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DEVELOPMENTAL IMPACT OF "SILENT" EAR HEALTH CONDITIONS

BY SALLY BROCKETT, MS

The autism epidemic now claims an estimated 1 in 110 children in the United States, according to the Centers for Disease Control and Prevention (CDC, 2010). Although a variety of causes are being investigated, it is suspected that more than one factor is responsible. Kelly Dorfman, MS, a licensed nutritionist and co-founder of Developmental Delay Resources, has coined the term post-traumatic ear infection syndrome (PTEIS) to refer to children who are apparently normal at birth but in the aftermath of chronic ear infections and inflammation go on to develop auditory processing problems and developmental delays. For children on the autism spectrum, there may be a subgroup of such children for whom chronic ear infections and undiagnosed episodes of middle ear fluid and negative pressure are among the factors contributing to their developmental disabilities (Dorfman, 2004).

Unfortunately, otitis media, or middle ear inflammation, has become so common that many parents accept it as a normal condition of childhood. Parents therefore may not take the necessary step of learning more about its causes and what can be done to intervene and stop the chronic cycle of disease. When parents understand that "common" does not mean "normal," they become more involved in seeking treatment directed at the underlying causes. When, in addition, parents understand the potential impact of recurrent middle ear inflammation on their child's development, they are more likely to vigorously seek to put an end to the problem.

COSTS AND PREVALENCE OF OTITIS MEDIA

Otitis media is the most common disease in children under the age of 15 years. The prevalence of this condition is immense, with 10 million children in the US affected annually. Since 1980, there has been a 150% increase across ages, and a 224% increase in children under two years of age (Nsouli, 2003). The associated costs in terms of both clinician effort and healthcare expenses are staggering. Each year, otitis media is responsible for:

- 25 million pediatric office visits
- 75% of all pediatric follow-up visits
- $3 to $4 billion worth of costs for medical and surgical intervention
- An additional $26 billion in related costs

The extremely high figure for "related costs" represents the cost of professionals who are needed to provide support or ancillary services to the child and family. This includes speech and language therapists, educational audiologists, academic tutoring/support services, pediatric neurologists, psychologists, and other professionals (Nsouli, 2003). These support services become necessary when the fluid and/or inflammation in the middle ear disrupts the compliance or proper function of the ear drum, causing conductive hearing loss.

When parents understand that "common" does not mean "normal," they become more involved in seeking treatment directed at the underlying causes.

This may occur at intermittent intervals of frequent but relatively short durations, or the conductive loss may be of long duration.

If this type of hearing loss occurs during early development or during the early years of schooling, it may cause mild to serious difficulties in speech and language development. It can also have an impact on a child's ability to learn phonics and acquire reading skills. Moreover, when the fluid and middle ear congestion interfere with balance, motor skills may be affected. The end result can require intensive, often expensive, long-term intervention in the areas of socialization, academics, emotional and psychological development, and sensory/motor skills. When the end result is very serious and is combined with a diagnosis of autism spectrum disorder, the associated interventions and costs are considerably higher.

UNDERSTANDING THE PHYSIOLOGY OF THE EAR

The middle ear cavity is located in the space behind the ear drum and in front of the inner ear. This space contains the ossicles or tiny bones that transmit sound vibrations from the ear drum to the oval window at the beginning of the cochlea. It also contains two tiny muscles, the tensor tympani and the stapedius, which are responsible for regulating the tension on the ossicles. The opening of the Eustachian tube is also located in this cavity. The Eustachian tube allows air to enter the cavity from the throat and nose, and also allows fluid to drain from the cavity to the nose/throat area.

When fluid collects in the middle ear cavity, it can interfere with the optimal function of the middle ear. If the fluid remains for a period of time, it may become infected and/or may thicken so that it cannot easily drain. This condition can be very painful due to the pressure exerted by the fluid and swelling of the tissues in the ear. At times, the pressure may be so great that it ruptures the ear drum, and the fluid drains out through the external ear canal.

Several contributing factors may result in middle ear fluid, or otitis media. In his book, *Childhood Ear Infections*, Dr. Michael Schmidt reports four main causes (Schmidt, 1990):

- Allergies
- Infection
- Mechanical obstruction
- Nutritional deficiency

Fortunately, there are preventive steps that can be taken, and treatments that can be used to address these causes and reduce or eliminate chronic problems with otitis media. (See Dr. Schmidt's book for a detailed explanation).

"SILENT" CONDITIONS THAT MAY NOT BE RECOGNIZED

Although parents generally become aware of a severe ear infection due to their child's behavior, there are two "silent" conditions that may disrupt optimal ear function without being obvious to parents and other caregivers, namely fluid and negative Eustachian tube pressure.

Fluid: In the first instance, fluid can be present without causing noticeable behavior problems or complaints from the child. Without the additional cues of a runny nose, cough, fever, or watery eyes, the parents or caregivers may not be aware that there is a problem. Moreover, if the child is on the autism spectrum, he may not be able to clearly communicate how he feels. The child may go to school, participate in daily activities, attend therapy sessions, and so forth, while no one realizes that he may not be getting the most benefit from these activities. A child with undetected fluid or inflammation in the ear may not accurately hear his teacher as she presents the lesson in phonics, and his distortions in hearing may cause him to misunderstand the spelling word given. During science he may be distracted by a group of teachers discussing something in the hallway. By the end of the day, the child may be so tired from working at understanding auditory information that he becomes disruptive during his private speech therapy session. In this scenario, a lot of time, effort, and money are being invested, but the return on the investment is reduced due to the fact that fluid and/or inflammation are interfering with proper transmission of sounds.

Chronic negative Eustachian tube pressure: Chronic negative Eustachian tube pressure is the second "silent" ear health condition that is often not recognized and, therefore, may remain untreated. The air pressure in the middle ear cavity should be equal to the air pressure in the external ear canal for the middle ear system to transmit vibrational signals most efficiently (Duffey, 2007; Schwartz, 2003). There are various situations in which this balance of air pressure may be disrupted, causing the middle ear cavity to have less pressure or negative pressure relative to that in the external ear canal. We are all familiar with the changes in pressure in our ears during flight or when traveling in mountainous regions. Swallowing or yawning may quickly restore the balance by allowing air to enter the Eustachian tube through the nose/mouth passages.

Restoring the balance in the air pressure or reducing the negative Eustachian tube pressure becomes more difficult if there are conditions that block the passageways. Fluid in the middle ear cavity can close off the opening to the Eustachian tube, and swollen membranes in the ear and Eustachian tube can also form a blockage to air flow. When the air flow is blocked, the air pressure in the middle ear cavity decreases and a vacuum may be created, causing the ear drum to be pulled inward or retracted. This condition does not allow for optimal transmission of sound vibrations. As a result, the quality of hearing may be reduced, distorted, or hearing sensitivity (with sounds seeming louder) may develop (Roumeliotis, 2011).

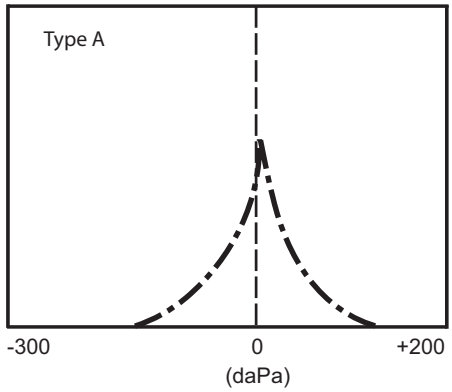
TESTING FOR MIDDLE EAR FLUID AND EUSTACHIAN TUBE PRESSURE

Doctors typically use an otoscope to look into a child's ear to observe the ear drum. Because the ear drum is translucent, they can also see if fluid is present behind the ear drum. Although it is often possible to detect the level of fluid and the type of fluid, assessment can be more difficult if the fluid is clear and thin or watery. Some physicians use a pneumatic otoscope that allows them to put a puff of air into the canal so that they can observe the movement of the ear drum. The movement is typically impaired if fluid is present.

A tympanometer is another device that may be used for determining if fluid is present. The procedure introduces air pressure into the external ear canal which should stimulate movement of the ear drum. In normal conditions, the ear drum will vibrate appropriately and send a normal signal back to the probe of the tympanometer. If fluid is present, however, the ear drum may be stiffened or have less mobility, and a different response will be generated.

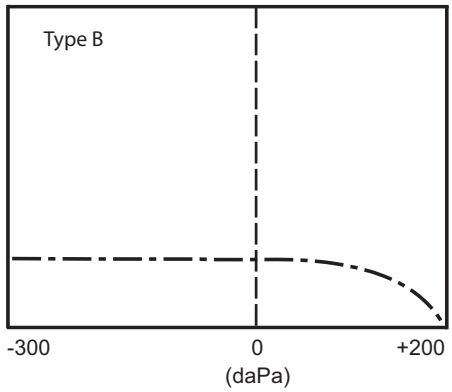
The tympanometer is also useful for measuring middle ear cavity or Eustachian tube pressure. The response data from the movement of the ear drum generates a graph that provides specific information about the condition and function of the middle ear. The graphs are categorized as three main types, each representing different conditions in the middle ear (Duffey, 2007). The following figures (Figures 1-3) are simple representations of the three types of graphs. (Graphs from an actual child would look somewhat different due to variation in individual characteristics.)

Figure 1



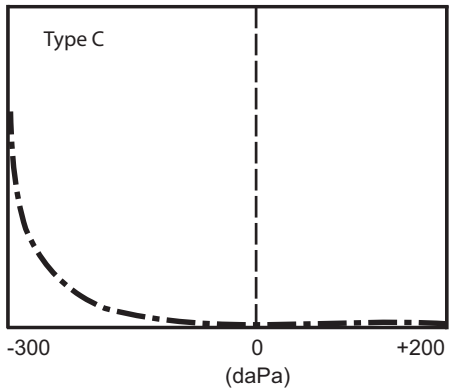
Type A: This type of graph looks like a teepee, with a nice peak and pressure between +50 and -150 daPa. This is considered to be a normal test result.

Figure 2



Type B: In this case, the graph is a flat line, indicating little or no movement of the ear drum. This suggests fluid or an infection in the middle ear cavity. A flat line may also occur if pressure-equalization (PE) tubes are present or if the ear drum is perforated.

Figure 3



Type C: This graph has a peak, though it is shifted to the left or negative range, and may even be nearly off the chart. Type C indicates negative middle ear/Eustachian tube pressure which may be caused by a blocked Eustachian tube or retraction of the ear drum (Esse & Thibodeau, n.d.). This is associated with sinus or allergy congestion, or may be seen at the end of a cold or ear infection. The pressure may be -150 daPa or even a much greater negative number. The amount of ear drum retraction corresponds to the amount of negative pressure (Schwartz, 2003).

EFFECTS OF MIDDLE EAR FLUID AND NEGATIVE PRESSURE

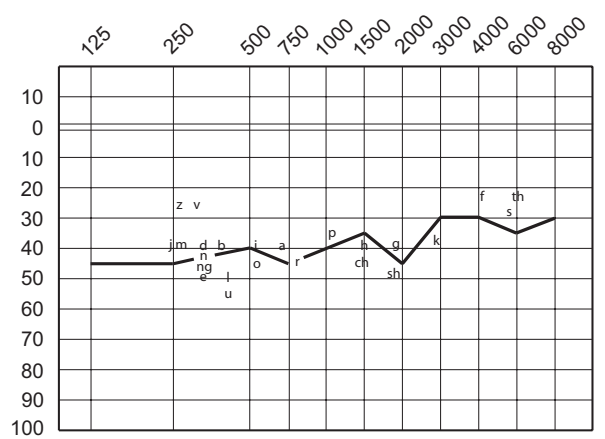
It is easily understood that permanent hearing impairment creates difficulties for a child and requires special interventions in order for the child to maximize his development and learning. However, many people do not realize that temporary, short-term hearing impairment can also have a permanent or lifelong impact. Unfortunately, temporary hearing loss most commonly occurs during the important period when early language should be developing at a rapid rate (Greene, 1998). When a child is sent to school with fluid or negative Eustachian tube pressure, he is handicapped by distortions in the way he hears things, an inability to block out background noise, possibly hypersensitive hearing or impaired hearing, and perhaps an irritating feeling of fullness or blockage in his ears.

Because a young child, and especially one on the autism spectrum, does not know that these conditions are not typical, he often does not complain or report the problems, and they remain undiagnosed and untreated. If this situation persists long enough, even more significant, long-term problems may develop. Learning ability, social-emotional development, and motor skills may all be negatively affected. Eventually, the child may be referred for special education services, or the family may seek private assistance.

When a child has a diagnosis of central auditory processing disorder (CAPD), sometimes just referred to as auditory processing disorder (APD), his ability to attend to, discriminate, remember, recognize, and understand auditory information is impaired. In challenging listening environments, such as environments with noisy backgrounds or poor acoustics, or those involving speakers with foreign accents or rapid speech, the processing problems can become even more significant (Kane, 2011). The young child in school with CAPD spends his day in exactly this type of challenging situation. He struggles to sort out the meaning of the teacher's directions, to remember the rules of the game at recess, to associate the correct sounds with letters so that he can sound out a word, and to block out classroom noise to do his seatwork. A child diagnosed with autism may never even receive a diagnosis of CAPD due to his inability to complete the battery of tests required, but it is often evident that the same sorts of processing problems are preventing progress in such cases.

Figure 4 shows an example of a child's audiogram depicting mild to moderate hearing loss due to middle ear fluid. The speech sounds on the audiogram illustrate which sounds this child may not hear well due to the hearing impairment. The threshold of hearing is shown by the dark line. All speech sounds above the dark line will not be heard during the period of time that the child's hearing is blocked by congestion. Ideally, the threshold of hearing should be at 20dB or less.

Figure 4



Given that even a typical child may not report his difficulties with middle ear health, a child on the autism spectrum is far less likely to indicate problems.

New research provides insight into why a relatively short-term hearing deprivation during childhood may lead to persistent hearing deficits long after hearing is restored to normal (Popescu & Polley, 2010). Dr. Daniel Polley, from the Massachusetts Eye and Ear Infirmary, reports that when children develop viscous fluid in the middle ear cavity, the quality of acoustic signals reaching the brain is degraded and is associated with long-lasting loss of auditory perceptual acuity. Dr. Polley compares this problem to the classic example of amblyopia, or lazy eye, which develops when balanced visual signals are not transmitted from each eye to the brain during the critical period for visual cortex development.

Using rats at varying stages of development to test the impact of temporary hearing loss, Dr. Polley and his colleague Dr. Maria Popescu demonstrated that temporary hearing loss in one ear causes distortion in auditory patterning in the brain, weakens the deprived ear's representation, and strengthens the open ear's representation. In this study, the scope of reorganization was most striking in the cortex, rather than the "lower" parts of the auditory pathway, and was more pronounced when hearing deprivation began in infancy than in later life (Popescu & Polley, 2010).

PRACTICAL STEPS FOR PARENTS

Parents of all children, but particularly those with developmental disabilities, need to be alert to the possibility of "silent" ear health conditions that may have an impact on the child's well-being and progress. Given that even a typical child may not report his difficulties with middle ear health, a child on the autism spectrum is far less likely to indicate problems. In children with ASD, behaviors can also be easily misinterpreted because they may not seem to be related to an ear condition.

Parents can easily monitor their child's ear health with a middle ear monitor, which is available in stores and through the Internet. Physicians can also teach parents how to use an otoscope so that they can do home checks and learn when to bring the child in for an office exam. Use of these tools can assist parents in seeking medical intervention sooner and in managing fluid and negative Eustachian tube pressure more effectively.

Because many children on the autism spectrum participate in speech or language therapy and sound-based listening programs, it is extremely important to know that there are no ear health conditions that may interfere with the benefits to be gained from these activities. Surprisingly, most listening programs do not require any type of ear health evaluation prior to or during the training period. (An exception: Berard auditory integration training [AIT] practitioners are trained about the importance of ear health and typically request that their clients' ears be evaluated.) If an ear health evaluation is not discussed with parents during consultation for a sound-based listening program, parents can use the middle ear monitor and otoscope (if properly trained) to monitor their child prior to attending listening training and speech/language therapy sessions. This can help assure that the child's ears are in an optimal state to receive the auditory stimulation.

Parents should also monitor children's middle ear health when they are participating in occupational and physical therapy. Because balance and motor control are regulated through the semicircular canals in the inner ear, as well as through the vestibular system and the cerebellum, children may gain greater benefit from these therapies if the ear is not congested and inflamed. A lot of time and expense may be saved if the ear health condition is corrected so that balance and coordination are not impaired.

With increased understanding of these "silent" ear health conditions, children can be monitored and treated as needed to ensure that auditory stimulation is not being disrupted at the point of transmission through the middle ear.

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