ANALYSIS OF THE AETIOLOGY OF ACUTE SUPPURATIVE OTITIS MEDIA IN PATIENTS TREATED BETWEEN 2023 AND 2024 AT THE MILITARY INSTITUTE OF MEDICINE – NATIONAL RESEARCH INSTITUTE, DEPARTMENT OF PAEDIATRICS, NEPHROLOGY AND PAEDIATRIC ALLERGOLOGY

Analiza etiologii ostrych ropnych zakażeń ucha środkowego u pacjentów hospitalizowanych w Klinice Pediatrii, Nefrologii i Alergologii Dziecięcej Wojskowego Instytutu Medycznego – Państwowego Instytutu Badawczego leczonych w latach 2023–2024

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Abstract

Introduction and objective: Acute otitis media is one of the most common inflammatory conditions in childhood. The aim of the study was to analyse the aetiology of acute suppurative otitis media in paediatric patients hospitalised between 2023 and 2024. **Materials and methods:** Seven patients with acute suppurative otitis media with perforation who underwent ear canal swabbing for culture were retrospectively analysed. **Results:** The following pathogens were isolated: *Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus pyogenes* and *Staphylococcus epidermidis*. **Conclusions:** Culture with antibiogram is crucial in cases with tympanic membrane perforation and purulent discharge for selecting a targeted and effective antibiotic therapy.

Streszczenie

Wprowadzenie i cel: Ostre zapalenie ucha środkowego jest jedną z najczęstszych chorób zapalnych wieku dziecięcego. Celem pracy była analiza etiologii ostrych ropnych zapaleń ucha środkowego z perforacją u pacjentów pediatrycznych, hospitalizowanych w latach 2023–2024. **Materiał i metody:** Analizie retrospektywnej poddano dane pacjentów hospitalizowanych z powodu ostrego ropnego zapalenia ucha środkowego z perforacją, u których wykonano wymaz z przewodu słuchowego i posiew uzyskanego materiału. **Wyniki:** U dzieci, u których wykonano posiew ropnej wydzieliny z objętego zapaleniem ucha wyizolowano następujące patogeny: *Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Staphylococcus epidermidis*. **Wnioski:** W przypadku perforacji błony bębenkowej i wycieku ropnej wydzieliny ocena posiewu z antybiogramem jest kluczowa w doborze celowanej i skutecznej antybiotykoterapii.

Keywords: *Streptococcus pyogenes*; *Pseudomonas aeruginosa*; acute suppurative otitis media

Słowa kluczowe: *Streptococcus pyogenes*; *Pseudomonas aeruginosa*; ostre ropne zapalenie ucha środkowego

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Introduction

Acute suppurative otitis media (ASOM) is a common childhood infection characterised by a sudden onset of symptoms and a dynamic course. The tympanic mucosa, the mastoid cavity, and the Eustachian tube may be involved. The incidence of cute otitis media (AOM) peaks in the autumn and winter. Most cases occur in children between 6 and 24 months of age [1]. About 60% of children under 4 years of age have had at least one AOM episode [2]. The infection typically spreads from the nasal cavity or nasal pharynx, through the Eustachian tube. The blood-borne route may co-occur in the course of severe infectious diseases, while the exogenous route is a direct consequence of tympanic membrane trauma.

Patients with AOM, which typically occurs as a complication of viral respiratory tract infection, usually present with bacterial and/or viral discharge in the tympanic cavity [3]. Otitis media, recurrent acute otitis media (RAOM) and chronic otitis media with effusion (COME) in particular, may affect language and cognitive development. AOM risk factors include:

- Eustachian tube dysfunction;
- recurrent upper respiratory tract infections (mainly in children attending nurseries/kindergartens);
- inhalant and food allergies;
- hypertrophied pharyngeal tonsil;
- craniofacial abnormalities;
- exposure to tobacco smoke;
- short breastfeeding (up to 3 months of age) [4, 5].

The clinical picture of AOM depends on the patient's age and is characterised by a wide spectrum of symptoms ranging from restlessness, reluctance to suck, tender tragus in infants; through rhinitis, fever, cough, vomiting in older children, including specific symptoms of ear inflammation, such as ear pain, hearing impairment or discharge in the ear canal. Symptoms of tympanic membrane (TM) perforation include an increase in pain and its resolution after the leakage of blood-stained purulent contents. In addition to the clinical picture, the diagnosis is based on otoscopic findings. The image of the tympanic membrane in AOM may vary, depending on the duration and aetiology of infection. The following 4 features of the tympanic membrane are assessed during otoscopy: position, mobility, colour and transparency. Congestion and thickening of the tympanic membrane, dilated TM vessels, impaired mobility and reduced transparency obscuring anatomical details are indicative of inflammation. TM malformation into the external auditory canal has the greatest predictive value in identifying tympanic effusion [6]. The presence of purulent discharge behind TM indicates bacterial aetiology. In 12 of the 17 guidelines reviewed, the diagnosis of AOM was based on the presence of fever and otalgia, effusion in the tympanic cavity and TM inflammation [7, 8]. About 50% of patients with AOM do not develop otalgia, and tender tragus alone does not indicate middle ear inflammation.

Management depends on the child's age and clinical symptoms. Since viruses are the main aetiology of AOM in children, symptomatic management is the treatment of choice. Ibuprofen is the preferred treatment for relieving symptoms due to its anti-inflammatory effects. It alleviates pain and fever within 24 hours in 2/3 of children with AOM. Lack of improvement after symptomatic treatment in a follow-up after 1–3 days, including increased TM congestion, persistent fever >38°C, or effusion behind TM, is an indication for antibiotic therapy. Other indications include:

- age <6 months;
- fever >39°C;
- severe earache;
- vomiting;
- children <2 years of age with bilateral or severe AOM;
- craniofacial malformations;
- autoimmune deficiencies;
- Down's syndrome;
- ear discharge,
- recurrent AOM: 3 episodes/6 months or 4 episodes/year [9].

The incidence of TM perforation is estimated at 2–10% of all diagnosed AOM cases. If AOM is accompanied by purulent discharge, an ear swab should be done before starting antibiotics. Appropriately selected antimicrobial therapy leads to discharge resolution and spontaneous closure of perforated TM. Most guidelines point to amoxicillin as first-line treatment. In the case of failure, amoxicillin with clavulanic acid or ceftriaxone is recommended [3]. Topical antibiotics are not recommended due to limited efficacy and the risk of complications in cases of membrane disruption. Topical treatment is reserved for patients with ventilation drainage, where the use of ciprofloxacin drops may be considered at an initial stage [9].

Aim

The aim of this study was to analyse the aetiology and treatment outcomes in acute suppurative otitis media in our patients.

Materials and methods

Medical records of patients treated for AOM with TM perforation in the Department of Paediatrics, Paediatric Nephrology and Allergology of Military Institute of Medicine – National Research Institute (WIM-PIB) in the period from 3rd May 2023 to 11th May 2024. The following data were collected: sex, age at diagnosis, clinical symptoms (fever, ear discharge, TM perforation), aetiology of infection and treatment used. Otitis was diagnosed as a red TM in otoscopy and the presence of purulent discharge. All patients had swabs taken from the external ear canal for culture. The infection status was verified in the Microbiology Laboratory of the Department of Laboratory Diagnosis (WIM-PIB). Data enabling identification of patients (name, surname, Polish Resident ID No.) were included in the analysis. The personnel of the Department of Paediatrics, Paediatric Nephrology and Allergology (WIM PIB) were the administrators of the patients' data.

Results

Of the children diagnosed and treated for AOM with TM perforation in the Department of Paediatrics, Paediatric Nephrology and Allergology, positive culture was ob-

tained in 7 children (2 girls and 5 boys) aged between 5 weeks and 10 years. Patients' data, such as age, sex, AOM aetiology, otoscopic TM image, vaccination status, presence of fever, and antibiotic therapy used, are presented in Table 1.

Four out of seven children presented with general symptoms, including fever; 6/7 patients had undergone full mandatory vaccination programme. One child was unvaccinated. The following pathogens were isolated in cultures taken from the affected ears: *Haemophilus influenzae*, *Pseudomonas aeruginosa* (2 patients), *Streptococcus pyogenes*, *Staphylococcus aureus* (2 patients). In one case, *Staphylococcus epidermidis* was cultured, which was probably due to a pre-laboratory error. Isolation by culture of the above pathogens formed the basis for targeted antibiotic therapy.

Discussion

AOM can be either viral or bacterial. Enteroviruses, respiratory syncytial virus (RSV), influenza viruses, adenoviruses and rhinoviruses are responsible for viral AOM. Viral infection is believed to be a cofactor accelerating bacterial migration through the Eustachian tube [10, 11]. However, bacterial infections remain the predominant cause of both acute and recurrent otitis media, accounting for 80% of all diagnosed cases. According to available sources, *Streptococcus pneumoniae*, *H. influenzae* and *Moraxella catarrhalis* are the most common bacterial causes of AOM in children [12].

Immunisation against *H. influenzae* type b (Hib) and *S. pneumoniae* has significantly reduced the number of episodes of otitis media. The incidence of *S. pneumoniae* infections has decreased significantly since the introduction of the pneumococcal conjugate vaccine into the Immunisation Programme [10]. On the other hand, the number of unattended mandatory vaccinations has increased almost 2-fold during the last 5 years, from 48.6 thousand missed vaccinations in 2019 to 87.3 thousand in 2023 [11]. A variety of aetiologies of purulent ear infections in children were observed among patients hospitalised at the Department of Paediatrics (WIM-PIB). The isolated pathogens differed from the three most common ones reported in the National Antibiotic Guidelines or other sources [12]. A case of a 6-month-old girl with otitis media with perforation caused by *H. influenzae* was reported. Parental refusal of any vaccinations in the child was notable. *S. pyogenes* (Group A *Streptococcus*, GAS), a gram-positive coccus responsible for infections such as pharyngitis, scarlet fever and impetigo, but which can also cause life-threatening invasive infections defined as iGAS (isolation of GAS from a normally sterile site), was isolated in a 6-year-old boy with fever and purulent ear discharge. iGAS usually manifests in children as cellulitis, streptococcal toxic shock syndrome (STSS), necrotising fasciitis (NF) and pneumonia [13]. The increase in the incidence of iGAS infections among children under 10 years of age, observed from autumn and winter 2022, is alarming compared to previous years [14–16]. Factors responsible for the increased incidence of iGAS infections are not fully understood. One hypothesis is the presence of a large group of susceptible individuals, children in particular, as a consequence of the introduced pandemic containment measures, which reduced exposure to typical childhood infections and the resulting lack of specific immunity to GAS (the so-called 'immunity debt'). This is supported by a large increase in respiratory tract infections caused by viruses such as influenza virus and RSV during the same period [17, 18]. It has been estimated that GAS is responsible for 2–3% of paediatric AOM cases [10]. Acute mastoiditis (AM) is the most common potentially serious complication of AOM. It is usually caused by *S. pneumoniae* or GAS [19, 20]. Cases of brain abscesses developing as AOM complication caused by *S. pyogenes* have also been published [18]. *P. aeruginosa*, a relatively rare aetiology of otitis media, yet very important one due to the great dif-

Table 1. Summary of collected clinical data on patients with otitis media with perforation hospitalised in the Department of Pediatrics, Pediatric Nephrology and Allergology in the period from May 2023 to May 2024.

Age	Sex	AOM aetiology	Otoscopic image	Mandatory vaccinations	Fever	Treatment used
5 weeks	male	*Pseudomonas aeruginosa*	Left ear: purulent discharge in the auditory canal, TM partially visible – red, no reflex Right ear: TM with red margins, purulent discharge behind the membrane	yes	–	ceftazidime
6 weeks	male	*Staphylococcus aureus* MRSA+	Left ear: purulent discharge in the auditory canal with visible TM perforation	yes	+	amikacin
6 months	female	*Haemophilus influenzae*	Right ear: profuse purulent discharge in the auditory canal. TM bilaterally difficult to visualize	no	–	amoxicillin/clavulanic acid
17 months	male	*Staphylococcus aureus*	Bilaterally reddened TM, no reflex	yes	+	amoxicillin
6 years	male	*Streptococcus pyogenes*	Right ear – purulent discharge in the auditory canal, perforation possible	yes	+	amoxicillin/clavulanic acid
8 years	male	*Staphylococcus epidemidis*	Right ear – purulent discharge in the auditory canal with TM perforation	yes	+	amikacin
10 years	female	*Pseudomonas aeruginosa*	Right ear – purulent discharge in the auditory canal	yes	–	amikacin

ficulty in treating conditions caused by this bacillus, was isolated form cultures of purulent ear contents collected from two patients [21]. Biofilms formed by *P. aeruginosa*, which are bacterial aggregates adhering to the surface of the middle ear cavity suspended in a self-generated extracellular matrix that provides a protective environment, are source of recurrent and persistent infections. Bacterial biofilms show increased resistance to antibiotics and host's protective mechanisms, giving rise to recurrent infections in closed body cavities, such as the middle ear [22, 23]. A good therapeutic response can be achieved by combining two antibiotics, e.g. ceftazidime with an aminoglycoside, obtaining a synergistic effect in an inpatient setting [24, 25]. Due to some cases of arthropathy reported after fluoroquinolones, this group of antimicrobials is reserved for life-threatening situations in children [26, 27].

S. epidermidis and *S. aureus* were isolated by culture in 2 described patients, and may represent bacterial flora of the external auditory canal. We would like to draw attention to the correct technique for collecting samples for examination, as an incorrectly performed procedure may prevent proper identification of the aetiological agent. The presence of infected, purulent discharge in the middle ear may cause TM perforation. This occurs as a result of chronic negative pressure in the tympanic cavity. Minor perforation usually heals within a few weeks, while larger perforations sometimes require an ENT intervention. Perforation can be diagnosed based on a leakage of purulent discharge into the ear canal, which was observed among the patients discussed in this study. Additionally, children susceptible to otitis media may present with symptoms of chronic otitis and their sequelae, including hearing impairment [28, 29]. There are clinical conditions with a much milder course, such as exacerbation of seasonal allergic rhinitis, redness of the eardrum associated with crying or trauma. Such non-purulent conditions do not pose a risk of serious infectious complications, and the use of antibiotics in their treatment may compromise the protective effect of antibiotics in AOM [30]. It may also indirectly lead to purulent otitis with a different aetiology than before. Furthermore, the number of pathogens resistant to commonly used antibiotics is growing, which is another threat to paediatric patients. Even short cycles of antibiotic therapy may be associated with the emergence of resistant pathogens [31, 32]. Identification of pathogens using specific criteria prompts therapeutic decisions and shapes trends for medical interventions. Also, attention should be paid to social and educational strategies to combat hearing loss associated with otitis media. These measures should involve the child's family, healthcare providers and be embedded in coordinated primary care systems [33].

Conclusions

Therapeutic decisions should be made individually for each case. Careful monitoring of patients and early implementation of clinically appropriate therapy is recommended. In cases with purulent ear discharge, the decision on antibiotic treatment should be based on swab culture as targeted antimicrobial therapy will reduce the risk of severe complications such as mastoiditis or meningitis [10]. Our findings, in line with current guidelines, confirm the benefits of immunisation in preventing infections caused by pathogens such as *H. influenzae* and *S.pneumoniae*. Further research is needed to determine the cause of the growing incidence of infections with a different aetiology than generally assumed.

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