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Otolaryngology -- Head and Neck Surgery 2011 145: 1025 originally published online 16 August 2011
DOI: 10.1177/0194599811419098

The online version of this article can be found at:
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What is This?
Demographics and Microbiology of Otorrhea through Patent Tubes Failing Ototopical and/or Oral Antibiotic Therapy

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No sponsorships or competing interests have been disclosed for this article.

Abstract
Objectives. Posttympanostomy tube otorrhea (PTTO) results in significant health care cost and decreased satisfaction with care. The authors reviewed PTTO failing initial ototopical and/or oral antibiotic therapy and microbiology/susceptibility data from cultures.

Study Design. Case series with chart review.

Setting. A community university satellite ambulatory clinic and the outpatient clinic of a children’s hospital.


Results. PTTO occurred an average of 13 months after tube placement. Median otorrhea duration was 21 days (mean, 42 days). A mean of 1.6 visits (range, 1-6) to the pediatric otolaryngology office was required for PTTO resolution. Ototopical therapy was reported used in 198 of 228 (87%) episodes of otorrhea prior to pediatric otolaryngology visit. Nearly 50% of patients were prescribed at least 1 or more courses of systemic antibiotics. Staphylococcus aureus accounted for 52% of the organisms cultured, with 57% methicillin-resistant S aureus (MRSA). S aureus resistance to clindamycin was high (49%) and resistance to levofloxacin was low (1.8%). MRSA was 68% clindamycin resistant, much higher than both ours and the children’s hospital’s clindamycin resistance rate of MRSA cultured from all other body sites.

Conclusions. PTTO that presents as having failed ototopical and/or oral antibiotics most commonly consists of S aureus, Streptococcus pneumoniae, and Pseudomonas aeruginosa. MRSA is highly prevalent in this population. It is not necessary to culture PTTO that presents to an otolaryngology office, as resistance to levofloxacin was only 1.8%. It is unclear why the same fluoroquinolone ototopical therapy that failed initially is often successful in treating PTTO after otolaryngologist visit.

Keywords
otorrhea, posttympanostomy tube otorrhea, methicillin-resistant Staphylococcus aureus resistance, ototopical therapy

Received February 23, 2011; revised June 30, 2011; accepted July 14, 2011.

In the past several years, tympanostomy tube placement has become the most common surgical procedure performed in children.1 In 1996, it was estimated that around 512,000 children under the age of 15 years underwent this procedure in the United States, with the procedure being performed approximately 1 million times per year.2 The reported prevalence of posttympanostomy tube otorrhea (PTTO) is variable, with a range of 1.7% to 74%; most studies report a 16% rate.3-6 Posttympanostomy tube otorrhea negatively affects parents’ view of their children’s care and results in a significant amount of health care cost.4 Multiple studies have examined the microbiology of otorrhea associated with tympanostomy tubes.7-10 Commonly isolated organisms include Streptococcus pneumoniae, Hemophilus influenzae, Moraxella catarrhalis, Staphylococcus aureus, and Pseudomonas aeruginosa. Viral detection methods have shown concomitant viral infection in as many as 70% of
cases, with Picornaviridae family representing 60% of viral findings. Current evidence suggests that a topical fluoroquinolone, with or without a corticosteroid and in combination with thorough aural toilet, is the treatment of choice for acute otitis media with tympanostomy tube. The use of ototopical antibiotics such as fluoroquinolone drops, alone or in combination with steroids, is preferred to systemic antibiotics. The advantage of fluoroquinolone drops is that they can be applied directly to the affected middle ear through a patent tympanostomy tube, usually in a concentration great enough to overcome antibiotic resistance that may be present. Additionally, fluoroquinolones do not carry the concern of ototoxicity associated with aminoglycosides. When ototopical treatment fails, resulting in persistent PTTO, patients may be cultured and are often treated empirically with systemic antibiotics; it is this group of patients who we wanted to examine.

In a time of growing concern about antibiotic-resistant bacteria, judicious use of systemic antibiotic therapy is critical. This was demonstrated in a 2005 study by Coticchia and Dohar, in which patients who developed MRSA otorrhea were those who had an increased exposure to broad-spectrum antibiotics. Although guidelines have been set forth recommending the use of fluoroquinolone therapy as the first-line treatment of choice for PTTO, it is unclear why many children often present to the otolaryngology office for persistent otorrhea after caretakers report they have used ototopical therapy. This study reviewed children with culture-positive PTTO, with emphasis on microbiology and susceptibility data and treatment outcome of PTTO after a visit to the otolaryngology office.

**Materials and Methods**

**Study Design**

We performed a retrospective chart summary on patients 18 years or younger with the diagnosis of PTTO seen by pediatric otolaryngology from January 2004 to January 2009, all of whom had cultures performed. The patients were seen from either a university hospital-satellite community pediatric otolaryngology clinic, KU Medwest, or at the regional tertiary children's hospital, Children's Mercy Hospital and Clinics. The study was approved by both the University of Kansas Medical Center Institutional Review Board and the Children's Mercy Hospital and Clinics Institutional Review Board. We excluded patients with cystic fibrosis, immunocompromise, incomplete documentation, and non-otorrhea-related cultures. Data collected included demographics, ototopical and systemic antibiotic treatments used before and after otolaryngology visits, culture and susceptibility data obtained by respective hospital laboratories, and treatment outcomes.

**Data Analysis**

Data were collected in a Microsoft Access database. Statistical analysis was performed with SPSS, version 17.0 (SPSS Inc, Chicago, Illinois). Demographics and other categorical variables are summarized by frequencies and percentages. Quantitative variables are summarized by medians and distribution statistics.

**Terminology**

Early otorrhea is defined as occurring within 2 weeks of tympanostomy tube placement, whereas late otorrhea occurs after 2 weeks of tube placement. Persistent otorrhea is ear drainage that continues despite reported treatment with ototopical and/or oral antibiotics. This is in contrast to recurrent otorrhea, defined as a new episode of otorrhea in a patient who experienced otorrhea resolution after treatment.

**Results**

A total of 202 patients were reviewed, with an additional 26 episodes of recurrences for which cultures were obtained. Thus, a total of 228 late and recurrent otorrhea episodes were reviewed. Twenty-eight episodes occurred in patients from the university satellite ambulatory clinic setting, whereas 200 episodes occurred in patients seen in the outpatient clinic of our children's hospital. There were 58% males and 87% white patients. Most common indications for tympanostomy tube placement included recurrent acute otitis media (80 patients, 35%) and chronic otitis media with effusion (66 patients, 29%). The median age of patients was 23.5 months at the time of tube placement (interquartile ratio [IQR], 13-49) and 38.5 months at the time of otorrhea onset (IQR, 21-64). The median duration of otorrhea prior to seeking otolaryngological care was 21 days (IQR, 7-42).

Based on available documentation in the chart, a total of 205 (90%) episodes of PTTO presenting to otolaryngology clinics involved children who had already been on ototopical therapy, oral antibiotic therapy, or both, and 23 episodes were treated with neither. Ototopical therapy was reportedly used to treat 198 of 228 (86.8%) episodes of otorrhea, with ciprofloxacin/dexamethasone (64.6%), followed by ofloxacin (20.2%). Tobramycin/dexamethasone was used to treat 4 episodes and sulfacetamide drops were used to treat 1 episode prior to otolaryngology visit. Of all otorrhea episodes, 120 (52.6%) were also prescribed oral antibiotics; 113 (50%) were treated with both ototopical and oral antibiotics, and 7 episodes were treated with oral antibiotics without ototopical therapy. Only 85 (37.2%) episodes were treated with ototopical therapy alone without oral antibiotics. Oral antibiotics were most often prescribed by the patient’s primary care physicians (62%), other otolaryngologists (17%), and other allied health professional or physicians other than the patient’s primary physician (21%). Amoxicillin and amoxicillin/clavulanate were most commonly prescribed, followed by trimethoprim/sulfamethoxazole and some form of cephalosporin. More than 23% of episodes had been treated with at least 2 or 3 courses of different oral antibiotics.

Patients required a median of 1 visit (mean of 1.6 visits) to the pediatric otolaryngology office for otorrhea resolution (range, 1-6 visits). During the pediatric otolaryngology visit, microscopic examination and suctioning were performed, cultures were obtained, and education was provided on good aural toilet. "Wicking" or absorption of otorrhea using twirled up tissue or toilet paper (not the same as wick placed for treating
otitis externa) and use of tragal pump maneuver were demonstrated. Fifty-two patients (25%) in this study group underwent tube removal for otorrhea resolution at the recommendation of the pediatric otolaryngologist for persistent otorrhea despite appropriate ototopical and oral antibiotic treatments.

*S aureus* was the most common otorrhea organism cultured (n = 119, 52%), with methicillin-resistant *S aureus* (MRSA) accounting for 57.1% (oxacillin resistant). *P aeruginosa* was seen in 55 patients (24%) and *S pneumoniae* in 32 patients (14%) (Table 1). *H influenza* accounted for only 1% of organisms cultured, and *M catarrhalis* accounted for only 0.4% of organisms (Table 1). *S aureus* susceptibilities showed 48.7% resistance rate to clindamycin and 1.8% resistance rate to levofloxacin (Table 2). Clindamycin resistance was seen in 68% of MRSA organisms, significantly higher than the 23% clindamycin resistance rate among methicillin-sensitive *S aureus*. Of note, the clindamycin resistance of otorrhea-cultured MRSA (67.6%) was significantly higher than that of MRSA cultured from all other body sites (24%) at the tertiary children’s hospital, whereas the clindamycin resistance of MSSA appeared similar between the 2 groups (otorrhea MSSA resistance at 23.5% vs all other body sites MSSA resistance at 20%).

*P aeruginosa* was identified in 55 patients (24%), with 1 case of amikacin resistance, 3 cases of gentamicin resistance, and 3 cases of aztreonam resistance. All were susceptible to levofloxacin.

*S pneumoniae* (n = 32) accounted for 14% of all organisms. We found 3.5% resistance to penicillin, 7.5% resistance to erythromycin, and 0% resistance to ceftriaxone.

### Discussion

The literature differentiates between early and late otorrhea, and our study focused on late otorrhea. Previous research proposed that the organisms responsible for PTTO are similar to those seen in acute otitis media, although current literature suggests different microbial patterns. Treatment recommendations for PTTO focus on good aural toilet and topical fluoroquinolone therapy, but the use of systemic therapy remains common. The emergence of resistant organisms in PTTO may point to the overuse of inappropriate systemic therapy for initial PTTO treatment. Since we found only 28 episodes in a 5-year period at the university satellite clinic from the practice of 1 pediatric otolaryngologist, we decided to include PTTO seen in outpatient clinics of our regional children’s hospital. The other 200 episodes of culture-positive otorrhea reviewed reflect the combined practice of several pediatric otolaryngologists. We had hoped to compare potential differences of PTTO in patients seen at the 2 different clinic settings, which was not possible.

Our findings showed organism patterns different from those classically associated with PTTO, with very few cultures positive for *H influenza* and *M catarrhalis*. Differences found in our study may be attributable to the fact that this study reviewed only patients who presented to an otolaryngology office after failing previously prescribed therapy, including ototopical and/or oral antibiotics. Therefore, it is possible that through prior exposure and selection pressures from oral antibiotic use, we observed a much higher MRSA rate. Another explanation is that since the majority of the otorrhea episodes were treated at the outpatient clinic of our children’s hospital, where patients are more likely to have medical comorbidities, such patients may have increased exposure to systemic antibiotic and frequent visits to a tertiary hospital may potentially alter microbes.

The resistance patterns of organisms seen in our study were, in some cases, significantly different from those cultured from all body sites. Resistance to levofloxacin in all bacterial species was very low, less than 2%, which raises the question as to why in this group of patients, the reported initial use of fluoroquinolone topical therapy was not successful. Possible explanations include inadequate aural toileting, insufficient “wicking” of otorrhea, and not using the tragal pump maneuver to eliminate air columns. Although we are unable to explain why there was treatment failure when appropriate ototopical therapy was used, our study demonstrates the following points. First, routinely obtaining cultures when PTTO presents in the otolaryngology office is probably unnecessary, especially if the otolaryngologist is likely to prescribe further fluoroquinolone ototopical therapy based on our knowledge about excellent susceptibility to fluoroquinolone regardless of the organism. We have confirmed this by studying a group of patients in whom culture and susceptibility data were available in everyone. We

### Table 1. Microbiology

<table>
<thead>
<tr>
<th>Organism</th>
<th>No. (%)</th>
</tr>
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<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>119 (52)</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>55 (24)</td>
</tr>
<tr>
<td><em>Streptococcus pneumoniae</em></td>
<td>32 (14)</td>
</tr>
<tr>
<td>Other</td>
<td>11 (5)</td>
</tr>
<tr>
<td><em>Streptococcus pyogenes</em></td>
<td>9 (4)</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>2 (1)</td>
</tr>
<tr>
<td><em>Moraxella catarrhalis</em></td>
<td>1 (0.4)</td>
</tr>
</tbody>
</table>

### Table 2. *Staphylococcus aureus* Susceptibility (N = 119)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistant (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxacillin (MRSA)</td>
<td>57.1</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>48.7</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>36.4</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>1.8</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>1.8</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>0</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>0</td>
</tr>
<tr>
<td>Rifampin</td>
<td>0</td>
</tr>
<tr>
<td>Synercid</td>
<td>0</td>
</tr>
<tr>
<td>Linezolid</td>
<td>0</td>
</tr>
</tbody>
</table>
are impressed by our finding that more than 52% of all cultured organisms were *S. aureus*, with 57% of these being clindamycin-resistant MRSA. This is in stark contrast to a not yet published study by the senior author reviewing all cultures from cervical lymphadenitis requiring surgical incision and drainage, in which more than 98% of the MRSA isolated from neck abscesses were clindamycin sensitive. Again, this may be a result of selection pressure from frequent systemic antibiotic use found in the PTTO population.

Second, our research highlights the need for further research focused on appropriate and adequate use of ototopical therapy. Emphasis on good aural toilet is essential to maximize treatment success using ototopical therapy. Third, as we only studied PTTO patients who had cultures done for their otorrhea and not all patients with PTTO who presented during the same study period, we are unable to determine whether this population was different than other PTTO patients. Fourth, as there are no standard protocols for either culturing or treating persistent PTTO, depending on which pediatric otolaryngologist saw the patient, some patients were prescribed oral trimethoprim/sulfamethoxazole with or without sulfa-based ototopical therapy because of suspicion of MRSA, and successful treatment outcome in these cases may reflect such treatment and not just repeated use of more fluoroquinolone therapy. Finally, the fact that only 37.5% of otorrhea episodes were prescribed ototopical therapy only as the primary treatment modality demonstrates the opportunity for otolaryngologists to further emphasize PTTO management.

It was not possible to measure compliance of ototopical therapy. Even if caretakers report using it as recommended, the patient may not receive adequate therapy or may receive an incomplete course of therapy. Anecdotally parents often report that when there is otorrhea, they use ototopical therapy daily until they no longer notice otorrhea, which is often less than 7 days.

*S. aureus* was the most common bacteria isolated among children with PTTO in this study, with majority being MRSA. The increase in the incidence of MRSA is similar to what has been observed in children hospitalized with *S. aureus*. In this study, two thirds of MRSA were clindamycin resistant, a stark contrast to what is observed among all MRSA isolates from other sites at our institutions and what is reported among community-associated MRSA isolates. Saunders et al quoted a similar MRSA clindamycin resistance rate in their review of all patients with otorrhea. The differences observed in clindamycin resistance underscore the importance of the clinical condition to *S. aureus* infections and show that the institutional antibiogram often is not predictive of *S. aureus* susceptibilities in a spectrum of clinical infections. Most of our patients received several courses of systemic antibiotics, a known MRSA risk factor.

Of the patients who received systemic antibiotic guided by otorrhea cultures, MRSA was the most commonly identified and treated organism. Trimethoprim/sulfamethoxazole was the most commonly used antibiotic to treat MRSA-positive patients. Several studies prescribe the use of linezolid, trimethoprim/sulfamethoxazole, and ototopical gentamicin for the treatment of MRSA otorrhea; such recommendations counter the clinical practice guidelines offered by the American Academy of Otolaryngology–Head and Neck Surgery regarding systemic and ototoxic therapy. Goldblatt et al showed that topical ofloxacin was more effective than oral amoxicillin/clavulanate in the treatment of PTTO when *S. aureus* or *P. aeruginosa* was present. Inappropriate use of systemic therapy has been correlated with increased rates of antimicrobial resistance in bacteria associated with otitis externa, and such misuse can lead to increased resistance in bacteria causing otitis media. Some literature suggests little need for systemic therapy, citing that there are no guidelines for its use. The high rates of clindamycin resistance among our *S. aureus* isolates suggest this agent should not be used in PTTO treatment.

Guidelines for tube removal when PTTO is persistent are yet to be established, and it is not surprising therefore that practice patterns vary regarding timing and initiation of oral antibiotic therapy as well as timing for tube removal. This study does not address practice guidelines or suggest a best practice algorithm. Our data also suggest a need for consensus regarding otorrhea culture and treatment guidelines to minimize overuse of oral antibiotics.

**Conclusion**

PTTO that presents as having failed ototopical and/or oral antibiotic therapy most commonly consists of *S. aureus, S. pneumoniae, and P. aeruginosa*. MRSA is highly prevalent in this population. Based on microbiology susceptibility data, it is not necessary to culture PTTO that presents to an otolaryngology office even when otorrhea appears to have failed initial appropriate fluoroquinolone ototopical therapy, as resistance to levofloxacin was only 1.8% for *S. aureus*. Further research is critical in understanding why PTTO may fail initial ototopical therapy in order to reduce burden on overuse of health care system for PTTO as well as excess and unnecessary use of systemic antibiotics for treating PTTO.

**Author Contributions**

Inessa Fishman, data acquisition, drafting of manuscript, and critical revision; Kevin J. Sykes, database design, data analysis, Rebecca Horvat, acquisition of data, interpretation of data, critical revision of manuscript; Rangaraj Selvarangan, acquisition of data, interpretation of data, critical revision of manuscript; Jason Newland, interpretation of data, critical revision of manuscript; Julie L. Wei, concept, design, analysis and interpretation of data, critical revision of manuscript, final approval.

**Disclosures**

Competing interests: None.

Sponsorships: None.

Funding source: None.

**References**