Suppurative Complications of Acute Otitis Media

Changes in Frequency Over Time

Marc C. Thorne, MD; Linda Chewaproug, MS; Lisa M. Elden, MD

Objective: To review the experience at the Children’s Hospital of Philadelphia in the management of suppurative complications of acute otitis media from 2000 to 2007, with an emphasis on changes in frequency over time.

Design: Retrospective cohort study.

Setting: Academic, tertiary care children’s hospital.

Patients: The study population comprised 87 children (age <18 years) with acute mastoiditis treated at our institution over the period of January 1, 2000, to December 31, 2007. Acute mastoiditis was defined by evidence of inflammation in the middle ear space and signs of mastoid inflammation (postauricular swelling, redness, or tenderness) or radiographic evidence of destruction of mastoid air cells, sigmoid sinus thrombosis, or abscess formation. Patients with underlying cholesteatoma were excluded.

Main Outcome Measure: Frequency of cases of acute mastoiditis per year.

Results: The frequency of cases of acute mastoiditis at our institution was positively correlated with calendar time, both for all cases of acute mastoiditis (Spearman rank correlation, $r=0.73; P=.04$) and for cases of mastoid subperiosteal abscess ($r=0.96; P<.001$).

Conclusions: We observed an increase in the frequency of cases of acute mastoiditis with subperiosteal abscess seen at our institution over the study period, controlling for case volume. These findings suggest an increase in incidence, although further population-based studies are required to definitively evaluate this possibility.


A CUTE OTITIS MEDIA (AOM) represents one of the most common childhood infections. The condition is generally self-limiting, with most children experiencing symptom resolution within 2 to 3 days. Despite this benign natural history, AOM may progress to a number of suppurative complications including acute mastoiditis, sigmoid sinus thrombosis, and intracranial abscess. Before the antibiotic era, acute mastoiditis was the most common infectious condition requiring hospitalization among infants and children. Although the incidence decreased considerably with the advent of antibiotics, acute mastoiditis continues as the most frequent suppurative complication of AOM.

Recent guidelines for the management of AOM in the United States have included options for observation without the use of antimicrobial agents for selected children. With this change in recommended practice as a backdrop, a number of recent publications have sought to examine evidence for an increasing incidence of acute mastoiditis, yielding conflicting results. Prompted by the perception in our group that we have been consulted more frequently to manage suppurative complications of AOM in recent years, we sought to examine the experience at the Children’s Hospital of Philadelphia, Philadelphia, Pennsylvania, in the management of these conditions since January of 2000.

Institutional review board approval was obtained to retrospectively review all cases of acute mastoiditis treated at the Children’s Hospital of Philadelphia between January 1, 2000, and December 31, 2007. Potential cases were identified by querying billing records and diagnostic codes to identify Current Procedural Terminology and International Classification of Diseases, Ninth Revision codes for mastoid surgery and/or acute mastoiditis. All medical rec-
ord during this period were available in a uniform electronic format, helping to ensure comparability of available information over the calendar time included in the study. A review of the medical records of these potential cases identified patients for inclusion in the study. Inclusion criteria for the study included age younger than 18 years, evidence of inflammation in the middle ear space and signs of mastoid inflammation (postauricular swelling, redness or tenderness) or radiographic evidence of destruction of mastoid air cells, sigmoid sinus thrombosis, or abscess formation. Patients with underlying cholesteatoma were excluded from the study.

Demographic and clinical information for all patients meeting these criteria were then abstracted from the medical records using a standard data collection form and entered into a database for further analysis. Statistical testing was performed using the Stata statistical software (StataCorp College Station, Texas). The α level was set at .05 for all statistical tests.

A total of 99 patients were identified meeting the inclusion criteria, with 12 patients excluded because of underlying cholesteatoma. Table 1 presents baseline demographic and clinical information for the full cohort of patients. The mean age of the study population was 56 months, with a median of 37 months, indicating a positively skewed age distribution. Children with subperiosteal abscess were nearly 7 years younger than children presenting with intracranial complications (95% confidence interval [CI], 52-112 months younger). This difference was statistically significant at P=.047 (95% CI, 0.1-21.6 fewer days of symptoms) (2-sample t test with unequal variances).

Bacteriologic test results were available from 67 patients, and the results are tabulated in Table 2. The most commonly identified organism was Streptococcus pneumoniae (28%) followed by polymicrobial infections (13%) and group A Streptococcus (10%). Again, differences are noted between the subperiosteal abscess group and the intracranial complication group, with Streptococcus pneumoniae seen more commonly in children with subperiosteal abscess (38%) than in the children with intracranial complications (6%), in whom polymicrobial and other streptococcal infections were the most frequently identified.

Next, we sought to examine evidence for a change in the frequency of acute mastoiditis over the study period. A graphical display of the number of cases of acute mastoiditis per year, along with a line of best fit is presented in Figure. A. Figure. B, presents a similar display for cases of subperiosteal abscess. Correlation analysis was performed to assess the relationship between the number of total cases of acute mastoiditis and the number of cases of subperiosteal abscess and calendar time. Correlation analysis yields values between −1 and 1 for a correlation coefficient. Positive values indicate that one variable increases as the other variable increases, while negative values indicate an inverse relationship. An increasing absolute value of the correlation coefficient toward 1 indicates an increasing strength of the association.

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Correlation analysis with Spearman rank correlation confirmed a statistically significant positive linear relationship, with r=0.73 (P=.04) between the total number of cases of acute mastoiditis and calendar time. Similarly, the increase in cases of subperiosteal abscess over calendar time was statistically significant, with r=0.96 (P<.001). To control for case volume as a potential explanation of the increase in number of cases per year, we divided the number of cases of acute mastoiditis overall and the number of cases of subperiosteal abscess by the total volume of consultations at our department for the year. This denominator was chosen because our initial contact with patients with acute mastoiditis is through consultation from either the emergency medicine or general pediatric services. Results from Spearman rank correlation showed a positive correlation between cases of acute mastoiditis per

### Table 1. Baseline Demographic and Clinical Data

<table>
<thead>
<tr>
<th>Demographic and Clinical Data</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48 (55)</td>
</tr>
<tr>
<td>Female</td>
<td>39 (45)</td>
</tr>
<tr>
<td>Antibiotic therapy prior to presentation</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>53 (61)</td>
</tr>
<tr>
<td>No</td>
<td>34 (39)</td>
</tr>
<tr>
<td>Antibiotic resistance</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19 (22)</td>
</tr>
<tr>
<td>No</td>
<td>19 (22)</td>
</tr>
<tr>
<td>No growth</td>
<td>49 (56)</td>
</tr>
<tr>
<td>Transferred from outside institution</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>21 (24)</td>
</tr>
<tr>
<td>No</td>
<td>66 (76)</td>
</tr>
<tr>
<td>Complication of AOM&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Subperiosteal abscess</td>
<td>42 (47)</td>
</tr>
<tr>
<td>Sigmoid sinus thrombosis</td>
<td>14 (16)</td>
</tr>
<tr>
<td>Intracranial abscess</td>
<td>4 (5)</td>
</tr>
<tr>
<td>None</td>
<td>29 (33)</td>
</tr>
</tbody>
</table>

Abbreviation: AOM, acute otitis media.

<sup>a</sup>Two patients presented with both subperiosteal abscess and sigmoid sinus thrombosis.
In our series, children with intracranial suppurative complications of AOM could be distinguished from other patients presenting with acute mastoiditis on a number of grounds. Children with intracranial complications on average were older and had a longer duration of symptoms prior to presentation. Given these findings, a high index of suspicion for intracranial complications is required in older children with prolonged symptoms following an episode of AOM. This is especially important, as a recent review of our experience with otogenic lateral sinus thrombosis revealed that neurologic rather than otoologic symptoms were dominant in the presentation of this condition.9

A number of studies in the recent literature have sought to examine trends in the frequency or incidence of acute mastoiditis over time and have yielded conflicting results.4-8 A major critique of many of these studies, including our present study, is that they fail to provide appropriate data to calculate incidence rates. To calculate incidence rates, one needs a measure of person-time at risk for disease. As individual hospitals do not serve a defined population, data from these institutions are unable to provide the required person-time measurements of risk. Therefore, changes in the frequency with which cases present to the hospital may reflect changes in referral patterns or catchment areas, rather than changes in risk for disease. Interestingly, the population-based study by Kværner et al in Norway did not identify any increase in incidence over the period 1999 to 2005.7 To help control for the possibility of changes in referral patterns or catchment area, we examined the proportion of cases that had been presented at an outside institution and were then transferred to our facility for care. Although a crude measure for changing referral patterns, the finding that there was a smaller proportion of our cases that had been presented first to an outside institution over time suggests that the increase in frequency we have observed may not be due to changes in referral patterns.

Similarly, we attempted to control for changes in volume by dividing by the number of consultations seen by our division. This analysis showed a moderate correlation between cases of acute mastoiditis per consultation and calendar time ($r = 0.64$), although this correlation was not statistically significant ($P = .09$). However, the correlation between the number of cases of subperiosteal abscess per consultation and calendar time remained strong and statistically significant ($r = 0.93; P < .001$). This suggests that while the increase in the incidence of acute mastoiditis overall may not be statistically significant, the severity of these infections is increasing, as evidenced by the increase in subperiosteal abscess formation. This increase in the incidence of acute mastoiditis with subperiosteal abscess does not appear to be due to changes in surgical volume, since the relationship holds despite controlling for the number of consultations seen within our department.

Figure. Number of cases of acute mastoiditis (A) and subperiosteal abscess (B) per year. Solid line represents the line of best fit.
Changes in antibiotic treatment recommendations for AOM have raised concern that the incidence of complications of AOM would increase. In our study, we found that antibiotic therapy prior to presentation decreased over calendar time; however the correlation was weak and not statistically significant. In addition, none of the patients in our study were noted to have developed acute mastoiditis following observation for an episode of AOM. This may reflect a low prevalence of use of this treatment option in the population served by our hospital or lack of complete documentation of such an approach in the inpatient medical record. This finding suggests that a change in antibiotic prescribing practices would not account for the changes in frequency that we have observed.

An increasing frequency of antibiotic resistance among bacterial pathogens offers an additional potential explanation for the observed changes in the frequency of acute mastoiditis. Pichichero and Casey10 have documented the emergence of a multiresistant pneumococcal strain following introduction of a 7-valent conjugate pneumococcal vaccine in the year 2000. Although the frequency of antibiotic resistance was significantly positively correlated with calendar time in our study, the overall prevalence of antibiotic resistance was relatively low (22%). This low prevalence suggests that changes in antibiotic resistance would not fully explain the increased frequency of suppurative complications of AOM identified in this study. Serotype information was not available in our culture results. Although we measured vaccination status in our patients, this variable did not prove to be useful because the medical records identified most patients as “up to date” with regard to immunizations (97%). Specific vaccination history was not available for review.

In conclusion, we have demonstrated an increased frequency of children presenting with acute mastoiditis at our institution over the period 2000 to 2007, primarily due to an increase in the frequency of cases of subperiosteal abscess. This increase in cases of acute mastoiditis with subperiosteal abscess does not appear to be fully explained by changes in practice volume, referral patterns, antibiotic therapy, and antibiotic resistance, suggesting a possible increase in incidence. However, population-based studies that include appropriate data for calculation of person-time at risk will be necessary to definitively determine if the incidence of suppurative complications of AOM is on the rise.

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Correspondence: Lisa M. Elden, MD, The Children’s Hospital of Philadelphia, Richard D. Wood Center, First Floor, 34th Street and Civic Center Boulevard, Philadelphia, PA 19104-4399 (elden@email.chop.edu).

Author Contributions: Dr Elden had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Thorne and Elden. Acquisition of data: Thorne, Chewaproug, and Elden. Analysis and interpretation of data: Thorne and Elden. Drafting of the manuscript: Thorne. Critical revision of the manuscript for important intellectual content: Thorne, Chewaproug, and Elden. Statistical analysis: Thorne. Administrative, technical, and material support: Thorne, Chewaproug, and Elden. Study supervision: Thorne and Elden.

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REFERENCES