**Abstract**

**Objectives:** To review the literature concerning the impact of otitis media on language acquisitions in children.

**Method:** Medline. The following keywords were used for searching: otitis media, hearing, language and children.

**Results:** The hearing loss observed in otitis media may be a result of: 1) structural disorders in the middle ear; 2) ultrastructural lesions and biochemical anomalies in the cochlea or 3) abnormalities in the central auditory pathways. About 50% of cases of secretory otitis media, for instance, are accompanied by mild fluctuating hearing loss. According to the literature, since the first three years of life are critical for language development, children affected by otitis media in this period are at risk for presenting disturbances in language acquisition, behavior and later academic achievement.

**Conclusion:** The main consequences of otitis media and hearing loss on language acquisition are phonetic and speech articulation problems, as well as impairment of reading comprehension.


---

**Impact of otitis media on language acquisition in children**

Aracy P.S. Balbani,1 Jair C. Montovani2

“The limits of my language mean the limits of my world”.

Ludwig Wittgenstein, Austrian philosopher (1889-1951)

The shortened period of maternal breastfeeding, the early entrance to day care centers and the interaction with large numbers of other children in the same day care center/school are some of the factors which have led to an increase in the incidence of childhood otitis media.1,2

During the last twenty years, the incidence of acute otitis media (AOM) increased by 68% in Finland, while that of repeat AOM increased by 39% in the United States.3 In developed countries, the current prevalence of secretory otitis media (SOM) is 20% in infants.4 In underdeveloped countries, chronic otitis media (COM) - characterized by a perforated tympanum - remains a significant cause of hearing loss in childhood. Research performed in the Southeast of Brazil showed that the prevalence of COM among school age children was 0.94%.5

The first study to relate otological disease during childhood with compromised language acquisition was published in 1969.6 In 1994, an “Agency for Health Care Policy” policy in North America stated that otitis media and the resulting hearing loss do not only affect language, but also behavior and attention.7

---

1. PhD, Otorhinolaryngologist, School of Medicine, Universidade Estadual Paulista.
2. Professor, School of Medicine, Universidade Estadual Paulista.
Manuscript received Dec 11 2002, accepted for publication Mar 12 2003.
Concern over the consequences of otitis media in childhood - primarily in relation to language acquisition - has modified the trend of elective otorhinolaryngological surgery, with the result that tympanocentesis with ventilation tube insertion is now the most common procedure among children in a large number of different countries. In the USA, an inquiry revealed that, in 1994, 580,000 operations were performed to insert ventilation tubes for children and adolescents of up to 15 years old. More than 313,000 of the children who underwent surgery were not yet three years old.\(^8\) In 1996, one in every 110 North American children received ventilation tubes, almost double the number of children undergoing tonsillectomy that year.\(^9\) Nevertheless, Rosenfeld et al.\(^9\) point out that ventilation tubes insertion is not capable of affecting language development over the short term, and Berman.\(^7\) adds that significant differences in terms of language acquisition are not always found between children with SOM treated clinically and those who undergo surgery. As can be observed, the subject is controversial and merits the attention of pediatricians, otorhinolaryngologists, phonologists and speech therapist.

The objective of this study is to present current knowledge about hearing loss with severe otitis media and its impact upon children’s language acquisition. We have selected articles catalogued in the Medline database under the keywords “otitis media”, “language”, “hearing” and “child”. On searching the Lilacs database no studies were found of about hearing loss with severe otitis media and its impact upon children’s language acquisition. We have selected articles catalogued in the Medline database under the keywords “otitis media”, “language”, “hearing” and “child”.

Literature review

**Hearing loss with otitis media**

**Structural alterations to the middle ear**

The most common structural complications due to infections of the middle ear are: perforation of the tympanic membrane, the formation of tympanosclerosis deposits, adhesion of the tympanic membrane to the ossicular chain or the promontory, ossicular chain fusion, the formation of deep retraction pockets and cholesteatoma.\(^10\) With chronic otitis media, the following can be observed: hardening/erosion of the ossicular chain or, mechanical occlusion of the oval window by granulation tissue, cholesteatoma and purulent secretions.\(^11\) All of these alterations can result in conductive hypoacusia.

Around 80% of children have at least one episode of SOM by eight years of age. Of the children affected, approximately 55% have mild hearing loss at speech frequencies.\(^12\) Santos et al.\(^13\) show that even mild hypoacusia is sufficient to prejudice certain auditory functions. The fluctuating nature of hearing loss from otitis media (which may alternate with periods of normal hearing) leads to an inconsistent sound stimulus to the auditory central nervous system, making it difficult for the child to perceive the sounds of speech. Furthermore, fluid in the middle ear can produce noise at the cochlea, distorting the perception of sounds.

**Biochemical and structural alterations of the cochlea**

In many cases of secretory or chronic otitis media, conductive hearing loss coexists with sensorineural hearing loss at high frequencies.\(^14-16\) In order that this phenomenon could be better analyzed, experimental models of middle ear infections have been created which permit the electrophysiological and pathoanatomical investigation of the cochlea.\(^17\)

The majority of experimental studies employ *Streptococcus pneumoniae*, since a third of children are asymptomatic carriers of pneumococcus in their nasopharynx, and its transition to a pathogenic state makes it one of the primary etiological agents of otitis media in humans. The possibility has been raised that pneumococcus adhere to the epithelial respiratory cells of the middle ear mucosa by means of the platelet activator factor (PAF) receptor. Starting from this adhesion the inflammatory process of otitis media occurs, triggered by components of the bacterial cell wall.\(^18\)

It has already been demonstrated that there is diffusion of bacterial toxins and cytokines from the middle ear to the cochlea by way of the round window membrane (Figure 1),\(^10,17\) provoking ultra-structural lesions in the inner ear, such as the rupture of the cochlear membranes.\(^18,19\)

Doubt remains over the irreversible nature of cochlear lesions in otitis media. Evaluating children and adolescents with antecedents of ventilation tubes insertion (already free of effusion from the middle ear and with normal tympanometry), it was shown that alterations remain at tonal limits with high-frequency audiometry.\(^20\) Nevertheless, Mutlu et al.\(^16\) showed that some children with sensorineural hearing loss at high frequencies associated with secretory otitis media presented reversal of their hearing loss after clinical or surgical treatment.

**Alterations to the central auditory canals**

Auditory processing is performed by structures in the brain stem and cerebral cortex, allowing sound stimuli to be analyzed and interpreted (locate the source of a sound, memorize verbal sounds, etc.), which is fundamental to the development of speech and language.\(^13\) In order to assess the possible effect of unilateral SOM on binaural auditory processing, a study used plugs to seal the left ear of ferret kits (*Mustela putorius furo*).\(^21\) The plug was fitted at around 29 days and left for between seven and 15 months. Unilateral conductive hypoacusia was documented by means of brainstem evoked response audiometry (BERA). After the kits had been trained to locate sound stimuli (an ability dependant upon binaural hearing), it was perceived that the majority of them managed to perform the task, despite a higher number of errors when compared with the animals in the control group (normal hearing). Removal of the plug enabled a partial re-establishment of function in one to two months. Four to six months later there were no significant
differences between the animals in the control group and those who had had plugs. The authors point out that long-term unilateral conductive hypoacusia leads to binaural auditory processing deficiencies which can take months to recover after the otitis media has been cured.

It is accepted that the treatment of secretory otitis media in children with mitochondrial diseases can retard the degeneration of the cochlea and of the nervous fibers in the brain stem. One of the primary clinical manifestations of mitochondrial diseases is progressive sensorineural hearing loss, since the vascular furrow of the cochlea is one of the tissues which have the highest metabolic demands. Furthermore, when performing audiological assessment by BERA, lesions are often encountered in the central auditory canals of these patients. Mitochondrial diseases are episodic, presenting stable periods or periods of slow progression interspersed with rapid neural degeneration events. Monitoring children with mitochondrial diseases, it was discovered that infections of the upper airways - including otitis media - trigger, in between three and seven days, an episode of neural degeneration. This phenomenon is similar to that observed with the Reye syndrome, in which neurological lesions result from a defect in the oxidization of fatty acids by the mitochondrial.

**Impact on language acquisition**

Language development begins very early on, even during its prenatal phase the child is capable of recognizing voices and the sounds of speech. It is known that there is a universal language acquisition pattern, i.e., phonemes, syllables and prosody (the pronunciation of words) appear to come in the same sequence and at the same ages in all languages that have been studied. Slowly, this development becomes more specific and acquires the characteristics of the mother tongue of each child.

During the first year of life, communication is based on the syllable. When the child discovers that its voice provokes reactions by those around it, its vocal behavior becomes more varied, incorporating phonemes such as “ba”, “pa” and “da”. The first words do not generally sound the same as the way they are pronounced by adults, but they are intelligible.

To the extent that the child practices producing sounds and words, it gradually perceives and incorporates vocabulary, syntax and pronunciation. The level of understanding is often above the level of production, i.e. the child understands more words and phrases than it can manage to produce.

Correct treatment of otitis media during the first three years of life is extremely important, since this is the phase...
of greatest language development. At around 18 months, the vocabulary of a child has, on average, about 50 words. By three years, this has already reached 1,000 words. This expansion, obviously, does not only depend upon the integrity of the auditory system, but also upon communication with other children and with the adults who live in the same environment. In the USA, a study revealed that poorer families tended to use around a third of the vocabulary spoken by families from higher social classes.

Children within the age group from one to three years who have hearing loss have greater difficulty in acquiring language, less perception of those sounds of speech which contain silent consonants or fricatives such as /s/ and /z/. (24) and frequently make phonetic errors in the pronunciation of /l/ and /r/. The most common cause of this is mild conductive hypoacusia - even though unilateral - provoked by otitis media. During these infections the child receives distorted sound stimuli, which explains the phonetic errors.8

A hypothesis can be found in the literature that states that the hearing of the right ear and the auditory processing of the left temporal lobe are dominant in language functions. Klausen et al.12 showed that children eight and ten years old, with a history of myringotomy and ventilation tube insertion to treat SOM had significantly worse performance in comparison to normal controls in: tests of the articulation of words, discrimination of sounds and auditory attention. According to the authors, children with a history of SOM in the right ear were at a disadvantage in the tests. Based on these results, the authors proposed that early life auditory deficit in the right ear affects the development of the cortical language comprehension center. On the other hand, Borg et al.23 did not find any significant differences in terms of language when comparing children with right-side auditory deficiency with those with left-side deficiencies.

There are those that argue that SOM alternates periods of mild conductive hypoacusia with periods of normal hearing, and that a large proportion of cases tend to resolve spontaneously in a few weeks.8 There is controversy based on the auditory deficit over the early indication of surgery for ventilation tubes insertion when treating SOM.

Maw et al.25 evaluated alterations to language, behavior and learning in 182 children suffering from bilateral secretory otitis media, with an average age of two years. Half of the children were submitted for tympanocentesis and the other half received clinical treatment (medication). After nine months, hearing loss remained significant within the unoperated group, with an average retardation of three months compared to the level of speech comprehension predicted for their age. Both groups had a deficit in verbal expression when compared with children without hearing problems. After 18 months’ follow-up, all of the children who had been treated for SOM (clinically or surgically) presented normal language.

In a cohort study of otitis and language, 30 one year-old children were assessed for otitis media incidence, submitted for BERA and followed-up until they were nine years old. The majority of children who presented a diagnosis of bilateral AOM at 30% or more of their post-natal consultations had altered auditory limits during the first year of life, becoming normal in later years. Nevertheless, during follow-up, 60% of these children presented some language disturbance.26 Another study suggests that children with otitis media during the first three years of their lives continued to have difficulties with the comprehension of visual language, the articulation of words, with attention and reading capacity until they were 11 years old.10

Luotonen et al.27 found that children with a history of repeated AOM during the first three years of life were making unsatisfactory progress at school in reading, comprehension of texts and verbal and written expression. In the case of girls, in addition to language difficulties, mathematic ability was also compromised. This finding is attributed to: 1. the strict relationship between cortical language processing and the performance of mathematical operations,27 and 2. the differences in metabolism and functional organization between the language areas of the brains of the male and female sexes.27,28

Taking these findings into account, it is believed that otitis media and the resulting hearing loss, during the first three years of life can have long lasting effects, prejudicing not only language acquisition during this crucial period, but also the future scholastic attainments of the child.26-30

Discussion

More than 30 years have passed since the publication of the first study into the association between childhood otitis media and retarded language development.6 During this period innumerable works have returned conflicting results, probably due to different methodologies employed in the diagnosis of otitis media.4,8 For example, an older study based on pneumatic otoscopy for secretory otitis media diagnosis,26 while another used tympanometry.20 On investigating the incidence of acute otitis media, some authors had recourse to medical records,26,30 and others used questionnaires filled out by the patients’ parents.27,28 These differences in methodology make much more difficult the comparison of the results obtained and the analysis of the consequences of otitis media on language acquisition.

For Paradise,8 problems with the methodology of innumerable studies make pairing between cases and controls difficult because they use variables such as socio-economic level, nutritional and cultural factors, which are known to influence the language acquisition of children. The heterogeneous nature of the groups studied does not permit certain confirmation of the disturbances to language resulting from otitis media. To the author, research with reduced samples make the extrapolation of results unviable.
Many children with SOM have normal auditory limits. Paradise\textsuperscript{8} believes that this is the reason for some studies concluding that there is no causal relationship between middle ear effusion and retarded language acquisition.

As we have seen, the data presented in literature serve as a warning to pediatricians, otorhinolaryngologists, phonologists, speech therapists, and educators. Following up cases of otitis media within the pediatric age group, it is important to question parents over the child’s progress in language acquisition, and also enquire of their teachers how their progress is at school. It is possible that many of these children will need monitoring both by a pedagogue and a speech therapist, concurrently with antibiotic and/or surgical treatment of the middle ear. We are reminded that the participation of pediatricians is vital to the treatment of otitis media and the avoidance of its sequelae in sufferers, and also to bring the issue to the attention of parents and teachers.

While this study has not approached the subject, the effects of otitis media on balance\textsuperscript{11} and behavior\textsuperscript{32} have also been the cause of many clinical and psychological experiments over the years.

Ever more children are being submitted for surgery to insert ventilation tubes because of a single milliliter of liquid in the middle ear.\textsuperscript{8,9} This possibly occurs as a result of concerns on the part of pediatric otorhinolaryngologists about the sequelae of otitis media. There is a hypothesis that the privation from sound stimuli provoked by this milliliter of secretion has a negative effect upon the auditory cortex which is equivalent to the effect of congenital blindness on the visual cortex.\textsuperscript{8} This and other fascinating neurophysiological questions such as the possible dominance of the right ear in central auditory processing, the sexual differences in this function, the development of auditory processes in the children of bilingual families, and the connection between language, memory and visual communication merit deeper research.

Finally, it is vital, not just to treat, but also to prevent otitis media and its sequelae in childhood\textsuperscript{1}: by means of the fight against malnutrition, the improvement of the social and hygienic conditions of the public and universal access to health services, including the application of vaccines against untypable *Haemophilus influenzae* and pneumococcus, since these etiological agents of otitis media are presenting more and more strains that are resistant to antibiotics.\textsuperscript{33} Indirectly, these measures can improve not just the language acquisition of children, but also their quality of life, widen their horizons in this world replete with sound.

Acknowledgements

The authors would like to thank Sra. Sueli Loureiro Knoll for the illustration.


Impact of otitis media on language acquisition... – Balbani APS et alii

Corresponding author:
Aracy P.S. Balbani
Rua Maneco Pereira, 365
CEP 18270-400 – Tatuí, SP, Brazil
Fax: +55 (15) 251.3852 / 251.6691
E-mail: a_balbani@hotmail.com