# Ventilation Tubes

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Ann Hermansson

## Background

Acute otitis media (AOM) and secretory otitis media (SOM) or otitis media with effusion (OME) [1] is fairly well defined in international recommendations. The difference basically is that while AOM is an infectious disease with acute onset, SOM is the presence of effusion in the middle ear without any associated signs of acute ear infection. It is thus different from AOM, which causes pain and symptoms of acute illness, in having much less obvious symptoms and not having an acute onset. SOM might cause a substantial hearing loss which if present for longer periods can affect both speech development and behavior [2].

Most children experience a few episodes of AOM, while almost all will suffer SOM for shorter periods during and after upper airway infections [3]. Also, most episodes of AOM are followed by an episode of SOM. In most countries, the recommended treatment for both uncomplicated sporadic AOM and SOM is watchful waiting. This is since they tend to be self-limiting, healing well in most cases without treatment or sequele.

In some instances, however, the child will experience recurrent episodes of AOM. The definition of recurrent AOM (rAOM) is agreed to be when there is three or more episodes in 6 months, or four in 1 year with the most recent in the last 6 months [4]. These children and their families experience a substantial impact on quality of life that actually has been shown to be comparable to childhood asthma [5]. Repeated episodes of AOM are also related to frequent antibiotic use, since most guidelines recommend antibiotic treatment of these children. Children with rAOM will also suffer frequent, perhaps prolonged, periods of SOM.

SOM might also have a more complicated course with repeated or perhaps long-standing periods of hearing loss. It has been suggested that these episodes could affect not only hearing but also speech development, general behavior, and perhaps vestibular function [6, 7]. No long-term effect of antibiotics has been shown in the treatment of SOM [8], and no other medical treatments are recommended [9].

## History of Ventilation Tubes

Already in 400 BC, the Hippocratic school described middle ear effusion that could be relieved by incising the eardrum [10]. Myringotomy was practiced to relieve "deafness" with various success during the centuries thereafter. A more scientific approach to myringotomy was begun in the late eighteenth century, and in 1801 Astley Cooper presented two papers to the Royal Society showing that myringotomy indeed could improve hearing. He was aware that bone conduction must be present and to ensure this he placed a watch on the patients' incisors or mastoid and made sure they could hear it better than when it was held near the outer ear [11]. Later in the nineteenth century, Adam Politzer is credited with the first use of suction to remove fluid [12]. He is also thought to have designed the first ventilation tube, in an attempt to overcome the problem of keeping the perforation open for a longer period. Several other attempts were done to keep the perforation open. They however met with very little success, and the attempts were abandoned. It was not until 1954 that a vinyl tube that was successful in airing the middle ear was introduced by Beverly Armstrong [13], and the use of ventilation tubes was introduced worldwide.

## Effect of Ventilation Tubes

Ventilation tubes have now been used in the treatment of middle ear problems for many years. The tubes are not supposed to drain the ear but to overcome the pressure differences and ventilate the ear. In this way, they fulfill the double purpose of preventing collection of fluid in the middle ear and create a better environment for the middle ear mucosa.

A. Hermansson (✉)
Department of ENT, Lund University Hospital, Lund, Sweden
e-mail: ann.hermansson@med.lu.se



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Ventilation tubes are used in both rAOM and SOM, and indeed many of the children treated with ventilation tubes will suffer from a combination of both. When used in rAOM, the main indication is reducing the numbers of AOM episodes while in SOM the main indication is to better the hearing [9].

In a Cochrane review [14] published in 2018, it is concluded that children receiving grommets are less likely to have AOM recurrences compared to those managed by active monitoring or placebo medication. However, the effect is modest already during the first six months and even lower after 12 months.

Another Cochrane review [15] states that no effect was seen on speech development in otherwise healthy children after ventilation tube placement.

Some studies have however shown a positive effect on quality of life (QoL) of children with OM after insertion of ventilating tube [16], especially in those suffering from both rAOM and severe SOM. There are also indications in all studies that ventilation tubes should be considered earlier in otherwise impaired children. In several studies, it has been stated that ventilation tubes for rAOM should only be considered if there are persistent SOM in one or both ears [17–20]. There is also an ongoing discussion on the additive effect of ventilation tubes and adenoidectomy in the treatment of rAOM. There seems indeed to be a modest effect on the number of recurrences, especially in children under the age of two years, if adenoidectomy is done when placing tubes [21, 22].

Since keeping antibiotic use low in children is strongly suggested to reduce the risk of antibiotic resistance in upper airway pathogens, prolonged antibiotic treatment is not recommended as first-line treatment in rAOM. It has also been suggested that ventilation tubes may reduce the severity of AOM recurrences and allow for topical rather than oral antibiotic treatment of AOM episodes which would make the impact on antibiotic use greater than the reduction in numbers of episodes would suggest.

SOM mostly resolves spontaneously; thus, all current guidelines recommend a three-month period of watchful waiting in children with SOM who are not at particular risk for speech, language, or learning problems. Medical treatments such as decongestants, antihistamines, and oral/intranasal corticosteroids are either ineffective or may cause adverse effects [23–25]. Ventilation tubes are thus the main option in children with SOM and hearing impairment lasting more than 3 months [26, 27].

The most common problem in children treated with ventilation tubes is ear discharge. It has been shown that in small children, it is often caused by an AOM while in older children it is more often caused by contamination through the ear canal. It has also been shown that topical treatment with ear drops is sufficient in most cases and oral antibiotics seldom are needed [28, 29]. Probably due to biofilm formation, some patients will experience prolonged periods of otorrhea, sometimes resulting in the need for removal of the tube [30].

The other major risk is that of persistent perforation of the tympanic membrane. When using modern tubes, it has been shown to be low. The long-term results after ventilation tube treatment are good, although more tympanosclerosis are seen in patients treated with ventilation tubes [31, 32]. Some have claimed that the use of ventilation tubes might cause more cholesteatomas to develop, while others have claimed that tubes could prevent the formation of cholesteatomas. No conclusive evidence has been found of either theory [33, 34].

Different types of ventilation tubes have been tried both concerning design, material, and coating. Tubes designed to stay longer have a greater risk of causing persistent perforations and tympanosclerosis [35]. On the other hand, early extrusion is a problem in some patients causing re-operations. This risk seems to differ with different kinds of tubes [36].

It is interesting to note that there are great regional differences in the use of ventilation tubes, indicating that indications vary not only over time but also regionally. Denmark is probably the country where most tubes are used with a prevalence as high as almost 30% during the first three years of life [37], while neighboring Sweden have much lower rates. It is also interesting to note that although some countries have shown a declining rate of ventilation tube use after the introduction of vaccine against pneumococci, this has not been the case in Denmark.

## References


1. Rosenfeld RM, Shin JJ, Schwartz SR, Coggins R, Gagnon L, Hackell JM, et al. Clinical practice guideline: otitis media with effusion (update). Otolaryngol Head Neck Surg. 2016;154:S1–S41.
2. Roberts J, Hunter L, Gravel J, Rosenfeld R, Berman S, Haggard M, Hall J, Lannon C, Moore D, Vernon-Feagans L, Wallace I, Carey WB. Otitis media, hearing loss, and language learning: controversies and current research. J Dev Behav Pediatr. 2004;25:122.
3. Todberg T, Koch A, Andersson M, Olsen SF, Lous J, Homøe P. Incidence of otitis media in a contemporary Danish National Birth Cohort. PLoS One. 2014; https://doi.org/10.1371/journal.pone.0111732.
4. Goycoolea MV, Hueb MM, Ruah C. Otitis media: the pathogenesis approach. Definitions and terminology. Otolaryngol Clin N Am. 1991;24:757–61.
5. Brouwer CN, Rovers MM, Maillé AR, Veenhoven RH, Grobbee DE, Sanders EA, et al. The impact of recurrent acute otitis media on the quality of life of children and their children and caregivers. Clin Otolaryngol. 2005;30(3):258–65.
6. Cohen MS, Mandel EM, Furman JM, Sparto PJ, Casselbrant ML. Tympanostomy tube placement and vestibular function in children. Otolaryngol Head Neck Surg. 2011;145(4):666–72.
7. Herzog C, Homøe P, Koch A, Niclasen J, Dammeyer J, Lous J, Kørvel-Hanquist A. Effects of early childhood otitis media and ventilation tubes on psychosocial wellbeing—a prospective cohort study within the Danish National Birth Cohort. Int J Pediatr Otorhinolaryngol. 2020;133:109961.

8. Venekamp RP, Burton MJ, van Dongen TMA, van der Heijden GJ, van Zon A, Schilder AGM. Antibiotics for otitis media with effusion in children. Cochrane Database Syst Rev. 2016;2016(6):CD009163.
9. Simon M, Haggard RM, Rosenfeld H, Jia S, Peer M-N, Calmels V, Couloigner N, Teissier. International consensus (ICON) on management of otitis media with effusion in children. Eur Ann Otorhinolaryngol Head Neck Dis. 135(1):S33–9.
10. Black NA. Is glue ear a modern phenomenon?—a historical review of the medical literature. Clin Otolaryngol. 1984;9(3):155–63.
11. McGovern FH. Sir Astley Cooper and his otological papers. Ann Otol Rhinol Laryngol. 1984;93(6 pt 1):531–3.
12. Mudry A. The role of Adam Politzer (1835-1920) in the history of otology. Am J Otol. 2000;21(1):753–63.
13. Armstrong BW. A new treatment for chronic secretory otitis media. Arch Otolaryngol. 1954;59(4):653–65.
14. Venekamp PM, Schilder AGM, Nunez DA. Grommets(ventilation tubes) for recurrent acute otitis media in children. Cochrane Database Syst Rev. 2018;2018(5):CD012017.
15. Browning G, Rovers M, Williamson I, Lous J, Burton M. Grommets (ventilation tubes) for hearing loss associated with otitis media with effusion in children. Cochrane Database Syst Rev. Review—Intervention Version published: 06 October 2010 Version history.
16. Heidemann, Lauridsen HH, Kjeldsen AD, Faber CE, Johansen ECJ, Godballe C. Quality-of-life differences among diagnostic subgroups of children receiving ventilating tubes for otitis media. Otolaryngol Head Neck Surg. 2015;153(4):636–43.
17. McDonald S, Langton Hewer CD, Nunez DA. Grommets (ventilation tubes) for recurrent acute otitis media in children. Cochrane Database Syst Rev. 2008;4:CD004741.
18. Rosenfeld RM, et al. Clinical practice guideline: tympanostomy tubes in children. Otolaryngol Head Neck Surg. 2013;149:S1–35. 179. Boonacker, C. W. et al.
19. Hellström S, et al. Ventilation tube treatment: a systematic review of the literature. Otolaryngol Head Neck Surg. 2011;145:383–95.
20. Lous J, Ryborg CT, Thomsen JL. A systematic review of the effect of tympanostomy tubes in children with recurrent acute otitis media. Int J Pediatr Otorhinolaryngol. 2011;75:1058–61.
21. Boonacker CW, et al. Adenoidectomy with or without grommets for children with otitis media: an individual patient data meta-analysis. Health Technol Assess. 2014;18:1–118.
22. Kujala T, Alho OP, Loutonen J, Kristo A, Uhari M, Renko M, et al. Tympanostomy with and without adenoidectomy for the prevention of recurrences of acute otitis media: a randomized controlled trial. Pediatr Infect Dis J. 2012;31(6):565–9.
23. Griffin G, Flynn CA. Antihistamines and/or decongestants for otitis media with effusion (OME) in children. Cochrane Database Syst Rev. 2011;9:CD003423. 181.
24. Simpson SA, Lewis R, van der Voort J, Butler CC. Oral or topical nasal steroids for hearing loss associated with otitis media with effusion in children. Cochrane Database Syst Rev. 2011;5:CD001935.
25. Venekamp RP, et al. Antibiotics for otitis media with effusion in children. Cochrane Database Syst Rev. 2016;6:CD009163.
26. National Institute for Health and Clinical Excellence. Surgical management of otitis media with effusion in children. NICE Clinical Guideline 60. Developed by the National Collaborating Centre for Women's and Children's Health. NICE; 2008. http://www.nice.org.uk/nicemedia/pdf/CG60NICEguideline.pdf.
27. Rovers MM, et al. Grommets in otitis media with effusion: an individual patient data meta-analysis. Arch Dis Child. 2005;90:480–5.
28. van Dongen TM, van der Heijden GJ, Venekamp RP, Rovers MM, Schilder AG. A trial of treatment for acute otorrhea in children with tympanostomy tubes. N Engl J Med. 2014;370:723–33.
29. Granath A, Rynnel-Dagöö B, Backheden M, Lindberg K. Tube associated otorrhea in children with recurrent acute otitis media: results of a prospective randomized study on bacteriology and topical treatment with or without systemic antibodies. Int J Pediatr Otorhinolaryngol. 2008;72(8):1225–33.
30. Wang JC, Hamood AN, Saadeh C, Cunningham MJ, Yim MT. Cordero strategies to prevent biofilm-based tympanostomy tube infections. J Int J Pediatr Otorhinolaryngol. 2014;78(9):1433–8.
31. Cayé-Thomasen P, Stangerup SE, Jørgensen G, Drozdziewic D, Bonding P, Tos M. Myringotomy versus ventilation tubes in secretory otitis media: eardrum pathology, hearing, and eustachian tube function 25 years after treatment. Otol Neurotol. 2008;29(5):649–57.
32. Alenezi EMA, Robinson M, Choi RSM, Veselinovic T, Richmond PC, Eikelboom RH, Brennan-Jones CG. Long-term follow-up after recurrent otitis media and ventilation tube insertion: hearing outcomes and middle-ear health at six years of age. Int J Pediatr Otorhinolaryngol. 2022;163:111379.
33. Roland NJ, Phillips DE, Rogers JH, Singh SD. The use of ventilation tubes and the incidence of cholesteatoma surgery in the paediatric population of Liverpool. Clin Otolaryngol Allied Sci. 1992;17(5):437–9.
34. Djurhuus BD, Christensen K, Skytthe A, Faber CE. The impact of ventilation tubes in otitis media on the risk of cholesteatoma on a national level. Int J Pediatr Otorhinolaryngol. 2015;79(4):605–9.
35. Van Heerbeek N, De Saar GMAC, Mulder JJS. Long-term ventilation tubes: results of 726 insertions. Clin Otolaryngol Allied Sci. 2002;27(5):378–83.
36. Knutsson J, Priwin C, Hessén-Söderman AC, Rosenblad A, von Unge M. A randomized study of four different types of tympanostomy ventilation tubes—full-term follow-up. Int J Pediatr Otorhinolaryngol. 2018;107:140–4.
37. Pedersen TM, Mora-Jensen AC, Waage J, Bisgaard H, Stokholm J. Incidence and determinants of ventilation tubes in Denmark. PLoS One. 2016;11:e0165657–11.