ETIOLOGICAL FACTORS OF HEARING ANALYZER IMPAIRMENT AND REHABILITATION OF CHILDREN WITH HEARING IMPAIRMENT USING COMPUTER PROGRAMS (LITERATURE REVIEW)

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Abstract*. As you know, a healthy child perceives the world around him through five senses: sight, hearing, smell, taste and touch. Among the five senses, vision and hearing are the most important for a person: it is through them that we receive maximum information about the environment. If for some reason a child loses any of them, then he develops a feeling of lack of information.*

Keywords*: auditory analyzer, rehabilitation, etiology, mutation, sensorineural hearing loss.*

Introductions. Hearing occupies a special place, with the help of which the child perceives the world around him. Through auditory perception, the child picks up sounds, recognizes the proximity or distance from sources, the direction of the sound wave, and also distinguishes sounds by strength and tone. But there are situations when, for one reason or another, a child is deprived of a full-fledged perception of the world from the moment of his birth or from early childhood.

About 6% of the world's population (278 million people) suffer from deafness or have hearing problems. According to statistics from the World Health Organization for industrialized countries, the number of people in the world suffering from hearing impairments of more than 40 dB per better-hearing ear, of various etiologies, is about 300 million [7]. The number of hearing impaired patients in the Russian Federation exceeds 13 million people, more than 1 million are children. Out of 1000 newborns, 1 child is born with total deafness. In addition, during the first 2-3 years of life, 2-3 more children lose their hearing [7].

According to the American Academy of Audiology, more than 665 thousand children with hearing impairments exceeding 40 dB are born worldwide every year. This number increases with age, doubling by the age of 9. According to WHO forecasts, by 2020, more than 30% of the entire global population will have hearing impairments [17].

The causes of damage to the auditory analyzer are quite diverse and heterogeneous. Hearing impairment is genetically predisposed, and hereditary pediatric diseases can affect (syndromic (20-30%) - autosomal recessive (80%), autosomal dominant (15%), associated with the X chromosome (3-4%), mitochondrial (1-2%); non-syndromic (70-80%). Currently, 70 genes responsible for the development of sensorineural hearing loss have been identified, in particular, those responsible for the production of Connexin 26 (according to Eva Orzan Padova). In the last decade, with the introduction into clinical practice of fundamental bio-technological methods of molecular biology, it has become possible to identify the molecular genetic factors that cause hearing impairment, to study the molecular pathophysiology of the death of structures of the auditory analyzer. Mutations 35delG and 167delT of the connexin 26 gene should be the object of research in clarifying the cause of sporadic hearing loss in early childhood [6]. The work of S.G. Zhuravsky proved that recessive mutations of only one GJB2 gene reveal the genetic nature of prelingual hearing loss in 70% of cases. This leads to the conclusion that it is necessary to widely

publicize the possible consequences of marriage, as well as to examine future parents with close relatives with congenital hearing impairments [6].

Increasingly, hearing disorders in young children occur even in utero, which is confirmed by research data [1], according to which over the past 7 years there has been an increase in the importance of perinatal pathology by 2.72% as one of the causes of the formation of sensorineural hearing loss (impaired sound perception) in children. Moreover, it was found that hearing pathology is found in 12.2% of children with a burdened antenatal period and in 10.1% of children with a burdened intranatal period [1].

In this regard, the factors responsible for the development of hearing disorders in children, that is, the causes of hearing loss, depending on the moment of exposure, are divided into antenatal, intranatal and postnatal [12,13,14]. Antenatal and intranatal etiological factors lead to the formation of congenital hearing disorders. In addition, acquired and hereditary hearing disorders are described in the literature. In most cases, not one, but several factors have a pathological effect on the hearing organ. Their effect is especially dangerous in the first 3-4 months of pregnancy, when the structures of the auditory analyzer are laid and differentiated [18,19]. Antenatal causes include adverse factors affecting the fetus in the prenatal period. These include the pathological course of pregnancy - toxicosis of the I and II halves, nephropathy, threat of termination, anemia, Rh sensitization, etc.; viral and bacterial infectious diseases of the mother during pregnancy, which primarily include cytomegalovirus and herpes infections, influenza, rubella, toxoplasmosis; somatic diseases of the mother (diabetes mellitus, cholesterol, cardiovascular diseases, kidney diseases, etc.); treatment of the mother during pregnancy with ototoxic drugs - antibiotics (aminoglycoside series), diuretics (furosemide, ethacrylic acid), salicylates, etc.; alcohol, drugs, smoking, exposure to a number of agricultural and industrial substances, radiation during pregnancy, etc. Prenatal causes include the effect of adverse factors during childbirth, leading to asphyxia of the newborn, intracranial birth trauma (rapid or prolonged, premature birth; breech, pelvic or facial presentation; surgical aids in childbirth - obstetric forceps, vacuum extractors, cesarean section; bleeding in childbirth, placental abruption, threat of rupture of the uterus, etc. etc.).

Postnatal causes of hearing loss in young children have an adverse effect on the child's body after birth. Among them: hyperbilirubinemia (including hemolytic disease of newborns), cerebral circulatory disorders of the I-III st., organic lesions of the central nervous system (CNS), pneumopathy, infections, meningitis, meningoencephalitis, complications after vaccinations, traumatic brain injuries, inflammatory diseases of the middle and inner ear, foreign bodies of the external auditory canal, exogenous ototoxins, psychogenic factors, allergic and somatic diseases, etc. When exposed to the same damaging factors during this period in children with the consequence of perinatal encephalopathy, damage to the sensorineural zone of the hearing aid occurs 4 times more often [21,22,23]. Children with hearing loss often have a complex defect: damage to the peripheral part of the auditory analyzer and pathology of the central nervous system. This combination is explained both by the common origin and properties of the receptors of the cochlea and the nervous system, and by the pathogenetic mechanisms of the formation of hearing disorders. An unfavorable factor, in most cases, affects not only the auditory analyzer, but also various parts of the brain. The features of the etiopathogenesis of hearing disorders in young children suggest that in most cases, hearing loss and deafness in children of this age group is of a sensorineural nature, that is, it consists in a violation of the functioning of the sound perception apparatus. Thus, hypoxia, which is caused by most of the etiological factors listed above, and asphyxia cause circulatory disorders in the inner ear. The resulting ischemia of the sensorineural region of the labyrinth leads to further disorders of microcirculation and cerebrospinal fluid

dynamics, acidosis and disorders of tissue metabolism. The toxic effect of the products of impaired metabolism causes the development of microangiopathies of the vessels of the inner ear and capillaries of the vascular strip of the cochlea, which carry out trophic, metabolic, etc. important processes for the normal functioning of the cochlea, and also affects the receptor apparatus of the spiral ganglion, which is highly sensitive to hypoxia. In addition, circulatory disorders, ischemia, acidosis and toxic products of impaired metabolism have a damaging effect on the central nervous system as a whole, causing the development of microcirculation disorders, hemorrhages, leukomalacia, etc. processes in various parts of the brain, including in the central parts of the auditory analyzer. Thus, hypoxia and asphyxia lead to pathological changes in the cochlea, auditory nerve and central parts of the auditory analyzer [9,10,20]. The damage to the hearing organ as a result of birth trauma is explained by the occurrence of hemorrhages in various parts of the hearing organ and the central nervous system due to mechanical trauma. In this regard, surgical aids in childbirth (obstetric forceps, vacuum extractor, caesarean section) cause hearing impairment in 7-27% of cases [24].

Intrauterine viral and bacterial infections can cause a violation of the hemodynamics of the inner ear, damage to the vascular strip, degenerative changes in the spiral ganglion, stretching of the integumentary membrane, etc., resulting in damage to the sensorineural area of the hearing organ due to morphological changes in its peripheral part, mainly the spiral ganglion. In addition, it is possible to damage the central parts of the auditory analyzer.

The development of bilirubin encephalopathy is also dangerous. It has long been known that indirect bilirubin is highly soluble in lipids and is a neurotropic poison. In addition, the sensitivity of the subcortex to indirect bilirubin increases under conditions of hypoxia. With nuclear jaundice, staining and, accordingly, toxic damage occurs to various structures of the brain, primarily the basal ganglia, as well as the lateral sections of the bottom of the IV ventricle, where the cochlear nuclei are located, that is, the second neurons of the auditory analyzer pathway, as a result of which fields of devastation can form with the subsequent development of gliosis in many parts of the brain. Therefore, children who have suffered from nuclear jaundice, along with other neurological symptoms, are characterized by hearing impairment (from deafness to complete deafness) [15,16,21]. The use of ototoxic drugs by a woman during pregnancy, including aminoglycoside antibiotics, can also lead to hearing impairment in the child. According to the Research Institute of Otolaryngology in Kiev, the cause of congenital hearing loss in 20% of children is neuritis of the auditory nerve of antibiotic origin. The effects of some ototoxic antibiotics on the hearing organ are described in the literature. For example, kanamycin and neomycin can cause damage to the cochlea, streptomycin affects the sensory epithelium of the vestibular apparatus, gentamicin affects the cochlea and vestibular apparatus [18,21].

The auditory and speech development of a child depends on the timely detection of hearing loss or deafness, the adequacy of the choice of a technical means of rehabilitation (hearing aid, cochlear implant), and the sufficiency of sign language teaching assistance. Early detection of hearing impairment and comprehensive rehabilitation of the child allow children with sensorineural hearing loss and deafness to have a good level of speech development and contribute to the social integration of the child [4,11,16,19,21].

The earlier special medical and pedagogical measures were taken to eliminate the effects of hearing loss, the more successfully the child will develop. The creation of a speech environment in the family, early hearing replacement, organization of special work on the development of auditory perception and speech determines the successful development of a child [5]. The first statements about the possibility of teaching deaf children are already found in the writings of Aristotle. In the XVI century. the possibility of mastering speech with the help of its written form

was mentioned by the Italian philosopher, physician and mathematician J. Cardano (1501-76), at the same time in Spain, the first attempts were made to teach children written and oral speech using dactylology. In 1620, the first methodological work dedicated to teaching deaf children by Joan Pablo Bonet "On the nature of sounds and the art of teaching a deaf mute to speak" was published in Madrid [25].

To date, there are various methods of teaching deaf and hard of hearing children. In recent years, computers as a means of learning and development have been increasingly introduced not only in schools, but also in preschool educational and correctional institutions. Educational and educational computer programs (KP) designed for preschool children are appearing on the information technology market. There are numerous CP aimed at the development of visual and auditory perception, attention, memory, verbal and logical thinking, etc. They are successfully used in the education of children of school and preschool age with special needs, including children with hearing impairment. The use of computer technology makes correctional work with children with hearing impairment more effective and allows you to work on the formation, development and correction of the following characteristics: sound reproduction, prosodic components of oral speech, phonemic hearing and perception, lexical and grammatical means of language, communication skills, articulatory motility, reverse speech kinesthesia, fine motor skills of fingers (working with a manipulator – mouse, keyboard), auditory and visual perception, attention, verbal and visual memory, will and motivation, verbal and logical thinking [2,3,7]. Special computer technologies have been developed for children with hearing impairments, in which the voice of a speaking person is transformed into visual symbols on the monitor screen. There are special computer programs aimed at the formation of pronunciation in hard-of-hearing and hard-of-hearing students, which can be divided into four modules: group I-to work on breathing and voice; group II- to work on speech sounds; III- to work on verbal and logical accents and expressiveness of speech; IV- to work on self-control over your own speech. According to V. S. Vasilyeva, most children of early and preschool age were engaged in CP with great interest. They were able to perform tasks with CP aimed at familiarizing themselves with the sounds of the surrounding world, distinguishing and recognizing sounds; evoking voices, stimulating vocal activity in non-speaking/small-speaking children, developing voice power and speech breathing. In children of both age groups, the success of the proposed tasks depended on the child's interest, the state of his hearing and speech development, the type of hearing prosthesis, etc. According to the results of the study of the score, the age limit of using KP for working with children (from 2-2.5 years old) was revealed, and the author also revealed that the effectiveness of working with KP depends primarily on the individual characteristics of the child, and not on his age. These include the level of development of attention, auditory perception, and the formation of educational and cognitive skills. In general, young children needed a longer acquaintance with the teaching KP, they behaved more passively than preschoolers, but no less interested. The use of computer technology in the development of auditory perception and auditory memory of children with impaired hearing contributes to the most effective corrective effect on the child in the formation of a normal motor stereotype, gnostic-practical and speech functions, develops total multilateral communication and adaptation to the social environment, helping to overcome the lack of information about the world [2].

The use of video materials helps in a very short time to present a large amount of information in a compressed, concentrated form, professionally prepared for perception, helps to look into the essence of phenomena and processes inaccessible to the human eye (ultrasound image, spectral analysis, the influence of radioactive elements on the course of biological, chemical and biochemical processes, the course of fast and slow processes.

The works of I. G. Zakharova prove that when mastering speech sounds with the help of computer programs, hard-of-hearing children perceive them audibly and visually and control their pronunciation also audibly [2].

Conclusion. Thus, the causes of damage to the auditory analyzer are quite diverse and heterogeneous: hearing impairment is genetically predisposed, hereditary pediatric diseases can affect; antenatal and intranatal etiological factors lead to the formation of congenital hearing disorders, and postnatal factors have an adverse effect on the child's body after birth. This means that the auditory and speech development of a child depends on the timely detection of hearing loss or deafness, the adequacy of the choice of a technical means of rehabilitation (hearing aid, cochlear implant), and the sufficiency of sign language teaching assistance. The use of computer programs makes correctional work with children with hearing impairment more effective, increases the motivational readiness of children to conduct remedial classes, and students expand their computer skills.

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