

Extubation was successful in 24 (92%) of the 26 children, including the two patients with a leak of ≥25 cm of H₂O. One patient who did not have a leak test performed immediately preextubation required reintubation secondary to airway obstruction 1.5 days following extubation. He was successfully extubated 3.5 days later. One patient required a tracheostomy for underlying disease. Intravenous corticosteroid therapy was utilized prior to extubation in 12 (46%) of the 26 intubated patients.

Blood cultures were performed for 34 (74%) of the 46 patients and were all negative. Gram staining of all tracheal aspirates revealed leukocytes (mean, 10–25 per high-power field). Tracheal aspirates were submitted for bacterial culture for 45 (98%) of the 46 children. *Moraxella catarrhalis* was recovered from 12 (27%) of these 45 patients: 11 (42%) of the 26 intubated and 1 (5%) of the 19 nonintubated patients (P = .007). *S. aureus* was recovered from 10 of 45 (22%), *Streptococcus pneumoniae* from 10 (22%), *H. influenzae* from 8 (18%), group A *Streptococcus* from 4 (9%), *Mycobacterium gordonae* from 2 (4%), and *Candida albicans* from 2 (4%). There were no differences in the recovery of *S. aureus*, *S. pneumoniae*, or *H. influenzae* between intubated and nonintubated patients.

Tracheal aspirates from 25 of the 46 patients (54%) were submitted for viral culture. Influenza A virus was recovered from 18 (72%) of the 25 viral cultures. There was no difference in recovery of influenza A virus between intubated and nonintubated patients. For 13 of 18 patients (72%), bacterial organisms were recovered along with influenza A. Respiratory syncytial virus (RSV) was isolated from 1 of 25 (8%) and influenza B from 1 of 25 (4%). Mixed flora (bacterial and viral) were recovered from 15 patients (60%). No organisms were recovered in tracheal cultures for 7 of 45 patients (16%). All patients were treated initially with cefuroxime, with additional antibiotic changes made as indicated by the susceptibility of the pathogens.

There were no deaths during the study period. Morbidity occurred only in the group of intubated children, and these conditions included unplanned extubation in 4 of 26 (15%), all of whom were reintubated without difficulty, and prolonged periods (2–4 days) of irritability, agitation, and/or weakness after extubation in 4 of 46 (9%). These symptoms were felt to be secondary to narcotic or benzodiazepine abstinence syndrome. No morbidity was noted among the nonintubated patients.

**Discussion**

The 14 months between January 1995 and February 1996 marked a significant increase in the number of patients with bacterial tracheitis diagnosed at this institution. This series represents the largest reported cohort of patients with bacterial tracheitis and further describes the changing clinical picture associated with this diagnosis. Table 2 summarizes the characteristics of patients in the current and previous studies. Similarities noted in patients in the current study and those in previous reports include the absence of prior chronic illness, a similar length of illness prior to admission, the presence and degree of fever, and an elevated WBC count.

In contrast to those in previous reports, patients in the present study were on average 21 months older and were unlikely to be described as toxic in appearance. In addition, the duration of intubation, PICU stay, and hospital stay were shorter in our series than in previous reports. Radiographic signs of bacterial tracheitis, including tracheal wall irregularities or intratracheal membranes, were present in 82% of radiographs in the present study, vs. only 32% in the study by Han et al. [4]. Although the greater incidence of radiographic findings of intratracheal membranes in our study may be attributable to a greater propensity for tracheal invasion by the organisms now causing the condition, this is unlikely, considering the overall diminished

![Figure 3](https://image.com/figure3.png)
severity of illness in the children in the current study. Alternatively, the accuracy of radiographic diagnosis of tracheal abnormalities may have improved from that in the past.

Involvement of the lungs in the infectious process was suggested by Friedman et al. as a marker of the severity of the disease [13]. Our data support this suggestion in two ways: the overall lower incidence of pulmonary involvement in the present study correlates with the milder course of the disease in these patients, and only intubated children had pulmonary infiltrates.

The diagnosis and management of cases in our study generally followed the algorithm outlined by Gallagher and Myer [5]. In the nonintubated patients, the signs and symptoms of upper-airway obstruction were subtle in comparison with those in the intubated patients. This finding is best explained by the larger airway diameter and decreased propensity for significant airway obstruction in these older children. For older children, an age group in which croup is no longer common, special attention was given to signs and symptoms that might indicate another diagnosis. Such signs and symptoms included very high fever or an acute change in the course of the illness. When there was a clinical suspicion of bacterial tracheitis, airway radiographs were obtained. On the basis of significant clinical or radiographic findings, flexible bronchoscopy was performed, followed by rigid bronchoscopy as indicated.

Fifty-seven percent of cases in this study were managed without tracheal intubation, in contrast to previous reports indicating that >80% of children required tracheal intubation or tracheotomy [3, 7, 11]. The reduced rate of tracheal intubation may be related to several factors. First, as noted above, children in the present study were older than in previous series. Second, the disease may be less virulent than in the past. Third, otolaryngologists and intensivists may be more apt to allow children to be treated expectantly without an endotracheal tube in place. We noted a significant reduction in the rate of intubation toward the end of the study period, despite the fact that the ages and clinical characteristics had not changed. We speculate that the reduced rate of intubation was more likely due to physician comfort and experience over time rather than an actual reduction in the severity of airway obstruction.

The results of tracheal aspirate cultures were very different from previous reports. *S. aureus* was the major pathogen recov-
erated in 35%–75% of previously reported cases [3, 7]. Many of the studies in the past have not looked for viruses. Viral cultures, when performed, have a reported yield of zero to 85% in cases of bacterial tracheitis [4, 7, 8, 11]. The most prevalent organism in the present study was influenza A virus, which was isolated from 72% of viral tracheal aspirates.

Our results support the notion that viral infection may predispose the patient to subsequent colonization and infection with bacteria [3, 7–9, 14–16]. A preceding viral infection may result in a transient local or systemic immunodeficiency state, thus facilitating bacterial superinfection [8, 9, 14, 15]. Although the most prevalent organism recovered in this study was a virus, the presence of abundant leukocytes on gram staining of the tracheal aspirate favors the diagnosis of a true bacterial infection rather than mere bacterial colonization or uncomplicated viral laryngotracheitis [3, 17]. Alternatively, the relatively high yield of viral cultures in the present study and the relatively mild pattern of the disease raise the possibility that the present clinical series represents mainly viral disease with bacterial colonization, rather than a true bacterial infection [18].

Unlike in previous studies, _M. catarrhalis_ exceeded _S. aureus_ as the most common bacterial pathogen, accounting for 27% of the isolates in this series. Isolation of this organism was associated with a more severe course, with significantly more patients requiring tracheal intubation (11 of 12 [92%] _M. catarrhalis_ isolates were from intubated patients). _M. catarrhalis_ is a respiratory pathogen that was not recovered in the early reported cases of bacterial tracheitis. More recently, _M. catarrhalis_ has been isolated from children with this disease [5, 19–21]. In these reports, infection with _M. catarrhalis_ has been associated with previous injury to the tracheal mucosa, either by concomitant RSV infection or by intubation with a cuffed endotracheal tube [19, 21].

In the present series, all _M. catarrhalis_ isolates were β-lactamase-producing, two were associated with RSV infection, one was associated with recent manipulation to the airway, and no cuffed endotracheal tubes were utilized. Unlike _M. catarrhalis_ infections, infections with _S. aureus, S. pneumoniae_, or _H. influenzae_ were not associated with an increased need for intubation.

The results of this study suggest that bacterial tracheitis may be changing toward a less morbid condition. The decreased severity of illness may be secondary to a shift in the predominant organism. It appears that many patients can be treated without tracheal intubation. However, the potential hazards of this syndrome should not be overlooked, and all patients should be monitored carefully in the intensive care unit.

References