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Features of clinical course and diagnosis in pediatric otitis media with ARVI

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Abstract. Acute otitis media remains one of the most frequent infectious diseases in paediatric practice, with growing concerns about antibiotic resistance necessitating precise diagnostic and therapeutic approaches. The aim of this study was to establish age-specific aetiological patterns and develop evidence-based criteria for the differential diagnosis of otitis media in children with acute upper respiratory infections. A prospective observational study included 68 patients aged 1 to 13 years. The study demonstrated a clear age-dependent aetiological pattern: viral causes predominated in younger children (67.9% among infants, 63.2% in early childhood, 53.8% in middle childhood), whereas bacterial infections were more prevalent in older children (57.1% in late childhood and 100% in adolescence). Temperature patterns showed a strong correlation with aetiology: subfebrile temperatures (37.1-38.0 °C) were typically associated with viral infections (64.7% of cases), whereas febrile (38.1-39.0 °C) and high febrile temperatures (> 39.0 °C) were characteristic of bacterial infections (54.2% and 20.8%, respectively). Video endoscopy successfully differentiated three main clinical-morphological forms: secretory otitis (38.2%, predominantly viral), acute purulent otitis (35.3%, bacterial), and bullous otitis (26.4%, predominantly viral). Key clinical predictors of a complicated disease course included age under three years, recurrent otitis history, high fever, otorrhoea, hearing loss, and systemic signs of intoxication. Treatment strategies emphasised rational antibiotic use, with amoxicillin as first-line therapy for bacterial cases and symptomatic management for viral aetiology. This study establishes an individualised diagnostic algorithm based on age, temperature patterns, and endoscopic findings, enabling clinicians to optimise treatment decisions and reduce inappropriate antibiotic prescribing. The practical value of this research lies in providing evidence-based tools for paediatricians and otolaryngologists to improve diagnostic accuracy, enhance treatment outcomes, and contribute to antimicrobial stewardship in the management of paediatric otitis media

Keywords: differential diagnosis; viral aetiology; bacterial infection; video endoscopy; age-dependent patterns; temperature patterns; antimicrobial resistance

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Introduction

The issue of acute otitis media (AOM) remains a pertinent topic of research in contemporary paediatric practice, as evidenced by a significant number of recent scientific publications by both domestic and international authors. C. Gavrilovici *et al.* [1], in their study, conducted a comprehensive analysis of the bacterial spectrum associated with of AOM in children and antimicrobial resistance profiles. The authors examined 147 samples, of which 97 (65.98%) had positive cultures, with *Streptococcus pneumoniae* and *Haemophilus influenzae* being the most prevalent microorganisms. A concerning proportion – 82.85% (58/70) of *Streptococcus pneumoniae* strains – were found to be multidrug-resistant, highlighting the seriousness of antibiotic resistance even in the era of pneumococcal conjugate vaccines. A. Danishyar & J.V. Ashurst [2] presented a thorough analysis of current approaches to the diagnosis and treatment of AOM. They highlighted that acute otitis media is the second most common paediatric diagnosis in emergency departments, surpassed only by upper respiratory tract infections. The researchers noted that although AOM can occur at any age, it is most frequently observed between of 6 and 24 months of ages.

B. Zielnik-Jurkiewicz & A. Bielicka [3] identified *S. pneumoniae* as the most frequently isolated pathogen from the middle ear in children with treatment failure of AOM. The authors found that most strains were antibiotic-resistant and proposed microbiological identification of bacterial strains and determination of their resistance levels as a necessary component of effective treatment. In large-scale epidemiological study, G.J. Huang *et al.* [4] systematically analysed of the global burden of otitis media across 204 countries and territories over nearly 30 years. This investigation was part of the Global Burden of Disease study 2021 and provided unique data on the temporal trends in the prevalence of otitis media on a global scale. This investigation, conducted as part of the Global Burden of Disease Study 2021, provided unique insights into temporal trends in the prevalence of otitis media worldwide. V. Frey Esgård *et al.* [5] analysed diagnostic methods and written recommendations for AOM in primary care. The authors underscored the importance of accurate diagnosis at the primary healthcare level and the need to standardise diagnostic approaches.

The study by P. Bajorski *et al.* [6] demonstrated that 80% of recurrent acute otitis media episodes in children occurred between of 6 and 21 months of ages, with the majority intervals between episodes being less than 5 months. The researchers identified predictors facilitating the forecasting of further episodes and the assessment of the appropriateness of tympanostomy tube insertion. G. Castelli Gattinara *et al.* [7] presented evidence-based recommendations for antibiotic therapy in acute and recurrent otitis media in children. The authors focused on the rational use of antibiotics for mild, severe, and recurrent forms of otitis in previously healthy children, emphasising the need for an individualised approach. In the systematic review by H.L. Gaddey *et al.* [8] analysed current approaches to the diagnosis and treatment of AOM. The authors noted that by the age of three, 50% to 85% of children will have experienced at least one episode of AOM, making it a virtually universal childhood experience.

The study emphasised the importance of symptomatic diagnosis and rational antibiotic prescription. Thus, the analysis of contemporary literature demonstrated that the issue of acute otitis media is at the forefront of international medical attention. The main research direction focused on combating antibiotic resistance, developing new diagnostic approaches, implementing rational antibiotic therapy, and creating effective preventive strategies. The paucity of Ukrainian studies in international databases indicated the necessity to intensify scientific efforts in this crucial paediatric field. Therefore, the aim of the study was to comprehensively assess the clinical course of otitis media in children with acute upper respiratory tract infections, contingent upon the aetiology of the disease, to identify key pathogenetic and prognostic factors, and to develop a comprehensive, evidence-based management strategy. This includes the implementation of feasible outpatient diagnostic methods and tailored treatment approaches.

Materials and Methods

The study included 68 patients aged from 1 to 13 years who met the inclusion criteria and did not have any of the exclusion criteria. Inclusion criteria were: presence of symptoms of acute upper respiratory tract infection and clinical signs indicating otitis media. Exclusion criteria included: established immunodeficiency states, chronic otitis media, anatomical malformations of the ear or nasopharynx, oncological diseases, recent (within the last 2 weeks) use of systemic antibiotics, as well as lack of informed consent from parents or legal representatives. According to the features of postembryonic development, the patients were divided into the following age groups: infancy (up to 12 months) – 28 children (41.2% of the total), including 12 boys (42.9%) and 16 girls (57.1%); early childhood (1-3 years) – 19 children (27.9%), including 8 boys (42.1%) and 11 girls (57.9%); first childhood (4-7 years) – 13 children (19.1%), including 6 boys (46.2%) and 7 girls (53.8%); second childhood (8-12 years for boys, 8-11 years for girls) – 7 children (10.3%), including 3 boys (42.9%) and 4 girls (57.1%); adolescence (13-16 years for boys, 12-15 years for girls) – 1 girl (1.5%) aged 13 years.

Patients were consecutively recruited between January and April 2025, allowing coverage of the seasonal increase in viral and bacterial infections. During history taking, special attention was paid to the presence of concomitant diseases, frequent viral upper respiratory infections, allergic conditions, and potential risk factors for complications such as premature birth, gastroesophageal reflux, immunodeficiency states, and anatomical abnormalities of the nasopharynx. Diagnosis of otitis media included video endoscopy of the upper respiratory tract and ear with assessment of tympanic

membrane mobility and condition, the condition of the auditory canal, as well as laboratory methods, including complete blood count and C-reactive protein (CRP) level when necessary to differentiate viral and bacterial aetiology. Since the study was conducted in an outpatient setting with limited diagnostic resources, this approach was the only feasible method for differential diagnosis. The treatment of patients was conducted in accordance with the Unified Clinical Protocol of Primary, Secondary (Specialised), and Tertiary (Highly Specialised) Medical Care: Acute Otitis Media [9], developed by the State Expert Centre of the Ministry of Health of Ukraine. In cases of confirmed bacterial infection, antibacterial therapy was prescribed (amoxicillin as the first-line drug, or amoxicillin/clavulanate in cases of increased resistance risk). In cases of viral infection, symptomatic treatment was provided, which included antipyretics or analgesics, necessarily combined with irrigation therapy of the upper respiratory tract. The study was conducted in accordance with the ethical principles of the Helsinki Declaration [10]. The parents and legal guardians of all participants in the experiment were informed about the risks associated with participation in the study and the publication of data, as well as the conditions for maintaining confidentiality. Written informed consent was obtained prior to inclusion in the study groups. No biological material in the form of tissues or cells was used. Clinical observations complied with modern standards of assessment in paediatric practice.

Parallel to the clinical study, a systematic analysis of contemporary scientific literature was conducted using electronic databases such as PubMed, Google Scholar, and Web of Science. The search was performed using keywords and their combinations: "otitis media", "acute otitis media", "middle ear infection", "upper respiratory tract infection", "Eustachian tube dysfunction", "paediatric otitis", "complications of otitis media", "antibiotic resistance in otitis media", and "treatment protocols for otitis media". Particular attention was paid to articles published during the period from 2020 to 2025, which contained detailed descriptions of clinical manifestations, modern approaches to diagnosis, treatment, and prevention of complications of otitis in the context of upper respiratory tract infections.

Results

Etiological factors in the development of otitis media

Etiologically, middle ear infections may be caused by viral, bacterial, or mixed agents. The most common pathogens of otitis media are *Streptococcus pneumoniae* [11, 12], *Haemophilus influenzae* [13], as well as *Streptococcus pyogenes*, *Moraxella catarrhalis*, *Staphylococcus aureus*, *Viridans streptococci*, and *Pseudomonas aeruginosa* [14]. These microorganisms are characterised by high virulence and the ability to adhere to the mucous membrane of the respiratory tract, facilitating their further penetration into the middle ear. Viral pathogens include rhinoviruses, adenoviruses, influenza and parainfluenza viruses, which commonly trigger upper respiratory tract infections, thereby creating favourable conditions for secondary bacterial infection. Viral infections of the upper respiratory tract, particularly those caused by respiratory syncytial virus (RSV), influenza virus, and adenovirus, play a leading epidemiological and pathogenetic role, as they are significantly more often associated with the development of otitis media.

Anatomical features of childhood. The middle ear, which is an air-filled cavity lined with respiratory epithelium, is anatomically connected to the nasopharynx via the Eustachian tube, which provides secretion drainage and maintains normal pressure in the middle ear cavity [14]. This anatomical structure ensures ventilation of the tympanic cavity and mucus drainage, so any dysfunction contributes to fluid accumulation and inflammation development. In infants and children, the structure of the Eustachian tube differs from that in adults: it is shorter, positioned more horizontally, and only reaches adult form by approximately seven years of age. At rest, the tube is usually closed. It opens during yawning and swallowing. Any anatomical or physiological dysfunction of the tube can lead to AOM. In children, the Eustachian tube is relatively shorter, wider, and more horizontal than in adults, which creates favourable conditions for unhindered entry of pathogenic microorganisms from the nasopharynx directly into the middle ear [14]. Moreover, insufficient pneumatisation of the mastoid process in children significantly increases the risk of mastoiditis [15] – a potentially dangerous complication of otitis.

Another important factor is the anatomical peculiarity of the aditus ad antrum opening, which connects the tympanic cavity with the antrum and mastoid cells – in children, this canal is wider, facilitating faster spread of the infectious process to adjacent structures. When infectious agents penetrate the mucosa of the Eustachian tube, swelling occurs, leading to its obstruction. Obstruction disrupts normal secretion drainage and tympanic cavity ventilation, resulting in negative pressure formation. Under its influence, the mucosa of the tympanic cavity begins to secrete exudate – fluid that may be serous or purulent depending on the nature of the pathogen. In viral infections, the exudate is usually clear and contains no significant leukocytes, whereas in bacterial infections it becomes thicker and purulent due to active migration of neutrophils and other immune cells to the site of inflammation. This pathological process causes characteristic clinical manifestations, including ear pain, hearing loss, and fever. From a pathogenetic point of view, otitis development is closely related to Eustachian tube dysfunction, which often occurs against the background of infection. As a result, negative pressure forms in the tympanic cavity, exudate accumulates, and favourable conditions arise for colonisation and multiplication of bacterial pathogens.

Routes of infection spread. Infection can enter the middle ear through various pathways, the most common of which is the retronasal route – the penetration of infection from the nasopharynx through the Eustachian tube into the middle ear [14]. Under normal conditions, the Eustachian tube plays an important role in ventilating the middle ear and maintaining pressure equilibrium between

the tympanic cavity and the external environment. However, during inflammatory processes in the nasopharynx, especially in acute respiratory viral infections, the mucosa of the tube swells, which reduces its patency. This creates favourable conditions for the retrograde spread of pathogenic microorganisms into the middle ear. Children, especially those under three years of age, have an increased risk of this infection mechanism due to the anatomical characteristics of the Eustachian tube – its short, wide, and horizontal structure.

Another mechanism is the haematogenous route, where pathogens reach the middle ear through the bloodstream. This route of spread occurs less frequently than the retronasal pathway but becomes important in systemic infectious diseases. For example, measles, scarlet fever, or influenza may be accompanied by generalised bacteraemia or viraemia, resulting in pathogens reaching various organs and tissues, including the middle ear.

The third infection route is the so-called traumatic pathway, which occurs when the tympanic membrane is damaged. Normally, this structure is a reliable barrier protecting the middle ear from the external environment. However, as a result of trauma, tympanic membrane perforation, or complicated acute purulent otitis, a hole may form through which pathogenic microorganisms directly enter the middle ear. Without appropriate treatment, purulent fluid from the middle ear can spread to adjacent anatomical areas and lead to complications such as tympanic membrane perforation, mastoiditis, labyrinthitis, petrositis, meningitis, brain abscess, hearing loss, lateral or cavernous sinus thrombosis, and other complications [15].

In this context, early diagnosis and timely treatment of otitis are particularly important for preventing such complications. Although acute otitis media is a very common disease among children [9], the precise benefit of antibiotic therapy in paediatric AOM remains a subject of debate. The global problem of increasing antibiotic resistance among the main bacterial pathogens of otitis significantly complicates the choice of effective antibacterial therapy and potentially may lead to the ineffectiveness of standard treatment regimens. In this context, rational use of antibiotics based on modern diagnostic methods and an individualised approach to each patient becomes especially important.

Description of the sample. To conduct a more detailed analysis of the clinical manifestations of middle ear otitis in children, a study was carried out aimed at examining its etiological structure depending on the age category of patients. It was found that the nature of the disease course, the form of otitis, and the type of pathogen vary significantly across different age groups. Etiological verification was performed based on the results of video endoscopic examination and laboratory diagnostic methods. Consolidated data on the distribution of cases of secretory, purulent, and viral otitis by age groups are presented in Table 1.

Table 1. Distribution of otitis media aetiology by age groups

Age group	Total patients (n)	Secretory otitis	Purulent otitis	Virus otitis
Infancy (up to 12 months)	28	11 (39.3%)	9 (32.1%)	8 (28.6%)
Early childhood (1-3 years)	19	8 (42.1%)	6 (31.6%)	5 (26.3%)
First childhood (4-7 years)	13	4 (30.8%)	6 (46.2%)	3 (23.1%)
Second childhood (8-11 years)	7	2 (28.6%)	3 (42.9%)	2 (28.6%)
Adolescence (13+ years)	1	1 (100%)	0 (0%)	0 (0%)
Total	68	26 (38.2%)	24 (35.3%)	18 (26.4%)

Source: created by the authors based on the results of the study

Analysis of the obtained data demonstrates variability in the etiological structure of middle ear otitis depending on the age of the patients. In younger age groups (infant and early childhood), viral aetiology predominates, whereas in patients of older age categories, the bacterial nature of the disease is more frequently detected. The secretory form of otitis dominates in all age groups, indicating its high prevalence regardless of age. These results emphasise the necessity of a differentiated approach to the diagnosis and treatment of middle ear otitis, taking into account age-related characteristics and the etiological factor.

The duration from the onset of the disease to seeking medical help ranged from 1 to 6 days, with 42 patients (61.8%) seeking help on the 2nd or 3rd day after the onset of symptoms. Ear pain and the sensation of ear fullness were the main symptoms observed in 42 (61.7%) of the examined patients, regardless of age group. The obtained results regarding the duration from the onset of symptoms to seeking medical help demonstrate an important clinical trend. Most patients (61.8%) sought medical help on the 2nd-3rd day after the onset of the disease, which may indicate moderate parental vigilance and a gradual increase in clinical symptoms to a level that causes concern. Although such an approach is not delayed, it creates a risk of losing valuable time for early diagnosis, especially in young children, in whom inflammatory processes tend to progress rapidly and can cause intracranial complications.

It should be noted that only 6 patients (8.8%) sought medical help on the first day after symptom onset, indicating limited parental awareness or underestimation of the severity of otitis media at an early stage. The largest share was patients – 42 persons (61.8%) – who sought help on the 2nd-3rd day after symptom onset, which is an optimal period for starting treatment and achieving effective conservative therapy. At the same time, 20 patients (29.4%) sought help only on the 4th-6th day of the disease, which is undesirable because it increases the risk of complications, prolonged course, and reduced treatment effectiveness.

These data highlight the need for active educational work with parents regarding the importance of timely medical consultation at the first signs of upper respiratory tract infections, especially in the presence of symptoms such as ear pain, hearing loss, fever, irritability, refusal to eat, or sleep disturbances. Explaining the possible consequences of delaying medical intervention, with emphasis on the risks of purulent otitis, auditory system damage, and potential complications, should become an essential part of the daily practice of paediatricians, otolaryngologists, and family physicians.

Clinical picture. In patients with secretory otitis media, the dominant complaints were a sensation of ear fullness and hearing impairment, in the absence of pain. The leading clinical symptom of acute external otitis (AEO) is ear pain, which can be particularly intense. An important differential sign from acute middle ear otitis (MEO) is the worsening of pain when pressing on the auricle or tragus in the case of AEO. Symptoms usually develop progressively over two days. Often, a small amount of whitish discharge is observed, as well as swelling and erythema of the skin of the external auditory canal. This corresponds to the findings in the study by A. Jamal *et al.* [14].

An increase in body temperature to 38°C and higher, against the background of an upper respiratory tract infection, was observed in 58 patients (85.3% of the total), of which 52 (89.7%) were aged 1 to 5 years, and 6 (10.3%) were aged 6 to 12 years. The distribution of febrile response by aetiology is presented in Table 2, providing greater clarity regarding the correlation between fever and the underlying cause of otitis media in different age groups.

Table 2. Distribution of temperature response by types of otitis media

Temperature response	Secretory otitis (n = 26)	Bacterial (purulent) otitis (n = 24)	Viral (bullous) otitis (n = 18)
Subfebrile (37.1-38.0°C)	22 (84.6%)	6 (25.0%)	0 (0%)
Febrile (38.1-39.0°C)	4 (15.4%)	13 (54.2%)	6 (33.3%)
High febrile (> 39.0°C)	0 (0%)	5 (20.8%)	2 (11.1%)
No temperature elevation	0 (0%)	0 (0%)	10 (55.6%)
Total	26 (100%)	24 (100%)	18 (100%)

Source: created by the authors based on the results of the study

A subfebrile temperature (37.1-38.0°C) was detected in 28 patients (48.3% of all cases with elevated temperature), of which 22 (78.6%) had viral otitis and 6(21.4%) had bacterial otitis. The identification of these aetiological factors was based on the clinical presentation, objective endoscopic findings, bacteriological analysis, and laboratory investigations. This temperature response was most characteristic of young children: 8 patients (28.6%) in the infant group (up to 12 months), 13 patients (46.4%) in the early childhood group (1-3 years), 4 patients (14.3%) in the first childhood group (4-7 years), and 3 patients (10.7%) in the second childhood group (8-12 years). Clinically, these children exhibited mild irritability, occasional otalgia, and minor disturbances of sleep. In most cases (82.1%), symptomatic treatment without the use of antibiotics proved effective.

A febrile temperature (38.1-39.0°C) was recorded in 23 patients (39.7% of all cases with elevated temperature), of which 10 (43.5%) had viral otitis and 13 (56.5%) had bacterial otitis. The distribution by age groups was as follows: 9 patients (39.1%) in the infant group, 8 patients (34.8%) in the early childhood group, 4 patients (17.4%) in the first childhood group, and 2 patients (8.7%) in the second childhood group. The clinical picture was dominated by moderate or severe ear pain (91.3% of cases) and sleep disturbances (87.0% of cases).

A high-grade febrile temperature (> 39.0°C) was observed in 7 patients (12.0% of all cases with elevated temperature), of which 2 (28.6%) had viral otitis and 5 (71.4%) had bacterial otitis. The distribution by age groups was as follows: 2 patients (28.6%) in the infant group, 3 patients (42.8%) in the early childhood group, 1 patient (14.3%) in the first childhood group, and 1 patient (14.3%) in the second childhood group. All children with high fever presented with marked anorexia and pronounced asthenia.

The analysis of parental complaints and psychoemotional background as part of the anamnesis for high temperature revealed. In children, the clinical picture of otitis was accompanied by asthenovegetative symptoms such as irritability, crying, refusal to eat, sleep disturbances, and constant fatigue. Among 68 patients, 65 (95.6%) were found to exhibit these symptoms. In infants (under 12 months), typical signs included frequent touching or rubbing of the ear, as well as inconsolable crying, which worried the parents. During anamnesis collection, when asked about pain in the right or left ear, parents often described the situation indirectly: "I don't know if it hurts, she keeps touching her right ear and cries, so I think it does, but we're not sure. And she cries". In children aged 1 to 3 years, parents often elaborated on the asthenovegetative symptoms, noting signs of restlessness, persistent crying, sleep disturbances, reduced appetite, and increased irritability (17 out of 19 patients, 89.5%).

In older children (from 4 to 13 years), more specific complaints such as ear pain, a sensation of fullness, and hearing loss were reported (20 out of 21 patients, 95.2%). Asthenovegetative symptoms and manifestations in the studied group were also similar, including feelings of fatigue, difficulty concentrating, and thinking. According to parental reports, 47 patients (69.1%) experienced either temporary or permanent hearing loss. Of them, 18 patients had a viral aetiology. Discharge from the ear, which was purulent due to perforation of the eardrum, experienced in 24 patients (32.29% of the total), of which 24 (100%) had bacterial aetiology, representing 100% of all bacterial pathology. Moreover, a direct proportional relationship

between asthenia and elevated temperature was observed. In 100% of patients with a temperature exceeding 38.5°C, asthenovegetative symptoms such as lethargy and hypodynamia were noted.

Aspects of diagnosing specific forms of otitis media

Accurate and timely diagnosis is crucial for prescribing appropriate treatment. In the case of AEO, the diagnosis is established based on physical examination. For the verification of middle ear otitis with effusion, a detailed medical history combined with a thorough clinical examination is required. The presence of signs of inflammation and fluid in the middle ear, identified through anamnesis, indicates MEO. To assess the mobility of the tympanic membrane, pneumatic otoscopy is applied [14]. The identification of etiological factors and forms of otitis was based on clinical data, objective findings from endoscopic examination, bacteriological studies, and laboratory tests. According to the results of the otoscopic evaluations, 68 patients with various forms of otitis media showed characteristic morphological changes in the eardrum, which allowed for differential diagnosis between different forms of the disease. Among the examined patients, were identified 3 main forms of otitis media: secretory otitis media, acute purulent otitis media, and viral (bullous) otitis media. According to the results of laboratory blood tests including C-reactive protein (CRP) levels, it was found that in all observed groups, there was an increase in this indicator; however, in acute purulent otitis, the levels were significantly higher, which corresponds to the study by N.R. Tejani *et al.* [16]. In their study, children with bacterial acute otitis media had significantly higher CRP concentrations (mean 1.58 ± 3.16 mg/dL) compared to those with non-bacterial forms (mean 0.64 ± 1.24 mg/dL). Moreover, elevated CRP levels above 2.0 mg/dL were found in 22% of bacterial AOM cases, whereas only 6% of non-bacterial cases reached this threshold, suggesting a strong association between CRP elevation and bacterial aetiology.

In 26 patients from the secretory otitis group, pronounced changes in the nasopharynx during endoscopy were observed, including an increase in adenoid vegetations, the dripping of mucopurulent secretion along the back wall of the pharynx, and hyperaemia of the mucosa at the level of the nasopharyngeal vault. It should be noted that secretory otitis media does not always indicate a specific aetiology and can be a result viral, bacterial, or combined upper respiratory tract infections. The data are presented in Table 3.

Table 3. Etiological characteristics of different forms of otitis media in the study population

Type of otitis	Number of patients	Percentage of patients	Aetiology
Secretory otitis	26	38.2	Viral
Acute purulent otitis	24	35.3	Bacterial
Bullous otitis	18	26.4	Viral

Source: created by the authors based on the results of the study

Secretory otitis (Fig. 1), diagnosed in 26 patients (38.2%), is characterised by a milky appearance of the tympanic membrane, most prominently in the area of the handle of the malleus and the light reflex. In 17 cases, retraction Figure 1b of the eardrum was observed, indicating impaired ventilation of the middle ear and a decrease in pressure in the tympanic cavity. In this form of otitis media, the integrity of the eardrum is preserved, and fluid accumulation (Fig. 1a) is present in the middle ear in 9 patients, without clear signs of acute ear inflammation. Secretory otitis media is characterised by the presence of effusion in the middle ear and may last up to 12 weeks following an episode of acute otitis media, regardless of the primary aetiology.

In acute purulent otitis (Fig. 2), which was identified in 24 patients (35.3%), there is pronounced hyperaemia of the tympanic membrane, accompanied by its bulging (2 patients, Fig. 2d), indicating the presence of purulent exudate in the middle ear cavity. The light reflex in such cases is absent, flattened, or appears as a weak flash. A characteristic feature of acute purulent otitis was the perforation of the tympanic membrane (21 patients, Fig. 2a, b, c) with the presence of purulent discharge in the external auditory canal. This form of otitis had a bacterial aetiology and was accompanied by febrile or high-grade febrile temperature.

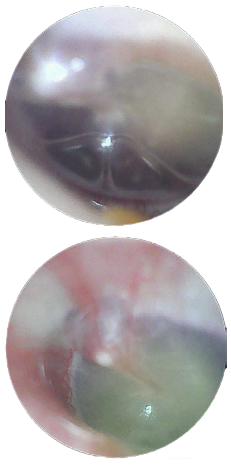

Figure 1. Secretory otitis

Notes: a – fluid accumulation behind the intact tympanic membrane in secretory otitis media (milky appearance); b – retraction of the tympanic membrane indicating impaired middle ear ventilation

Source: created by the authors based on the results of the study

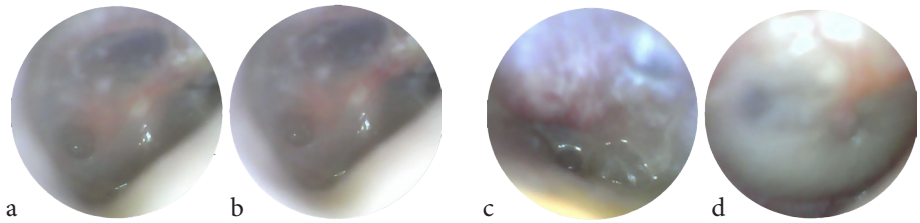

Figure 2. Perforated acute purulent otitis media: Visible perforation with inflammatory signs
Notes: a – tympanic membrane perforations with purulent discharge in acute purulent otitis media; b – tympanic membrane perforations with purulent discharge in acute purulent otitis media; c – angular perforation of the tympanic membrane with purulent discharge in acute purulent otitis media; d – bulging and hyperaemic tympanic membrane indicating purulent exudate in the middle ear
Source: created by the authors based on the results of the study

Viral (Bullous) otitis (Fig. 3), which was identified in 18 patients (26.4%), was characterised by the formation of typical bullae on the surface of the eardrum, filled with serous or haemorrhagic contents. This form of the disease is associated with damage to the endothelium and nerve fibres and had a viral aetiology. Patients with bullous otitis complained of intense, pulsating pain in the ear due to the involvement of nerve endings in the inflammatory process. Clearly visualised during otoscopy, these bullae are a pathognomonic sign of this form of otitis and were observed in the form of a single (Fig. 3a, c, d) and multiple bullae (Fig. 3b).

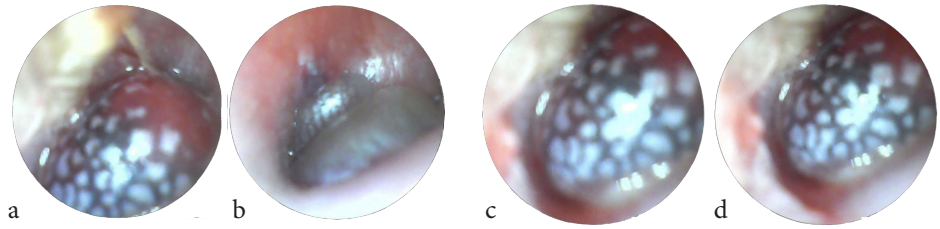

Figure 3. Bullous otitis media: characteristic bullae on the tympanic membrane
Notes: a – single bullae on the tympanic membrane filled with haemorrhagic fluid in viral (bullous) otitis; b – multiple bullae visible on the tympanic membrane in viral (bullous) otitis; c – single bullae on the tympanic membrane filled with serous fluid in viral (bullous) otitis; d – single bullae on the tympanic membrane filled with haemorrhagic fluid in viral (bullous) otitis
Source: created by the authors based on the results of the study

These observations during otoscopic examination not only allowed for the diagnosis of different forms of middle ear otitis but also provided the opportunity to assess the degree of the inflammatory process and select appropriate personalised treatment strategies for each patient individually. In particular, the presence of haemorrhagic bullae (Fig. 3a, d) was associated with a more intense inflammatory response and higher levels of discomfort reported by the patients. The differentiation between serous and haemorrhagic content (c vs d) also contributed to distinguishing viral aetiologies and guided the decision-making process regarding the need for symptomatic versus antimicrobial therapy.

Treatment. Treatment of otitis media requires a comprehensive approach that considers the patient's age, clinical picture, and potential complications. Effective therapy aims to combat the infection, reduce inflammation in the upper respiratory tract, relieve pain, and prevent possible complications. The main method of treating bacterial otitis media is the use of antibacterial therapy. All patients with a bacterial aetiology of the disease and purulent discharge in the external auditory canal underwent microbiological testing to determine sensitivity and prevent antibiotic resistance. In this study, bacterial aetiology was identified in 35.3% (24 out of 68) of patients. In 100% of these cases, amoxicillin was prescribed, as the bacterial flora was sensitive to this drug. The dosage was based on the child's body weight. Alternative antibiotics, such as macrolides, were not used, which may indicate the absence of allergic reactions to penicillins in the studied groups. The use of antibiotics is justified when the clinical picture indicates a bacterial infection, for example, in the presence of high fever, purulent ear discharge, or severe ear pain. First-line drugs in such cases are antibiotics from the penicillin group, particularly amoxicillin, as confirmed by the research of G. Castelli Gattinara *et al.* [7], who also recommend amoxicillin as a first-line drug in their Italian intersocietal consensus.

If the disease is accompanied by an acute clinical picture or there is a risk of developing antibiotic-resistant bacterial strains, the physician may prescribe amoxicillin in combination with clavulanic acid (amoxicillin-clavulanate). This combination is effective even against bacteria that produce beta-lactamases, making them resistant to regular penicillins. In cases where the patient has an allergic reaction to penicillins, an alternative is the prescription

of antibiotics from the macrolide group, such as azithromycin or clarithromycin. Macrolides are the drugs of choice for diseases caused by atypical pathogens such as Mycoplasma pneumoniae or Chlamydia pneumoniae, as noted by J.O. Klein [17]. Although this therapeutic option was noted for completeness, no cases of atypical bacterial infections were found among the study participants; thus, this recommendation remained theoretical in the context of this study. Decongestants were prescribed in 55 out of 68 cases (80.9%) in the form of nasal drops or sprays according to paediatric dosage. These medications are an important part of otitis therapy, as decongestants improve the patency of the Eustachian tube in cases with a tendency toward bacterial processes. This helps normalise middle ear pressure and reduce nasopharyngeal mucosal swelling. Preparations based on xylometazoline or oxymetazoline quickly relieve nasal congestion, which promotes better drainage of exudate from the middle ear cavity, aligning with the recommendations of T. Hayashi *et al.* [13] regarding the importance of Eustachian tube patency. The use of decongestants should be limited to 5-7 days to avoid the development of medication-induced rhinitis. Subsequently, nasal irrigation is recommended. Nasal irrigation – irrigation therapy (with saline solutions) – was used in only 12 cases (17.6%). It is also worth noting the use of topical corticosteroids to reduce local inflammation. In the current study, mometasone was used in 100% of cases.

Analgesics, particularly non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, may be used alone or in combination to achieve effective pain control in patients with otitis media. As noted by J.L.H. de Sévaux *et al.* [18], ibuprofen and paracetamol are the most widely used drugs in children. This is also confirmed by the results of the current study, where ibuprofen was prescribed in 94% of cases and paracetamol – in 87%. In patients with secretory otitis (38.2% of cases), analgesics were not used, unlike cases of acute purulent otitis (35.3%) and bullous otitis (26.4%), where analgesics were the main component of therapy. A similar approach is described in the study by Y. Bondarenko *et al.* [19], who also reported combined use of ibuprofen with paracetamol in 12.5% of cases – mainly in cases of severe pain (Visual Analogue Scale (VAS) > 5) or hyperthermia, which corresponds to observations regarding the need for enhanced analgesic therapy in severe cases. Specifically, authors note that in 13 children there was a decrease in intervals between fever peaks when monotherapy with ibuprofen or paracetamol proved insufficiently effective. In such cases, doctors resorted to alternating antipyretics – a strategy allowed by current clinical guidelines as an exceptional measure in cases of resistant hyperthermia. The alternating scheme involved administering paracetamol at a dose of 10-15 mg/kg, followed 4 hours later by ibuprofen at 5-10 mg/kg, with strict adherence to the maximum allowable daily doses. This approach is based on pharmacokinetic characteristics: ibuprofen is usually administered every 8 hours, and paracetamol every 4 hours, which allows for alternation. Combined therapy was not prescribed for more than 3 days. However, the authors emphasise that this strategy has limited application due to the risk of overdose, potential masking of progressive disease symptoms, and possible toxic load on the liver and kidneys. Moreover, there is currently insufficient evidence for the superiority of alternating antipyretics over monotherapy in terms of efficacy and safety, as noted by other researchers [19].

In cases of mild pain (VAS≤5), clinical guidelines recommend the use of local analgesics based on phenazone and lidocaine as first-line treatment. According to NICE guidelines, phenazone 40 mg/g in combination with lidocaine 10 mg/g is recommended as ear drops – 4 drops 2-3 times a day for up to 7 days [20]. This combination should be used only when immediate oral antibiotics are not prescribed and there is no perforation of the tympanic membrane or otorrhoea. At the same time, due to the outpatient format of this study and limited availability of local medications, only systemic symptomatic therapy was used. Ibuprofen was used mainly due to its combined analgesic and anti-inflammatory action, whereas paracetamol was used as an antipyretic. A.S. Lieberthal *et al.* [21] also noted that ibuprofen may have advantages in pain control due to its anti-inflammatory component, especially in cases of mild to moderate pain. Despite clear recommendations for the use of analgesics in acute otitis media in children, as noted by J.L.H. de Sévaux *et al.* [18], existing data on the effectiveness of paracetamol or NSAIDs – both as monotherapy and in combination – remain limited. The authors noted that data comparing the efficacy of ibuprofen with paracetamol, as well as their combination, are contradictory, which complicates the formation of definitive clinical conclusions.

In the presented study, local antiseptic drops were not used in cases of viral or secretory otitis. However, as noted by J. Buyten *et al.* [22], in cases of bacterial origin, drops based on ciprofloxacin or ofloxacin may be appropriate. Such treatment should be conducted under medical supervision, taking into account the risks associated with tympanic membrane perforation. In cases of severe course or presence of purulent effusion before perforation, surgical intervention may be appropriate. R.E. El Feghaly *et al.* [11] emphasised the effectiveness of paracentesis (myringotomy) for draining the middle ear cavity, which helps reduce pain and prevent complications. In patients with chronic effusion accumulation or frequent relapses, tympanostomy is recommended, which provides long-term drainage. The obtained data are practically significant for choosing a rational treatment approach. In younger age groups, a cautious approach to antibiotic prescription is appropriate, as in the vast majority of cases otitis has a viral aetiology and may be self-limiting with symptomatic treatment, adequate monitoring, and observation of the child's condition. For such patients, the use of analgesics and anti-inflammatory drugs, nasal decongestants, and evaluation of treatment effectiveness within 48-72 hours before considering the need for antibacterial therapy is recommended.

In contrast, in older children, especially adolescents, clinicians should maintain heightened vigilance regarding the bacterial nature of otitis, especially when symptoms such as persistent fever, otorrhoea, severe ear pain, signs of intoxication, hearing loss, or lack of improvement during symptomatic therapy are present. In such cases, early prescription of antibiotics is justified, and the choice of drug should be based on clinical guidelines, where amoxicillin is the first-line drug considering local antibiotic resistance patterns. In paediatric practice, it is important to timely identify clinical prognostic factors indicating the risk of complicated otitis. Key factors that should alert the physician include the child's age – especially the first three years of life, when the likelihood of recurrences increases. Also significant is the presence of frequent episodes of otitis in the history, indicating a chronic predisposition to the disease. Other alarming signs include high body temperature, otorrhoea, hearing loss, and general signs of intoxication, such as drowsiness, refusal to eat, sleep disturbances, and decreased activity [21]. Modern clinical guidelines emphasise the advisability of outpatient treatment of uncomplicated cases of otitis media in children, especially with probable viral aetiology. In such cases, the main method is symptomatic treatment, including the use of antipyretics and analgesics, nasal cavity sanitation, adequate hydration, and monitoring of the child's general condition. A mandatory follow-up examination within 48 hours is required to assess disease progression and identify possible bacterial complications [15]. Empirical prescription of antibiotics without clear objective indications should be avoided, as it contributes to the development of antibiotic resistance, complications, and microbiome disruption. This was demonstrated in the study by P.A. Knupp-Pereira *et al*. [23].

Indications for antibacterial therapy include the presence of pronounced clinical symptoms, particularly in children under 2 years of age combined with severe symptoms, purulent ear discharge as a sign of tympanic membrane perforation, febrile or high temperature, severe general condition, signs of systemic intoxication, lack of improvement following 48-72 hours of symptomatic treatment. In such cases, amoxicillin remains the drug of choice with proven efficacy against the main bacterial pathogens of otitis. Prevention of otitis media plays an important role in reducing morbidity and preventing intracranial complications. One of the key directions is effective control of upper respiratory tract infections – timely treatment of rhinitis, pharyngitis, and adenoiditis reduces the risk of infection spreading to the ear cavity. An important preventive measure is vaccination against pneumococcus and influenza, as these pathogens often cause or complicate the course of otitis. It is also necessary to eliminate modifiable risk factors: passive smoking, which negatively affects the mucous membrane of the respiratory tract; nutritional disorders that weaken immunity; and adenoids, which create conditions for chronic inflammation. Thus, the modern approach to the treatment of otitis media in children involves a differentiated strategy depending on the patient's age, clinical picture, and disease severity. A balanced combination of symptomatic therapy with rational use of antibacterial drugs is a priority, allowing optimal treatment outcomes while minimising the risk of antibiotic resistance and side effects. It is especially important to pay attention to foci of chronic infection at the level of the upper respiratory tract, especially at the level of the nasopharynx and the Pirogov-Waldeyer lymphoepithelial ring.

Conclusions

The conducted study revealed a clear relationship between age and the aetiology of middle ear otitis in children, which has significant clinical implications for differentiated approach to diagnosis and management. In younger age groups, particularly among infants (up to 1-year-old), 67.9% of otitis cases were a viral origin. In early childhood (1-3 years), viral aetiology was found in 63.2% of cases, and in preschoolers (3-6 years) – in 53.8%. This trend indicates a high frequency of virus-associated forms of otitis in children under 7 years, often occurring against the background of acute respiratory viral infections, including adenoviral or rhinoviral infections, and owing to the functional and anatomical characteristics of the auditory (Eustachian) tube in infants.

Meanwhile, in older age groups, such as middle childhood (7-12 years) and adolescence (13-17 years), the proportion of bacterial otitis cases increases significantly. Specifically, in middle childhood, bacterial aetiology accounted for 57.1% of cases, and in adolescence – 100%. This trend may be related to a more mature immune system, a lower frequency of otitis association with viral infections, and an increased frequency of complicated courses of upper respiratory infections in this age group.

A connection was also found between the type of temperature response and the aetiology of the disease. Subfebrile temperature (37.1-38.0°C) is more often associated with viral processes (64.7% of cases), while febrile (38.1-39.0°C) and high fever temperatures (> 39.0°C) are characteristic of bacterial infections (54.2% and 20.8%, respectively). This supports the use of temperature as a readily available and simple clinical marker for the preliminary assessment of disease aetiology and the necessity for antibiotic therapy.

The use of video endoscopy made it possible to differentiate three main clinical-morphological forms of middle ear otitis: secretory otitis (38.2% of cases), acute purulent otitis (35.3%, bacterial aetiology), and bullous otitis (26.4%, predominantly viral origin). The obtained morphological changes in the tympanic membrane were typical for each form, highlighting the diagnostic value of video endoscopy and the need for its broader adoption in routine paediatric practice, especially in cases of ineffective therapy or recurrent episodes of otitis.

Thus, the results of the study emphasise the need for an individualised approach to diagnosing and treating middle ear otitis in children, taking into account age, clinical symptoms, temperature response, otoscopy results, and video endoscopy data. This approach not only helps improve

treatment outcomes and reduce the risk of complications but also minimises the inappropriate use of antibiotics, which is important in the context of growing antibiotic resistance. Among the most important treatment recommendations confirmed by the study results are the prescription of amoxicillin as the first-line drug in confirmed bacterial aetiology, refraining from antibacterial therapy in cases of viral otitis without signs of a severe course, the use of symptomatic agents (antipyretics, analgesics, vasoconstrictive drugs), and the evaluation of treatment effectiveness after 48-72 hours with subsequent adjustment of the strategy if necessary. It is also important to emphasise the widespread implementation of video endoscopy as an effective tool for differentiating forms of otitis.

Considering the obtained results, a promising direction for further research is the development and clinical testing of unified diagnostic algorithms using video endoscopy for the early detection of various forms of otitis media, especially in young children, where the clinical picture may be nonspecific. Special attention should be given to studying the effectiveness of stepwise antibiotic therapy depending on the form of otitis and the age of the child, as well as evaluating the role of combined use of systemic and local anti-inflammatory agents in reducing symptoms and preventing complications.

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