

The Clinical Diagnosis of Infantile Pneumonia

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RATIONAL CLINICAL EXAMINATION REVIEW SOURCE

This is a rational clinical examination abstract, a regular feature of the *Annals'* Evidence-Based Emergency Medicine (EBEM) series. Each 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 the rational clinical examination review is: Margolis P, Gadomski A. Does this infant have pneumonia? *JAMA*. 1998;279:308-313. 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

The purpose of this abstract is to review the reliability and validity of the signs and symptoms commonly used by the clinician to make the diagnosis of infant pneumonia or determine the need for chest radiography.

DATA SOURCES

The authors conducted a MEDLINE search from 1982 to 1995 using the medical subject headings "pneumonia," "diagnostic tests," "sensitivity and specificity," "reproducibility of results," "physical exam" and "medical history taking." The MEDLINE search identified 38 articles. A review of a compendium of references prepared by the World Health Organization identified 4 more articles.

STUDY SELECTION

The authors reviewed all articles, and disagreements were resolved by discussion.

The methods developed for the *JAMA* rational clinical examination series, not elucidated in the article, were used to assess quality. Studies conducted in a family's home or on inpatients were excluded (n=29). A single study involving 312 patients in an outpatient setting was used to assess the precision of symptoms and signs. Five of 7 studies included were

performed in an emergency department (ED) setting and 2 were in developing nation outpatient centers.

DATA EXTRACTION AND ANALYSIS

Methods of data extraction were not discussed. The authors did not statistically pool results, because of age and methodologic differences among the studies. Confidence levels were calculated according to the method suggested by Koopman Agreement was measured with κ statistics.¹

MAIN RESULTS

Precision

A single study reported on interobserver reliability by having 56 patients independently examined by pairs of pediatricians.² Overall, physicians agreed more often on the absence of a physical examination finding than on its presence, and the presence of lower respiratory infection was associated with the highest agreement ($\kappa=.83$). κ Values for physical examination signs and diagnoses are shown in Table 1.

Accuracy

Considerable variability was noted in the reported accuracy of clinical findings. Table 2 demonstrates the characteristics of these studies. All selected studies used chest radiographs read by a radiologist as the reference standard. In 6 of 7 studies, the radiologist was blinded to the clinical results. In the seventh study, no comment was made as to whether the radiologist was blinded or not.

Combinations

Two of the 7 studies addressed a combination of findings. One study found that the absence of nasal flaring, grunting, retractions, tachypnea, rales, or decreased breath sounds ruled out pneumonia.³ When present, these same signs raised the likelihood of pneumonia. Notably, in this study the presence of these signs was used in the decision to order chest radiographs, potentially artificially lowering both the likelihood ratio (LR)- and the LR+.

One study found that in children 8 months of age and younger, the absence of respiratory findings substantially decreased the likelihood of a radiographic pneumonia (LR- = 0.10; 95% confidence interval [CI] 0.03 to 0.04), whereas their presence increased the likelihood (LR+ = 3.4; 95% CI 2.6

Table 1. Interobserver agreement between physicians for individual clinical findings.

Clinical Findings	Pairs of Observers	κ	Proportion of Agreement	
			Finding Present	Finding Absent
Social interactions				
Attentiveness	53	0.49	0.55	0.95
Smiling	49	0.51	0.76	0.75
Crying	55	0.26	0.58	0.68
Quality of crying	15	0.63	0.67	0.96
Consolability	35	<0.10	0.22	0.73
Physical appearance				
Movement	56	0.54	0.57	0.97
Color	55	0.66	0.67	0.99
Respiratory effort				
Retractions	56	0.48	0.7	0.79
Use of accessory muscles for inspiration or expiration	53	0.59	0.74	0.85
Auscultation				
Prolonged expiratory phase	54	0.22	0.52	0.7
Audible wheezing	54	0.7	0.83	0.87
Adventitious sounds	56	0.3	0.55	0.75
Inspiratory wheezing	56	0.29	0.36	0.93
Expiratory wheezing	56	0.63	0.77	0.85
Diagnoses				
LRI	50	0.83	0.94	0.89
Pneumonia	50	0.63	0.67	0.97

LRI, Lower respiratory infection.

to 4.3). Similarly, as the number of positive respiratory findings increased, the probability of a positive chest radiograph increased.⁴

CONCLUSIONS

Observation of the child may be the most critical component of the examination, and respiratory rate should be counted for a full minute or 2 30-second intervals. Auscultation is relatively unreliable. The most valuable individual finding for ruling out pneumonia is the absence of tachypnea. If all clinical sign results are negative (respiratory rate, auscultation, and work of breathing), the chest radiograph result is unlikely to be positive.

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COMMENTARY: CLINICAL IMPLICATION

Pneumonia is responsible for 4 million deaths per year worldwide in children and is one of the leading causes of death among children. Its presentation is commonly seen in the practice of emergency medicine.⁵ Unlike adults, children may present with more generalized symptoms such as fever, decreased activity, or inability to eat, rather than respiratory symptoms. Although the majority of pneumonias in childhood are viral, bacterial pneumonia continues to carry significant morbidity and mortality.

Although the true criterion standard for the diagnosis of pneumonia is bronchoalveolar lavage or lung biopsy, for practical purposes a positive chest radiograph is used in the clinical setting. Thus, the utility of the clinical examination and the decision to order a chest radiograph are matters of importance in daily emergency practice. This rational clinical examination contribution examines the evidence about the reliability and validity of symptoms and physical examination in diagnosing pneumonia.

Using a relatively comprehensive English-language-only search up to 1995, the authors attempted to summarize the evidence in this field qualitatively. The likelihood of selection and publication bias in this review is high, and an update is urgently needed on this topic. Overall, the authors evaluate a number of studies that have examined these questions in a variety of settings and populations, ranging from outpatient centers in developing nations to EDs in the United States, and ranging in age from younger than 8 months to 17 years. These population disparities and multiple methodologic disparities led the author to consider and discuss the results of these 7 studies individually rather than attempting to pool data.

The final conclusions (eg, respiratory rate measurement, observation, tachypnea indicating the need for chest radiograph, and absence of findings obviating the need for chest radiograph) appear to be sensible for the emergency clinician. Observing the child before interacting is critical both for activity level and respiratory rate determination. Counting the respiratory rate for a full minute in the undisturbed child has been recommended by others.⁶ The fact that auscultation is relatively unreliable, especially when negative, is both sensible and consistent with analogous studies on adult patients evaluated for pneumonia.⁷ This is an important conclusion, given the traditional habit of investing particular significance in negative auscultation results. Positive auscultatory findings, of course, can be of benefit; however, the absence of tachypnea appears to be the most useful individual finding in decreasing the likelihood of pneumonia. Independently, it is inadequate to rule out the disease.

Since Margolis and Gadomski published their review in 1998, there have been other studies suggesting the incidence of occult pneumonia may be as high as 19% in sicker children.⁸ As always, the decision to order a chest radiograph must be based on the treating clinician's judgment.

Table 2. Operating characteristics of signs and symptoms from studies included in review.

Source, y	Item	Likelihood Ratio Positive (95% CI)	Likelihood Ratio Negative (95% CI)
Description of breathing (time or explanation)			
Redd et al, 1994	Respiratory rate ≥ 50 breaths/min (3–11 mo)	1.93 (na)	0.36 (na)
Harari et al, 1991	Respiratory rate ≥ 50 breaths/min	2.17 (na)	0.52 (na)
Crain et al, 1991	Respiratory rate ≥ 60 breaths/min (<8 wk)	8.00 (5.3–12.1)	0.55 (0.4–0.8)
Lozano et al, 1994	Respiratory rate ≥ 50 breaths/min (0–11 mo)	1.67 (1.2–2.3)	0.52 (0.4–0.7)
Leventhal, 1992	Tachypnea (clinician judgment of fast breathing)	2.03 (1.5–2.7)	0.32 (0.1–0.7)
Taylor et al, 1995	Tachypnea (maximal sensitivity and specificity in different age strata)	3.22 (2.5–4.1)	0.34 (0.2–0.6)
Zukin, 1986	Tachypnea (\geq SD for age)	1.56 (0.9–2.6)	0.75 (0.5–1.2)
Work of breathing			
Redd et al, 1994	Chest in-drawing	2.39 (na)	0.70 (na)
Harari et al, 1991	Chest in-drawing	2.46 (na)	0.78 (na)
Lozano et al, 1994	Chest in-drawing	1.27 (1.0–1.5)	0.53 (0.3–0.9)
Crain et al, 1991	Chest in-drawing	26.00 (5.7–118.8)	0.75 (0.6–0.9)
Redd et al, 1994	Nasal flaring (3–11 mo)	6.60 (na)	0.71 (na)
Lozano et al, 1994	Nasal flaring	1.19 (0.9–1.6)	.83 (0.6–1.1)
Leventhal, 1992	Nasal flaring	1.94 (1.0–3.8)	0.79 (0.6–1.1)
Lozano et al, 1994	Grunting	1.21 (0.8–1.8)	0.89 (0.7–1.1)
Leventhal, 1992	Grunting	3.17 (1.1–9.2)	0.86 (0.7–1.0)
Temperature			
Harari et al, 1991	>38°C	1.15 (na)	0.95 (na)
Zukin, 1986	Fever	1.47 (1.3–1.7)	0.17 (0.02–1.1)
Auscultation			
Leventhal et al, 1992	Crepitations	2.10 (1.2–3.8)	0.73 (0.5–1.0)
Lozano et al, 1994	Crepitations	1.78 (1.4–2.3)	0.36 (0.2–0.5)
Crain et al, 1991	Crepitations	15.00 (2.9–78.0)	0.86 (0.7–1.0)
Zukin, 1986	Crepitations	2.90 (1.4–3.7)	0.57 (0.3–0.97)
Lozano et al, 1994	Wheezes	0.63 (0.4–1.1)	1.12 (1.0–1.3)
Crain et al, 1991	Wheezes	4.00 (0.4–37.1)	0.97 (0.9–1.1)
Zukin, 1986	Wheezes	0.19 (0.03–1.3)	1.30 (1.2–1.5)

na, CIs could not be reported, because insufficient information was available.

TAKE HOME MESSAGE

In the diagnostic evaluation of children with suspected pneumonia, clinicians should observe the child closely and count the respiratory rate for a full minute. Without positive clinical findings, including respiratory signs, pneumonia is unlikely. Although the auscultatory examination is not useful for ruling out pneumonia, tachypnea and its absence may be helpful findings in the decision to proceed with chest radiography. Finally, the reference standard test (chest radiography) is relatively inexpensive and carries with it minimal associated risk.

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EBEM TEACHING POINT

Confirmation bias. “Confirmation bias” is a term that refers to an error of inductive inference in which new evidence is interpreted in a way that conforms to an existing hypothesis,

even in the absence of objectively confirmatory data. The problem is ubiquitous enough that the foundational basis for the scientific method is therefore constructed to *disprove* hypotheses rather than confirm them.

In the evaluation of chest radiographs of infants for the detection of pneumonia, the clinicians who ordered the imaging test believed in varying degrees that pneumonia may be present and visible. The physicians’ preexisting index of suspicion for the presence of pneumonia had the potential to substantially affect their interpretation of the radiograph, a test with established interobserver variability. Therefore, it is methodologically important that the studies reviewed in this rational clinical examination use radiologists blinded to the clinical presentations of the infants being evaluated, a measure undertaken to avoid confirmation bias.

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