

Leukocyte Shift Index and Subtypes of Acute Otitis Media in Children

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Abstract

The aim of this research was to study the features of clinical and laboratory parameters of acute otitis media (AOM), taking into account the value of the leukocyte shift index (LSI) in pediatric patients with the demonstration of clinical cases.

Methods and Results: This study included 100 children (55 boys and 45 girls) with AOM. The mean age of all patients was 4.32 ± 0.31 years. Group 1 included 50 patients (30 boys and 20 girls) with acute suppurative otitis media (SupAOM). Group 2 included 50 patients (25 boys and 25 girls) with acute serous otitis media (SerAOM). As a marker for determining the activity of the inflammatory process and the disorders of the immunological reactivity of the body, we chose LSI, calculated taking into account the parameters of the general blood test. Our results show the diagnostic significance of LSI in predicting the clinical course of AOM in patients in the age group of 2-16 years. The development of SerAOM is predicted when the LSI is 1.05 ± 0.08 ; SupAOM - 2.08 ± 0.23

Conclusion: The results obtained can be useful in providing specialized medical care for children of this age group, for optimizing the algorithms for preventive examinations and therapeutic interventions, and for offering the possibility of predicting the severity of the disease and timely treatment of SupAOM requiring a surgical intervention followed by systemic antibiotic therapy in order to prevent otogenic complications and hearing. (*International Journal of Biomedicine. 2022;12(1):63-66.*)

Key Words: acute otitis media • leukocyte shift index • children

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Abbreviations

AOM, acute otitis media; **LSI**, leukocyte shift index; **SerAOM**, acute serous otitis media; **SupAOM**, acute suppurative otitis media; **ICC**, intracranial complication.

Introduction

In recent years, the number of patients with acute otitis media (AOM) has increased, accounting for 75.1% - 80% of all diseases of the middle ear.⁽¹⁾ A study has shown that in the Russian Federation, acute serous otitis media (SerAOM) (ICD-10-CM Code H65.07) and acute suppurative otitis

media (SupAOM) (ICD-10-CM Code H66.019) are the main causes of hearing loss in children aged 2-5 years.⁽²⁾ The growth of otogenic complications in children amounts to one case of intracranial complication (ICC) per 350-450 cases of inflammatory diseases of the middle ear. The mortality rate for ICC ranges from 5% to 50%.^(3,4) Despite the achievements of modern medicine, the otogenic ICC in purulent-inflammatory diseases of the ear in children remain relevant subjects for research.⁽⁵⁾

The aim of this research was to study the features of clinical and laboratory parameters of AOM, taking into

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account the value of the leukocyte shift index (LSI) in pediatric patients with the demonstration of clinical cases.

Materials and Methods

This study included 100 children (55 boys and 45 girls) with AOM. The mean age of all patients was 4.32 ± 0.31 years. All patients were treated in the department of pediatric otolaryngology at the Regional Clinical Hospital No.2 of Tyumen in the period from 2018 to 2020. Group 1 included 50 patients (30 boys and 20 girls) with SupAOM. Group 2 included 50 patients (25 boys and 25 girls) with SerAOM.

As a marker for determining the activity of the inflammatory process and the disorders of the immunological reactivity of the body, we chose LSI, calculated taking into account the parameters of the general blood test.^(6,7) $LSI = (\text{eosinophils} + \text{basophils} + \text{myelocytes} + \text{metamyelocytes} + \text{stabs} + \text{segmented neutrophils}) / (\text{monocytes} + \text{lymphocytes})$. The LSI value of 1.96 ± 0.56 is considered normal.⁽⁶⁾

All children were admitted on an emergency basis with complaints of earache, headaches, unilateral or bilateral hearing loss, hyperthermia, anxiety, sleep disturbance, and speech development disorders. All children were examined by an otorhinolaryngologist, pediatrician, as well as by a neurologist, anesthesiologist, neurosurgeon, and audiologist according to the indications.

Upon admission, patients underwent clinical and laboratory diagnostics, radiography, and CT of the temporal bones and paranasal sinuses. CT or MRI with contrast was performed for diagnostic purposes to exclude ICI. Children of Group 1 underwent surgical treatment (myringotomy), which was supplemented with antromastoidotomy, according to the indications. All received a course of antibiotic therapy and local therapy.

Statistical analysis was performed using the statistical software STATISTICA (v10.0, StatSoft, USA). The normality of distribution of continuous variables was tested by one-sample Kolmogorov-Smirnov test. Continuous variables were presented as mean \pm SEM. Means of 2 continuous normally distributed variables were compared by independent samples Student's t test. A value of $P < 0.05$ was considered significant.

The study was conducted in accordance with ethical principles of the WMA Declaration of Helsinki (1964, ed. 2013) and approved by the Tyumen State Medical University Ethics Committee. Written informed consent was obtained from the parent/guardian of each patient.

Results

A comparative analysis of LSI in the studied groups revealed significant fluctuations in this indicator from 0.77 to 3.8 in Group 1 and from 0.33 to 2.56 in Group 2. In the age subgroup of 13-16 years, SupAOM was detected in one patient and SerAOM in 4 cases. LSI levels in the patients ($n=41$) from 2 to 16 years of Group 1 were 2.08 ± 0.23 , and of Group 2 ($n=47$), 1.05 ± 0.08 ($P=0.0001$). In Groups 1 and 2, LSI values in the age groups of 2-5 years were 2.19 ± 0.28 and 1.00 ± 0.07 ($P=0.0001$),

respectively; in the age groups of 6-12 years, 2.98 ± 0.82 and 1.07 ± 0.17 ($P=0.0435$), respectively (Table 1).

Table 1.

LSI values in Groups 1 and 2 according to the age subgroups

Age subgroups (yrs)	Mean age		LSI		P-value
	Group 1 n=50	Group 2 n=50	Group 1 n=50	Group 2 n=50	
0-1	0.83 ± 0.09 n=9	0.83 ± 0.20 n=3	1.20 ± 0.43 n=9	0.77 ± 0.44 n=3	0.5022
2-5	3.29 ± 0.17 n=34	3.69 ± 0.20 n=35	2.19 ± 0.28 n=34	1.00 ± 0.07 n=35	0.0001
6-12	6.50 ± 0.37 n=6	8.63 ± 0.86 n=8	2.98 ± 0.82 n=6	1.07 ± 0.17 n=8	0.0435
13-16	13.0 n=1	14.50 ± 0.75 n=4	1.04 n=1	1.64 ± 0.92 n=4	-

P-value between LSI (Group 1 and Group 2)

LSI levels are affected by the characteristics of the physiological state of neutrophils and lymphocytes, depending on age (the first cross at 5 days and the second at 5 years); obviously, this circumstance explains the absence of statistically significant differences between Groups 1 and 2 in children aged between 0 and 2 years ($P > 0.05$).

Currently, the use of LSI for predicting SupAOM in children has enough grounds for clinical use in practical healthcare, and widespread implementation in the algorithms of preventive examinations. Domestic scientists have shown the role of LSI in assessing the body's immunological reactivity, the severity of endogenous intoxication, and its complications.^(7,8) The results obtained in our study indicate that in children aged between 2 and 16 years, the LSI levels of 1.05 ± 0.08 and 2.08 ± 0.23 can suggest the formation of SerAOM and SupAOM, respectively.

In addition, the possibility of early diagnosis of the purulent process in the middle ear, both at the outpatient stage of diagnosis and upon admission to the ENT department of a children's hospital, is very important. The availability of the LSI assessment, its information content in the absence of expensive diagnostic methods (multispiral CT, tympanometry, otomicroscopy) allows performing timely diagnosis, surgical treatment, and the necessary antibiotic therapy to prevent otogenic complications.

Case Presentation 1

An 11-year-old boy was admitted on 07.18.2019 to the department of pediatric otolaryngology for emergency indications. Complaints: pain in the left ear, fever up to 38.0°C .

Anamnesis morbid

The child fell ill on 07.15.19. Outpatient treatment (amoxicillin, otipax) was prescribed by an ENT doctor.

Anamnesis vitae

Child from second full-term pregnancy, body weight at birth – 4200g. The patient grew and developed according to his age. Scheduled vaccinations. Past diseases: acute respiratory infections, chickenpox, bronchitis, tonsillitis, pneumonia. History of allergies is not burdened. History of allergies is not burdened.

Clinical Findings, Diagnostic Assessment, and Treatment

General condition of moderate severity. Consciousness is clear. Body temperature - 38.0°C. The respiratory rate – 21 breaths per minute. The heart rate is 84 bpm. The abdomen is soft; the liver and spleen are not palpable. Urination is not disturbed. The stool is normal.

Local status

Nose: without features.

Oropharynx: mucous membranes are pink and edematous; the pharynx is symmetrical; the soft palate is mobile, with no plaque.

Larynx: sonorous voice, free breathing.

Ears: Tympanic membrane of AD is grey, the cone of light is preserved; tympanic membrane of AS is hyperemic, infiltrated, the cone of light is not preserved.

Standard laboratory diagnostic methods are performed. General blood test (07.18.2019): Segmented Neutrophils – 67%, Stabs - 5%; Basophils - 1%; Lymphocytes - 20%; Monocytes - 7%; Eosinophils -1%, Platelets $126 \times 10^9/L$, Hemoglobin 137 g/L; Erythrocytes $5.13 \times 10^{12}/L$, Leukocytes $8.71 \times 10^9/l$. LSI=2.7.

LSI=2.7.

Ophthalmologist's examination, "Acute suppurative left-sided non-perforated otitis media."

Treatment: Paracentesis of the left tympanic membrane (of 07.18.2019) followed by conservative therapy.

Local status at discharge (07.26.2019).

Otoscopy: AS - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable; AD - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable.

This clinical case indicates that the value of LSI of 2.08 is associated with the development of an acute purulent process, requiring a surgical intervention followed by systemic antibiotic therapy.

Case Presentation 2

A 12-year-old girl was admitted on 08.17.2020 to the department of pediatric otolaryngology for emergency indications. Complaints: hearing loss.

Anamnesis morbid

The child was sick for 3 months; against the background of frequent colds, hearing loss appeared. Conservative treatment without effect. Tympanogram (07.28.2020): type C/ type B.

Anamnesis vitae

The patient grew and developed according to his age. Scheduled vaccinations. Past diseases: acute respiratory

infections, otitis media, chickenpox, bronchitis, tonsillitis, paracentesis of the eardrums on both sides (07.03.2020). History of allergies is not burdened.

Clinical Findings, Diagnostic Assessment, and Treatment

General condition of moderate severity. Consciousness is clear. Body weight - 53 kg, height - 158 cm. The respiratory rate – 22 breaths per minute, saturation - 100%. The heart rate is 98 bpm. The abdomen is soft; the liver and spleen are not palpable. Urination is not disturbed. The stool is loose.

Local status

Nose: without features. Oropharynx: mucous membranes are moist and pink; the pharynx is symmetrical; the soft palate is mobile, with no plaque.

Larynx: sonorous voice, free breathing.

Ears: Tympanic membrane of AD is gray-cloudy, retracted, the contours are poorly distinguishable; tympanic membrane of AS gray-cloudy, retracted, the contours are poorly distinguishable. Whispered speech: AD/AS - 6 m / 4 m.

Standard laboratory diagnostic methods are performed. General blood test (08.17.2020): Basophils - 1%; Neutrophils - 46.8%; Lymphocytes - 40.2%; Monocytes - 8.9%; Eosinophils -3.1%.

LSI=1.04.

Ophthalmologist's examination, "Acute left-sided serous otitis media."

Treatment: Conservative therapy.

Local status at discharge (08.20.2020).

Otoscopy: AS - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable; AD - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable. Whispered speech: AD/AS - 6 m / 6 m.

This clinical case indicates that the value of LSI of 1.04 is associated with the development of an acute serous otitis media.

Conclusion

This study demonstrates the diagnostic significance of LSI in predicting the clinical course of acute otitis media in patients in the age group of 2-16 years. The development of acute serous otitis media is predicted when the LSI is 1.05 ± 0.08 ; acute suppurative otitis media - 2.08 ± 0.23

The results obtained can be useful in providing specialized medical care for children of this age group, for optimizing the algorithms for preventive examinations and therapeutic interventions, and for offering the possibility of predicting the severity of the disease and timely treatment of acute suppurative otitis media requiring a surgical intervention followed by systemic antibiotic therapy in order to prevent otogenic complications and hearing loss.

Competing Interests

The authors declare that they have no competing interests.

References

1. Garashchenko TI, Kozlova RS. [Acute otitis media in children. Prejudices of pharmacotherapy]. *Detskaya Otorinolaringologiya*. 2013;(3):31-36. [Article in Russian].
 2. Yablonsky SV. [Modern approaches to the diagnosis and treatment of middle ear diseases in children]. *Rossiyskaya Otorinolaringologiya*. 2004;(4):91-99. [Article in Russian].
 3. Yakovlev VN, Kunelskaya NL, Yanyushkina ES. [Exudative otitis media]. *Vestnik Otorinolaringologii*. 2010;(6):77-80. [Article in Russian].
 4. Kuznetsova NE, Sinyakov AYu, Veshkurtseva IM, Kuznetsova TB. [The nature of intracranial complications in purulent-inflammatory pathology of the ear in children]. Scientific-Practical Conference "Modern aspects of head and neck surgery." 2019:17-18. [Article in Russian].
 5. Kuznetsova NE, Mamedov RR, Shcherbakova AF. Prevalence of otitis media with effusion in children. *International Journal of Biomedicine*. 2020;10(1):86-88. doi: 10.21103/Article10(1)_ShC1
 6. Ivanov DO, Shabalov NP, Shabalova NN, Kurzina EA, Kostyuchek IN. [Leukocyte indices of cellular reactivity as an indicator of the presence of hypo- and hyperergic variants of neonatal sepsis]. Available from: <http://www.medlinks.ru/article.php?sid=22330>. [Article in Russian].
 7. Mustafina ZhG, Kramorenko IuS, Kobtseva VIu. [Integral hematological indices in assessing body immunological reactivity in patients with ophthalmic pathology]. *Klin Lab Diagn*. 1999 May;(5):47-9. [Article in Russian].
 8. Speransky II, Samoilenko GE, Lobacheva MV. [Complete blood count - are all of its possibilities exhausted? Integral indices of intoxication as criteria for assessing the severity of endogenous intoxication, its complications, and the effectiveness of treatment]. *Acute and Emergency Conditions in the Practice of a Doctor*. 2009.19(6):5. [Article in Russian].
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