Hearing Evaluation. Instructions and More Appropriate Methods

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The development of language is a complex process, extending much further than the regular use of words. Tests to evaluate a child´s hearing implies knowledge of the consecutive steps that shape the functional behavior of the ear. Good hearing is an essential requirement for the development of communication skills and the integration of language, learning and interaction with the surrounding world. It is indispensable for development during the early life periods and preschool age, which sets up the basis for the following learning period during elementary education and prevention of difficulties in life. Great part of a child's learning depends on the information received by words and environmental sounds.

Early hearing disorders identification may improve the language and the model of development. The delay to identify an auditory defect causes a waste of precious time for the socio-emotional development of the child during his first year and it misses the detection until his preschool age, when he has to face the difficult task of catching up with the corresponding language group. That is why it is internationally agreed that there is the need to detect hearing loss very early in order to correct them as soon as possible and offer the child much better opportunities. Waiting until the child is grown up is inappropriate and will alter his developmental potential. Hearing loss is a silent disorder which acts as an invisible handicap at birth, since very few types of auditory damages are associated with obvious physical deformities. The deficit becomes evident only at an age when the child is expected to speak. When parents find out that there is a delay in language development as the first indicator, calling their attention of a possible hearing loss as well as a communication disorder with the social environment.

The cochlea develops at the third week of pregnancy and possesses adult function from the 20th week on. Using pure tones onto the maternal abdomen one finds a register of increase in the cardiac rhythm of the fetus, because he perceives sonorous vibrations through the amniotic fluid and hears his mother's heartbeat. This is proved by putting the baby in contact with the mother after birth: there is a decrease in cardiac and respiratory frequency; he cries less and calms down.

Newborns and children still on milk diet do exactly what they have to; therefore a correct stimulus should be applied to obtain the exact answer.

The newborn presents obvious reactions as alert reactions. An unexpected noise of 70dB reaches its highest intensity in only a few milliseconds and produces the

closing of eyes, startling, increasing of heartbeat and crying. If the same noise reaches its highest intensity in two milliseconds, he will open his eyes, look around, show interest and reduce his heartbeat. The first reaction is defensive and the second one shows the interest by means of the cochlear-muscular reflex, body movements with Moro reflex, head orientation towards the source of the sound, ocular and pupillary dilation, motor reflexes, facial gestures, as if he were protesting because of the noise, blinking, cochleo-palpebral reflex, crying reaction when waking up and hyperextensive movements of his head.

Children still on a milk diet cry less and sleep more if they are stimulated with light, temperature and sound. High frequencies determine painful auditory sensations and low frequencies reduce the response and have a tranquilizing effect. The wide noise frequencies increase the response or heartbeat. The change of stimulus will also elicit a response.

Between 4 and 7 months the answer to sounds is to look for the source of it, to emit la-la-la noises while the ocular-palpebral reflex persists. From 7 to 9 months the sound is localized again, modulated sounds and lulled voices are emitted. Between 9 and 13 months the child localizes the sounds down or behind, imitates noises, stammered out different tones or syllables like ma-ma-ma-ma. From 13 to 24 months he localizes the sound coming from another room and answers the sound or the words with normal words.

Contrast noises capture the attention of the child and he is able to differentiate the auditory stimulus. The response depends on the status before stimulation: the more passive, more activity and vice versa; before the tests he must have little activity in order to facilitate the answer.

The tests are compared being on light sleep, profound sleep or on activity of limbs. Noises of broad spectrum, narrow band and pure tones are the best. The more intense responses are to be found in light sleep and in a normal environment with stimulus of 90dB or soundproofed at 35dB.

The pediatrician is the first person to see the child; it is his obligation to detect these auditory problems and classify the child as a high risk to be referred to the otorhinolaryngologist who must help to complement the identification of these problems and prescribe the treatment. There is the need to have a history of the child´s hearing loss investigating parents, brothers, grandparents, cousins, uncles, since the genetic losses are recessive autosomal; the hearing loss may also be stable, fluctuating or progressive.

The responses will also depend upon the chronological and mental age, neurological status, hearing level, readiness and motivation, previous experience and the environment in which the examination is being held.

The integrity of the higher nervous centers becomes evident with the habituation of repetitive tones and reduces the cardiac response. The startling response is renewed if frequencies are changed; if it is normal, the responses are less evident. The time of latency of the response is also less evident. A lesion of the central nervous system does not extinguish the responses and there is no habituation. If the deafness is 80dB, the answer will occur at 85dB as the normal does at 5dB. A retarded child, with a clinical age of 1 year will respond with his own auditory

level, as a one year old child does. It is important to be familiar with a normal response or the auditory behavior.
Finding out about the activities the child performs at his particular age, and by listening to the quality of his voice, the hearing loss can be detected. An early and severe hearing loss is suspected if he emits high-pitched sounds and only vowels.
The initial test is the objective audiometry performed with 70, 80, and 90dB sounds, with resounding toys that provide the whole spectrum of sounds: whistle, acute tones; drum, deep tones; wide noise, medium tones. The stimulus should be 5 cm away from the newborn and the test must be done half hour before feeding, with a minimum duration of 0.3 to 1 second and on superficial sleep or wakefulness.
One out of 1000 of healthy newborns may suffer from severe or profound sensorineural hearing loss at birth. If we look at the data of any type of damage, this value may increase up to 15 for each 1000 newborn children. Around 10% of children still on a milk diet are considered of high risk for deafness. If we add the hearing loss disorders which can increase due to middle ear effusion the statistics may be even higher. 33% of newborn children who suffer from extreme immaturity present auditory alterations or problems of speech and language. The higher the survival of premature babies, the higher the number of children with disabilities or retardation in language development.
Hearing loss may occur in either sex, in any socio-economic group, in pre or post lingual, congenital or delayed, hereditary or produced by environmental problems. The condition varies in severity from light to profound and it can present any type of hearing loss: pure conductive, sensorineural or mixed. It may also be unilateral or bilateral, symmetric or asymmetric, an isolated problem or an element part of a syndrome, with or without related family history. Half of the hearing loss problems are due to hereditary causes and the other half are due to perinatal problems. 50% of the newborn children suffering from congenital deafness bear on their medical history one or more risk factors.
Almost twenty-five years ago, begun in the United States the hearing evaluation on infants by means of a behavioral technique, when awakening, but a great number of false positive were found. The evaluation has to be made before three months of age but not after six. The study will include the observation of the behavioral response and all audiometric tests, possible at this age, have to be done.
To remember more easily the complete interrogation for the child's history and the risk parameters, there is a mnemonics based on two English words: **hearing** and **risks**, which contain the majority of risk factors that may affect the newborn's hearing:

HEARING

H – Heredity, history of hearing loss in the family or hearing changes during childhood.

E – Means ear, and includes deformities of the ear, nose, maxilla and mouth, syndromes embracing craniofacial abnormalities, cleft palate, morphological alterations of the external ear.

A – Means anoxia and/or low Apgar at birth; it means severe asphyxia that may include infants with an Apgar punctuation of 0-5, who can not induce spontaneous respiration until 10 minutes and those with hypotonia even two hours after delivery.

R – For recipe. Meaning ototoxic drugs or toxic substances received pre or post natal.

I – Perinatal or neonatal infections. AIDS, Toxoplasmosis, Syphilis, Rubella, Cytomegalovirus, Herpes.

N – Neonatal intensive care or hyperbilirubin >15 mgs./dl or indications for exchange transfusion.

G – Retarded growth, low weight at birth, premature children or <1500 grams.

RISKS

R – Relapsing otitis or mastoid illness.

I – Childhood illness such as bacterial meningitis due to *Haemophilus influenza* that produces late hearing loss.

S – Trauma by sound, acoustic trauma and exposition to noises.

K – Physical trauma to noise and to cranium: "Knock out".

S – Complicated delivery.

There is another method of questioning by remembering the first 7 letters of the alphabet: A.- Asphyxia B,- Bacterial Meningitis, C.- Congenital perinatal infections, D.- Head & Neck defects, E.- Excess of Bilirubin, F.- Family history, G.- Low weight at birth.

Today there are some new risk factors such as: admission of newborns to an intensive care unit, the syndrome of maternal – fetal alcoholism and nicotinism, and mechanical ventilation. These questions, formulated at birth, require besides a multidisciplinary evaluation in which the family history and an otorhinolaryngological examination are included, laboratory and genetic tests results, followed by an audiological and language evaluation as well as a register of different examinations that would help to establish and confirm the diagnosis. Other specialists like neurologists, ophthalmologists, psychologists, should be called in, depending of the case. So, the average younger age in order to confirm the child hearing loss will be reduced to a maximum of 11 months.

Auditory screening or audiometry tests for motor responses should be performed. There are a variety of tests such as behavioral audiometry with games or visual reinforcement using illuminating toys, with tangible reinforcement, awarding the children with a candy. Those tests allow to evaluate whether the child recognizes or not familiar elements, besides evaluating the quality and the articulation of the voice. It is necessary to evaluate first the level of attention before evaluating the hearing level.

These standard tests are not suitable in mentally retarded, autistic, or patients with brain dysfunction, but that does not mean that they could not have hearing loss.

In mentally retarded patients the responses until the fourth month are undistinguishable from those of normal children because the neonatal reflex responses are still governing. When a five month old child does not turn his head or tries to grab an object he will have a mental age of three, and if he does not have

any auditory injury he will respond to tests at 45dB, corresponding to a 3 month old, which is the threshold of a normal response for those of a lesser chronological age. The autistics do not look back; they are busy with themselves and fix their attention on objects of their world, which substitute their interpersonal relations.

The search of criteria of high risk children decreased in hospitals with lower incidence of family history of hearing loss. This makes a difference in statistics. Besides, with a good perinatal and prenatal care the incidence of high risk neurological sequelae decreases, and consequently also the hearing loss. 75% of the children admitted to NICU (Neonatal Intensive Unit Care) who are mechanically ventilated, develop hearing loss 6 months after leaving NICU, although they presented a normal ABR (auditory brain stem response) before being discharged from the hospital. In developing countries or in low income areas, where the percentage of elder mothers is higher, where there is more genetic illnesses, consanguinity, infections and malnutrition, as well as mitochondrial sicknesses, or patients who had received renal transplants at early age, there is greater risk in developing disabilities.

The Joint Committee on Infant Hearing position statement includes suggestions for early identification of hearing impairment in infants up to 24 months of age. Methods such as the **ABR** and **OAE** (otoacustic emissions) are all available for screening in this age group.

A child is never too young to be treated for hearing loss. The earlier the intervention is started the greater the possibility of developing the maximum potential.

The activity of the external ciliated cells is being monitored by using otoacoustic emissions (OAE). The internal ciliated cells and the afferent cochlear function is mediated with action potentials and auditory potentials. In acute anoxia all aspects of the cochlear function are simultaneously lost. Median and prolonged hypoxia results in a clearly differential effect between the external and internal ciliated cells. Therefore, during a median hypoxia of 2 hours, the amplitude and thresholds deteriorate significantly while the function of the external ciliated cells, evident in OAE, shows little or no change at all. This demonstrates the difference of vulnerability of the internal and external ciliated cells, thus being an important etiological factor and proving the greater efficiency of ABR in detecting neonatal injuries. There is a strong movement developing in the world towards the auditory screening of newborns: ABR together with the OAE are better than a single test.

ABR has a sensitivity of 100% for auditory problems in high risk children and an specificity of 98% while the transitory OAE have a sensitivity of 50% and specificity of 84%. The responses in auditory field have the same sensitivity as the OAE but better specificity: 98%. This proves that the otoemissions do not seem to be as applicable to the screening of high risk children as shown on children born on time, because the injuries seem to be caused by retrocochlear damage. ABR is more specific for children with low weight.

The cost of the screening tests if compared to other blood tests, though it is higher, it will be lower on the long run, since there are more auditory lesions than phenylketonuria or hypothyroidism. Children with hearing loss identified before the sixth month of age, possess higher levels of perceptive and expressive

language, personal and social development and better vocabulary if treated rapidly.

Conclusions

Recent steps forward in the vital support systems of the newborn have contributed to the survival of high risk children. Nevertheless, protection of the auditory system and prevention of the consequences is still unreachable in neurology. **ABR** is a more economic test and provides better results in relation to cost-benefit for children of high risk, and specially in hypoxias.

The main objective is a program of early identification for the diagnosis of auditory damage at birth, to intervene properly and as early as possible. To identify before six months of age is the best strategy for the normal development of language in children with auditory problems and this can only be obtained by screening. The ideal is to examine the child as soon as he leaves the hospital and not after the end of the first month.

Screening is beneficial and justified as compared with the frequency of the illness. When a fast intervention is performed, such as an early amplification, the future costs decreases. The consequences of delayed assessment of suspected hearing loss is delayed intervention, not only for the affected child, but for the family as a whole.

Recommended readings

1. Hood LJ. Clinical Applications of the Auditory Brainstem Response, Singular Publishing Group, Inc., San Diego, 1998.
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5. Spivak LG. Universal Newborn Hearing Screening. Thieme, New York, 1998.