Tympanometry for diagnosis and treatment of otitis media in general practice

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Objective. The aim of this study was to evaluate the role of tympanometry for diagnosis, treatment and follow-up of otitis media in general practice.

Methods. The results from otoscopy performed by 40 physicians in general practice in Vejle County, Denmark were combined with the clinical condition and this was recorded as the preliminary decision about diagnosis, treatment and follow-up. Subsequently, tympanometry was performed in 3176 children aged between 1 month and 16 years; a total of 6352 tympanometries. With this added knowledge, a final decision about diagnosis, treatment and follow-up was recorded. The practitioners were trained in performing tympanometry including the interpretation of the results. Simultaneously, they were involved in the establishment of guidelines for diagnosis, treatment and follow-up of otitis media in general practice. The main outcome measures were changes between preliminary and final decisions about diagnoses, treatments and follow-up regimens.

Results. Tympanometry was performed successfully in 87.7\% of the children, and in 26.4\% changes in diagnoses were found. However, tympanometry did not influence the distributions of the main outcome measures in the sample as a whole. Uncomplicated cases were checked in general practice and referrals to specialists were not increased.

Conclusion. Tympanometry can be performed successfully in general practice after appropriate instruction. In 26.4\% of children, the diagnoses were changed, which may result in more appropriate treatment and follow-up. Tympanometry is a clinically relevant supplement to the examination of a child in general practice.

Keywords. Children, general practice, otitis media, tympanometry.

Introduction

Otitis media is one of the most common diseases in children seen by the GP. This condition may be categorized into two main groups that require different treatment and follow-up: \textit{acute otitis media} denotes acute infection of the middle ear cavity, i.e. empyema. The associated symptoms and signs are usually prominent but they may vary considerably.\textsuperscript{1} In \textit{secretory otitis media}, the middle ear fluid is without the characteristics of acute inflammation. Symptoms and signs are often lacking or minimal, e.g. a slight hearing impairment not recognized by the parents.\textsuperscript{2} Theoretically, the distinction between the two conditions is clear, but in the clinic they may be quite difficult to separate. The use of an otoscope, even by experienced physicians, shows unsatisfactory sensitivity and specificity for diagnosing secretory otitis media and for distinguishing between secretory otitis media and acute otitis media.\textsuperscript{3} This leaves the GP unable to categorize children’s ear problems into the common groups: a normal ear, negative middle ear pressure without fluid, secretory otitis media or acute otitis media.\textsuperscript{4} However, by combining otomicroscopy and tympanometry, the diagnostic precision is improved, a method which has been utilized by ear specialists for decades. Tympanometry is a non-invasive measurement of the relative air pressure of the middle ear cavity, where the graphic output (tympanogram) reflects the compressibility...
of air. If air has been replaced by middle ear fluid, the output reflects a rigid system. Thus, tympanometry alone cannot distinguish between acute otitis media and secretory otitis media. The clinical use of this technology is achieved by combining tympanometry with symptoms and signs, which has been successful in many clinical investigations. Such studies have shown that secretory otitis media may be diagnosed with a sensitivity of ~90% and a specificity of ~75%. In most cases of acute otitis media, the associated earache prevents the use of tympanometry, and the tympanogram may in fact show every possible category of middle ear condition.

Tympanometry has been introduced into general practice very slowly for various reasons. A prominent concern has been due to the high sensitivity for secretory otitis media and the associated risk of overtreatment because the rate of spontaneous cure is very high. In order to take this into account, education of GPs is mandatory, as noted at a Danish consensus conference. This was investigated further, with the conclusion that the quality of diagnosis and treatment of otitis media in general practice might be improved by the use of tympanometry, of which the final role should be elaborated further. Against this background, the present study describes the introduction of tympanometry into general practice, including education of the GPs involved. The results are a description of concurrent experiments.

The purpose of the study was to evaluate the introduction of tympanometry in general practice, specifically changes in diagnosis when the present diagnostic routine is supplemented by tympanometry. Furthermore, the adherence to guidelines for treatment was investigated, especially the agreed strategy for use of antibiotics. A separate analysis, not reported here, assessed if the habits of the GPs changed during the study.

Methods

Within the county of Vejle, Denmark, a total of 40 physicians from 16 general practices were selected due to their interest in this field of study. The population in Vejle County is distributed equally between the countryside and larger cities. Children aged up to 16 years were included if the GP performed otoscopy as part of a routine health check-up, or if middle ear disease was suspected. The inclusions were not necessarily performed consecutively and the mean number included by a GP was 76 children (range: 3–274). The collection of data took place between April 1996 and April 1997, and 6352 tympanometries were performed in the 3176 children who were included. Their mean age was 3.6 years, ranging from 0.1 to 15.6 years and the female/male ratio was 0.88. Figure 1 displays the design of the study. The Regional Ethics Committee approved the study.

Education and guidelines for GPs

Initially, tympanometry instruction sessions were organized, during which otolaryngologists discussed their experience of middle ear diagnostics. In this context, the GPs became involved in the establishment of guidelines for diagnosis and treatment of middle ear disease to be used in the present investigation. It was decided that the guidelines about the use of antibiotics in acute otitis media could not be based on evidence from suitable clinical studies, which is in agreement with others. Accordingly, they were based on a combination of the available scientific data, the experience from the preceding study and the experience of the participants. A summary of the guidelines is shown in Appendix 1.

Introduction of tympanometry in the clinic

Each consultation simulated two situations: the clinical procedure with and without tympanometry. Based on the present routine, the preliminary decision on diagnosis, treatment and follow-up was recorded. Then tympanometry was performed and, subsequently, the final decisions on diagnosis, treatment and follow-up were recorded. In both situations, five categories were used: normal ear; acute otitis media; secretory otitis media; in doubt; and other diagnosis.

This procedure enables a description of changes in diagnosis, treatment and follow-up related to the knowledge from tympanometry. The instruments used were either an Interacoustics AT22 (Interacoustics, Assens, Denmark) or a Danplex ZA82 (Danplex, Copenhagen, Denmark). Both instruments investigate the interval of air pressure of the external ear canal between +200 daPa and −300 daPa. The results were recorded as the air pressure of the ear canal corresponding to the peak of the tympanogram. If no peak could be identified, the presence of fluid in the middle ear was assumed. All tympanograms and their interpretation were checked by an investigator (E.C.J.J.), and errors were recorded. Each ear was described separately, and the ear with the most pathological condition denoted the condition for analytical purposes.
Results

The performance of tympanometry

The instructions for this procedure could be adhered to in 87.7% (2785/3176) of all children investigated. The problems encountered were due to technical failures, lack of co-operation from the child or an ambiguous tympanogram. Due to the checking of all tympanograms by the investigator, disagreement with the clinical diagnosis according to the guidelines was found in 3.8% (120/3176) of the children. Usually, this was due to erroneous interpretation of the tympanogram. One example would be the confusion of a flat tympanogram due to fluid with a corresponding graph due to occlusion of the probe by the skin of the ear canal found in 0.5% (15/3176) of the children—in this case, the volume of the ear canal is close to zero.

The effect of tympanometry in the clinic

In the material as a whole, the knowledge from tympanometry did not change the distribution of the diagnoses (Fig. 2). However, corresponding analysis of each child separately showed that the diagnosis changed in 26.4% (840/3176). This is described further in Figure 3, where changes between diagnostic groups are displayed.

Finally, 17.5% (556/3176) of the children received symptomatic treatment (analgesics and decongesting nose drops), and changes related to tympanometry were recorded in 3.5% (111/3176). Antibiotics were used in 6.2% (196/3176) of the children, 5.1% (161/3176) of whom had acute otitis media and 0.5% (16/3176) secretory otitis media. In those with acute otitis media, the use of an antibiotic was not in agreement with the guidelines in 54.7% (88/161) due to lack of fever and/or because their general condition was normal. In 87.6% (141/161), penicillin V was used, 11.2% (18/161) had ampicillin and 1.2% (2/161) received erythromycin.

The pattern of follow-up did not change as a result of tympanometry in the sample as a whole, as shown in Figure 4. Analysis of changes in each child showed that 20.1% (637/3176) had changes from the preliminary to the final check-up. This was concurrent with changes of diagnosis in 80.7% (514/637).

Among children with secretory otitis media, the GP checked 77.6% (832/1072), while 12.1% (130/1072) were referred to an otolaryngologist and the remaining 10.3% (110/1072) were already receiving treatment by specialists. Of those with secretory otitis media who were referred to a specialist, 35.4% (46/130) had experienced a shift in diagnosis related to tympanometry, and 30 children had the preliminary diagnosis ‘normal’.

In total, 5.7% (182/3176) of the children were referred to a specialist and 38.5% (70/182) had had diagnostic changes related to tympanometry.

Among those with secretory otitis media, 11.4% (122/1072) were considered as complicated cases, i.e. treatment failure in general practice, suspicion of permanent hearing impairment, speech/language problems, suspicion of adenoids or other otological disease. All were checked, 29.5% (36/122) by the GP, 57.4% (70/122) by an otolaryngologist, while 13.1% (16/122) had already been checked by a specialist.

Discussion

The study describes a complex experiment where physicians are test objects by acting in two simulated clinical situations. A prerequisite for scientific comparison would therefore be that the two situations are separate and that the variability of major parameters is known, and this is not the case. For example, no attempt was made to check the validity of the preliminary otoscopic diagnosis, since this would involve other physicians. It was not checked whether the physicians carried out the tympanometry before the otoscopy. It is assumed that tympanometry is the major intervention supported by education, and it is not possible to decide if education alone would have a similar efficacy.

Consequently, no statistically significant differences emerged from the study. However, the GPs involved were well motivated and they generated plenty of data leading to a conclusion, which most clinicians find clinically relevant.

The descriptive analysis required compromises, of which a classic example is the fact that each child may have ears in different conditions. By assigning the diagnosis of the most pathological ear to the child, important clinical information is lost in order to obtain a clearer description of the investigated interventions.

The problems encountered in 12.3% of the children associated with the performance of tympanometry were acceptable when compared with the range of 4–35% reported in other studies.14,15
The changes in diagnoses that seem most relevant to the clinic are associated with the preliminary diagnoses 'normal' or 'secretory otitis media'. Knowledge from tympanometry changed 'normal' to 'secretory otitis media' in 16% (286/1788) and secretory otitis media to 'normal' in 21% (188/906). Initial 'doubt of the diagnosis' changed to secretory otitis media in 47% (65/137), as may be calculated from Figure 3. Accordingly, a more correct diagnosis was probably obtained in 19% [(286 + 188 + 65)/(1788 + 906 + 137)] of children with those three diagnoses, which are the most difficult to clarify in the clinic.  

Among those with preliminary acute otitis media, 31.3% (82/262) changed diagnosis after tympanometry. This uncertainty is also reflected in an international study in general practice. The participants felt certain when diagnosing acute otitis media based on otoscopy in 58% of infants to 73% of older children.  

Few children in the present study had acute otitis media requiring antibiotic treatment according to the guidelines. This may be because many of those patients are seeking medical help outside normal office hours, or are unsuitable for tympanometry. The fact that 54.7% received an antibiotic in conflict with the guidelines is surprising, because the participants had been involved in drawing up the guidelines. On the other hand, other investigations have shown that physicians' prescribing of antibiotics does not always correspond to their theoretical knowledge. Accordingly, their personal interference with patient/parents, including expectations of treatment, fear of complications and 'old habits', may be more important.  

The study shows that the GPs checked uncomplicated ear problems in children, which has been recommended in the literature. The fear of over-referral and overtreatment of secretory otitis media has not been documented. It is unlikely that chronic suppurative otitis media with or without cholesteatoma was overlooked during the study. In general, this may be a major concern when check-up of ears takes place outside the specialist field, especially without an otomicroscope.  

It is still a major diagnostic problem that no method can separate acute otitis media from secretory otitis...
media. In order to approach this, the current techniques may be utilized better, for instance by introducing tympanometry into general practice as in the present study. New methods hopefully will emerge, e.g. ultrasound. In particular, better methods for research into the use of antibiotics in acute otitis media are required, as even important papers lack an identification of this dominating diagnostic problem.

Tympanometry provides objective documentation and may be valuable as a key for otoscopy. In the long term, this educational element may render tympanometry superfluous to the experienced GP. This indicates that tympanometry and education for GPs should result in more relevant cases being referred for treatment by otolaryngologists whereas uncomplicated cases can be checked while the children remain in the familiar surroundings of general practice.

Conclusion

In this complex clinical experiment, tympanometry was introduced as a supplement to otoscopy in the clinical diagnosis in general practice. This changed the diagnosis in about one-quarter of the children. The GPs checked uncomplicated cases and the number of referrals to specialists was not increased. Tympanometry is a clinically relevant supplement to the examination of a child in general practice.

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References

Appendix 1. Guidelines for diagnosis and treatment of otitis media in general practice

The clinical decisions should combine symptoms and signs, otoscopy and tympanometry. In general, three scenarios are described: acute, subacute and chronic.

**Acute.** Development within a few days with earache and deteriorated general condition. Otoscopy showing signs of acute infection (red to yellow, opaque, bulging). If fever $>38^\circ$C, penicillin V 50 mg/kg/day for 5 days was recommended. Symptomatic treatment with analgesics and/or decongesting nose drops, saline for infants. Check-up if symptoms persist.

**Subacute.** Intermittent or constant ear problems for weeks to a few months. Otoscopy showing a pale, red and retracted eardrum, even air bubbles or fluid level. Tympanometry indicating negative pressure or fluid in middle ear. Symptomatic treatment with analgesics and/or decongesting nose drops, saline for infants. If middle ear pressure more negative than $-299$ daPa or fluid present, a check-up should be scheduled in 4 weeks.

**Chronic.** Persisting, discrete ear problems for months. Most cases referred to otologist due to: abnormal tympanometry for $>3$ months, four episodes or more of acute otitis media within 12 months, therapeutic failure in general practice, suspicion of significant hearing impairment and/or speech/language problems, or other otological disease.

### Table of the combinations of symptoms and signs of the guidelines

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>'Normal'</th>
<th>'Secretory otitis'</th>
<th>'Acute otitis'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otoscopy</td>
<td>Normal</td>
<td>Abnormal, no acute infection</td>
<td>Abnormal, plus acute infection</td>
</tr>
<tr>
<td>Tympanogram daPa</td>
<td>+200 to $-299$</td>
<td>$-299$ to flat</td>
<td>Any type</td>
</tr>
<tr>
<td>General condition</td>
<td>Normal</td>
<td>Fever $&lt;38^\circ$C</td>
<td>Deteriorated, fever $&gt;38^\circ$C</td>
</tr>
</tbody>
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