

CLINICAL UPDATE: Acute otitis media in children

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Word count: 2,250 (excl. references and boxes)

Keywords: otitis media; diagnosis; analgesics; anti-bacterial agents.

Box: What you need to know

- Acute otitis media (AOM) is a common, painful, distressing condition of childhood. Although commonly presenting to primary care, recent research suggests systemically well children with ear pain can be managed at home initially with over-the-counter painkillers.
- For those seen in primary care, the presence of middle ear effusion (MEE) is a prerequisite for AOM diagnosis; AOM overdiagnosis and subsequent unnecessary antibiotic prescribing might be reduced by pneumatic otoscopic confirmation of MEE.
- Oral antibiotics are commonly prescribed for AOM despite strong evidence that they have little impact on the natural course of what is generally a self-limiting condition in otherwise healthy children in high-income countries. There is some evidence to support the use of topical analgesics, but further research is needed to confirm its role in everyday practice.
- Oral antibiotics should be offered to children diagnosed with AOM who are systemically very unwell and those at high-risk of complications because of pre-existing comorbidity. Oral antibiotics can be considered in children below 2 years of age with bilateral AOM and those of any age with AOM and acute ear discharge due to a spontaneous rupture of the eardrum.
- Although rare in high-income countries, potentially life-threatening suppurative complications can occur in children with AOM which require prompt recognition, referral and treatment.

Box: Sources and selection criteria

We reviewed the reference list of the Nature Reviews Disease Primer Otitis Media- authored by an international group of experts in September 2016.¹² To retrieve relevant studies published since, we searched PubMed and the Cochrane Library from September 2016 to present using the search term “acute otitis media[TiAb]”. We also reviewed the National Institute for Health and Care Excellence (NICE) guideline 91 “Otitis media acute: antimicrobial prescribing”, published 28 March 2018³¹ and the American Academy of Pediatrics (AAP) guideline “The diagnosis and management of acute otitis media”, published March 2013⁷. We also used our personal archives for any additional relevant (published or unpublished) studies.

Box: Questions for future research

Future research must prioritise improving AOM diagnosis in primary care and treatment options to reduce unnecessary antibiotic use.

- What is the impact of performing pneumatic otoscopy versus regular otoscopy in primary care in terms of improving diagnosis, antibiotic prescribing and patient-reported outcomes in children with symptoms indicative of AOM?
- What is the accuracy and cost-effectiveness of novel middle ear imaging techniques combining otoscopy with infrared sensing technologies (e.g. optical coherence tomography, shortwave infrared, Raman spectroscopy) for diagnosing AOM in children?
- How effective are anaesthetic ear drops in improving symptoms and reducing antibiotic prescribing and consumption in children with AOM?
- How effective are antibiotic ear drops compared to oral antibiotics in children with AOM presenting with acute ear discharge due to a spontaneous rupture of the eardrum in reducing symptoms, side-effects and antimicrobial resistance?
- Are antibiotics delivered transtympanically via non-invasive technologies safe, effective and practical to administer in children with AOM?

Box: Additional educational resources

- National Institute for Health and Care Excellence clinical guideline 91 “Otitis media acute: antimicrobial prescribing”, 2018.
<https://www.nice.org.uk/guidance/ng91>
- American Academy of Pediatrics guideline “The diagnosis and management of acute otitis media”, 2013.
<https://pediatrics.aappublications.org/content/131/3/e964>
- Overview of various otoscopic images (resource is free):
<https://www.pediatrics.wisc.edu/education/acute-otitis-media/exercises/images/>

Box: Information resources for patients

The following free access websites provide information for the public about acute middle ear infection, its symptoms, natural course and treatment (including whether and when to seek medical help and when antibiotics may be needed)

- <https://www.nhs.uk/conditions/ear-infections/>
- <https://patient.info/ears-nose-throat-mouth/earache-ear-pain/ear-infection-otitis-media>
- <https://www.nice.org.uk/guidance/ng91/informationforpublic>
- <https://thuisarts.nl/middenoorontsteking-0> (in Dutch)

Box: Education into practice

- The presence of middle ear effusion - featuring as bulging of the eardrum or otorrhoea on otoscopy and/or impaired mobility of the eardrum on pneumatic otoscopy - is critical for AOM diagnosis⁷; When and how do you look for the presence of middle ear effusion to ascertain AOM diagnosis in children?
- Diagnosis of AOM should include an assessment of the severity of ear pain and parents/carers should be given advice on the use of systemic analgesics at an age-appropriate dose guided by the child's condition^{15,36}; In what detail have you discussed pain and pain management during recent childhood AOM consultations? Would you alter your approach during these consultations to advise parents more explicitly about pain relief?

Box: How patients were involved in the creation of this article

A parent (MvdH) whose child experienced AOM during early childhood has co-authored this article. She has provided input throughout the development of this paper. Two patient reviewers reviewed this article for The BMJ and suggested discussing the mechanism of AOM in children and how GPs can address parents' concerns. We have amended this article accordingly and are grateful for their input.

Acute otitis media (AOM) is an acute infection of the middle ear space characterised by the presence of middle ear effusion (MEE) and ear pain and/or fever.¹ It affects children in their early years with one in two having had three AOM episodes by the age of three.^{2,3} Over a third of preschool children consulted a doctor for earache or ear discharge in a large prospective cohort study in England (13617 children).⁴

As recent COVID-19-related changes in the delivery of primary care⁵ have demonstrated, not all children with suspected AOM need to be managed in a healthcare setting. Indeed, a multidisciplinary panel of UK nurses, general practitioners (GPs) and Emergency Department Consultants agreed that systemically well children with ear pain could be managed at home initially without primary care input.⁶ For those seeking professional help, accurate diagnosis of AOM by confirmation of MEE is key.⁷ This can however be particularly challenging in young children and evidence indicates that AOM is overdiagnosed and is therefore potentially overtreated in primary care.⁸⁻¹⁰

How is it caused?

AOM is usually preceded by an upper respiratory tract infection (URTI) or 'common cold'.¹¹ This is thought to disturb the nasopharyngeal microbiome paving the way for pathogenic bacteria to infect the middle ear via the Eustachian tube.¹²

AOM is predominantly a bacterial disease with bacteria cultured in 62% (range 25-95%) of patients.¹³ *Streptococcus pneumoniae*, nontypeable *Haemophilus influenzae* and *Moraxella catarrhalis* are most commonly reported globally¹³, but pathogen

dominance varies between countries. The introduction of pneumococcal conjugate vaccines (PCVs) has shifted pathogens towards non-vaccine pneumococci serotypes, nontypeable *H. influenzae* and *Staphylococcus aureus*.^{13,14} About 5% of middle ear fluid samples show viruses only.¹⁵

Who gets it?

Young children are more prone due to the immature function of their immune system and Eustachian tube which is shorter, wider, more horizontal and floppy in infants than in adults.¹²

Risk factors include male gender, indigenous ancestry, family history of AOM, otitis media with effusion (OME), adenoid hypertrophy, cleft palate, immunodeficiency, low socioeconomic status, exposure to tobacco smoke, having older siblings, day-care attendance, and pacifier use.¹⁶⁻¹⁹ Breastfeeding may protect against AOM by virtue of differences in feeding compared to bottle and immunomodulatory and anti-inflammatory properties of human milk.²⁰

How do patients present?

Ear pain is the most prominent and distressing symptom.⁷ New onset ear discharge occurs in 15-20% of children with AOM.^{21,22} Ear symptoms can be subtle (tugging, rubbing or holding the ear) especially in young preverbal children, or rarely may be absent.⁷ The child may have fever, irritability or sleep disturbance. These symptoms are less specific; they do not differentiate children with AOM from those with an URTI without evidence of AOM.^{7,23}

How is it diagnosed?

The presence of MEE is a prerequisite for the diagnosis of AOM.⁷ Box 2 lists key diagnostic criteria of AOM. The normal eardrum is pearly grey, translucent and concave (Image 1). A red, bulging eardrum seen on otoscopy (Practical box 1; Image 2) is indicative of MEE.²⁴

Confirm the diagnosis with pneumatic otoscopy where possible. Pneumatic otoscopy allows visual assessment of eardrum mobility. A bulb is attached to the otoscope via which air is puffed into the external auditory canal (Image 3). Distinctly impaired mobility of the eardrum on pneumatic otoscopy is highly predictive of MEE.²⁵ It is widely recommended as a diagnostic modality for AOM²⁶ and OME (also called glue ear). Pneumatic otoscopy might be difficult to perform in young children due to narrow ear canals and tendency to squirm. It might however reduce overdiagnosis of AOM in primary care.⁸⁻¹⁰

Ear discharge or otorrhoea (visible discharge in the external auditory canal), can be present in AOM due to a spontaneous perforation or rupture of the eardrum, or draining ventilation tube.

What are other conditions to consider?

AOM is often followed by OME. In OME, MEE is also present upon (pneumatic) otoscopy but pain and fever are absent and hearing loss due to MEE is the most prominent symptom. The absence of MEE precludes AOM and warrants examination for other conditions associated with referred ear pain, such as pharyngitis, tonsillitis, or dental infections. Ear discharge is also seen in chronic suppurative otitis media (which does not have an acute presentation as per AOM and features as persistent

(>2 weeks) drainage through an eardrum perforation), or acute otitis externa (inflammation of the external auditory canal). Although sometimes difficult to distinguish from AOM presenting with ear discharge, acute otitis externa typically presents with ear pain and/or itchiness, redness and swelling of the external auditory canal, it presents at a later age (beyond early childhood) and is often the result of exposure to contaminated water, e.g. swimming.²⁷

Practical box 1: Key diagnostic criteria of AOM

A recent systematic review showed that diagnostic criteria and recommended diagnostic instruments varied across national acute otitis media guidelines in Europe.²⁶ Standard otoscopy was recommended in 88% (15/17), pneumatic otoscopy in 60% (9/15) and tympanometry in 47% (7/15) of the guidelines. In 71% (12/17), the following key diagnostic criteria were listed:

1. **Acute onset of symptoms** such as ear pain (tugging, rubbing or holding the ear in preverbal child) and/or fever;
2. **Presence of middle ear effusion** which can feature as bulging of the eardrum or otorrhoea on otoscopy and/or impaired mobility of the eardrum on pneumatic otoscopy;
3. **Inflammation of eardrum** featuring as intense erythema of the eardrum on otoscopy.

How is it managed?

AOM is generally a self-limiting infection in otherwise healthy children in high-income countries. Systematic literature review have shown that in 90% of these children, ear pain fully resolves within seven to eight days²⁸ and in 80% worst symptoms settle within 3 days without antibiotics.^{29,30} In high income countries, symptomatic treatment with analgesics is therefore the mainstay of AOM management with immediate oral antibiotics indicated for children with severe or persistent illness.^{7,31}

The main cause of ear pain in young children with RTI symptoms with or without fever is AOM. Therefore, experienced parents/carers may be able to self-diagnose and manage, and GPs conducting remote consultations can reassure parents/carers of children with RTI symptoms and mild ear pain who are not systemically unwell that the likely cause is AOM, advise analgesia and provide safety netting advice to reconsult if symptoms do not improve within 3 days or significantly worsen (see also Practical Box 2) at any time.

While most children experience sporadic AOM episodes, a subset suffer from recurrent AOM defined as three or more AOM episodes in six months or four in one year.⁷ The impact of these recurring infections on children's quality of life equals that of childhood asthma.³² Albeit treatment of individual episodes of children with frequently repeating AOM is similar to those with sporadic episodes, the recurring nature of the condition may justify ENT consultation to exclude underlying pathology and discuss the pros and cons of treatment modalities to prevent future AOM recurrences such as insertion of ventilation tubes or antibiotic prophylaxis.³³⁻³⁵

Addressing parents' needs, beliefs and concerns

Parents have expressed that they would want primary healthcare professionals to provide lay information about the cause and natural course of AOM, reassurance about its general favourable prognosis.³⁶⁻³⁹ They need advice how to best alleviate ear pain with systemic analgesics at an age-appropriate dose and to reconsult if symptoms do not improve within 3 days or significantly worsen (see also Practical Box 2) at any time. Parents, in particular of young children, worry about their child's

illness and potential long-term implications of AOM^{36,36}; these concerns can be explicitly addressed during the consultation.

Parents' views and expectations of antibiotics for AOM vary across countries. An interview study among Australian parents revealed that they considered antibiotics the best treatment option for AOM³⁸ whereas Canadian parents³⁶ expressed mixed views and those from the Netherlands tend to accept a no-antibiotic strategy, provided that GPs explain why antibiotics would not be needed (see Antimicrobial treatment section).³⁷

Pain management

You may offer regular doses of paracetamol or ibuprofen at an age-appropriate dose for pain.^{31,40}

Although listed as treatment option in the AAP guideline⁷, topical analgesics were not included in the 2018 NICE guideline.³¹ Data on the effectiveness of topical analgesics is scarce. A 2011 systematic review included five trials of which two (117 children) compared anaesthetic ear drops with placebo.⁴¹ Anaesthetic drops provided a rapid, short-term reduction in ear pain 10 - 30 minutes after instillation in children aged 3 to 19 years with AOM.⁴¹ A recent UK trial suggested anaesthetic ear drops could reduce antibiotic consumption by reducing ear pain, but did not meet the sample size target as it was terminated prematurely due to placebo supply issues.⁴² Together, these observations warrant urgent confirmation in a larger study, especially since the UK MHRA has recently licenced an anaesthetic ear drop containing lidocaine and phenazone for use in AOM in children.

Antimicrobial treatment

Systemic antibiotics

Oral antibiotics reduce the duration of AOM symptoms^{22,30} and shorten time with MEE⁴³ compared with placebo, but the magnitude of these effects is modest. 20 children need to be treated with oral antibiotics for one child to experience reduction in pain at 4-7 days compared to placebo (absolute rates, 119 of 638 children [19%] for oral antibiotics vs 154 of 625 children [25%] for placebo) suggests high quality evidence from a Cochrane review (7 trials, 1263 children).³⁰ Antibiotics also modestly reduce the number of children developing an eardrum perforation (33 children need to be treated with oral antibiotics to prevent one child with a perforation) and contralateral AOM episodes (11 children need to be treated with oral antibiotics to prevent one child experiencing contralateral AOM).³⁰ These benefits need to be balanced against adverse effects of antibiotics including gastro-intestinal upset, skin rash (14 children need to be treated with antibiotics for one child to experience an additional episode of gastro-intestinal upset or skin rash)³⁰ and antimicrobial resistance⁴⁴.

For otherwise healthy children with AOM presenting with mild ear pain and who are not systemically unwell, watchful waiting or a back-up (delayed) antibiotic prescription, to be used if symptoms do not improve within 3 days or significantly worsen (see also Practical Box 2) at any time.^{26,31}

For children with AOM who are systemically unwell but do not have symptoms and signs of a more serious illness (Practical Box 2) and for those at high-risk of complications (age < 6 months, pre-existing co-morbidities such as craniofacial malformations, Down syndrome and immunodeficiency), immediate oral antibiotics

are indicated.³¹ Immediate oral antibiotics may also be considered in children below 2 years of age with bilateral AOM and those of any age with AOM and acute ear discharge due to a spontaneous rupture of the eardrum.³¹ Antibiotics have been shown to be more beneficial in resolving ear pain and/or fever in these subgroups.²²

The recommended type, dosing and duration of antibiotic regimen of choice vary across countries and depend on local antimicrobial resistance patterns and cultural/societal preferences. In most European countries, amoxicillin for 5 (but up to 10) days is the first-line antibiotic for children with AOM with a switch to a broader-spectrum antibiotic such as amoxicillin-clavulanate administered orally or intravenously if initial treatment fails after 48-72 hours.²⁶ In case of penicillin allergy, European guidelines either recommend oral clarithromycin or oral trimethoprim-sulfamethoxazole.²⁶

Topical antibiotics

Antibiotic ear drops are recommended in children with ventilation tubes (a treatment option for children with persistent OME and/or recurrent AOM to facilitate middle ear ventilation) who develop acute ear discharge.³³ A landmark trial in the Netherlands in such children showed higher resolution rates of otoscopically-confirmed ear discharge at 2 weeks compared with oral antibiotics and initial observation (absolute resolution rates, 72 of 76 children [95%] for topical antibiotics vs 43 of 77 children [56%] for oral antibiotics vs 34 of 75 children [45%] for initial observation).⁴⁵ Various topical antibiotic formulations are available in the UK of which the non-ototoxic quinolone containing drops are currently considered most appropriate.⁴⁶

Some GPs haven't taken this approach to children with AOM and acute ear discharge where the spontaneous rupture in the eardrum could provide entry of the antibiotic into the middle ear. These children tend to have a worse prognosis and a more prolonged duration of ear pain and/or fever than those without ear discharge.^{21,22} Topical antibiotics might be an attractive alternative to oral antibiotics in these children since they are considered to cause less antimicrobial resistance⁴⁷, but to date there is no evidence to support the use of locally applied antibiotics in these children.⁴⁶

When to refer?

Practical box 2: Red flags from the history and examination

- Febrile AOM at very young age (< 3 months of age)
- Non-resolving, severe pain
- Non-resolving fever
- Persistent or severe headache (with or without vomiting)
- Vision problems (blurred vision, diplopia, hemianopia, photophobia)
- Post auricular swelling and/or redness
- Meningism or focal neurology
- Cranial nerve palsy

Any of the following symptoms or signs are indicative for intermediate-risk for serious illness⁴⁸:

- pallor of skin, lips or tongue reported by parent or carer
- not responding normally to social cues
- no smile
- wakes only with prolonged stimulation
- decreased activity
- nasal flaring
- dry mucous membranes
- poor feeding in infants

- reduced urine output
- rigors

Any of the following symptoms or signs are indicative for high-risk for serious illness⁴⁸:

- pale/mottled/ashen/blue skin, lips or tongue
- no response to social cues
- appearing ill to a healthcare professional
- does not wake or if roused does not stay awake
- weak, high-pitched or continuous cry
- grunting
- respiratory rate greater than 60 breaths per minute
- moderate or severe chest indrawing
- reduced skin turgor
- bulging fontanelle

Serious suppurative complications of AOM (Practical box 3) are rare in high-income countries^{29,30,49}, but occur more commonly in low- and middle-income countries with an estimated 20,000 deaths worldwide each year.³ Advise parents to seek medical help if the child becomes unwell, if symptoms worsen rapidly or significantly (Practical Box 2), or do not improve after 3 days (48-72 hours for those receiving immediate antibiotics).³¹

In unwell children with suspected AOM, perform a comprehensive physical, including head and neck, examination with special attention to signs indicative of serious systemic illness or acute suppurative complications of AOM (Practical Box 2 and 3).

Immediate referral of these children to hospital is advised for further investigation and treatment.^{31,48}

Practical box 3: Complications of AOM

Extracranial (within the temporal bone or neck):

- Mastoiditis
- Petrositis
- Labyrinthitis
- Bezold abscess (neck abscess)
- Facial paralysis
- Permanent (sensorineural) hearing loss

Intracranial (in cranial cavity):

- Meningitis
- Brain abscess
- Epidural abscess
- Subdural empyema
- Focal otitic encephalitis
- Sigmoid or lateral sinus thrombosis
- Otitic hydrocephalus

How can it be prevented?

Preventative measures include reducing exposure to modifiable risks and vaccination. The American Academy of Pediatrics (AAP) recommends avoiding tobacco smoke exposure, reducing pacifier use and day care group size, and promoting exclusive breastfeeding for 6 months or longer.⁷

Pneumococcal conjugate vaccines (PCVs) during infancy have been implemented in national immunization programs in many countries in the last two decades. A 2019 Cochrane review (7 trials, 59415 children) of 7-11-valent PCVs in early infancy versus control vaccines noted that PCVs did not impact the overall incidence of AOM and their effect in healthy low-risk infants is uncertain.⁵⁰ The evidence is of moderate to high quality. None of the trials used the newer PCV containing 13 different types.

A Cochrane review published in 2017 (4 trials, 3134 children) found low-quality evidence that influenza vaccination in children aged 6 months to 6 years may lead to a small reduction in AOM compared to placebo. 25 children needed to be vaccinated to prevent one child having at least one AOM episode over at least six months of follow-up (absolute rates, 489 out of 1932 children [25%] for influenza vaccine vs 351 out of 1202 children [29%] for control).⁵¹

Acknowledgements

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Contributors

ADH and RPV conceived the article. All authors (RPV, AGMS, MvdH, ADH) designed the article. RPV wrote the first draft of the paper, and AGMS, MvdH, ADH commented on it. All authors approved the final version, and RPV is the guarantor.

Competing interests

We have read and understood the BMJ policy on declaration of interests and declare the following interests:

RPV is co-investigator and collaborator in trials comparing topical with oral antibiotics for children with AOM and acute ear discharge funded by the Netherlands Organisation for Health Research and Development (ZonMw) and the NIHR HTA programme and principle investigator on a grant proposal for a trial comparing

anaesthetic ear drops to usual care in children with AOM to ZonMw (pending funding decision).

AGMS is co-investigator in trials comparing topical with oral antibiotics for children with AOM and acute ear discharge funded by the Netherlands Organisation for Health Research and Development (ZonMw) and the NIHR HTA programme and on a grant proposal for a trial comparing anaesthetic ear drops to usual care in children with AOM to ZonMw (pending funding decision). As Director of the NIHR UCLH BRC Hearing Theme and National Specialty Lead of NIHR CRN ENT, AGMS advises companies on the design and delivery of clinical trials in the field of otitis media and hearing loss and serves on the Scientific Advisory Board of Novus Therapeutics.

MvdH is PPI member in a trial comparing topical with oral antibiotics for children with AOM and acute ear discharge funded by the Netherlands Organisation for Health Research and Development (ZonMw) and PPI member in a grant proposal for a trial comparing anaesthetic ear drops to usual care in children with AOM to ZonMw (pending funding decision).

ADH is chief investigator and collaborator of trials comparing topical with oral antibiotics for children with AOM and acute ear discharge funded by the NIHR HTA programme and the Netherlands Organisation for Health Research and Development (ZonMw) and collaborates on a grant proposal for a trial comparing anaesthetic ear drops to usual care in children with AOM to ZonMw (pending funding decision).

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