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RISK FACTORS OF HEARING IMPAIRMENT IN PEDIATRIC PATIENTS WITH CHRONIC OTITIS MEDIA

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Summary

Introduction. Chronic otitis media (COM) is one of the most common disorders in pediatric practice. The burden of the disease in industrialized countries is associated with hearing loss and further developmental delay in the child. COM is most often associated with a conductive type of hearing impairment since bone elements of the auditory chain undergo destruction due to the chronic purulent inflammation.

Objective: The aim of our study is the identification of risk factors in pathogenesis if COM for the possible development of effective preventive measurements.

Materials and methods: The current study presents the analysis of personal data and medical records using the descriptive and regression statistics. Sixty-five pediatric patients with chronic otitis media were enrolled. The study was conducted otorhinolaryngological department of the City Clinical Hospital No. 5 of the Health Department of Almaty in the period from March 2018 to March 2020.

Results and conclusions. The results of our investigation demonstrated that some prevalent characteristics of paediatric patients with chronic otitis media may act as possible risk factors for the impairment of hearing function. Thus, the avoiding of acute inflammatory middle ear diseases and total cancelling of treatment with ethanol containing ear drops may contribute greatly in the prevention of hearing loss and impairment.

Key words: *chronic otitis media, risk factors, hearing loss.*

Резюме

ФАКТОРЫ РИСКА СНИЖЕНИЯ СЛУХОВОЙ ФУНКЦИИ У ДЕТЕЙ С ХРОНИЧЕСКИМ СРЕДНИМ ОТИТОМ

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Введение. Хронический средний отит (ХСО) является одним из наиболее распространенных заболеваний в педиатрической практике. Бремя болезни в индустриально развитых странах связано с потерей слуха и дальнейшей задержкой развития ребенка. ХСО чаще всего сочетается с кондуктивным типом тугоухости, так как костные элементы слуховой цепи подвергаются деструкции вследствие хронического гнойного воспаления.

Целью нашего исследования является выявление факторов риска в патогенезе ХСО для последующей разработки эффективных профилактических мероприятий.

Материалы и методы. В настоящем исследовании представлен анализ персональных данных и медицинских карт с использованием описательной и регрессионной статистики. В исследование было включено 65 детей с хроническим средним отитом. Исследование проводилось в оториноларингологическом отделении Городской клинической больницы №5 Департамента здравоохранения города Алматы в период с марта 2018 года по март 2020 года.

Результаты и выводы. Результаты нашего исследования показали, что некоторые наиболее распространенные характеристики детей с хроническим средним отитом могут выступать в качестве возможных факторов риска нарушения функции слуха. Таким образом, предотвращение острых воспалительных заболеваний среднего уха и полная отмена лечения ушными каплями, содержащими этанол, могут в значительной степени способствовать профилактике потери и нарушений слуха.

Ключевые слова: *хронический средний отит, факторы риска, потеря слуха.*

Түйіндеме

СОЗЫЛМАЛЫ ОРТА ОТИТКЕ ШАЛДЫҚҚАН БАЛА ЖАСЫНДАҒЫ НАУҚАСТАРДЫҢ ЕСТУ ҚАБІЛЕТІНІҢ ТӨМЕНДЕУ ФАКТОРЛАРЫ

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Кіріспе. Созылмалы орта құлақ отиті (СОО) педиатриялық тәжірибеде жиі кездесетін аурулардың бірі болып табылады. Индустриалды дамыған елдердегі аурудың ауыртпалығы есту қабілетінің жоғалуымен және баланың дамуының одан әрі кешігуімен байланысты. СОО көбінесе есту қабілетінің жоғалуының өткізгіш түрімен біріктіріледі, өйткені есту тізбегінің сүйек элементтері созылмалы іріңді қабыну салдарынан жойылады.

Мақсаты. Біздің зерттеуіміздің мақсаты келешектегі тиімді алдын алу шараларын әзірлеу үшін СОО патогенезіндегі қауіп факторларын анықтау болып табылады.

Материалдар мен тәсілдер. Бұл зерттеу сипаттамалық және регрессиялық статистиканы пайдалана отырып, жеке деректер мен медициналық жазбалардың талдауын ұсынады. Зерттеуге созылмалы орта құлақ отитімен ауыратын 65 бала қатысты. Зерттеу Алматы қаласы Денсаулық сақтау басқармасының №5 қалалық клиникалық ауруханасының оториноларингология бөлімшесінде 2018 жылдың наурыз айынан 2020 жылдың наурыз айына дейін жүргізілді.

Нәтижелер мен қорытындылар. Біздің зерттеуіміздің нәтижелері созылмалы орта құлақ отиті бар балалардың ең жиі кездесетін кейбір сипаттамалары есту қабілетінің жоғалуының ықтимал қауіп факторлары ретінде әрекет етуі мүмкін екенін көрсетті. Осылайша, ортаңғы құлақтың жедел қабыну ауруларының алдын алу және құрамында этанол бар құлақ тамшыларымен емдеуді толығымен тоқтату есту қабілетінің жоғалуы мен нашарлауының алдын алуға үлкен ықпал етеді.

Түйінді сөздер: *созылмалы отит медиасы, қауіп факторлары, есту қабілетінің жоғалуы.*

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Introduction

Chronic otitis media (COM) is one of the most common disorders in pediatric practice. Annually about thirty million patients seek for medical service because of the inflammation of the middle ear. Since the diagnostic and classification approaches in definition of the disease vary throughout the world the prevalence of COM in the world ranges from 65 to 330 million cases per year [4]. The burden of the disease in industrialized countries is associated with hearing loss and further developmental delay in the child. In developing countries, the problem of COM is strongly correlated with deaths and severe complications leading to disability Exacerbations of COM may lead to the antibiotic resistance, deterioration in the quality of life of children and their parents. The economic losses linked with the management of the disease and temporary disability of parents due to the opening of sick leave to care for a child [11].

Obviously, COM is most often associated with a conductive type of hearing impairment since bone elements of the auditory chain undergo destruction due to the chronic purulent inflammation. However, the constant presence of pathogenic flora in the middle ear cavity promotes the absorption of microbial toxins and macromolecules that can affect the structures of the inner ear, leading to the development of sensorineural hearing loss [2]. Intracranial complications of COM can lead to the development of deafness in 10% of patients [13].

Conceptually, the main trigger in the pathogenesis of COM is the acute inflammation of the middle ear. In the majority of cases the acute otitis media becomes a complication of the respiratory infections, manifested clinically by inflammation of the pharynx with damage of the Eustachian tube's mucous membrane. The defeat of the Eustachian tube (ET) is accompanied by a violation of the cycle of opening and closing of the pharyngeal opening, which leads to a decrease in pressure in the middle ear cavity and, as a result, aspiration of pathogenic bacteria from the nasopharynx. In addition, the viral infection itself provokes inhibition of the function of ET clearance, which is expressed in a decrease in mucus secretion in goblet cells and a slowdown in the sweeping movements of ciliated cells. Viruses can also promote the expression of certain molecules of the mucosal cell wall as additional co-

receptors of pathogenic bacteria [3, 9]. Another hallmark of COM is the development of mucositis, which is characterized by a hyperplastic process in the mucous membrane and excessive production of exudate. The mucositis itself is formed from biofilm - a structure consisting of microbial cell wall polysaccharides, fibrin and mucins of the macroorganism [5].

In most cases, the disease develops in early childhood, most often during the first two years of life. When clarifying the details of the anamnesis of life and disease, it is possible to identify such risk factors for the development of chronic otitis media as frequent episodes of acute otitis media, upper respiratory tract infections, trauma to the eardrum, and nutritional deficiencies [15]. Other causes associated with the development of COM are pathological conditions that affect the functionality of the auditory tube - congenital anomalies of the facial skeleton and diseases of the pharynx. One of the significant risk factors for the development of pathology is the low level of income in the family in which the child was born and grows [18].

The understanding and considering all risk factors for the development of inflammation of the middle ear and chronicity of the process make it possible to create a successful tactic for the management and treatment of patients with childhood COM. Thus, the aim of our study is the identification of risk factors in pathogenesis if COM for the possible development of effective preventive measurements.

Materials and methods

Enrollment of the participants in the study took place among patients hospitalized in the otorhinolaryngological department of the City Clinical Hospital No. 5 of the Health Department of Almaty in the period from March 2018 to March 2020. The inclusion criteria for the study were the following characteristics of patients: verified diagnoses of chronic otitis media with the concurrent adenoid hypertrophy (ICD10 codes - H66.1 Chronic perforated otitis media; J35.2 Adenoid hypertrophy grades 2-3); age <18 years; availability of informed consent of children and/or their parents or guardians. Children whose parents or guardians refused to participate in the study were excluded from the sample. The study was approved by the Ethics Committee of Kazakh medical university of continuing education (Protocol no.: 1, from January 15, 2019), and the research was conducted in compliance with principles of the Declaration of Helsinki and the Guideline for Good Clinical Practice.

For the collection of collect personal data and medical information, a clinical register of the study participant was developed. The register was filled in by copying information from the outpatient records and the patient's medical history. The missing data was obtained during a face-to-face meeting, telephone conversation, correspondence via mobile messengers or e-mail.

The clinical register was developed by the author of the study and includes the following sections:

1) passport data;
2) data on the antenatal period of development;
3) data on the characteristics of breastfeeding;
4) development of the child from birth to 12 months;
5) history of respiratory disorders;
6) history of hearing impairment;
7) otosurgical features;
8) nasopharyngeal surgery;
9) early and late postoperative periods.

The last part - the results of tone threshold audiometry (measurement of the air-bone interval) and otoendoscopy (anatomical integrity of the neotympanic membrane) - was filled out during repeated control examinations after 1, 3, 6, 12 months from the date of the surgical intervention.

Statistical analysis

The R 3.6.3 software (R Foundation for Statistical Computing, Vienne, Austria) was used for statistical analyses. Descriptive statistics for categorical variables are presented as absolute and relative frequencies (percentages, %), for quantitative ones - as medians (1st and 3rd quartiles) and mean (standard deviation).

The Mann-Whitney test was used to compare quantitative variables. Fisher's exact test was used to analyze the association between categorical variables. Regression analyses were carried out: dependent variable – air-bone gap; independent variables – different parameters from personal and medical records. A p-value <0.05 was defined as statistically significant.

Results

For the identification of risk factors of hearing loss 65 pediatric patients with chronic otitis media in combination with adenoid hypertrophy receiving the surgical treatment were enrolled within 2 years. The age median of sample was 9,42 (5,73-12,22). The males: females' ratio was equal to 1,24 (36 boys and 29 girls).

Table 1 demonstrates the health condition of maternal health condition, the details of history of delivery and feeding. On third of mothers had some somatic pathologies, and every fifth female was affected with the disorder of reproductive system. The vast majority of children were born in term, but only half of them were fed with breast milk. Only 4% of participants were feeding in vertical position.

Table 1.

The history of pregnancy and breast feeding (n=65).

Variables		N	%
Extragenital pathology of mother		19	29,23
Genital pathology of mother		13	20,0
Delivery	Natural	50	76,92
	Caesarean section	15	23,08
Delivery time	In term	56	86,15
	Premature delivery	9	13,85
Child feeding	Breast	35	53,84
	Bottle-feeding	5	7,69
	Mixed	25	38,47
Feeding position	Vertical	3	4,62
	Horizontal	22	33,85
	Mixed	40	61,53

Also, we checked the prevalence of possible risk factors within the first year of life (Table 2). About one third of children had the allergy in their history. The overwhelming majority of patients were vaccinated according to the Kazakhstani national vaccination calendar. More than half of participants suffered from exudative otitis. The quarter of patients had the relatives with the hearing impairment. About 80% of children were treated with ethanol-containing ear drops.

Table 2.

First 12 months of life and history of ENT disorders.

Variables	N	%
History of allergic conditions and diseases	23	35,39
Vaccination on schedule	54	83,08
Family history of hearing impairment	19	29,23
Episodes of impaired breath	29	44,62
History of acute otitis media	16	24,62
Episodes of otorrhea	38	58,46
Use of ethanol containing ear drops	51	78,46

Table 3 shows the condition of nose, throat and the presence of adenoid hypertrophy. Every third patient had the II degree of disease. Approximately half of the patients suffered from sleep obstructive apnea syndrome. It seems obvious that some patients had the ENT comorbidities. About half of children had the 1-3 months history of sinusitis of different locations.

Table 3.

History of upper airways pathology.

Variables		N	%
Degree of adenoid hypertrophy	I degree	10	15,38
	II degree	21	32,31
	III degree	10	15,38
	II degree + choanal syndrome	13	20,0
	III degree + choanal syndrome	11	16,93
Sleep obstructive apnea syndrome		31	47,69
Pharmacological treatment of sinusutis		49	75,38
Local intranasal glucocorticosteroids		26	40,0
History of sinusitis	1 month	19	29,23
	1-3 months	32	49,23
	3-6 months	9	13,84
	More than 3 months	5	7,7

About 60% of patients suffered from COM more than 3 years. The ration of participants with one sided and two-sided forms of disease was 1:1. More than 60% of children were treated with systemic and local antibiotics. Two thirds of patients had the experience of exposure to ethanol-containing ear drops. The median of air-bone gap was equal to 43,48 (38,03-51,97) dB. According to computer tomography half of the children had the sclerotic type of pneumatization of temporal bone Table 4.

Table 5 contains the analysis of possible risk factors of hearing impairment. In this case the linear regression method was used. It allows to evaluate the impact of several qualitative parameters on the air-bone gap variable. The significant increase of air-bone gap was associated with the previous history of acute otitis media, the episodes of otorrhea, and the treatment with ethanol-containing ear drops.

Table 4.

History of chronic otitis media and hearing impairment.

Variables		N	%
History of COM	1-3 months	4	6,15
	3-12 months	4	6,15
	1-3 years	17	26,15
	More than 3 years	40	61,55
Affected side	One sided	36	55,38
	Two sided	29	44,62
Exacerbation of otitis prior to surgery as an otorrhea	Less than 1 month	1	1,54
	1-3 months	17	26,15
	More than 3 months	47	72,31
Frequency of exacerbations	No exacerbations	1	1,54
	From 1 to 3 times per year	42	64,62
	More than 3 times per year	22	33,84
ENT* interventions			
Pharmacological treatment	Systemic antibiotics	64	98,46
	Inhaled forms of glucocorticoids	38	58,46
	Local antibiotics	62	95,38
	Local corticosteroids	47	72,31
	Ethanol containing ear drops	61	93,85
Type of hearing impairment according to ICD-10 before the surgery	Conducting hearing loss, bilateral (H.90)	35	53,85
	Conductive hearing loss, unilateral with unrestricted hearing on the contralateral side (H90.1)	29	44,61
	Mixed conductive and sensorineural hearing loss, unilateral with unrestricted hearing on the contralateral side (H90.7)	1	1,54
Air-bone gap, dB (median (1st and 3rd quartiles)		43,48 (38,03-51,97)	
Computer tomography	Good pneumatization	19	29,23
	Sclerotic type of pneumatization	32	49,23
	Loss of pneumatization	13	20,0
	Pathological lesions	1	1,54
Remission period of COM before the surgery	Less than 1 month	9	13,85
	1-3 months	25	38,46
	More than 3 months	35	53,84

*Ear, Nose, Throat

Table 5.

Factors affecting the air-bone gap parameter.

Variable		β [95% CI]	p*	p**
Male gender		1.3 [-3.5; 6.0]	0.5966	
Extragenital pathology		-1.6 [-6.8; 3.6]	0.5320	
Genital pathology		5.2 [-0.6; 11.0]	0.0773	
Caesarean section		1.1 [-4.5; 6.7]	0.6893	
Premature delivery		1.2 [-5.6; 8.1]	0.7213	
Child feeding	Bottle-feeding	7.7 [-1.3; 16.7]	0.0930	0.2152
	Mixed	-0.2 [-5.1; 4.7]	0.9315	
Feeding position	Horizontal	-4.1 [-15.9; 7.7]	0.4904	0.6892
	Mixed	-4.9 [-16.3; 6.6]	0.3997	
History of allergic conditions and diseases		2.7 [-2.2; 7.6]	0.2723	
Family history of hearing impairment		4.2 [-0.9; 9.3]	0.1079	
Vaccination on schedule		-1.3 [-7.6; 5.0]	0.6892	
Episodes of impaired breath		-3.8 [-8.4; 0.9]	0.1111	
History of acute otitis media		6.7 [1.5;11.9]	**0.0128**	
Otorrhea		4.7 [0.6; 8.8]	**0.0448**	
Use of ethanol containing ear drops		5.6 [0.3; 10.9]	**0.0353**	
Sleep obstructive apnea syndrome		0.0 [-4.7; 4.8]	0.9889	

p* – p-values were evaluated in comparison with the base figures;
p** - p-values were evaluated in comparison of subgroups

Discussion

One of the most common causes of conductive hearing loss is chronic inflammatory diseases of the ear, such as otitis media with persistent discharge due to perforation of the tympanic membrane. Without adequate treatment of chronic otitis media, some of the symptoms of the disease - hearing loss or ear discharge - can significantly reduce the patient's quality of life [13, 21].

There is a wide range of modified and non-modified risk factors of chronic otitis media. The assumption about the role of heredity in the chronicity of the inflammatory process in the middle ear is confirmed by a large-scale longitudinal study by Rovers et al. (2002). A prospective follow-up of 1373 pairs of twins in England and Wales demonstrated the concordance of the middle ear disease scale (MEDS) with different variables. If in the development of acute otitis media the influence of the external environment was decisive (0.18 vs 0.10), then heredity turned out to be a statistically significant anamnestic factor for COM (0.57 vs 0.72) [16]. Another risk group for the development of inflammatory pathology of the middle ear are children with congenital pathology of the facial skeleton. These data are also confirmed by a series of experimental studies, during which a gene responsible for the development of one or another bone and cartilage structure of the facial skeleton was deactivated in knock-out mice. Such interventions led to various anatomical and physiological disorders of the Eustachian tube, followed by the development of inflammation of the middle ear [6, 7, 17]. In addition, adenoiditis can serve as an independent variable that has a prognostic value in the success of surgical treatment of patients with COM. According to Hong et al. (2008) one third of cases of chronic inflammatory pathology of the middle ear is accompanied by adenoiditis, and adenotonsillectomy reduces the frequency of exacerbations of chronic reflux and significantly improves the function of the Eustachian tube [8]. Another important risk factor for the development of pathology of the middle ear is the passive smoking. Children of smoking women are especially at risk, in this case, the likelihood of developing otitis media increases by 50% or more [19]. Another modifiable cause contributing to infection of the middle ear cavity is the use of pacifiers and teethers. The results of a controlled cohort study by Niemela et al. (2000) showed that children whose parents stopped using pacifiers after reading an information booklet about their dangers had 33% fewer episodes of acute otitis media [12].

The results of our investigation demonstrated that some prevalent characteristics of paediatric patients with chronic otitis media may act as possible risk factors for the impairment of hearing function. This data is concordant with the data from other studies. There is significant decrease of hearing function (more than 40dB) in every fifth child with chronic otitis media [1]. Thirty percent of patients with bilateral sensoneural loss of hearing had the middle ear disorder. Furthermore each exacerbation of the inflammatory process may worsen the already existing hearing impairment [10]. In its turn the impairment or loss of

hearing is followed with development and speech delay, the worsening of verbal communication and socialization, and behaviorial and cognitive disorders [20].

Conclusion

Thus, the avoiding of acute inflammatory middle ear diseases and total cancelling of treatment with ethanol containing ear drops may contribute greatly in the prevention of hearing loss and impairment.

Authors contribution:

Shamshudinov T. initiated the study, collected personal and clinical data.

Shamshudinov T. and Taukeleva S. designed the study and wrote the manuscript together.

Shamshudinov T. contributed to statistical analysis.

All authors read and approved the final manuscript.

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