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Acute Otitis Media in children – a review of current literature

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SUMMARY

Introduction and purpose

Acute otitis media (AOM) is an infection of the middle ear, with acute onset of symptoms and signs, frequently including otalgia, fever, and otorrhea. It affects 80% of children by the age of 5 years, hence the need to collect and share current knowledge on risk factors, pathophysiology, diagnosis, treatment and complications of AOM.

A brief description of the state of knowledge

AOM is an extremely common infection in children, usually bacterial. Numerous risk factors lead to it, with allergies, allergic rhinitis and gastro-esophageal reflux disease being the most frequent. Inflammation within the eustachian tube causes effusion to accumulate inside the middle ear, leading to irritating symptoms. A thorough medical history and careful physical examination are used to assess, whether the patient meets obligatory criteria: acute onset of symptoms, evidence of effusion, and tympanic membrane inflammation. Observation is often sufficient, and symptoms start fading without any antimicrobials. Should this not be the case, systemic antibiotic therapy is recommended. Regardless of antibiotics, pain management is of great importance. Complications are unlikely to occur with proper diagnosis and treatment.

Conclusions

AOM, being a frequent condition in children, requires good knowledge on diagnostics and management to avoid as many complications as possible. Remembering possible risk factors and symptoms, both specific and less common, leads to faster diagnosis, which then decreases the risk for unnecessary pain and possible complications. Understanding the biology behind

AOM together with utilization of new methods in physical examination is key to providing better care. Promising research is made on new ways to treat AOM with drug delivery systems.

Keywords: Acute Otitis Media; Otalgia; Otorrhea; Middle Ear Effusion**;** Otoscopy

1. Introduction and purpose

Acute Otitis Media (AOM) is an infection of the middle ear space, with acute onset of symptoms and signs, frequently including otalgia, fever, and otorrhea. It affects the majority (80%) of children by the age of 5 years and it is the most common reason for antibiotic prescription in pediatric patients. [1, 2, 3, 14] AOM is the second most common reason for consulting a family physician in children, second only to infections of the upper respiratory tract, thus having a negative economic impact. [24] Consulting various specialists, obtaining adequate medications, undergoing surgery, and finally rehabilitation can all be a financial burden for individuals, their families and healthcare systems in general. [35] AOM can furthermore lead to a wide variety of local and systemic complications such as discomfort, pain and hearing loss. [29]

The means of this article is to broaden the knowledge on pediatric AOM in accordance with current literature, thus leading to more precise diagnosis, treatment and prevention of complications. The authors of this article aim to gather the most up to date knowledge from various scientific research papers, in order to summarize available information on AOM in children: it's risk factors, pathophysiology, diagnosis, treatment and possible complications.

2. Description of the state of knowledge

Risk factors

Researchers have found multiple risk factors leading to AOM. The most common are allergies, allergic rhinitis and gastro-esophageal reflux disease. [8] Additional risk factors include family history of AOM, recurrent infections of the upper respiratory tract, passive smoking, attending day care, being characterized by low socioeconomic status and no breastfeeding in patient's history. [1, 32] Moreover, male sex [32] and genetics also play an important role in determining the risk of having AOM. For instance, it has been noted that Native Americans suffer from it far more frequently than African Americans. Children with adenoid hypertrophy have higher risk of acquiring AOM as well. [17] Finally, pacifier use can increase the risk by exacerbating eustachian tube dysfunction due to change of pressure while sucking, potentially leading to an episode of AOM. [5]

Anatomy, pathophysiology and etiology

Anatomy

Acute otitis media, as the name suggests, is a disease affecting the middle ear. While the outer ear, consisting of an auricle and a meatus (an external auditory canal), is mainly responsible for the process of collecting and admitting sound waves, the middle ear's function, being a cavity within the temporal bone, is to transmit sound waves received from the outer ear at the tympanic membrane, all the way to the inner ear via tiny auditory ossicles, where actual hearing can be conducted with the aid of cochlea. It is vital to remember the existence of the eustachian tube (ET), a link between the middle ear, space filled with air and coated with respiratory mucosa, and the back of one's nose. [5]

Pathophysiology

AOM is a medical condition of the middle ear, when fluid accumulates within its cavity. It can be either purulent or suppurative, leads to acute inflammation, and causes distressing symptoms such as otalgia (ear pain) and fever. The above-mentioned ET plays a vital role in the pathogenesis of AOM. With its main function being the control of fluid drainage and pressure in the middle ear, any anatomical or physiological dysfunction of ET, such as inflammation, can lead to AOM through fluid retention within the middle ear cavity, which eventually turns into purulent effusion, characteristic of the condition. With the middle ear generally being a sterile place, it is thanks to various pathogens, such as viruses and bacteria, as well as allergic reactions, why the primary inflammation inside the ET occurs, eventually leading to AOM. [5, 23, 27, 35]

Etiology

Viruses, bacteria, and certain genetic factors are all associated with AOM. It is worth noting however, that out of these three, it is bacterial pathogens that are believed to be the most common factor behind AOM. [16]
Streptococcus pneumoniae, a gram-positive, diplococcic, spherical bacterium, is responsible for more than half of all the cases, joined by Haemophilus influenzae and Moraxella catarrhalis to form a trio of the most frequent causative agents of AOM. [5, 20, 28]

Diagnostics

Although many differences exist between American and European guidelines for AOM management, there are significant similarities when it comes to diagnostic recommendations. Clinicians and researchers from both sides of the Atlantic agree on three basic elements: evidence of middle ear effusion (MEE), tympanic membrane (TM) inflammation, and acute onset of specific symptoms are all necessary to diagnose AOM. [1] It can thus be defined as an infection of the middle ear, with acute onset of symptoms and signs, often including otalgia, fever, as well as otorrhea. [3] Diagnosis should therefore be made after taking a thorough medical history and performing a careful physical examination of the patient. [5]

Medical history

Taking history has a crucial impact not only on establishing suspicion of AOM, but also as the first step needed to meet the diagnostic criteria. The most important and clear symptom to look for is acute onset of otalgia. Preverbal children can present symptoms of ear pain. These include tugging, rubbing or holding the ear. It is important to remember that fever is in fact optional, and lack thereof does not necessarily exclude the possibility of AOM. [21] Acute onset has not been clearly defined, but many guidelines adopt ‘no more than 3 weeks’ as the widely accepted length of symptoms. [3] Moreover, infants and small children with AOM are usually irritable, cry excessively, suffer from diminished sleep, and have trouble with their appetite. [5, 22] It is important to mention that none of the above is sensitive or specific enough, and these symptoms alone are not helpful in distinguishing AOM from a simple infection of the upper respiratory tract. [22]

Physical examination

A thorough physical assessment of the patient, especially of the affected ear, is crucial in meeting the diagnostic criteria. Because symptoms of AOM can often be non-specific or even absent, a direct observation of the TM represents a vital step on a way towards a correct diagnosis. [19]

Otoscopy

Most European guidelines recommend standard otoscopy to search for both the signs of middle ear inflammation (intense erythema or yellow color of the TM), as well as signs of MEE (bulging of the TM or otorrhea). [3, 21, 22]

Otomicroscopy

Otomicroscopy was introduced to bring standard otoscopic examination to a new level. It enables the physician to assess an enlarged view of the TM in three dimensions, as well as an easier removal of cerumen. It offers better results of MEE detection as compared to standard otoscopy, but being an expensive technology with space limitations, requiring proper training,

and the inability to provide etiological diagnosis, lacks sense for pediatricians and general practitioners in their daily practice. [21]

Pneumatic otoscopy (PO)

Although PO allows the clinician to assess the TM just as well as with standard otoscopy, it is significantly better at examining the presence of fluid behind the TM, measuring its movement under pressure. It has certain limitations however, that limit its usefulness in everyday practice. It is difficult to perform in children, due to smaller dimensions of their ear canals and tendency to wriggle. Moreover, its effectiveness relies on how experienced the operator is and requires both vast training and practice to achieve satisfactory results. [21] During the last decade, there have been various opinions among experts whether to recommend the use of pneumatic otoscopy in the diagnosis of AOM. Due to its limitations, its use seems to be unjustified in routine cases, although recommended when doubts arise regarding the presence of MEE. [10]

Tympanocentesis

While being a gold standard of AOM diagnosis, tympanocentesis is neither recommended nor justified as a routine method in daily practice. [10] It is a remarkable diagnostic option, used to differentiate true AOM from otitis media with effusion (OME), hence the status of a reference method. It is recommended to guide the choice of antibiotic therapy to achieve the highest accuracy in certain difficult cases requiring precise identification of AOM etiology: those having recurrent episodes or being at high risk of an unsatisfactory outcome, i.e. neonatal and immunocompromised patients. [6, 21]

Tympanometry (TP) and Acoustic Reflectometry (AR)

Both TP and AR are further methods used in diagnostics of AOM, although not routinely. TP evaluates changes in acoustic impedance of the TM with air pressure variations in the ear canal. It's less influenced by cerumen, a problem associated with standard and pneumatic otoscopy, but requires airtight seal, making the accuracy vastly dependent on the cooperation of the child. AR on the other hand analyses the acoustic response of the TM to an emitted sound. It has some benefits over PO and TP, lacking the need for an air-tight seal and proper cooperation, but numerous factors, including middle-ear pressure, size of the ear canal, position of the TM, as well as the amount of effusion, make results debatable. Practically

speaking, both methods can help to detect effusion within the middle ear, thus allowing for a more accurate diagnosis, but due to certain limitations did not make their way among physicians as primary methods in AOM diagnosis. [21]

Treatment

For years systemic antibiotic therapy has been a standard method of treating AOM. [34] Official guidelines have evolved significantly over the last two decades, to achieve more accurate management of the condition and protect patients from unnecessary overuse of antibiotic treatment, which has significant consequences, such as adverse drug events, increased risk of antibiotic-resistant and Clostridoides difficile infections, as well as negative changes in the microbiome, making patients more susceptible to pathogens. [31] Moreover, it is deemed essential to restrict the use of antibiotics to correct groups of patients and use as narrow-spectrum drugs as feasible. [4] Several strategies have been developed to reduce avoidable antibiotic administration, including observation, delayed prescribing and decreasing the duration of antibiotic therapy. [33]

Observation/delayed prescribing

78% of AOM cases spontaneously self-resolve after 10-12 days without antibiotic treatment. [16] Considering both the risks of untreated AOM and those associated with antibiotic exposure, it is recommended to begin treatment with a period of observation prior to prescribing antibiotics in some patients. This approach of watchful waiting should be adopted in children 24 months or older, who are immunocompetent, have no chronic ear conditions or otorrhea, and have had otalgia for less than 48 hours, fever less then 39°C and pain characterized by ‘mild’, able to be controlled with analgesics. [1, 16] Additionally, in patients 6 months or older the strategy of observation or delayed antibiotic prescription is also recommended, provided that the infection is unilateral and at most mildly painful. [1, 31]
A similar approach to observation is delayed prescribing, which means a prescription given to the caregiver to fill in the event of symptoms worsening or not improving after 48 to 72 hours. Studies have proved this strategy able to reduce antibiotic exposure significantly, while maintaining patient and caregiver satisfaction as compared to an immediate prescription. [31]

Antibiotics

First-line therapy

When antibiotics are necessary, both American and most of European first-line treatment guidelines for uncomplicated AOM recommend amoxicillin, which remains the most suitable first-line agent, despite changes in etiology over the years. [1, 7] A dosage of 80 to 90 mg per kg per day is given orally in two divided doses. [5]

Penicillin allergy

For children allergic to penicillin with no history of high-risk allergic reaction, second- and third-generation cephalosporins, for example cefuroxime or intramuscular ceftriaxone, should be prescribed. For those with such history alternative regimens with clindamycin, macrolides or trimethoprim-sulfamethoxazole are recommended. [1, 5]

Follow-up and reassessment

In case of symptoms persisting after 2-3 days of proper antibiotic therapy, diagnosis should be reassessed and in case of being confirmed, considered a treatment failure, first aided by an empiric broadening of antibiotic coverage as explained below. Further treatment failure requires determining antibiotic susceptibility of the middle ear fluid cultures collected through tympanocentesis. [5]

Second-line therapy

In the event of treatment failure (2 days – 2 weeks of treatment with no improvement or worsening), recurrence (new infection after 15-30 days from the previous one) or a history of unresponsiveness to amoxicillin, a second-line treatment of amoxicillin-clavulanate is recommended. It covers a broader range of microorganisms, including those able to produce beta-lactamase. In comparison to oral cephalosporins, macrolides and clindamycin, it achieves higher concentrations in the middle ear and provides better coverage against common pathogens responsible for middle ear infections. A dosage of 90:6.4 mg of amoxicillin-clavulanate per kg per day is given orally in two divided doses. [1, 5, 9]

In case of failure with amoxicillin-clavulanate or non-penicillin antibiotic therapy, intramuscular ceftriaxone should be administered. [1]

Duration of antibiotic therapy

A 5-day antibiotic regimen is recommended for most children 2 years and older. A 10-day regimen is generally recommended to younger children, however less severe symptoms and/or a definite follow-up plan to extend the duration of therapy if needed, enable a clinician to decrease the primary duration of prescribed treatment. A duration of 10 days is also recommended for children with TM rupture. [1]

Additional care recommendations

Regardless of the decision to postpone antibiotics or prescribe them immediately, patients and their caregivers should be advised on pain management. Controlling it reduces anxiety and leads to better fluid intakes. Both ibuprofen and paracetamol alone are more effective at dealing with AOM pain than placebo. [1, 11] Paracetamol is the analgetic of choice. [3]

Future perspectives

Researchers nowadays are working on new solutions in topical antimicrobial treatment in AOM, which to this day has only been viable only when tympanostomy tube was inserted. Efforts are being made to create enhanced drug delivery systems, able to transport antibiotics into the middle ear, thanks to their ability to increase drugs permeability through the TM. These new methods would allow to fight even stronger pathogens and overcome antibiotic resistance due to a significant increase in drug concentration at the site of infection. [25]

Complications

AOM therapy consists of both pain relief and reducing the risk of complications, which are rare in a properly diagnosed and adequately managed episode. Complications are divided into 2 categories: extra- and intra-cranial. The most common are hearing impairment, possibly transforming itself into hearing loss, mastoiditis and TM rupture. [1, 5, 15]

Much less commonly can AOM cause a subperiosteal abscess or a Bezold's abscess, as well as facial nerve palsy, labyrinthitis or a subdural abscess. Occasional involvement of the inner ear is also possible, causing sensorineural hearing loss or vestibular symptoms. [12, 13, 18]

3. Conclusions

AOM is an extremely common infection in pediatric population, requiring adequate knowledge on its diagnostics and management to avoid complications. Multiple risk factors lead to it, with allergies, allergic rhinitis and gastro-esophageal reflux disease being among the most frequent. Remembering all the possible risk factors and symptoms, both specific and less common, leads to faster diagnosis, which then decreases the risk for unnecessary pain and possible complications. While AOM is usually a bacterial infection, viruses can lead to it as well. The most common cause is a Streptococcus pneumoniae infection, which causes inflammation of the eustachian tube (ET), leading to its dysfunction and accumulation of purulent effusion inside the middle ear. Understanding the biological processes behind AOM together with utilization of first-class methods in physical examination, such as otomicroscopy, pneumatic otoscopy, tympanometry or acoustic reflectometry, is key to providing better care. Physicians should be encouraged to adopt these new techniques, offering higher accuracy, despite the need for proper training, before their benefits can be fully utilized. For the time being however, in accordance with official guidelines, a thorough medical history and careful physical examination with otoscopy are enough to make a diagnosis. Three key criteria are required: acute onset of specific symptoms (such as otalgia, fever or otorrhea), evidence of effusion within the middle ear, as well as tympanic membrane inflammation. A period of short observation prior to antibiotic prescription is recommended and often sufficient for symptoms to start fading without any medications. Should this not be the case, amoxicillin is to be administered as the recommended first-line therapy. Pain management is an important part of management, and for this reason either paracetamol or ibuprofen should be prescribed. The most common complications, however unlikely to occur, are hearing impairment, mastoiditis and tympanic membrane rupture. Promising research is made on new ways to treat AOM with drug delivery systems.

Disclosure

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