Tympanometry in general practice: use, problems and solutions

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Objectives. The diagnosis in children with middle ear symptoms is often difficult. Tympanometry is recommended as a supplementary diagnostic tool with a high predictive value for fluid or no fluid in the middle ear. The aim of this study was to examine how tympanometry was used in Danish general practice in 2009, to report common problems general practitioners (GPs) and GP nurses encounter in tympanometry and to evaluate the effect of a practical and theoretical course.

Methods. A 1-year registration of the use of tympanometry in the Danish National Health Service Register in two regions with 40% of all Danish GPs and a survey among 197 participants in a course on diagnosis of otitis media and tympanometry in children were used. The Danish National Health Insurance covers 100% of GPs because they administer reimbursement for their activities, including tympanometry.

Results. During the year 2009, 1433 GPs in 702 clinics were on the list. A total of 417 clinics performed 35 529 tympanometries. Some 285 clinics (40.6%) did not perform tympanometry in 2009. The active clinics performed 42 tympanometries per GP. A 1-day course improved the knowledge and practical skills of the participating GPs and nurses. A majority (70%) stated in a self-reported questionnaire that tympanometry often provided important information, especially about middle ear fluid, and 48% reported that tympanometry several times during the past 2 weeks had changed their management of a middle ear problem. Few had not used their tympanometer during the 2 weeks preceding the survey. The response rate was 72%.

Conclusions. The use of tympanometry is very skewed. A 6-hour course could improve GPs’ care of patients with middle ear problems by using tympanometry.

Keywords. General practice, health care education, impedance audiometry (tympanometry), otitis media, self-reported survey.

Background

Middle ear problems are very common in preschool children. The diagnosis of middle ear disease is often difficult for general practitioners (GPs) as well for ear, nose and throat and paediatric specialists.1–3 Besides medical history and general objective examination, the GP has to rely on otoscopy, often in a narrow and angled ear canal with hair and earwax. In addition, the child may have low examination compliance. Acute otitis media (AOM) and otitis media with effusion (OME) are the two most common middle ear diseases in children. AOM is diagnosed when middle ear effusion is present, demonstrated by pneumatic otoscopy, tympanometry, air fluid level or a bulging tympanic membrane, in addition to an evidence of acute inflammation in the middle ear with opaque, white or erythematous tympanic membrane or purulent fluid from the middle ear and symptoms of otalgia, irritability or fever. OME is diagnosed when middle ear effusion is present, and the middle ear is without acute inflammation and without symptoms of acute illness.4 Often, OME is present when the child gets a cold, and sometimes it develops into AOM, and a period with AOM is often followed by a period with MEE. Thus, we often see middle ears where the differentiation between AOM and OME is difficult. The differentiation between AOM and OME is important because the treatment is different. AOM is the most common indication for antibiotics in preschool children, and OME is not affected by antibiotics.4

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The US Clinical Practice Guideline on OME made a strong recommendation that clinicians use pneumatic otoscopy as the primary diagnostic method and gave as option that tympanometry can be used to confirm the diagnosis and document the effusion duration.4 Pneumatic otoscopy improves the diagnosis by between 15% and 26% compared with usual otoscopy,5 but pneumatic otoscopy is seldom used by GPs. In Denmark, only 11% of the GPs used pneumatic otoscopy in a survey carried out in 1994, although 36% had access to the equipment.6 Tympanometry is an electroacoustic measurement of the impedance of the tympanic membrane. Tympanometry has a high sensitivity and specificity in diagnosing middle ear effusion in young children when compared with results of myringotomy without overpressure ventilation.7–10 In a Finnish vaccine study, a positive predictive value of 0.93 for effusion in the middle ear of a flat tympanogram was found, and a normal tympanogram had a negative predictive value of 0.94.10 Several studies have found nearly the same positive predictive value of a type B tympanogram.8,11 Despite these impressive figures, the use of tympanometry in general practice has only increased very slowly. In 1998, Jensen et al.6 showed that tympanometry was seldom used (3%) in general practice in Denmark, although handheld equipment has been on the market for more than 15 years.

To improve the quality of the diagnosis in children with ear symptoms, the GPs in Denmark have since 2006 been paid a special fee (~€13) for performing tympanometry, when clinically indicated. Regardless of that, it is our impression that the use of tympanometry is skewed, that is, some GPs never use it and other uses it a lot. For that reason, we wanted to investigate the use of tympanometry and any associated problems.

Aims of the study

The aims of this study were as follows:

- to report how often tympanometry was used in Danish general practice in 2009;
- to report common problems among GPs and practice nurses performing tympanometry;
- to evaluate the effect of a practical and theoretical course on tympanometry.

Methods

The Danish National Health Service Register covers all GP clinics in all five regions in Denmark because they administer reimbursement for GPs’ activities, including tympanometry.12 During the year 2009, 1433 GPs in 702 clinics were on the list of the Region of Southern...
Denmark \((n = 923)\) and the Region Zealand \((n = 510)\). In January 2009, all GPs in two regions in Denmark and their practice nurses were invited to participate in one of four identical tympanometry and otitis media 6-hour courses. The scope was update on middle ear disease, details on a prospective cohort study on middle ear problems, theoretical and practical information on tympanometry, technical presentation of two different tympanometers and practicing performing of tympanometry. A short questionnaire was sent to all participants 6 weeks after the courses. In the questionnaire, they were asked about their experience with tympanometry, about problems before and after the course, their experience with tympanometry the last 2 weeks and how they evaluated the different elements of the course.

The course was an introduction to participate in a prospective cohort study on children with middle ear problems in general practice.

Data were analyzed using the Statistical Package for the Social Sciences (version 16; SPSS Inc., Chicago, IL) and *Statistics with Confidence, 2nd edition*. The level of significance used was 5%, and 95% confidence intervals (CIs) will be given when relevant. The analyses are especially comparing reported problems before and after the course.

**Results**

*Use of tympanometry*

During the year 2009, 418 of the 702 clinics performed 35,529 tympanometries, and 284 clinics (40.4%) did not use tympanometry (Table 1). The use of tympanometry had a very large variation between GPs, from no use up to a maximum of 527 tympanometries per GP per year. The skewed distribution of tympanometries performed per GP is illustrated in Figure 3, including all clinics. Figure 3 shows a big variation among the clinics using tympanometry with many ‘low users’ and a few ‘high users’. The mean value was 85 tympanometries per clinic or 42 per GP performing tympanometries and 25.2 among all GPs in the two regions (Table 1). The number of GPs in the clinic had no relation to the use of tympanometry (ANOVA, \(P > 0.8\)).

**Problems in performing tympanometry**

Of the 197 participants in the courses, 49 (25%) were practice nurses and 148 (75%) were GPs. A total of 142 (72%; 95% CI, 65–78) completed the questionnaire. No differences in problems profile between nurses and GPs were found, and they are therefore analyzed as one group.
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Problems in performing tympanometry

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Of the 142 participants, 48 (34%) have not used tympanometry before and 94 (62%; 95% CI, 52–71) of the participants with experience in tympanometry had frequently one or more problems when performing tympanometry. The total number of frequent problems was 172. The type of problems is listed in Table 2. None of the 94 experienced participants were without problems when performing tympanometry.

After the course, the number of frequent problems was reduced significantly (Table 2). The rates of frequent problems 6 weeks after the course did not differ between the experienced and the nonexperienced group of participants (Table 2).

Solutions and new knowledge

All the 142 responding participants obtained new knowledge or new practical skills to a high degree in 35% to 50% and to some degree in approximately 40% in five of the six topics at the course (Table 3). The use of antibiotics was a minor topic at the course, although 103 participants said they obtained some new knowledge, and 39 thought it was correct knowledge.

### Table 1  Number of tympanometries performed in 2009

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of GPs</th>
<th>No. of clinics</th>
<th>No. of tympanometries</th>
<th>No. of clinics using tympanometry, ( n (%) )</th>
<th>No. of tympanometries per active clinic [and in active GPs], mean</th>
<th>No. of tympanometries per all GPs, mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Denmark</td>
<td>923</td>
<td>407</td>
<td>23 570</td>
<td>277 (68)'</td>
<td>85.1 [41.8]'</td>
<td>28.4 (47.5)'**</td>
</tr>
<tr>
<td>Zealand</td>
<td>510</td>
<td>295</td>
<td>11 959</td>
<td>141 (48)'</td>
<td>84.8 [43.4]'</td>
<td>20.8 (44.3)'**</td>
</tr>
<tr>
<td>Total</td>
<td>1433</td>
<td>702</td>
<td>35 529</td>
<td>418 (59)'</td>
<td>85.0 [42.3]'</td>
<td>25.2 (46.3)</td>
</tr>
</tbody>
</table>

*Significant difference of 20% (95% CI, 13–27), \( P < 0.0001 \). **Man–Whitney \( U \) test, \( P < 0.001 \).

### Figure 3  Numbers of tympanometries per GP in 2009 in 702 clinics. Mean = 25 tympanograms per GP, median = 8 tympanograms per GP.

### Table 2  Frequent problems in tympanometry

<table>
<thead>
<tr>
<th>Type of frequent problems in 94 participants with experience in tympanometry</th>
<th>Before the course, ( n (%) )</th>
<th>Six weeks after the course, ( n (%) )</th>
<th>Absolute improvement (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the meaning of the displayed figures and use them as quality</td>
<td>41/93 (44.1)</td>
<td>6/94 (6.4)</td>
<td>37.7% (26–48)</td>
</tr>
<tr>
<td>Get a reliable curve written</td>
<td>38/93 (40.9)</td>
<td>10/94 (10.6)</td>
<td>30.2% (18–41)</td>
</tr>
<tr>
<td>Get airtight sealing</td>
<td>32/92 (34.8)</td>
<td>9/93 (9.7)</td>
<td>25.1% (13–36)</td>
</tr>
<tr>
<td>Understand what the curves means for the clinical decision</td>
<td>29/93 (31.2)</td>
<td>2/94 (2.1)</td>
<td>29.1% (19–39)</td>
</tr>
<tr>
<td>Problems handling the tympanometer</td>
<td>21/91 (23.1)</td>
<td>5/92 (5.4)</td>
<td>17.6% (8–28)</td>
</tr>
<tr>
<td>Get the children to cooperate</td>
<td>11/91 (12.1)</td>
<td>4/93 (4.3)</td>
<td>7.8% (0–17)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of frequent problems in 48 participants without experiences in tympanometry before the course</th>
<th>Before the course, ( n (%) )</th>
<th>Six weeks after the course, ( n (%) )</th>
<th>Absolute improvement (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the meaning of the displayed figures and use them as quality</td>
<td>–</td>
<td>4/41 (9.8)</td>
<td>–</td>
</tr>
<tr>
<td>Get a reliable curve written</td>
<td>–</td>
<td>4/43 (9.3)</td>
<td>–</td>
</tr>
<tr>
<td>Get airtight sealing</td>
<td>–</td>
<td>1/43 (2.3)</td>
<td>–</td>
</tr>
<tr>
<td>Understand what the curves means for the clinical decision</td>
<td>–</td>
<td>1/46 (2.2)</td>
<td>–</td>
</tr>
<tr>
<td>Problems handling the tympanometer</td>
<td>–</td>
<td>0/46 (0)</td>
<td>–</td>
</tr>
<tr>
<td>Get the children to cooperate</td>
<td>–</td>
<td>1/43 (2.3)</td>
<td>–</td>
</tr>
</tbody>
</table>

95% CI, 95% confidence interval
knowledge, especially about when not to use antibiotics. All 142 participants obtained new knowledge or skills in at least one topic.

A total of 100 participants (70%; 95% CI, 63–77) stated that tympanometry often provided additional information when handling a clinical ear problem, and another 33 participants (23%; 95% CI, 17–32) answered that tympanometry now and then provided important information. A total of 68 participants (48%; 95% CI, 40–56) said that tympanometry several times during the past 2 weeks had changed their management of middle ear problems, and another 46 participants (32%; 95% CI, 25–41) had experienced that once. Only 19 participants (13%; 95% CI, 9–20) said that tympanometry did not change the management of middle ear problems, and another 46 participants (4%) had not used tympanometry the past 2 weeks and 4 participants did not answer this question.

### Discussion

We found an unequal use of tympanometry, that is, 41% did not use it at all in 2009, many used it very seldom and a few used it a lot, although it has been available for more than 15 years, and reimbursement for doing tympanometry has been established for more than 2 years earlier in Denmark. This slow dissemination of tympanometry is surprising.

The reimbursement from the Danish National Health Service means that the equipment can be paid within 2 years in an average clinic with 85 tympanometers a year. An explanation for the slow diffusion could be that the technology is difficult to understand and difficult to handle for the average GP.

Our study does not provide the answer to what the optimal use of tympanometry is, but guidelines recommend using tympanometry to qualify the often difficult otoscopy in children and in patients with questionable otoscopy, meaning between zero and several times a day depending on the season. Only five of our participants had not used tympanometry within the past 2 weeks.

We had no figure on how many children the different clinics had on their list. An analysis of influence of number of children on the use of tympanometry could be interesting.

Our self-reported questionnaire to the participants showed that even GPs and nurses with experience in performing tympanometry had problems both in performing and in understanding tympanometry. We found that the course could improve the participants’ understanding and practical skills in using tympanometry, and even self-reported questionnaires have a tendency to overestimate interventions. After the course, 70% said that tympanometry often provided important information and approximately 50% had experienced that tympanometry had changed their treatment several times the past 2 weeks. Only five had not used their tympanometer in that period. Especially, the high negative predictive value of type A tympanograms was acknowledged. Unfortunately, we have no information how the treatment was changed by doing tympanometry, but from other Danish studies in primary care, we know that tympanometry means many changes in diagnosis and less use of antibiotics.

The results of our survey can be biased because we sent a questionnaire 6 weeks after the course. The answers to questions before and after the course could be biased by recall problems, or the participants might have wanted to please us, although they could answer anonymously. The response rate of 72% is acceptable but can provide nonresponder bias. Probably, the most positive participants have responded to the survey. Despite these possible problems, the results are convincing, and our sample of GPs and practice nurses was probably not representative of the two regions. They were all interested in improving their diagnostic capability in children with middle ear problems by learning how to perform proper tympanometry and to understand the details of the measurement. The fact that they also all wanted to recruit children to a prospective cohort study means a ‘positive’ selection bias with only 10% of all GPs in the regions. For that reason, we expect nonparticipants to have had more problems performing and understanding tympanometry.

In the United States, tympanometry was a part of the curriculum in approximately 60% of the family nurse

<table>
<thead>
<tr>
<th>Questions</th>
<th>Obtained new knowledge to a high degree, n (%)</th>
<th>Obtained new knowledge to some degree, n (%)</th>
<th>Obtained new knowledge, n (%), 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>New and important knowledge on tympanometry, n = 136</td>
<td>78 (57)</td>
<td>55 (41)</td>
<td>133 (98, 94–99)</td>
</tr>
<tr>
<td>New and important knowledge on middle ear problems, n = 139</td>
<td>74 (53)</td>
<td>58 (42)</td>
<td>132 (95, 90–98)</td>
</tr>
<tr>
<td>Taught me how to understand the curve and the figures, n = 128</td>
<td>60 (47)</td>
<td>56 (44)</td>
<td>116 (91, 84–95)</td>
</tr>
<tr>
<td>Taught me how to improve quality in tympanometry, n = 135</td>
<td>53 (39)</td>
<td>68 (51)</td>
<td>121 (90, 83–94)</td>
</tr>
<tr>
<td>Taught me new practical skills in tympanometry, n = 137</td>
<td>63 (46)</td>
<td>58 (42)</td>
<td>121 (88, 82–93)</td>
</tr>
<tr>
<td>New knowledge on the use of antibiotics, n = 136</td>
<td>18 (13)</td>
<td>85 (63)</td>
<td>103 (76, 68–82)</td>
</tr>
</tbody>
</table>

Table 3  The degree of new knowledge or practical skills after the course among the 142 participants
practitioner programs in 1999. A Finnish study found that a single training session in tympanometry was inadequate to qualify nurses to perform tympanometry independently, as their sensitivity (0.54) and specificity (0.82) to diagnose middle ear effusion were too low compared with a physician’s result.

Comparison with other studies
In a controlled study, Lildholdt et al. randomized 10 GPs to use tympanometry every time they found indication for otoscopy in children younger than 16 years, and 10 GPs were randomized to normal practice. The 10 GPs were trained in tympanometric diagnosis and treatment of ear diseases. The other 10 GPs did not change their principles for diagnosis and treatment (control group). After 1 year, 3166 children were included. AOM was diagnosed in 8.4% in the control group and 2.6% in the test group, and SOM (OME or glue ear) was found in 14.2% in the control group and in 25% in the test group. Antibiotics were prescribed for 7.6% in the control group and 4.1% in the test group. The trial showed that tympanometry after education and training significantly changed diagnosis and treatment of ear problems in children in general practice. After the trial, the 10 control GPs also had a course in tympanometry.

After training and instruction, Van Balen et al. found Micro-Tymp (Welch Allyn) to be a reliable diagnostic instrument in general practice. Sixty-one percent GPs handled the tympanometer faultlessly, and 39 GPs classified 47 different tympanograms according to Jerger’s modified classification, designating them as ‘OME’, ‘no OME’ or ‘interpretation impossible’. The gold standard was the consensus over the 47 tympanograms reached by three doctors very experienced in tympanometry. A total of 74% GPs had a satisfactory to almost perfect agreement with the gold standard.

The effect of introducing tympanometry in combination with training to the GPs was investigated in a prospective study with 40 GPs in Denmark. The GPs recorded their primary decision about diagnosis, treatment and follow-up in 3176 children up to 16 years of age and compared their decisions before and after doing tympanometry. Before the study, tympanometry instruction sessions were organized, during which otolaryngologists discussed their experience of middle ear diagnostics with the GPs. The GPs became involved in the establishment of guidelines for the diagnosis and treatment of middle ear disease to be used in the investigation. The diagnosis was changed in 26.4% after information from the tympanometer. The most difficult diagnosis was SOM, 16% were diagnosed as normal before tympanometry and 21% changed from SOM to normal after tympanometry.

Our study with a self-reported postal questionnaire to the GPs and their participating nurses cannot directly be compared with these three studies, but some of the same problems our participants encountered were also described in these prospective studies. In addition, important information from the tympanometer when treating otitis media in children was confirmed by our survey. An interesting finding was that the participants without experience in our survey had the same low frequency of problems as the more experienced participants after the course. It seems like they received the needed training to do tympanometry.

Conclusion
The use of tympanometry in general practice, which is now more than 15 years after its introduction, is still very skewed, that is, some GPs not using it, several using it a little and a few using it a lot. A 6-hour course could improve experienced and nonexperienced GPs’ and nurses’ care of patients with middle ear problems by improving both knowledge and practical skills. After the course, majority (70%) stated that tympanometry often provided important information, and 48% said that tympanometry several times during the past 2 weeks had changed their management of a middle ear problem. Only very few (4%) had not used their tympanometer in the past 2 weeks.

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References


