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Early Detection of OME in the First Four Years of Life to Prevent Delayed Language Development

Systematic Review & Recommendations

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TECHNICAL REPORT

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Systematic Review & Recommendations

Technical Report #01-3, September 2000

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ABSTRACT

Objectives: To consider the evidence for the early detection, during periodic health examinations, of otitis media with effusion (OME) in the first four years of life in the asymptomatic child.

Options: Tympanometry, microtympanometry, acoustic reflectometry and pneumatic otoscopy were the screening tools reviewed. Treatment interventions (mucolytics, antibiotics, steroids and surgical insertion of ventilation tubes) were assessed.

Outcomes: Preventing delay in acquiring language was considered the primary outcome.

Evidence: MEDLINE and other relevant databases were searched using the following terms: otitis media with effusion, middle ear effusion, OME, developmental disabilities, learning disorders, child development, language development disorders, speech disorders, mass screening, sensitivity and specificity. Relevant references from articles were also reviewed.

Benefits, Harms, and Costs: No randomised controlled trials assessing the overall process of earlier detection of OME and early intervention to prevent delay in acquiring language were identified, although one trial evaluated treatment in a screened population and found no benefit. The evidence regarding the use of screening tools such as tympanometry, microtympanometry, acoustic reflectometry and pneumatic otoscopy in the general population of children in the first four years of life is unclear. Some treatments (mucolytics, antibiotics, and steroids) resulted in the short-term resolution of effusions as measured by tympanometry. Ventilation tubes resolved effusions and improved hearing. Ventilation tubes in children with hearing loss associated with OME benefited children in the short term, but after 18 months, assessment of language did not differ from those children initially assigned to a period of watchful waiting. Most prospective cohort studies that evaluated the association between OME and language development lacked adequate measurement of exposure and/or outcome, or suffered from attrition bias. Findings with regard to the association were inconsistent.

Values: The strength of evidence was evaluated using the evidence-based methods of the Canadian Task Force on Preventive Health Care.

Recommendations: There is insufficient evidence for or against the use of tympanometry, microtympanometry, acoustic reflectometry and pneumatic otoscopy for earlier detection of OME in the general population of children up to the age of four years (**C recommendation**), and insufficient evidence to recommend early detection of OME to prevent delayed language development (**C recommendation**).

Validation: The members of the Canadian Task Force on Preventive Health Care reviewed the findings of this analysis through an iterative process. The Task Force sent the final review and recommendations to selected external expert reviewers and their feedback was incorporated.

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Background

In 1994, the Canadian Task Force on Preventive Health Care updated its review of evidence available for routine hearing assessment in pre-schoolers (1). The Task Force concluded that there was fair evidence to recommend against routine hearing assessment in pre-school age children (D recommendation). No specific recommendations were made regarding the early detection of otitis media with effusion (OME), which is defined as the accumulation of fluid in the middle ear without signs and symptoms of ear infection (2). The aim of this review was to consider the evidence for the early detection of OME in the first four years of life in the asymptomatic child in a periodic health examination. However, evidence from other settings such as screening the general asymptomatic population and follow up of children after acute otitis media was also be considered if relevant to the periodic health examination setting. Prevention of delay in language acquisition was considered a primary outcome.

Burden of suffering

OME (with its potential for hearing loss) is commonest during the most intensive period of language acquisition. Hearing loss fluctuates from a few decibels (DB) to as much as 50 DB, with a mean hearing level loss of 20-30 DB (3,4). At this level, hearing loss is often considered to be sufficiently serious to warrant intervention: a hearing loss of 30DB can mean that a normal conversation sounds like a soft whisper (4). However, some children with OME do not suffer important hearing loss, particularly when OME is unilateral. Documenting hearing prior to intervention is therefore important. Some argue that language acquisition is not easily influenced by milder, often intermittent hearing loss and suggest that children quickly recover from any potential impairment as a result of effusions that are usually self-limiting (5). Others suggest that younger children have poorly developed hearing to start with, and even mild hearing losses during critical periods can have permanent effects (5). Some investigators postulate a cumulative model, where OME alone causes few problems but when combined with sub-optimal social conditions, effects become apparent (5). Different aspects of language may be important in OME. Expressive language (articulation) or receptive language (the ability to comprehend the meaning of speech) may be impaired to different degrees. Furthermore, behaviour rather than language may be more affected since children with effusions may have to concentrate harder to hear (6). Their capacity to attend to language could suffer, reducing sustained attention to tasks.

Otitis media (including acute otitis and OME) costs the Canadian health care system about $600 million per year (7). The total annual cost of treating children less than five years for OME is estimated at more than $5 billion annually in the US (8). The insertion of ventilation tubes is the second commonest surgical procedure performed on children (8). In England and Wales, the annual expenditure by the National Health Service on surgical treatment for OME is around £30 million (4). OME is a common reason for prescribing antibiotics to children (9), a practice that contributes to the growing problem of bacterial resistance.

Methods

Guidelines for rules of evidence established by the Canadian Task Force on Preventive Health Care were used to classify the quality of study designs in a hierarchical fashion (10,11). The "causal (analytic) pathway" approach proposed by Battista and Fletcher was used in evaluating the evidence (12).

Extraction of evidence

MEDLINE was searched from 1966 to August 1999, focussing on screening (in general and in the early years), treatment (and subsequent language related outcomes), and the relationship between OME and language delay. Key search terms utilised included otitis media with effusion (OME), middle ear effusion, developmental disabilities, learning disorders, child development, language development disorders, speech disorders, mass screening, sensitivity and specificity. The Cochrane Database of Systematic Reviews and Controlled Trials Register, as well as the National Health Service Centre for Reviews and Dissemination Database were also searched for relevant studies and meta-analyses.

Further studies were identified from manual searching of the indexes of studies identified by electronic searchers, from indexes of review studies, and the index of the systematic review by the New Zealand Health Technology Assessment Clearing House for Health Outcomes and Health Technology Assessment (http://nzhta.chmeds.ac.nz/screen.htm). If a meta-analysis of suitable quality was found, only relevant individual trials published after the meta-analysis were sought.

Studies were excluded for the following reasons: 1) assessment of exposure that was retrospective (13-28), inadequate (29-35), or cross-sectional (36,37); 2) use of samples other than the general population, for example, studies that included only graduates of neonatal units (38-45), children with cleft palate (46,47), high-risk children in day-care (48-55), or specific ethnic groups (56-63); 3) evaluation of OME after the first four years of life (64-67); and 4) findings published in abstract form or in conference proceedings only.

Critical appraisal and consensus development

This evidence was systematically reviewed using the methods of the Canadian Task Force on Preventive Health Care. The Task Force of expert clinicians/methodologists from a

variety of medical specialities used a standardised evidence-based method for evaluating the effectiveness of screening interventions. The first author prepared a manuscript providing critical appraisal of the evidence. This included the identification and critical appraisal of key studies and ratings of the quality of this evidence using the Task Force's established methodological hierarchy (Appendix 1), resulting in a summary of proposed conclusions and recommendations for consideration by the Task Force. This manuscript was pre-circulated to the members in May 1999, and evidence for this topic was presented by the first author and deliberated upon at the 45the meeting in June 1999. The second author subsequently evaluated the quality of the studies, checked data extraction and contributed to the second draft of the report which was presented to Task Force members in November 1999 and January 2000.

At the meetings, the expert panellists addressed critical issues, clarified ambiguous concepts and analysed the synthesis of evidence. At the end of this process, the specific clinical recommendations proposed by the lead authors were discussed, as were issues related to the clarification of the recommendations for clinical application, and any gaps in evidence. The results of this process are reflected in the description of the decision criteria presented with the specific recommendations. The final decisions on the recommendations were arrived at by the Task Force members and the lead authors.

Following the meetings, the lead authors reviewed the manuscript accordingly. After a final revision, the Task Force sent the manuscript to experts in the field (identified by the Task Force members at the meeting). Feedback from these experts was incorporated into a subsequent draft of the manuscript that was submitted to this Journal.

Procedures to achieve adequate documentation, consistency, comprehensiveness, objectivity and adherence to the Task Force methodology were maintained at all stages during the review development, the consensus process and beyond. These were managed by the Task Force Office under the supervision of the Chair, and ensured uniformity and impartiality throughout the review process. The full methodology is described by Woolf and colleagues (10).

RESULTS

Step 1: Effectiveness of screening the general population the first four years of life

Barratt and colleagues described two designs for clinical trials assessing the impact of a screening process (68). A trial may assess the entire screening process (early detection and

intervention), in which case subjects are randomised to be screened and treated if early abnormality is detected, or not screened. No trial of this design was identified for OME. Alternatively, all subjects can be screened and those with positive test results randomised to be treated or not. Zielhuis and colleagues assessed the impact of screening a general population of children aged two years in Nijmegen for OME using this design (69). Rach and colleagues appear to have described the same patients in their report (70). The researchers completed screening on 73% of 1439 children with tympanometry in their own homes. Children with persistent effusions were referred (n=288) and attendees invited to participate in a randomised trial. After six months, there was no difference in Reynell test scores between those who received ventilation tubes (n=22) or no treatment (n=21). No differences in language measures were found when these children were followed up to age seven years (71). Because of the small numbers of subjects who participated in the RCT, the study lacked sufficient power to detect an important effect. Other reports of outcomes on children initially screened in this study will be considered in steps four and five of the analytic pathway (72-76).

Three other 'screening' studies were excluded because audiometry was the screening tool and subjects were not randomised (77-79). Two of these studies focused on older children (77,78). Three studies were excluded because referral rate was the outcome measure (80-82). Given the inconclusive evidence for or against screening for OME in the general population, we explore the remaining steps in the analytic pathway regarding evidence for and against early detection of OME to prevent delayed language development.

Step 2: Manoeuvres for early detection

The status of the middle ear can be evaluated with several techniques including tympanometry, acoustic reflectometry and otoscopy. Tympanometers test the compliance of the tympanic membrane and middle ear pressure, which is affected by fluid behind the eardrum. Microtympanometers are hand-held versions of these machines. Acoustic reflectometry uses sound waves to evaluate the status of the middle ear. A pneumatic seal of the ear canal is not required so it can be used in crying children possibly enhancing usefulness in younger children (83). Pneumatic otoscopy involves visual inspection of the eardrum and evaluation of its mobility while slightly increasing and then decreasing the pressure in the ear canal (2).

Hearing tests

Manoeuvres that examine hearing deficits, such as audiograms or distraction tests, are not yet useful for early detection. The former tests are not often feasible in children less than four years of age and are resource intensive (4), while the latter are not sufficiently sensitive (84).

Tympanometry

In pre-surgery populations, several studies have found sensitivities and specificities for tympanometry above 80% (85-90). In studies involving populations with a lower prevalence of OME that use otoscopy as the gold standard, sensitivities of around 80% and specificities of more than 90% have been reported (90,91).

Two studies assessed tympanometry in a community setting using pneumatic otoscopy as the 'gold standard' where the prevalence of OME ranged between 11% and 12% (91,92). The sensitivities were 65% and 95%, and the specificities were 65% and 80%.

Microtympanometry compared well with standard tympanometry (93-98). It must be emphasized however, that not all children with effusions suffer hearing loss (99). Tympanometry is therefore a surrogate measure for hearing loss. Positive predictive values ranged from 49% to 66.4% for a hearing loss greater or equal to 25DB after an abnormal tympanogram in referred populations (99-101).

Acoustic reflectometry

Reported sensitivities and specificities of acoustic reflectometry varied widely (87,102-113). However, performance of newer reflectometers approached that of tympanometers (87,107).

Pneumatic otoscopy

A review of five studies comparing pneumatic otoscopy with fluid present at the time of surgery found a mean sensitivity of 89% and a mean specificity of 80% (114). In one study, pneumo otoscopy identified less than half the effusions noted at CT scanning (115). In a primary care setting, where the prevalence of OME was31%, compared with tympanometry, otoscopy had a sensitivity of 76% and a specificity of 87% (116).

Decisions based on a combination of otoscopy, tympanometry and middle ear muscle reflex measures have high sensitivities and specificities (117,118), but this approach is resource intensive and has not been tested for use in clinical practice (2).

Problems with manoeuvres for the early detection

When assessing the properties of manoeuvres used for the early detection of OME, fluid found in the middle ear at the time of surgery is often considered the 'gold standard' (85-90,93,94,103,118-125). Since the prevalence of OME affects positive and negative predicative values of these manoeuvres, it is important that such characteristics be examined in community samples. For example, in a pre-surgery sample where prevalence of OME ranges from 41% (118) to 83% (119), the positive predictive value may be higher than in a community sample with a lower prevalence (126). Children in pre-surgery samples may also differ from those considered for early detection in the general population in other important variables such as age, duration of OME and related conditions. Most studies of screening tools use ears (and not children) as the unit of analysis, although there are a few exceptions (86,100,101). Using ears as the unit of analysis is a questionable practice since observations of both ears of a single child cannot be regarded as independent.

Relatively low levels of agreement among potential manoeuvres for early detection have been reported. McCandless and Thomas found an agreement of 93% between tympanometry and otoscopy, and 61% agreement between pure-tone audiometry and otoscopy (127). Interobserver reliability has also been found to be moderate. For example, Labrecque and colleagues obtained a kappa of 0.52 (95%CI 0.45 to 0.59) for agreement of interpretation of three sets of tympanograms obtained with a microtympanometer by three residents (128). In a study involving general practitioners trained for three hours in tympanometry, a kappa of 0.59 was obtained for classifying tympaongrams into five categories, but this improved for classification into three groups (kappa = 0.63) (129).

These problems with candidate screening tools are compounded by the recurrent, fluctuating nature of OME: it is only long-term OME that warrants treatment; a single measure of any type will fail to document clinically relevant chronicity. Children with positive tests would need to begin a period of observation with repeated testing.

Step 3: The effect of treatment on OME[1]

The majority of treatment studies have involved samples of children identified though routine care. Since the results are not necessarily generalisable to children identified with OME through attempts at early identification, we outline this evidence as it pertains to the analytic pathway, but do not make recommendations about treatment based on these studies. Intermediate outcomes such as resolution of effusions based on tympanometry are commonly used in this research.

Mucoactive drugs

Pignataro and colleagues conducted a meta-analysis of six placebo-controlled, randomised studies of mucoactive agents involving 483 patients, 430 (89%) of whom were successfully followed up (130). Patients with OME receiving oral SCMC/-lys versus placebo in six studies benefited by avoiding surgical intervention 2.31 times more frequently (CI 1.28-4.2, p<0.01), and reverting to normal tympanograms more often (OR 2.25,CI 0.97-5.22, p=0.058). Participants ranged in age from three to 12 years, and none of the studies included children less than three years of age. Most participants had OME for less than six months and had not previously been treated. Follow up ranged from one to three months and longer-term effects such as recurrences were not reported. Studies included placebo and no treatment controls, but outcome assessors were blinded to treatment condition. In all but one of the six individual studies, confidence intervals for odds ratios included unity. The single study showing benefit on its own included 19 subjects for analysis; the odds ratio favouring mucolytics was 18.92 (CI 2.03-177.6).

Antibiotics

Williams and colleagues examined the effectiveness of antibiotics as a treatment for OME and the prevention of recurrent OME (131). In this meta-analysis (131), 27 out of 33 studies met their inclusion criteria; tympanometry findings were used as the final outcome. Nine studies of antibiotic prophylaxis of recurrent otitis media with 958 subjects had a rate difference

[1] The results of new randomized trials have recently become available regarding the effect of treatment with tympanostomy tubes on language development<164,165> and quality-of-life outcomes.<166> These studies have not been evaluated as part of this systematic review. Their impact on the current recommendations will be evaluated in a future update.)

(RD) of 0.11 (95% CI 0.03 to 0.19) favouring antibiotic treatment. Twelve studies of short-term outcomes (one month) had a RD favouring antibiotics of 0.16 (95% CI, 0.03 to 0.29). Five of these studies were not placebo controlled and showed greater antibiotic effect than placebo controlled trials. Three evaluated hearing. Eight studies using the ear rather than the patient as the unit of analysis had a RD of 0.25 (95% CI, 0.10 to 0.40). Three were not placebo controlled and only one assessed hearing. There were no significant differences between the groups that received placebo compared to antibiotics (RD, 0.06; 95% CI, -0.03 to 0.14) in the eight studies of longer-term outcome (from six weeks to 11 months after starting treatment) of OME.

An earlier meta-analysis of short-term outcomes in patients with OME found a higher RD of 0.23 (95% CI, 0.11 to 0.35), but this analysis has been criticised for mixing studies which used ears and patients as the unit of analysis, and for inconsistent application of exclusion criteria (132). Stool and colleagues' meta-analysis of largely short-term studies found a 14% (95% CI 3.6% to 24.2%) increase in the probability that OME would resolve with antibiotic therapy compared to no treatment (2).

Since these meta-analyses, there have been three further revenant trials. Mandel and colleagues. randomised 111 effusion-free children aged from seven months to 12 years who had a history of recurrent OME to receive amoxicillin or placebo for one year (133). Follow up was achieved for 77.5%. The rates of new episodes of effusions in the amoxicillin group and placebo group were 1.81 vs. 3.18 ($p<0.001$).

Van Balen and colleagues recruited 433 children aged six months to six years with persistent OME from general practices into a period of watchful waiting (134). After three-months, 162 of the 223 participants with persistent effusions were randomised to receive co-amoxiclav or placebo for two weeks. The adjusted odds ratio for persistent effusions in both ears at two weeks was 0.25 (95% CI 0.11 to 0.58, $p=0.001$). Side effects (mostly gastrointestinal) occurred in 44% of antibiotic-treated versus 22% of control children. Long term outcomes were not reported.

Marchisio and colleagues screened 3413 children aged from five to seven years with pneumatic otoscopy and tympanometry, and randomised 111 of those still positive for OME after 12 weeks to receive ceftibuten for 14 days or no treatment (135). After eight weeks, 30.8% of those who treated with antibiotics had persisting bilateral OME compared with 52.6% of those who received not treatment.

Steroids

Rosenfeld conducted a meta-analysis of six trials assessing the effectiveness of systemic steroids in treating OME (136). Children receiving steroids for seven to 14 days were 3.6 times more likely than placebo-controlled subjects to have both ears free of effusion at the end of therapy (95% CI, 2.2 to 4.1). However, there was significant heterogeneity of results. Three of the studies included steroids alone and three studies used a combination of steroids and antibiotics. Studies generally involved small samples (range, n=22 to n=60), but all included children less than three years of age. However, The Agency for Health Care Policy and Research found contradictory evidence for steroid therapy alone or in combination with an antibiotic and did not recommend the use of steroids for this indication (2).

Since these meta-analyses, a trail comparing oral steroid plus antibiotic to placebo plus antibiotic and placebo plus placebo showed a benefit from adding oral steroid to antibiotic treatment after two weeks but this advantage was no longer apparent at six weeks and six months (137).

Three randomised controlled studies have examined the effect of topical, intra-nasal steroids in clearing middle ear effusions (138-140). Tracy and colleagues. recently demonstrated that a topical, intra-nasal steroid combined with an oral antibiotic was effective in clearing effusions in the short term, but by 12 weeks of treatment, differences in most outcomes were no longer statistically significant (140).

Surgery

Freemantle and colleagues reviewed 19 well-designed randomised controlled trials examining the effectiveness of surgical interventions for OME (4). The search strategy and selection criteria were not outlined explicitly in their report. It was not possible to combine the studies using meta-analysis, because of substantial variability across studies. The authors concluded that ventilation tubes and adenoidectomy alone or in combination were equally effective. Based on three studies, they estimated the magnitude in reduction of hearing loss after these procedures was an average 12DB at six months and under 6DB after 12 months post surgery. There was a large variation in effect between children. Myringotomy alone, tonsillectomy alone or in combination were ineffective interventions. Ventilation tube insertion was noted to lead to tympanosclerosis and slightly increased the incidence of chronic perforation

and cholesteatoma. Risks of surgery included exposure to an anaesthetic, possible psychological trauma and a slight risk of haemorrhage after adenoidectomy. The authors noted that between 20% and 35% of those receiving ventilation tubes experienced ear discharge, which was persistent in 5% of cases.

Since the publication of the review, Maw and Bawden have reported more fully on their study of 228 children (141,142). The median duration of OME was reduced from 7.8 years without surgery to 4.9 years with a ventilation tube, 4.0 years after adenoidectomy, and 2.8 years with the combination of a tube and adenoidectomy. A recent study of adenoidectomy and adenotonsillectomy for recurrent acute otitis media in a sample of 461 children aged three to 15 years, showed short term and limited efficacy in preventing episodes of acute otitis media and estimated proportion of time with effusions (143).

Other interventions

Auto-inflation (including nose blowing) has limited applicability in young children. A meta-analysis found six studies of autoinflation to be of variable and low quality; its use was not recommended for clinical practice (144). The role of non-steroidal antinflammatories (NSAIDS) may be explored with larger, well-designed studies. In two under-powered, placebo controlled trials, the was a non statistically significant trend favoring NSAIDS (145,146). A pilot study found a non statistically significant trend in favour of homeopathic treatment vs usual care for OME (147). A meta-analysis of four studies of antihistamines combined with decongestant therapy showed no effect on resolution of OME (2).

Step 4: the effect on language related outcomes of treating OME diagnosed through routine care (Table 1)

A randomized controlled trial examined the effect of treatment on language related outcomes in children recruited into the trial at the time of first appointment at an otolaryngology clinic (148). Bilateral effusions and hearing loss were documented prospectively for at least three months duration, after which children were randomised to receive ventilation tubes within six weeks, or, if required after a period of nine months of ‘watchful waiting’ (n=186) (148). Nine months after randomisation, those assigned to the ‘watchful waiting group’ had verbal comprehension and expressive language skills 3.24 months behind those in the early surgery

group. Eighteen months following randomisation, 85% of the 'watchful waiting' group had undergone tube insertion, and the groups no longer differed significantly with regard to language-related outcomes. However, 83 in the early surgery group completed the trial compared to 73 in the watchful waiting group.

As outlined in Table 1, the remaining studies included five controlled cohort studies. The sample sizes ranged from 25 to 58 participants; the findings regarding the effect of treatment on language ability were conflicting (76,149-152).

Step 5: the association between OME and adverse language related outcomes

Table 2 summarises the 13 groups of studies identified that considered the effect of OME during the first four years of life on language acquisition.

Two studies had high internal validity. Lous and Fiellau-Nikolajsen and Lous screened more than 90% of two separate entire birth cohorts in Hjorring, Denmark; follow up was achieved for more than 65% of children in both cohorts who had significant OME (153,154). The case control aspect of these studies involved careful matching. No lasting effects from OME were found. However, outcome was measured at age eight years, by which time children who had experienced OME may have 'caught up' with unaffected peers. In one of the studies, follow up evaluation involved only the Silent Reading Word Test.

The remaining eleven study groups had methodological flaws which posed substantial threats to internal validity. Only three studies documented hearing loss associated with effusions (5,155,156). Reports from studies of the Nijmegen cohort suffered from possible attrition bias (72,74). While documentation of OME was comprehensive and screening occurred at regular intervals, no attempt was made to follow up all screened subjects with language-related assessments. For example, Peters and colleagues did not indicate how subjects were selected for language assessment from the original sample screened for exposure to OME (72). The extent of subject overlap across studies was not clear: it appeared that some children might have been included in more than one report of outcomes. If this was the case, the studies could not be considered independent. Few significant differences in language outcomes attributable to OME were found despite multiple comparisons. Paradise and colleagues report follow up for a small proportion of the 6350 children enrolled into their ongoing study (156). Children from diverse backgrounds were enrolled by age two months and middle ear status was monitored at least

monthly with hearing tests for those with ongoing OME. Children in this cohort who met inclusion criteria for a trial of treatment with ventilation tubes became ineligible. The remaining children represented a broad range of exposure to OME. They were randomly selected from the remaining cohort for evaluation of language development, speech and sound production and cognition were evaluated at three years of age. The percentage of variance in scores for receptive vocabulary and verbal aspects of cognition explained by time with OME in the first year of life beyond that explained by socio-demographic variables ranged from 1.2% to 2.9%. There were no significant correlations between time with OME and scores on measures of spontaneous expressive language, speech and sound production, or other measured aspects of cognition

Similarly, the study by Friel-Patti and Finitzo achieved follow up for less than a third of subjects at age two years (157). Only two out of ten comparisons showed a statistically significant association between exposure to otitis media and language delay at age two years. A further evaluation of 70 children form the original cohort of 483 found that the risk of delayed language development depended on average hearing levels during exposure to OME (158).

The two studies by Teele and colleagues should be considered one study since the reports followed up mainly the same children at different times (159,160). Duration of OME was calculated by extrapolation from the number of episodes of acute otitis media. Those followed up at three years were not randomly selected from the original cohort, and less than 10% of those initially recruited underwent language assessments at the follow-up points. At three years of age, children with OME had lower scores on the three tests (Peabody Picture Vocabulary, Auditory Comprehension Quotient, Verbal ability Quotient) used to assess speech and language. At the seven-year follow up, the relationship between time with OME and language was significant in two of nine comparisons.

Kinshkowy and colleagues explored the association between recurrent otitis media and language outcomes (161). As in the studies by Teele and colleagues, inferences were made about duration of effusions from documented episodes of acute otitis media. More than 80% of the participants were assessed at follow up at two and three years of age, during the period when effects of exposure might be most apparent. A multivariate analysis included social variables and otitis media history and showed that only recurrent otitis media made a statistically

significant contribution to the overall Developmental Quotient and specifically to its language subsection at two years of age.

The study by Wright and colleagues has several methodological weaknesses. Recruitment occurred in the context of a study on vaccinations, leading to possible 'volunteer bias'. Follow up of the original sample fell below 50%, and blinding of language assessors to otitis history was not mentioned (162). No otitis media variable influenced language outcomes.

Vernon-Feagans and colleagues documented exposure meticulously, but the sample numbers were small (n = 36, n = 46 and n = 36), and it was not clear if studies were independent (5,6,155). The findings reported supported the 'cumulative effects model', in that an association was only found for chronic otitis media and language outcomes among those attending day care of poorer quality.

It was not appropriate to combine the data from studies in Table 2 due to the variability in outcome, assessment of exposure, attrition and duration of follow up.

INTERPRETATION

Summary of the key evidence

Although the association between OME and language development has undergone considerable investigation, few studies have directly addressed the question of early detection in the first four years of life. The analytic pathway approach is therefore particularly important to consider when examining the evidence for or against early detection.

No randomised controlled trials examining the overall process of screening for OME in the first four years of life and subsequent intervention to prevention of adverse language outcomes were identified. However, one trial screened children and then randomised those with persistent effusions to be treated with ventilation tubes or not. No effect on language was identified but given the small proportion that was randomised to receive treatment or not, there was likely insufficient power to detect a clinically important difference (step one in the analytic pathway).

Various manoeuvres for early detection are available, but performance has not been adequately assessed in community settings where prevalence and severity are lower than in pre-surgery groups. Indeed, manoeuvres have to be evaluated against each other in this setting, where it is not possible to use the 'gold standard' of documented hearing loss associated with the presence of middle ear fluid found at tympanocentesis (step two in the analytic pathway). No single reading can give an indication of chronicity which is crucial in a condition which is fluctuating and often self-limiting.

Most treatments were evaluated in populations which were identified through usual care. Studies of antibiotics have shown some short-term benefit in clearing effusions (step three in the analytic pathway), but long-term resolution of effusions has not been demonstrated. Antibiotics helped in reducing recurrences of acute otitis media. Evidence for benefit in the short and medium term must be considered in the context of rising bacterial resistance, side effects and lack of evidence for long term improvement in hearing in children with OME. A meta analysis of trials of mucolytics suggest short-term benefit in previously untreated children with OME of less than six months duration. Surgical management alone or in combination cleared fluid and improved hearing: a systematic review showed ventilation tubes and adenoidectomy were equally effective with some evidence suggesting the combination was better than either procedure alone. Treatment effectiveness studies generally used intermediate outcomes of

effectiveness, such as resolution of OME based on tympanometry. Therefore is it not known whether early detection of OME with subsequent treatment with modalities other than ventilation tubes prevents adverse language outcomes.

There is Level 1 evidence that treatment of OME with ventilation tubes compared to watchful waiting improved language outcomes at nine months (step four in the analytic pathway). However, by 18 months, differences were no longer apparent. This was a study of management among children referred to an otolaryngology clinic and not an evaluation of additional interventions for earlier detection. Consequently, this trial does not provide evidence to support attempts at earlier detection of OME.

With regard to step five in the analytic pathway, in five study groups there was no association between OME and language outcomes; in eight study groups, the minority of analyses showed a significant association. Socio-demographic variables appeared to explain more of the variance in measures of language development than exposure to OME. There was substantial variability across study groups in measurement of exposure (severity, laterality, associated hearing loss and persistence of OME) and outcome, and many of the studies suffered from major methodological weaknesses. Not all children with effusions suffer from significant hearing loss, a factor that is often considered as the causal link between OME and language delay. A wide range of language and developmental outcomes were used and the clinical importance of results obtained with these measures was not made clear. Generally, there was little discussion by the authors about the size of effect that would be regarded as clinically important. Interpretation of significant findings was difficult because of the broad array of language tests used without accompanying information about the clinical importance of change scores. Also, there was a high rate of intervention for OME in the studies that may have affected outcomes.

Canadian Task Force Recommendation (Table 3)

Based on these findings the Canadian Task Force on Preventive Health Care concludes that there is insufficient evidence to recommend for or against the use of tympanometry, microtympanometry, acoustic reflectometry and pneumatic otoscopy for earlier detection of OME in the general population of children up to four years of age (**C recommendation**). There

is insufficient evidence to recommend early detection of OME in children in the first four years of life to prevent delayed language development (**C recommendation**).

Recommendations of others

The US Agency for Health Care and Policy Research expert panel did not make a recommendation about early detection of OME (2). The New Zealand Health Technology Assessment Clearing House for Health Outcomes and Health Technology Assessment (http://nzhta.chmeds.ac.nz/screen.htm) stated that it was not possible to conclude whether or not screening programmes for OME in pre-school children are an effective health strategy. The Canadian Task Force on Preventive Health Care previously recommended that routine audiologic screening of pre-schoolers for hearing problems be excluded from the periodic health examination (Category D recommendation). Haggard and Hughes report for the UK Government Department of Health recommend against extending pre-school screening for OME (163).

Future research

Potential tools for early detection should be evaluated in settings of low prevalence. Future studies on the identification, effects and treatment of OME should prospectively document hearing loss associated with OME over time. Unilateral OME is unlikely to result in hearing loss warranting intervention and 'laterality' should be reported. Outcomes should include behavioral (e.g. measures of concentration) as well as language assessments. The reliability and validity of these outcome measures should be described, and clinically important differences specified. An RCT which allocates children at the level of exposure to strategies for early detection of OME would be necessary to determine the effectiveness of the overall screening process (early detection and subsequent management) in preventing language delay. However, such a resource intensive trial is unlikely to be justified until it is shown that deficits from OME in language and other developmental outcomes are large enough to be able to demonstrate treatment effects.

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References

1. Feightner JW. Canadian Task Force on the Periodic Health Examination, editors. The Canadian guide to clinical preventive health care. Ottawa: Health Canada; 1999; 27, Routine pre-school screening for visual and hearing problems. p. 298-303.
2. Stool SE; Berg AO; Berman S, et al. Otitis media with effusion in young children. Clinical practice guideline. Number 12. Rockville, MD: Agency for Health Care Policy and Research, Public Health Services, US Department of Health and Human Services; 1994.
3. Lous J. Secretary otitis media in schoolchildren: Is screening for secretary otitis media advisable? Danish Med Bull 1995;71-99.
4. Freemantle N, Sheldon TA, Song F, and Long A. The treatment of persistent glue ear in children: Are surgical interventions effective in combating disability from glue ear? Effective Health Care 1992;4.
5. Vernon-Feagans L, Emanuel DC, Blood I. The effect of otitis media and quality of day care on children's language development. J Appl Dev Psychol 1997;18(395):395-409
6. Feagans LV, Kipp E, Blood I. The effect of otitis media on the attention skills of day-care-attending toddlers. Devel Psychol 1994;30:701-8.
7. Elden LM, Coyte PC. Socioeconomic impact of otitis media in North America. J Otolaryngol 1998;27(Suppl 2):s9-s16
8. Gates GA. Cost effectiveness considerations in otitis media treatment. Otolaryngol Head Neck Surg 1996;114:525-30.
9. Culpepper L, Froom J. Otitis media with effusion in young children: Treatment in search of a problem? J Am Board Fam Pract 1995;8:305-16.
10. Woolf S, Battista RN, Geoffrey M. Assessing the clinical effectiveness of preventive maneuvers: analytic principles and systematic methods in reviewing evidence and developing clinical practice recommendations. J Clin Epidemiol 1990;43(9):891-905.
11. Canadian Task Force on the Periodic Health Examination. The periodic health examination. Can Med Assoc J 1979;121:1193-254.
12. Battista R, Fletcher S. Battista R, Lawrence R, editors.Implementing preventive services. New York: Oxford University Press; 1988;Making recommendations on preventive practices: methodological issues. p. 53-67.
13. Bishop D, Edmundson A. Is otitis media a major concern of specific developmental language disorders? Br J Disord Commun 1986;21:321-38.
14. Brookhouser PE, Goldgar DE. Medical profile of the language-delayed child: otitis prone versus otitis free. In J of Ped Otorhinolaryngol 1987;12:237-71.
15. Holm VA, Kunze LVH. Effect of chronic otitis media on language and speech development. Pediatrics 1969;43:833-9.
16. Jerger S, Jerger J, Alford BR, Abrams S. Development of speech intelligibility in children with recurrent otitis media. Ear Hear 1983;4:138-45.
17. Needleman H. Jaffe BF, editors.Hearing loss in children. A comprehensive text. Baltimore: University Park Press; 1977;Effects of hearing loss from early recurrent otitis media on speech and language development. p. 640-9.
18. Paradise JL. Management of middle ear effusions in infants with cleft palate. Ann Otol Rhinol Laryngol 1976;85(Suppl 25):s285-s288.

19. Sak RJ, Ruben RJ. Recurrent middle ear effusion in childhood: implications of temporary auditory deprivation for language and learning. Ann Otol 1981;90:546-51.

20. Bennett KE, Haggard MP. Behaviour and cognitive outcomes from middle ear disease. Arch Dis Child 1999;80:28-35.

21. Webster A, Bamford JM, Thyer NJ, Ayles R. The psychological, educational and auditory sequelae of early, persistent secretary otitis media. J Clin Psychol Psychiat 1989;30:529-46.

22. Haggard MP, Birkin JA, Browning GG, Gatehouse S, Lewis S. Behaviour problems in otitis media. Pediatr Infect Dis 1994;13:s43-s50.

23. Bax M, Hart H, Jenkins S. The behaviour, development, and health of the young child: implications for care. BMJ 1983;286:1793-6.

24. Bax M. Brown CC, editors.Infants at risk: pediatric roundtable 5. 1 ed. New Brunswick NJ: Johnson and Johnson; 1981;The intimate relationship of health, development and behaviour in the young child. p. 106-13.

25. Luotonen M, Uhari M, Aitola L, Lukkaroinen A-M, Luotonen J, Korkeamaki R-L. Recurrent otitis media during infancy and linguistic skills at age of nine years. Pediatr Infect Dis J 1996;15:854-8.

26. Lehmann MD, Charron K, Kummer A, Keith RW. The effects of chronic middle ear effusions on speech and language development; a descriptive study. Int J Pediatr Otorhinol 1979;1:137-44.

27. Zinkus PW, Gottlieb MI, Schapiro M. Developmental and psychoeducational sequelae of chronic otitis media. Am J Dis 1978;132:1100-4.

28. Zinkus PW, Gottlieb MI. Patterns of perceptual and academic deficits related to early chronic otitis media. Ped 1980;66:246-53.

29. Winitz H, Darley FL. Lassman FM, Fisch RO, Vetter DK, LaBenz ES, editors.Early correlates of speech, language and hearing. Littlejohn: PSG Publishing Company; 1980;Speech production. p. 232-65.

30. Brandes PJ, Ehinger DM. The effect of early middle ear pathology on auditory perception and academic achievement. J Speech Hear Disord 1981;46:250-7.

31. Shriberg LD, Flipsen P, Thielke HM, Kwiatkowski J, Kertoy MK, Katcher ML, Nellis RA, Block MG. Risk for speech disorder associated with early recurrent otitis media with effusion: two retrospective studies. J Speech Lang Hear Res 2000;43:79-99.

32. Black MM, Gerson LF, Freeland CAB, Nair P, Rubin JS, Hutcheson JJ. Language screening for infants prone to otitis media. J Pediatr Psychol 1988;13:423-33.

33. Hartsen G, Nettelbladt U, Schalen L, Kalm O, Prellner K. Language development in children with recurrent acute otitis media during the first three years of life: follow up study from birth to seven years of age. J Laryngol Otol 1993;107:407-12.

34. Paul R, Lynn TF, Lohr-Flanders M. History of middle ear involvement and speech/language development in late talkers. J Speech Hear Res 1993;36:1055-62.

35. Rvachew S, Slawinski EB, Williams M, Green CL. The impact of early onset otitis media on babbling and early language development. Acoust Soc Am 1999;105:467-75.

36. Allen DV, Robinson DO. Middle ear status and language development in preschool children. ASHA 1984;26:33-7.

37. Van Cauwenberge P, Van Cauwenberge K, Kluyskens P. The influence of otitis media with effusion on speech and language development and psycho-intellectual behaviour of the preschool child-results of a cross sectional study in 1512 children. Auris Nasus Larynx 1985;12(suppl 1):s228-s230.

38. Friel-Patti S, Finitzo-Hierber T, Conti G, Brown KC. Language delay in infants associated with middle ear disease and mild, fluctuating hearing impairment. Pediatr Infect Dis 1982;1:104-9.

39. Pearce PS, Saunders MA, Creighton DE, Sauve RS. Hearing and verbal-cognitive abilities in high risk pre-

term infants prone to otitis media with effusion. J Dev Behav Pediatr 1988;9:346-52.

40. Wallace IF, McCarton CM, Bernstein RS, Gravel JS, Stapells DR, Ruben RJ. Otitis media, auditory sensitivity, and language outcomes at one year. Laryngoscope 1988;98:64-70.

41. Wallace IF, Gravel JS, McCarton CM, Ruben RJ. Otitis media and language development at one year of age. J Speech Hearing Dis 1988;53:245-51.

42. Abraham SS, Wallace IF, Gravel JS. Early otitis media and phonological development at age 2 years. Laryngoscope 1996;106:727-32.

43. Wallace IF, Gravel JS, Schwartz RG, Ruben RJ. Otitis media, communication style of primary caregivers, and language skills of 2 year olds: a preliminary report. J Dev Behav Pediatr 1996;17:27-35.

44. Gravel JS, Wallace IF. Listening and language at 4 years of age: effects of early otitis media. J Speech Hear Res 1992;35:588-95.

45. Gravel JS, Wallace IF. Early otitis media, auditory abilities, and educational risk. Am J Speech Lang Path 1995;4:89-94.

46. Hubbard TW, Paradise JL, McWilliams BJ, Elster BA, Taylor FH. Consequences of unremitting middle-ear disease in early life. Otologic, audiologic and developmental findings in children with cleft palate. N Engl J Med 1985;312:1529-34.

47. Schonweiler R, Schonweiler B, Schmelzeisen R. Hearing capacity and speech production in 417 children with facial cleft abnormalities. HNO 1994;42:691-6.

48. Roberts JE, Burchinal MR, Koch MA, Footo MM, Henderson FW. Otitis media in early childhood and its relationship to later phonological development. J Speech Hearing Dis 1988;53:424-32.

49. Roberts JE, Burchinal MR, Collier AM, Ramey CT, Koch MA, Henderson FW. Otitis media in early childhood and cognitive, academic, and classroom performance of the school-aged child. Pediatrics 1989;83:477-85.

50. Roberts JE, Burchinal MR, Medley LP, Zeisel SA, Munday M, Roush J, Hooper SR, Bryant D, Henderson FW. Otitis media, hearing sensitivity, and maternal responsiveness in relation to language during infancy. J Pediatr 1995;126:481-9.

51. Roberts JE, Burchinal MR, Zeisel SA, Neede EC, Hooper SR, Roush J, Bryant D, Mundy M, Henderson FW. Otitis media, the caregiver environment, and language and cognitive outcomes at 2 years. Pediatrics 1998;102:346-54.

52. Roberts JE, Burchinal MR, Davis BJ, Collier AM, Henderson FW. Otitis media in early childhood and later language. J Speech Hearing Res 1991;34:1158-68.

53. Arcia E, Roberts JE. Otitis media in early childhood and its association with sustained attention in structured situations. J Dev Behav Pediatr 1993;14:181-3.

54. Roberts JE, Sanyal MA, Burchinal MR, Collier AM, Ramey CT, Henderson FW. Otitis media in early childhood and its relationship to later verbal and academic performance. Pediatrics 1986;78:423-30.

55. Roberts JE, Burchinal MR, Clarke-Klein SM. Otitis media in early childhood and cognitive, academic, and behavior outcomes at 12 years of age. J Pediatr Psychol 1995;20:645-60.

56. Lewis N. Otitis media and linguistic incompetence. Arch Otolaryngol 1976;102:387-90.

57. Fishler RS, Todd NW, Feldman CM. Otitis media and language performance in a cohort of Apache Indian children. AJDC 1985;139:355-60.

58. Kaplan GJ, Fleshman JK, Bender TR, Baum C, Clark PS. Long-term effects of otitis media. A ten-year cohort study of Alaskan Eskimo children. Pediatrics 1973;52:577-85.

59. Saim A, Saim L, Saim S, Ruszymah BH, Sani A. Prevalence of otitis media with effusion amongst pre-school children in Malaysia. Int J Pediatr Otorhinol 1997;41:21-8.

60. Nienhuys TG, Boswell JB, McConnel FB. Middle ear measures as predictors of hearing loss in Australian aboriginal schoolchildren. In J of Ped Otorhinolaryngol 1994;30:15-27.

61. Ogisi FO. Impedance screening for otitis media with effusion in Nigerian children. J Laryngol Otol 1988;102:986-8.

62. Thielke HM, Shriberg LD. Effects of recurrent otitis media on language, speech, and educational achievement in Menominee Indian children. L Am Indian Educ 1990;29:25-35.

63. Feagans L, Sanyal MA, Henderson FW, Collier AM, Appelbaum M. Relationship of middle ear disease in early childhood to later narrative and attention skills. J Pediatr Psychol 1987;12:581-94.

64. Silva PA, Chalmers D, Stewart I. Some audiological, psychological, educational and behavioural characteristics of children with bilateral otitis media with effusion: A longitudinal study. J Learning Disabilities 1986;19:165-9.

65. Brooks DN. Otitis media with effusion and academic attainment. In J of Ped Otorhinolaryngol 1986;12:39-47.

66. Brooks DN. Otitis media with effusion: academic attainment and socioeconomic background. In J of Ped Otorhinolaryngol 1987;13:165-70.

67. Lyn C, Jadusing WA, Ashman H, Chen D, Abramson A, Soutar I. Hearing screening in Jamaica: prevalence of otitis media with effusion. Laryngoscope 1998;108:288-90.

68. Barratt A, Irwig L, Galsziou P, Cummings RG, Raffle A, Hicks N, Muir Gray JA, Guyatt GH. Users' guides to the medical literature XVII. How to use guidelines and recommendations about screening. JAMA 1999;281:2029-34.

69. Zielhuis GA, Rach GH, van den Broek P. Screening for otitis media with effusion in preschool children. Lancet 1989;8633:311-3.

70. Rach GH, Zielhuis GA, van Baarle PW, van den Broek P. The effect of treatment with ventilating tubes on language development in preschool children with otitis media with effusion. Clin Otolaryngol 1991;16:128-32.

71. Schilder AG, Van Manen JG, Zielhuis GA, Grievink EH, Peters SAF, van den Broek P. Long term effects of otitis media with effusion on language, reading and spelling. Clin Otolaryngol 1993;18:234-41.

72. Peters SAF, Grievink EH, van Bon WHJ, Schilder GM. The effects of early bilateral otitis media with effusion on educational attainment: a prospective cohort study. J Learning Disabilities 1994;27:111-21.

73. Peters SAF, Grievink EH, van Bon WHJ, van den Bereken JHL, Schilder AGM. The contribution of risk factors to the effect of early otitis media with effusion on later language, reading, and spelling. Dev Med Child Neurol 1997;39:31-9.

74. Grievink EH, Peters SAF, van Bon WHJ, Schilder AGM. The effect of early bilateral otitis media with effusion on language ability: A prospective cohort study. J Speech Hearing Res 1993;36:1004-12.

75. Rach GH, Zielhuis GA, van den Broek P. The influence of chronic persistent otitis media with effusion on language development of 2- to 4-year-olds. In J of Ped Otorhinolaryngol 1988;15:253-61.

76. Schilder AGM, Hak E, Straatman H, Zielhuis GA, van Bon WHJ, van den Broek P. Long-term effects of ventilation tubes for persistent otitis media with effusion in children. Clin Otolaryngol 1997;22:423-9.

77. Feldman W, Milner RA, Sackett B, Iberst S. Effects of preschool screening for vision and hearing on prevalence of vision and hearing problems 6-12 months later. Lancet 1980;2:1014-6.

78. Augustsson I, Nilson C, Engstrand I. The preventive value of audiometric screening of preschool and young school-children. In J of Ped Otorhinolaryngol 1990;20:51-62.

79. O'Mara LM, Isaacs S, Chambers LW. Follow-up of participants in a preschool hearing screening program in child care centres. Can J Pub Health 1992;83:375-8.

80. Crampton P, Bandaranayake D. Evaluation of an otitis media with effusion screening pilot program. NZ Med J 1996;109:384-6.

81. Lucker J. Application of pass fail criteria to middle ear screening results. ASHA 1990;22:839-40.

82. Roush J, Tait CA. Pure-tone and acoustic immittance screening of pre-school aged children: an examination of referral criteria. Ear Hear 1985;6:245-50.

83. Kimball S. Acoustic reflectometry: spectral gradient analysis for the improved detection of middle ear effusion in children. Pediatr Infect Dis J 1998;17:552-5.

84. Davis AC, Wood S. The epidemiology of childhood hearing impairment: factors relevant to planning of services. Br J Audiol 1992;26:77-90.

85. Cooper JC, Hearne EM, Gates GA. Normal tympanometric shape. Ear and Hearing 1982;3:241-5.

86. Finitzo T, Friel-Patti S, Chinn K, Brown O. Tympanometry and otoscopy prior to myringotomy: issues in diagnosis of otitis media. In J of Ped Otorhinolaryngol 1992;24:101-10.

87. Barnett ED, Klein JO, Hawkins KA, Cabral HJ, Kenna M, Healy G. Comparison of spectral gradient acoustic reflectometry and other diagnostic techniques for detection of middle ear effusion in children with middle ear disease. Pediatr Infect Dis J 1998;17:556-9.

88. Mills RP. Persistent middle ear effusions in children with recurrent acute otitis media. Clin Otolaryngol 1987;12:97-101.

89. Fiellau-Nikolajsen M. Tympanometry and middle ear effusion: a cohort study in three year old children. In J of Ped Otorhinolaryngol 1980;2:39-49.

90. Nozza RJ, Bluestone CD, Kardatzke D, Bachman R. Towards the validation of aural acoustic immittance measures for diagnosis of middle ear effusion in children. Ear Hear 1992;13:442-53.

91. Roush J, Drake A, Sexton JE. Identification of middle ear dysfunction in young children: A comparison of tympanometric screening procedures. Ear Hear 1992;13:63-9.

92. Page AR, Kramer S, Novak J, Williams D, Slymen D. Tympanometric screening in elementary school children. Audiology 1995;34:6-12.

93. Fields MJ, Allison RS, Corwin P, White PS, Doherty J. Microtympanometry, microscopy and tympanometry in evaluating middle ear effusions prior to myringotomy. NZ Med J 1993;106:386-7.

94. Vaughn-Jones R, Mills RP. The Welch Allyn audioscope and microtymp: their accuracy and that of pneumatic otoscopy, tympanometry and pure tone audiometry as predictors of otitis media with effusion. J Laryngol Otol 1992;106:600-2.

95. van Balen FAM. Validation of a portable tympanometer for use in primary care. In J of Ped Otorhinolaryngol 1994;29:219-25.

96. Koivunen P, Alho O-P, Uhari M, Niemela M, Luotonen J. Minitympanometry in detecting middle ear fluid. J Pediatr 1997;131:419-42.

97. De Melker RA. Diagostic value of microtympanometry in primary care. BMJ 1992;304:96-8.

98. Wazen JJ, Ferraro JA, Hughes R. Clinical evaluation of a portable, cordless, hand-held middle ear analyzer. Otolaryngol Head Neck Surg 1988;99:348-50.

99. Anonymous. Sensitivity, specificity and predictive value of tympanometry in predicting a hearing impairment in otitis media with effusion. MRC Multi-Centre Otitis Media Study Group. Clin Otolaryngol 1999;24:284-300.

100. Dempster JH, Mackenzie K. Tympanometry in the detection of hearing impairments associated with otitis media with effusion. Clin Otolaryngol 1991;16:157-9.

101. Kzanas SG, Maw R. Tympanometry, stapedius reflex and hearing impairment in children with otitis media with effusion. Acta Otolaryngol (Stockh) 1994;114:410-4.

102. Schwartz DM, Schwartz RH. Validity of acoustic reflectometry in detecting middle ear effusion. Pediatrics 1987;79:739-42.

103. Babonis TR, Weir MR, Kelly PC. Impedance tympanometry and acoustic reflectometry at myringotomy. Pediatrics 1991;87:475-80.

104. Oyiborohoro JMA, Olaniyan SO, Newman CW, Balakrishnan SL. Efficacy of acoustic otoscope in detecting middle ear effusion in children. Laryngoscope 1987;97:495-8.

105. Douniadakis DE, Nikolopoulos TP, Tsakanikos MD, Vassiliadis SV, Apostolopoulos NJ. Evaluation of acoustic reflectometry in detecting otitis media in children. Br J Audiol 1993;27:409-14.

106. Combs JT. Predictive value of the angle of acoustic reflectometry. Pediatr Infect Dis 1991;10:214-6.

107. Block SL, Mandel E, Mclinn S, Pichichero ME, Bernstein S, Kimball S, Kozikowwski J. Spectral gradient acoustic reflectometry for the detection of middle ear effusion by pediatricians and parents. Pediatr Infect Dis J 1998;17:560-4.

108. Pellett FS, Cox LC, MacDonald CB. Use of acoustic reflectometry in the detection of middle ear effusion. J Am Acad Audiol 1997;8:181-7.

109. Silman S, Silverman CA, Arick DS. Acoustic-immittance screening for detection of middle-ear effusions in children. J Am Acad Audiol 1992;3:262-8.

110. Kemaloglu YK, Sever T, Beder L, Bayazit Y, Goksu N. Predictive value of acoustic reflectometry (angle and reflectivity) and tympanometry. Int J Pediatr Otorhinol 1999;48:137-42.

111. Buhrer K, Wall LG, Schuster L. The acoustic reflectometer as a screening device: A comparison. Ear Hear 1985;6:307-14.

112. Macknin ML, Skibinski C, Beck G, Hughes G, Kinney S. Acoustic reflectometry detection of middle ear effusion. Pediatr Infect Dis J 1987;6:866-8.

113. Avery CA, Gates GA, Prihoda TJ. Efficacy of acoustic reflectometry in detecting middle ear effusion. Ann Otol Rhinol Laryngol 1986;95:472-6.

114. Preston K. Pneumatic otoscopy: a review of the literature. Issues in Comprehensive Pediatric Nursing 1998;21:117-1128.

115. Takahashi H, Honjo I, Hasebe S, Sudo M, Tanabe M. The diagnostic and prognostic value of eardrum mobility in OME. Eur Arch Oto Rhino Lanyngol 1999;256:189-91.

116. Reves R, Budgett R, Miller D, Wadsworth J, Haines A. Study of middle ear disease using tympanometry in general practice. BMJ 1985;290:1953-6.

117. Bluestone CD, Cantekin EI. Design factors in the characterization and identification of otitis media and certain related conditions. Ann Otol Rhinol Laryngol 1979;5 part 1:13-8.

118. Cantekin EI, Bluestone CD, Fria TJ, Stool SA, Berry QC, Sabo DL. Identification of otitis media with effusion in children. Ann Otol Rhinol Laryngol 1980;89:s190-s195

119. Szucs E, Diependaele R, Clement PAR. The accuracy of tympanometry assessed by its sensitivity and specificity. Acta oto-rhino-laryngologica belg 1995;49:287-92.

120. Watters GWR, Jones JE, Freeland AP. The predictive value of tympanometry in the diagnosis of middle ear effusion. Clin Otolaryngol 1997;22:343-5.

121. Gates GA. Differential otomanometry. Am J Otol 1986;7:147-50.

122. Sassen ML, van Aarem A, Grote JJ. Validity of tympanometry in the diagnosis of middle ear effusion. Clin Otolaryngol 1994;19:185-9.

123. Nozza RJ, Bluestone CD, Kardatzke D, Bachman R. Identification of middle ear effusion by aural acoustic admittance and otoscopy. Ear and Hearing 1994;15:310-23.

124. Ovesen T, Paaske PB, Elbrond O. Accuracy of an automatic impedance apparatus in a population with secretary otitis media: principles in the evaluation of tympanometrical findings. Am J Otol 1993;14:100-4.

125. Palmu A, Puhakka H, Rahko T, Takala AF. Diagnostic value of tympanometry in infants in clinical practice. Int J Pediatr Otorhinol 1999;49:207-13.

126. Fletcher RH; Fletcher SW; Wagner EH. Clinical epidemiology: The essentials. 3 ed. Baltimore, MD: Williams and Wilkins; 1996.

127. McCandless GA, Thomas GK. Impedance audiometry as a screening procedure for middle ear disease. Tr Am Opth Otol 1974;78:98-102.

128. Labrecque M, Dostaler LP, Dumont H, Huard G, Laflamme L. Reproductibilite interobservateur d'un tympanometre portatif, le Micro Tymp. CMAJ 1993;148:559-64.

129. van Balen FAM, Aarts AM, De Melker RA. Tympanometry by general practitioners: reliable? In J of Ped Otorhinolaryngol 1999;48:117-23.

130. Pignataro O, Pignataro LD, Gallus G, Calori G, Cordaro CI. Otitis media with effusion and S-carboxymethylcysteine and/or its lysine salt: a critical overview. In J of Ped Otorhinolaryngol 1996;35:231-41.

131. Williams RL, Chalmers TC, Stange KC, Chalmers FT, Bowlin SJ. Use of antibiotics in preventing recurrent acute otitis media and in treating otitis media with effusion. JAMA 1993;270:1344-51.

132. Rosenfeld RM, Post JC. Meta-analysis of antibiotics for the treatment of otitis media with effusion. Otolaryngology- Head and neck surgery 1992;106:378-86.

133. Mandel EM, Casselbrant ML, Rockette HE, Bluestone CD, Kurs-Lasky M. Efficacy of antimicrobial prophylaxis for recurrent middle ear effusion. Pediatr Infect Dis 1996;15:1074-82.

134. van Balen FAM, De Melker RA, Touw-Otten FWMM. Double-blind randomised trial of co-amoxicalv versus placebo for persistent otitis media with effusion in general practice. Lancet 1996;348:713-6.

135. Marchisio P, Principi N, Passali D, Salpietro DC, Boschi G, Chetri G, Caramia G, Longhi R, Reali E, Meloni E, et al. Epidemiology and treatment of otitis media with effusion in children in their first year of primary school. Acta Otolaryngol (Stockh) 1998;118:557-62.

136. Rosenfeld RM, Mandel EM, and Bluestone CD. Systemic steroids for otitis media with effusion in children. Arch Otolaryngol Head Neck Surg 1991;117984-9.

137. Hemlin C, Carenfelt C, Papatziamos G. Single dose of betamethasone in combined medical treatment of secretory otitis media. Ann Otol Rhinol Laryngol 1997;106:359-63.

138. Shapiro GG, Warren Bierman C, Furukuwa CT, Pierson WE, Berman R, Donaldson J, and Rees T. Treatment of persistent Eustachian tube dysfunction with aerosolised nasal dexamethasone phosphate versus placebo. Ann Allergy 1982;4981-5.

139. Lildholdt T and Kortholm B. Beclomethasone nasal spray in the treatment of middle- ear effusion - a double blind study. Int J Pediatr Otorhinol 1982;4133-7.

140. Tracy JM, Demain JG, Hoffman KM, Goetz DW. Intranasal beclomethasone as an adjunct to treatment of chronic middle ear effusion. Ann Allergy Asthma Immunol 1998;80:198-206.

141. Maw R, Bawden R. Spontaneous resolution of severe chronic glue ear in children and the effect of adenoidectomy, tonsillectomy, and insertion of ventilation tubes (grommets). BMJ 1993;306:756-60.

142. Maw AR, Bawden R. The long term outcome of secretary otitis media in children and the effects of surgical treatment: a ten year study. Acta oto-rhino-laryngologica belg 1994;48:317-24.

143. Paradise JL, Bluestone CD, Colborn DK, Bernard BS, Smith CG, Rockette HE, Kurs-Lasky M. Adenoidenctomey and adenotonsilectomy for recurrent acute otitis media. JAMA 1999;282:945-53.

144. Reidpath DD, Glasziou PP, Del Mar CB. Systematic review of autoinflation for treatment of glue ear in

children. BMJ 1999;318:1177-8.

145. Varsano IB, Volovitz BM, Grossman JE. Effect of naproxen, a prostaglandin inhibitor, on acute otitis media and persistence of middle ear effusion in children. Ann Otol Rhinol Laryngol 1989;98:389-92.

146. Abramovich S, O'Grady J, Fuller A. Naproxen in otitis media with effusion. J Laryngol Otol 1986;100:263-6.

147. Harrison H, Fixsen A, Vickers A. A randomized comparison of homeopathic and standard care for the treatment of glue ear in children. Complementary Ther Med 1999;7(3):132-5.

148. Maw R, Wilks J, Harvey I, Peters TJ, Golding J. Early surgery compared with watchful waiting for glue ear and effect on language development in preschool children: a randomised trial. Lancet 1999;353:360-3.

149. Watanabe H, Shin T, Fukaura J, Nakaaki K, Tsuda K. Total actual speaking time in infants and children with otitis media with effusion. In J of Ped Otorhinolaryngol 1985;10:171-80.

150. Paden EP, Novak MA, Beiter AL. Predictors of phonologic inadequacy in young children prone to otitis media. J Speech Hearing Dis 1987;52:232-42.

151. Manders E, Tyberghein J. The effects of ventilation tube placement on hearing, speech, language, cognition and behaviour. Acta oto-rhino-laryngologica belg 1993;47:27-32.

152. Orlin MN, Effgen SK, Handler SD. Effects of otitis media with effusion on gross motor ability in preschool-aged children: preliminary findings. Pediatrics 1997;99:334-7.

153. Lous J, Fiellau-Nikolajsen M. A 5-year prospective case-control study of the influence of early otitis media with effusion on reading achievement. In J of Ped Otorhinolaryngol 1984;8:19-30.

154. Lous J, Fiellau-Nikolajsen M, Jeppesen AL. Secretary otitis media and language development: a six-year follow-up study with case control. In J of Ped Otorhinolaryngol 1988;15:185-203.

155. Vernon-Feagans L, Manlove EE, Volling BL. Otitis media and the social behaviour of day-care-attending children. Child Development 1996;67:1528-39.

156. Paradise JL, Dollaghan CA, Campbell TF, Feldman HA, Bernard BS, Colborn DK, Rockette HE, Janosky JE, Pitcairn DL, Sabo DL, et al. Language, speech sound production, and cognition in three-year-old children in relation to otitis media with effusion in their first three years of life. Pediatrics 2000;105(5):1119-30.

157. Friel-Patti S, Finitzo T. Language learning in a prospective study of otitis media with effusion in the first two years of life. J Speech Hearing Res 1990;33:188-94.

158. Shriberg LD, Friel-Patti S, Flipsen P, Brown RL. Otitis media, fluctuant hearing loss, and speech-language outcomes: a preliminary structural equation model. J Speech Lang Hear Res 2000;43:100-20.

159. Teele DW, Klein JO, Rosner BA, Greater Boston Otitis Media Study Group. Otitis media with effusion during the first three years of life and development of speech and language. Pediatrics 1984;74:282-7.

160. Teele DW, Klein JO, Chase C, Menyuk P, Rosner BA. Otitis media in infancy and intellectual ability, school achievement, speech, and language at age 7 years. J Infect Dis 1990;162:685-594.

161. Knishkowy B, Palti H, Adler B, Tepper D. Effect of otitis media on development: a community-based study. Early Human Development 1991;26:101-11.

162. Wright PF, Sell SH, McConnell KB, Sitton AB, Thompson J, Vaughn WK, Bess FH. Impact of recurrent otitis media on middle ear function, hearing and language. J Pediatr 1988;113:581-7.

163. Haggard M; Hughes E. Screening children's hearing: a review of the literature and the implications for otitis media. London: HMSO; 1991.

164. Paradise, JL, Feldman HM, Campbell TF, Dollaghan CA, Colborn DK, Bernard BS, et al. Effect of early or delayed insertion of tympanostomy tubes for persistent otitis media on developmental outcomes at the age of three years. *N Engl J Med* 2001;344(16):1179-87.

165. Rovers MM, Straatman H, Ingels K, van der Wilt GJ, van den Broek P, Zielhuis GA. The effect of ventilation tubes on language development in infants with otitis media with effusion: a randomized trial. *Pediatrics*

2000;106(3):E42.

166. Rovers MM, Krabbe PF, Straatman H, Ingels K, van der Wilt GJ, Zielhuis GA. Randomised controlled trial of the effect of ventilation tubes (grommets) on quality of life at age 1–2 years. *Arch Dis Child* 2001;84(1):45-9.

Table 1; Studies on the effect of treatment of OME on language development

Study	Method and participants	Outcome	Comment
Maw et al 1999	Controlled trial 182 children aged from 1.17 to 4.69 years randomised with bilateral effusions and hearing loss for at least three months randomised to receive ventilation tubes within six weeks or if required after a period 9 months of 'watchful waiting'. Follow up at 9 and 18 months	Nine months after randomisation, those assigned to 'watchful waiting' had comprehension and expressive language skills a mean of 3.24 months behind the early surgery group. By 18 months after randomisation, 85% of the 'watchful waiting' group had undergone tube insertion, and significant differences between groups in language outcomes no longer apparent.	Study of highest quality assessing the effects of treatment on developmental outcomes.
Watanabe et al 1985	Prospective controlled cohort 30 children aged from 3 to 9 years assessed for total speaking time before and after ventilation tube insertion, compared with 5 children assessed before and after adenoidectomy or tonsillectomy. Total speaking time recorded by a specially invented 'speech accumulator' apparatus. Pre and post assessment during same hospital admission as surgery.	Children spoke significantly more after ventilation tube insertion, while the control group did not significantly alter pre-surgery mean total speaking time of 10 min 24 sec per hour after surgery (before leaving hospital).	Pre and post assessments made in hospital during same admission as surgery.
Paden et al 1987	Prospective cohort 40 children aged between 18 and 35 months assessed for phonological skills before and after insertion of ventilation tubes. Children followed until achieved pattern of normal 3-year olds, or until age three.	Earlier onset and later remission predicted failure to catch up phonologically by age three.	Ascertainment of duration of OME pre-surgery involved retrospective review of medical records.
Manders and Tyberghein 1993	Prospective controlled cohort 18 children with mean age of 58 months assessed for language before and after insertion of ventilation tubes compared with a control group of 40 children free of otitis tested at the same times. Follow up six months after surgery.	Slight improvement for receptive (but not expressive) standardised Reynell Development Language Scale scores in the otitis media group after compared with before surgery. No differences in either expressive or receptive scores of controls between assessments. No significant differences between groups at either assessment.	
Orlin et al 1997	Prospective controlled cohort 13 children aged 24 to 60 months assessed for motor skills before and after ventilation tube insertion compared with 12 OME free children. Followed up a mean of 40 days later.	OME group had reduced Peabody Developmental Motor Scale Scores before surgery (0.87 vs. 0.94). At follow up the groups had roughly equal scores (0.99 vs. 1.02), with the OME group having a significantly higher proportional change index.	This study suggests a 'catch-up' period after surgery. Exposure assessed retrospectively.

Study	**Method and participants**	**Outcome**	**Comment**
Schilder et al 1997	Retrospective controlled cohort 56 children from the Nijmegen Cohort with bilateral effusions on 2 sequential 3 monthly screenings between ages of 2 and 4 years treated with ventilation tubes matched retrospectively with 102 children with OME who were not treated surgically. Assessed at age 7 to 8 years.	No differences between groups on 10 different tests of language ability, phonological ability, educational achievement and non-verbal intelligence tests.	Final analyses regarding education achievement and language done on only 13 surgically treated and 14 control children.

Table 2; Studies meeting selection criteria exploring association between OME and developmental delay

Study	Method	Participants	Identification of exposure and age at follow up	Outcome
Lous and Fiellau-Nikolajsen 1984	Prospective cohort with case control: 509/523 three year olds screened, 31/46 with OME matched with 31 controls without OME. Cases also compared to average scores for classmates (n=209) and for whole municipality (4895). Reading Test administered by teachers.	Birth cohort in a municipality in Denmark.	Pneumatic otoscopy, tympanometry; in all 3 year olds. Abnormal first test followed up for 6 months with 4 tests in all. Followed up at age 8 years.	No differences between OME group, controls, classmates and whole municipality Silent Reading Test scores.
Lous et al 1988	Prospective cohort with case-control: 435/463 3 year olds screened; 38/40 with OME matched with 28 controls without OME when tested at age 3. Comparisons to whole class as well. Reading Test (OS-400) administered by schoolteachers, An author administered Wechsler Intelligence Scale for Children (WISC) and Revised Peabody Picture Vocabulary Test (PVVT-R).	As above, but a separate cohort.	As above.	No differences between OME group, controls, classmates scores on Reading Test, WISC, and PVVT-R.
Vernon-Feagans and Manlove 1996	Prospective cohort: 17 with children with chronic otitis compared with 19 without OME. Assessors blinded.	As above.	Exposure as above. Followed up at age two years.	No differences in Toddler Behaviour Assessment Questionnaire and SICD. 2/3 main analyses significant for behaviour (otitis children more solitary behaviour, initiate fewer verbal interactions both positively and negatively).

Study	Method	Participants	Identification of exposure and age at follow up	Outcome
Feagans et al 1994	Prospective cohort: 35/46 children (23 chronic and 12 non chronic OME, 18 in high and 17 in low quality day acre) compared to each other and themselves when they had OME and when they were well (acting as own controls). Assessors blinded.	Children of predominantly educated professionals from three day care facilities in Pennsylvania.	Children screened weekly from 6 months to 4 years of age including tympanometry and pneumatic otoscopy. Followed up at one year and 18 months.	No differences in Sequenced Inventory of Communication Development (SCID) between chronic and non-chronic otitis groups. Differences in attention to language between those with chronic OME and non-chronic OME only in low quality day care. Parental assessment of non-attention behaviour correlated with chronic otitis.
Vernon-Feagans et al 1997	Prospective cohort: 30 with chronic and 37 with non chronic OME	As above.	As above.	Significant effect found for quality of day care on expressive language, with children with chronic OME in low quality day care performing worst.
Rach et al 1988	Prospective cohort Three groups selected from cohort of 1439; 1) OME 3-6 months (n=16) 2) OME >6 months 9 (N=36) 3) No OME (n=13) Assessors blinded.	Birth cohort in the city of Nijmegen, The Netherlands.	Tympanometry screening, quarterly between ages 2-4 years; Type B tympanogram on at least 2 consecutive occasions = OME. Followed up at age 2.5 to 3 years.	2/6 analyses of Reynell Development Language scales significantly lower scores for otitis media groups, both for expressive language.
Grievink et al 1993, Peters et al 1994, Peters et al 1997	Prospective cohort 1328/1439 fully screened; 395 selected for language testing at follow up; 305 agreed; 151 with OME, 37 with OME treated with ventilation tubes and 82 controls. Assessors blinded.	As above.	Exposure as above. Follow up at age 7 years.	Language ability: No effect of OME on 10 analyses. Reading and spelling: 1/8 analyses significant. Accumulative effect of risk factors: Boys spelling negatively influenced by OME.

Study	**Method**	**Participants**	**Identification of exposure and age at follow up**	**Outcome**
Paradise et al 2000	Prospective cohort 241of 6350 enrolled in study randomly sampled from four groups based on cumulative exposure to OME. Children in this cohort meeting entry requirements for RCT evaluating ventilation tubes were excluded. Assessors blinded.	Children up to two months of age presenting for primary care at one of two urban hospitals, one of two rural hospitals, and one of four suburban paediatric practices.	Pneumatic otoscopy at least monthly during the first three years of life supplemented by tympanometry: audiometric testing in children with 8 continuous weeks of OME and at 4-week intervals thereafter so long as effusions were present, when effusions resolved, and any child with suspected hearing loss. Followed up at age three years.	There were weak to moderate statistically significant negative associations between children's cumulative duration of OME in their first year of life and McCarthy General Cognitive Index (GCI), Peabody Picture Vocabulary Test-Revised (PPVT-R) and McCarthy Verbal subscale scores (the latter was also correlated with OME in the first three years combined). However, the percentage variance explained by the cumulative proportion of total days with OME in the first year of life beyond that explained by socio-demographic variables was only 2.1% for McCarthy GCI scores, 2.9% for McCarthy Verbal scores and 1.2% for PPVT-R scores.
Teele et al 1984	Prospective cohort: 205/2568 followed up; not a truly random selection from initial cohort invited for follow up. Assessors blinded to exposure	Children attending 5 health centres and private practices in Greater Boston.	Otoscopy when child attended for care from 0-3 months; no regularly scheduled study visits; time with effusion = number of episodes of AOM or asymptomatic effusion multiplied by 29 days. Followed up age 3 years.	3/3 analyses of Peabody Picture Vocabulary, Zimmerman and Pre-school Language tests statistically significant.
Teele et al 1990	As above: 498/1067 completed 7 years follow up; 207 randomly selected for language assessment; 13 exclusions. Assessors blinded.	As above.	Otoscopy when child attended for care from 0-3 months; no regularly scheduled study visits; time with effusion = number of episodes of acute otitis media or asymptomatic effusion multiplied by 23.4 days. Followed up at age 7 years.	2/9 linguistic ability items from Goldman Fritsoe Woodcock, "WUG", Peabody and Boston Naming Tests reach statistical significance.

Study	**Method**	**Participants**	**Identification of exposure and age at follow up**	**Outcome**
Friel-Patti and Finitzo 1990, Shriberg al 2000.	Prospective cohort 140/483 followed up at age 24 months. 70/483 followed up at age three years. Sequenced Inventory of Communication Development Scale (SCID) relies on parental assessment in younger children.	Middle class children attending private pediatric practice in Dallas.	Otoscopy and tympanometry at 6 months and every six months till age two; Also tympanometry at well and sick- child visits, and screening at day care and home. Between 6 and 18 months, tympanometry at least every 6 weeks; over 18 months, tympanometry at least every 12 weeks.	By age two years, 2/10 analyses of SICD-Receptive and SICD-Expressive statistically significant. At age three years, 33% of children with greater than 20bB hearing loss from age 12 to 18 months had a sub-clinical or clinical speech disorder assessed by Percentage of Consonants Correct compared to 2% of children with hearing levels equal or less than 20DB from 12 to 18 months.
Knishkowy et al 1991	Prospective cohort 195/233 assessed for Developmental Quotient (DQ), 217/233 for Stanford Binet Intelligence Quotient (IQ). DQ administered by primary care physician, IQ administered by psychologist, and blinding to history is not mentioned.	Children followed from between birth and six months to age 3 years; part of a 'promotion of growth development program.	Clinicians diagnoses and caregiver reports of acute otitis; children divided into recurrent otitis (>6 episodes of acute otitis) and non-recurrent otitis. Followed up at age 2 and 3 years.	Recurrent otitis related to maternal education, social class and maternal origin, duration of breast-feeding. Mean DQ score at 2 years and IQ at 3 years lower for recurrent OM group.
Wright et al 1988	Prospective cohort 73-107/210 had language evaluation. Blinding of assessors not mentioned.	Largely lower SES children participating in a larger study evaluating vaccination.	Otoscopy and tympanometry during 7 scheduled visits in first year and four during second year of life; numbers of visits with acute otitis and OME. Followed up at age 2 years.	No otitis related variables influenced Peabody Picture Vocabulary, Zimmerman, Bzoch and Boone language tests.

Table 3; Summary of CTFPHC Recommendations: Screening for Otitis Media with Effusion

Manoeuvre	Effectiveness	Level of Evidence <ref>	Recommendation
Screening to identify children with clinically important OME (tympanometry, microtympanometry, acoustic reflectometry and pneumo-otoscopy)	Performance of various manoeuvres has not been adequately assessed in community settings. No single reading can give an indication of chronicity which is crucial in a condition which is fluctuating and often self-limiting.	Cohort (II-2) <Multiple studies>	There is insufficient evidence to include routine early screening for otitis media with effusion (OME) in, or exclude it from, the periodic health examination of children up to 4 years of age (**C recommendation**).
Screening to prevent delay in language development as a result of OME	No effect on language was identified in a trial that screened children, then randomly assigned those with persistent effusion to be treated with ventilation tubes (versus usual care, delayed surgery or watchful waiting). There is no consistently demonstrated association between OME and language outcomes, and substantial variability across studies in measurements of exposure and outcome.	RCT (I), Cohort (II-2) <69-71>	There is insufficient evidence to recommend early screening for OME to prevent delayed language development (**C recommendation**).

Appendix 1:

Canadian Task Force on Preventive Health Care

Levels of Evidence and Grades of Recommendations

Levels of evidence	
I	Evidence from at least one well-designed randomized controlled trial
II-1	Evidence from well-designed controlled trials without randomization
II-2	Evidence from well-designed cohort or case–control analytic studies, preferably from more than one centre or research group
II-3	Evidence from comparisons between times or places with or without the intervention; dramatic results from uncontrolled studies could be included here
III	Opinions of respected authorities, based on clinical experience; descriptive studies or reports of expert committees
Grades of recommendations	
A	Good evidence to support the recommendation that the condition or manoeuvre be specifically considered in a periodic health examination (PHE)
B	Fair evidence to support the recommendation that the condition or manoeuvre be specifically considered in a PHE
C	Insufficient evidence regarding inclusion or exclusion of the condition or manoeuvre in a PHE, but recommendations may be made on other grounds
D	Fair evidence to support the recommendation that the condition or manoeuvre be specifically excluded from a PHE
E	Good evidence to support the recommendation that the condition or manoeuvre be specifically excluded from a PHE