Does This Child Have Acute Otitis Media?

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0196-0644/$-see front matter

doi:10.1016/j.annemergmed.2005.09.007

[Ann Emerg Med. 2006;47:113-116.]

RATIONAL CLINICAL EXAMINATION REVIEW SOURCE

This is a rational clinical examination abstract, a regular segment of the *Annals'* Evidence-Based Emergency Medicine (EBEM) series. Each segment features an abstract of a rational clinical examination review from the *Journal of the American Medical Association* and a commentary by an emergency physician knowledgeable in the subject area.

The source for this rational clinical examination review is: Rothman R, Owens T, Simel DL. Does this child have acute otitis media? *JAMA.* 2003;290:1633-1640. The *Annals'* EBEM editors assisted in the preparation of the abstract of this rational clinical examination review, as well as selection of the Evidence-Based Medicine Teaching Points.

OBJECTIVE

This review summarizes the precision and accuracy of history and physical examination findings in the diagnosis of acute otitis media in children.

DATA SOURCES

The authors completed a MEDLINE search using multiple search strategies for English-language articles that examined the role of signs and symptoms in the diagnosis of acute otitis media published between January 1966 and May 2002. Bibliographies of selected articles and standard primary care and pediatric textbooks were also examined.

STUDY SELECTION

Three hundred ninety-seven articles were identified that met initial inclusion criteria. From this initial selection, 50 complete articles were reviewed. Only 17 of these articles specifically examined the clinical presentation of acute otitis media. Two of the authors independently reviewed each of these articles, excluding the majority of them because of inadequate methodologic quality. Six articles were selected for final review. Four of these studies specifically evaluated the value of the clinical history,[1-4] 1 evaluated the physical examination,[5] and the final study reviewed the accuracy and precision[6] of the diagnosis of acute otitis media.

DATA EXTRACTION AND ANALYSIS

Quality was assessed using an established methodologic filter for assessing internal validity that has been explained in previous rational clinical examination reviews. Each article was assigned a level of evidence from 1 to 5, and both reviewers reached a consensus. The majority of studies were judged to be of low quality (evidence level 4) and limited by lack of appropriate blinding methodology and incorporation, spectrum, and verification bias. The authors included sensitivity, specificity, positive and negative likelihood ratios, and 95% confidence intervals (CIs) for each of the historical features reviewed in this article. Positive likelihood ratios for physical examination findings were calculated and adjusted for verification bias using the assumption that a normal otoscopic examination was present in patients who were not diagnosed with acute otitis media.

MAIN RESULTS

Four studies of sufficient quality evaluated the value of historical features in the diagnosis of acute otitis media. The Table shows the positive and negative likelihood ratios and CI when available for each feature. Historical features such as ear pain (n=2 studies; positive likelihood ratios 3.0 and 7.3), ear rubbing (n=1 study; positive likelihood ratio 3.3; 95% CI 2.1 to 5.1), and parental suspicion of acute otitis media (n=1 study; positive likelihood ratio 3.4; 95% CI 2.8 to 4.2) were found to be minimally helpful. The presence of a concurrent upper respiratory tract infection, fever, cough, rhinitis, sore throat, restless sleep, excessive crying, poor appetite, vomiting, and headache were not helpful (positive likelihood ratio $\approx$1.0).

In the single study reviewed that used tympanocentesis as a criterion standard,[5] several physical examination findings were found to be highly predictive of the diagnosis of acute otitis media. In this study, positive likelihood ratios were adjusted to account for presumed normal physical examination findings for children who did not undergo tympanocentesis. A tympanic membrane that was cloudy (positive likelihood ratio 34; 95% CI 28 to 42) or bulging outward (positive likelihood ratio 51; 95% CI 36 to 73) or whose mobility was distinctly impaired by pneumatic otoscopy (positive likelihood ratio 31; 95% CI 26 to

Table. Accuracy of symptoms and signs in the diagnosis of AOM.

Accuracy of Symptoms			Accuracy of Signs	
Symptoms	**Positive LR (95% CI)**	**Negative LR (95% CI)**	**Signs**	**Adjusted Positive LR (95% CI)**
Parental suspicion of AOM	3.4 (2.8–4.2)	0.4 (0.3–0.5)	Color	
Ear pain	3.0–7.3*	0.4–0.6*	Cloudy	34 (28–42)
Ear rubbing	3.3 (2.1–5.1)	0.7 (0.6–0.8)	Distinctly red†	8.4 (6.7–11)
URI	1.4 (1.2–1.6)	0.3 (0.2–0.5)	Slightly red	1.4 (1.1–1.8)
Fever	0.8–2.6*	0.3–1.4*	Normal	0.2 (0.19–0.21)
Cough	0.9–1.0*	1.0–1.2*	Position	
Rhinitis	1.0–1.3*	1.0–1.2*	Bulging	51 (36–73)
Sore throat	0.5 (0.3–0.8)	1.2 (1.1–1.3)	Retracted	3.5 (2.9–4.2)
Restless sleep	1.3 (1.1–1.6)	0.7 (0.5–0.9)	Normal	0.5 (0.49–0.51)
Excessive crying	1.8 (1.4–2.3)	0.7 (0.5–0.8)	Mobility	
Poor appetite	1.1 (0.8–1.4)	1.0 (0.8–1.1)	Distinctly impaired	31 (26–37)
Vomiting	1.0 (0.6–1.8)	1.0 (0.9–1.1)	Slightly impaired	4.0 (3.4–4.7)
Headache	0.4 (0.2–0.7)	1.2 (1.1–1.3)	Normal	0.2 (0.19–0.21)

AOM, Acute otitis media; *LR*, likelihood ratio; *URI*, upper respiratory infection.
*A range of positive and negative likelihood ratios is listed for symptoms reported in multiple studies.
†A distinctly red tympanic membrane was described qualitatively as "hemorrhagic," "strongly red," or "moderately red."

37) was found to be virtually diagnostic. Additionally, a distinctly red (ie, hemorrhagic, strongly red, or moderately red) tympanic membrane was also found to be predictive of the disease (positive likelihood ratio 8.4; 95% CI 6.7 to 11). Findings of a tympanic membrane that was retracted (positive likelihood ratio 3.5; 95% CI 2.9 to 4.2) or whose mobility was only slightly impaired on pneumatic otoscopy (positive likelihood ratio 4.0; 95% CI 3.4 to 4.7) were less helpful. In contrast, a normal-colored tympanic membrane (positive likelihood ratio 0.2; 95% CI 0.19 to 0.21) or one whose mobility was normal with pneumatic otoscopy (positive likelihood ratio 0.2; 95% CI 0.19 to 0.21) was not associated with a diagnosis of acute otitis media. Examples of these physical examination features can be reviewed within the acute otitis media section of the American Academy of Pediatrics Web site (available online at http://www.aap.org/otitismedia/www).

The authors were unable to find any studies specifically reviewing the precision of clinical history and found only a few studies reviewing the precision of physical examination in the diagnosis of acute otitis media. Fair to slight agreement (κ statistic 0.16 to 0.40) is seen when features such as tympanic membrane color, effusion, position, and mobility are compared as done by a pediatric resident compared with an otolaryngogolist.[6]

CONCLUSIONS

Although all of the studies reviewed in this analysis were subject to bias, physical examination findings such as a cloudiness or distinct redness, bulging, or distinctly immobile tympanic membrane were found to be helpful in making the diagnosis of acute otitis media. A normal color or normal mobility of the tympanic membrane on pneumatic otoscopy refutes the diagnosis of acute otitis media.

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COMMENTARY: CLINICAL IMPLICATION

Earache is responsible for 1.9 million emergency department (ED) visits yearly, and acute otitis media is diagnosed in more than 30 million clinic visits each year, at a total cost of nearly $5 billion,[7,8] making it one of the most common and costly childhood illnesses. The combination of a somewhat irritable, potentially febrile young child, often associated with inadequate visualization of the eardrum and parental diagnosis and treatment expectations, can lead to overdiagnosis of this condition in the ED. This systematic review examined the evidence about a variety of symptoms and signs commonly used to diagnose acute otitis media. Because many design limitations exist in the studies included in this review, this review should be interpreted cautiously. Ear pain and ear rubbing are the 2 most useful clinical symptoms, whereas fever, the presence of associated upper respiratory infection symptoms (eg, rhinitis, cough), and irritability are not helpful. It remains to be seen whether the combination of several of these clinical features more accurately predicts the presence of acute otitis media. Interestingly, one study found that parental suspicion of acute otitis media or alternative diagnosis might also be helpful in predicting whether their child has acute otitis media.

Physical examination findings such as a cloudy, bulging, or distinctly immobile eardrum on pneumatic otoscopy were all

strongly associated with the diagnosis of acute otitis media. Additionally, a distinctly red eardrum should positively influence diagnostic certainty of acute otitis media. Findings such as a retracted eardrum or slightly impaired mobility of the eardrum on pneumatic otoscopy were less useful. In contrast, an eardrum that is normal in color or that has normal mobility on pneumatic otoscopy is unlikely to be acutely infected.

In attempting to apply these results to the ED, one should notice that in all studies reviewed, pediatricians or otolaryngologists obtained the medical history and performed the physical examination on patients. In addition, these medical facilities were not always EDs; in one study, patients referred for "otalgia" were included, and another included only patients referred for tympanocentesis, which may have increased the prevalence of otitis media in the study populations and caused some verification bias because of an increased pretest probability of disease (see the Teaching Point below about pretest probability). Other concerns include that very few elements were assessed by more than a single study, and physician diagnosis of acute otitis media was considered the reference standard for diagnosis in studies of historical elements, whereas tympanocentesis was used as the reference standard for the diagnosis in the single study that assessed physical examination elements. These performance characteristics may also not translate with the same degree of certainty to an adult population.

However, these data appear robust enough that the practicing clinician may improve their diagnostic accuracy by considering the more impressive likelihood ratios found here in their assessments. For instance, imagine a child treated in the ED for ear discomfort. If the clinician finds a distinctly red tympanic membrane on examination, it seems that no further testing is required. Two positive findings are present, one with a positive likelihood ratio of at least 3.0 (ear pain) and another with a positive likelihood ratio of 8.4 (distinct redness). The diagnosis of acute otitis media is relatively secure. In addition, imagine the febrile child with questionable ear pain and a "slightly red" membrane. In this common scenario, an objective finding may be helpful. The finding of "distinct" immobility on pneumatic otoscopy would be adequate to secure the diagnosis of acute otitis media, and a finding of "slightly impaired" mobility may also be adequate. In fact, given the apparent utility of pneumatic otoscopy (and the lack of general availability of tympanocentesis) and its relative simplicity and availability, emergency physicians not performing this procedure may consider adding it to their arsenal of routine examination tools.

TAKE HOME MESSAGE

The presence of certain clinical symptoms appears to significantly increase the likelihood of acute otitis media; however, their absence cannot rule it out. Several clinical signs strongly suggest (ie, adjusted positive likelihood ratio >30 for each) the diagnosis of acute otitis media: cloudiness, bulging position, and distinct impairment of mobility on pneumatic otoscopy. Additionally, a distinctly red ("hemorrhagic," strongly red, or moderately red) eardrum should positively influence your diagnostic certainty of acute otitis media (adjusted positive likelihood ratio 8.4). In contradistinction, an eardrum that is normal in color (likelihood ratio 0.2) or has normal mobility on pneumatic otoscopy (likelihood ratio 0.2) argues against the diagnosis of acute otitis media.

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EBEM TEACHING POINT

Pretest probabilities and Bayes Theorem. In the 18th century, the nonconformist minister Thomas Bayes introduced a mathematical theory proposing that the probability of an event depends on the circumstances surrounding it. In medical diagnostic testing, this can be interpreted to mean that the probability of a disease can be estimated before a diagnostic test is administered and then reestimated based on the test result. The initial estimation is called "pretest probability" and is affected most by the presence or absence of signs, symptoms, and historical and demographic factors related to the disease. In the ED, most patients evaluated for otitis media have a complaint such as ear pain or fever that motivated their visit, which means that the prevalence of otitis media is higher in the ED than in an asymptomatic population from an outpatient setting but likely to be lower than in a group referred to a specialist for tympanocentesis. In general, pretest probability measures are difficult to obtain for many ED conditions, and general assessment (eg, low, moderate, high pretest probability) may be all that is practical. The impact of this assessment is generally intuitive. For instance, a positive test result such as ear rubbing in the setting of a patient evaluated for fever has a greater diagnostic impact than when found in an asymptomatic patient examined in an outpatient setting. The pretest probability therefore helps one to understand the diagnostic meaning of a result that carries a demonstrably useful (but nondiagnostic when applied alone) likelihood ratio.

In some complicated diseases, this can be difficult to quantify intuitively, and validated scoring systems such as the Wells' criteria for assessing deep venous thrombosis can be helpful by translating findings, symptoms, and historical features into established numerical probabilities of the disease. In such cases, the pretest probability can often offer a clear pathway and can occasionally obviate the need for further testing. As an example, the absence of specific criteria in the NEXUS c-spine rule indicates that the probability of a cervical fracture is so low that the confirmatory test itself (cervical spine radiography) is not recommended.

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