CLINICAL DECISIONS
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Chest Radiography for Presumed Pneumonia in Children

This interactive feature addresses the approach to a clinical issue. A case vignette is followed by specific options, neither of which can be considered either correct or incorrect. In short essays, experts in the field then argue for each of the options as assigned. Readers can participate in forming community opinion by choosing one of the options.

CASE VIGNETTE

A 4-Year-Old Boy with Fever, Cough, and Congestion

Julie R. Barzilay, M.D.

A 4-year-old boy is brought to a pediatric urgent care clinic with a 5-day history of cough and congestion and a 3-day history of fever. His maximum temperature at home was 39°C (102.2°F). The cough has been worsening. His medical history is notable for two previous episodes of acute otitis media (both more than a year earlier) and mild eczema.

In the office, his temperature is 38.4°C (101.4°F), the respiratory rate 36 breaths per minute, the heart rate 138 beats per minute, and the oxygen saturation 94% while he is breathing ambient air. He is normotensive. He appears comfortable and slightly tired but is alert and interactive with his parents and the examiner. He has moist mucous membranes. On auscultation of the lungs, scattered coarse sounds and some mild crackles are noted, more in the right lower lung field than in the left. He has mild subcostal retractions but no other retractions and no tracheal tugging or nasal flaring. He is not wheezing and has no focal areas of diminished aeration. He has rhinorrhea and erythema of the posterior oropharynx but no tonsillar enlargement or exudate. Other than the tachycardia, his cardiac examination is normal and skin perfusion is excellent. His tympanic membranes are normal. His abdomen is soft and nontender, and he has no rashes.

The patient's parents are worried and want to know what is causing their child's cough and how it can be treated. You must decide whether you should initiate empirical antibiotic therapy to treat a presumed bacterial pneumonia or whether radiography should be performed to better characterize the diagnosis.

TREATMENT OPTIONS

Which one of the following approaches would you take? Base your choice on the literature, your own experience, published guidelines, and other information.

1. **Initiate empirical antibiotic therapy for presumed bacterial pneumonia.**
2. **Obtain a radiograph to better characterize the diagnosis.**

To aid in your decision making, we asked two experts in the field to summarize the evidence in favor of approaches assigned by the editors. Given your knowledge of the issue and the points made by the experts, which approach would you choose?

From the Division of General Pediatrics, Department of Pediatrics, Boston Children's Hospital, Boston.

OPTION 1

Initiate Empirical Antibiotic Therapy for Presumed Bacterial Pneumonia

Mark I. Neuman, M.D., M.P.H.

The clinical vignette describes a child with a febrile respiratory illness who has borderline hypoxia and focal crackles on examination. We are asked to decide whether a chest radiograph should be performed or whether the child should be given empirical treatment with an antibiotic. This decision hinges on the accuracy of both a physical examination and chest radiography for the diagnosis of pediatric pneumonia, on the epidemiology of pneumonia, and on whether radiographic findings can be used to assess the need

for antibiotic treatment. Given the clinical scenario in a well-appearing child without coexisting medical conditions, empirical antibiotic treatment without performance of chest radiography is a reasonable approach.

Although a normal chest radiograph reliably rules out a diagnosis of pneumonia,[1] when the radiograph is abnormal, the cause cannot be reliably ascertained given the overlap in radiographic patterns among common bacterial, atypical bacterial, and viral infections. The Etiology of Pneumonia in the Community (EPIC) trial investigated the cause of radiographically confirmed pneumonia among hospitalized children.[2] Although bacterial causes were more common among children with consolidations and pleural effusions than among children with other types of infiltrates, viral infections predominated with all radiographic patterns of pneumonia. In fact, among children with a detected pathogen who had consolidations on radiography — a pattern typically considered indicative of bacterial infection — viruses accounted for nearly 80% of infections.

Another study conducted among children undergoing radiography for suspected pneumonia asked clinicians to indicate whether they planned to prescribe antibiotics before viewing the radiograph.[3] The study showed that 72% of children with a preradiography plan for antibiotics were treated, as compared with 19% of children without a plan for antibiotics. Ultimately, the radiograph influenced the treatment decision in less than 20% of children with suspected pneumonia.

In addition, the evaluation of a chest radiograph is subjective, even among expert pediatric radiologists. Although one study observed a high degree of agreement for alveolar infiltrates (kappa coefficient, 0.69), interrater agreement was lower for other types of infiltrates, including interstitial infiltrates (kappa coefficient, 0.14).[4] One might worry that skipping radiography would result in overdiagnosis of pneumonia, but a study by Geanacopoulos et al.[5] showed that this was not the case. That study took place within the years covered by the 2011 guidelines of the Infectious Diseases Society of America and the Pediatric Infectious Diseases Society that recommended against routine radiography for children with pneumonia in an outpatient setting. The study showed a decrease in the performance of radiography among children presenting to the emergency department for fever or respiratory distress, without a corresponding increase in pneumonia diagnoses.

Finally, clinical scoring systems can be used to assess the risk of pneumonia as an alternative to chest radiography. One example is the Pneumonia Risk Score,[6] which has been shown to be superior to clinical judgment in predicting risk and has been externally validated.[7] Other factors to consider are the costs associated with chest radiography, the radiation exposure, and the availability of radiography, particularly in the outpatient setting.

In summary, given that there is low concern for severe or complicated pneumonia in the child in the vignette, I would not order a radiograph. For most children who are determined to be at either high risk or low risk for pneumonia, chest radiography is not indicated. However, chest radiography may have value for children with intermediate risk, since the results may help to promote judicious prescription of antibiotics.

Disclosure forms provided by the author are available with the full text of this article at NEJM.org.

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OPTION 2

Obtain a Radiograph to Better Characterize the Diagnosis

Todd A. Florin, M.D., M.S.C.E.

This child presents with a constellation of signs and symptoms faced daily by clinicians caring for children: upper respiratory symptoms, cough, scattered lower airway sounds, and fever. The most common cause of this presentation, by far, is viral illness. Even in hospitalized children with evidence of pneumonia on radiography, viruses have been the pathogens most often detected by comprehensive testing.[8] However, to prevent additional complications, it is important not to miss bacterial pneumonia, for which antibiotics are beneficial.

Bacterial pneumonia is challenging to diagnose because of clinical features that overlap with those of most other respiratory conditions, a lack of accurate diagnostic tests, and the high prevalence of viral disease. Pneumonia lacks a standardized clinical definition, and no symptom or sign can reliably predict the presence of pneumonia on radiography.[9] Clinical prediction rules

that combine age and various signs and symptoms, including fever, low oxygen saturation, crackles, lack of wheezing, and focally decreased breath sounds, can improve diagnostic performance but are imperfect. One of these rules (the Pneumonia Risk Score) applied to the child in the vignette suggests a 42%, or intermediate, risk of radiographic evidence of pneumonia.[6] This rule, one of the better performing rules in the literature, had a sensitivity of 82%, specificity of 53%, and an area under the receiver-operating-characteristic curve of 0.72 to 0.76 when validated, which suggests that even the best-performing prediction rules have limitations for this heterogeneous, difficult-to-diagnose condition.[7]

So, why not give this child antibiotics "just in case"? *Primum non nocere — First, do no harm.* Giving antibiotics unnecessarily for viral illness exposes children to harms while providing no benefit and leads to avoidable side effects, including nonallergic side effects that may result in mislabeling of the child as allergic, and potentially severe complications. Among young children, antibiotics are the most common drug class resulting in emergency department visits for adverse drug reactions.[10] Overuse of antibiotics also promotes the development of antibiotic resistance, which is a public health threat and a leading cause of death worldwide.[11]

Chest radiography, despite its limitations, has been shown to alter management decisions in children in whom pneumonia is clinically suspected. One benefit of radiography is its high negative predictive value (98%), which suggests that if a radiograph is normal, pneumonia is highly unlikely and thus antibiotic treatment is not warranted.[1] In one prospective study, among children with clinically suspected pneumonia who had a preradiography plan for antibiotics, prescription of antibiotics after return of a normal radiograph was half of what had been planned before the radiography.[3] Ultrasonographic imaging at the bedside may increasingly replace radiography in assisting with clinical decision making.

Parental concern is part of every clinical decision in pediatrics, and parents should be provided with the pros and cons of management approaches to allow for shared decision making. In this case, obtaining a chest radiograph could allay some anxiety, particularly if it does not reveal a pneumonia.

In summary, given the predominance of viral respiratory disease, the desire to avoid the harms of unnecessary antibiotics, the high negative predictive value of radiography, and the wish to alleviate parental anxiety, I would recommend obtaining a radiograph in this child to better characterize his lower respiratory tract disease to guide antibiotic treatment decisions.

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