

# The Role of Physical Examination in Establishing the Diagnosis of Pneumonia

Itay Ayalon, MD,\* Miguel Marcelo Glatstein, MD,† Galit Zaidenberg-Israeli, MD,\*  
Dennis Scolnik, MB, ChB,‡ Amir Ben Tov, MD,\* Liat Ben Sira, MD,§ and Shimon Reif, MD\*

**Background:** Community-acquired pneumonia (CAP) is an important cause of acute respiratory disease in ambulatory care settings. The objective of this study was to assess the accuracy of medical history and physical examination in diagnosing CAP.

**Methods:** Pediatric residents prospectively completed a questionnaire documenting patients' medical history and physical examination whenever a chest radiograph was ordered on patients 1 month to 16 years of age. Chest radiographs were read by a pediatric radiologist.

**Results:** Of 525 children participating in the study, 181 (34%) demonstrated findings of pneumonia. Thirty-four (19%) had no symptoms other than fever, and 51 (28%) had normal lung auscultation. Pediatric residents had the same interpretation in 85% of cases in which radiographic CAP was diagnosed by the radiologist, and in 76% of cases in which radiographic pneumonia was excluded by the radiologist.

**Conclusions:** Results demonstrate the significant added value of chest radiography as an ancillary test for diagnosis of pneumonia in the emergency department setting.

**Key Words:** chest radiography, pneumonia, physical examination

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Community-acquired pneumonia (CAP) is a common disease with an incidence of almost 2% in developed countries.<sup>1</sup> Worldwide, more than 2 million children younger than 5 years die of pneumonia each year, accounting for almost 1 in 5 deaths in this age group.<sup>2</sup> The most commonly implicated bacteria are *Streptococcus pneumoniae*, followed by *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, and *Haemophilus influenzae*.<sup>3</sup> Occult pneumonia represents a diagnostic dilemma for physicians, especially pediatricians,<sup>4</sup> and distinguishing pneumonia from other causes of respiratory illnesses, such as acute bronchitis and upper respiratory tract infections, has important therapeutic and prognostic implications. Although the likelihood of pneumonia increases with longer duration of cough or fever and in the presence of leukocytosis,<sup>5</sup> the reference standard for diagnosing pneumonia is chest radiography. Nevertheless, many physicians rely on patients' history and physical examination to diagnose or exclude this disease.<sup>6</sup> Decision rules for diagnostic procedures have helped

revolutionize health care by decreasing the cost associated with unnecessary diagnostic studies and providing algorithms to increase physician efficiency.<sup>7</sup> Our study evaluated the utility of clinical indicators, elicited from history and examination of children with suspected CAP, compared with that of chest radiography in the emergency department (ED) of our institution.

## METHODS

This was a prospective, observational study approved by the institutional review board.

## Study Setting and Population

The study was performed at the Department of Pediatric Emergency Medicine, Dana-Dwek Children's Hospital, Sourasky Medical Center, Tel Aviv, between April 2007 and May 2010. During this period, pediatric residents were asked to complete a questionnaire whenever a chest radiograph was ordered in children 1 month to 16 years old on the suspicion that pneumonia could be the cause of their fever. The questionnaire contained a checklist of 6 symptoms and 11 physical findings (Table 1). Patients with suspected hospital-acquired pneumonia (positive radiographic results within 10 days of hospital discharge) or aspiration pneumonia were excluded. Residents were blinded to radiographic findings because all questionnaires were completed before the radiograph was obtained. Pediatric residency lasts 4 years in our country, and we analyzed our results in 2 groups: experienced physicians in the third and final years of training and less experienced physicians in the first 2 years of training.

All chest radiographs were interpreted by a board-certified radiologist blinded to the clinical findings. For the purposes of this study, only clearly visible and obvious findings of air-space disease on chest radiography were used to define pneumonia. These findings included air-space pattern consolidation in a lobar or segmental distribution representing consolidative pneumonia and patchy reticulonodular infiltrates representing bronchopneumonia. Other findings were excluded, and when in doubt, the radiograph was considered negative for pneumonia. Thus, positive radiographic findings of pneumonia were defined as the presence of new air-space opacities in the setting of acute respiratory symptoms.

We carried out an agreement analysis between pediatric residents and pediatric radiologist interpretations of chest radiographs using the  $\kappa$  coefficient. The  $t$  test was used for continuous variables with normal distribution. For continuous variables with nonnormal distribution, the Wilcoxon test was used, and for categorical data, the Fisher exact test. The significance level was set at  $P < 0.05$ . Items found to be significant on univariate analysis were entered into a multivariate regression analysis.

## RESULTS

Five hundred twenty-five consecutive pediatric patients who underwent a chest radiograph as part of their evaluation for suspected CAP were included in this study. Their demographic

From the \*Division of Pediatric Department and †Division of Pediatric Emergency Medicine, Department of Pediatrics, Dana-Dwek Children's Hospital, Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel; ‡Divisions of Pediatric Emergency Medicine and Clinical Pharmacology and Toxicology, Department of Pediatrics, The Hospital for Sick Children, University of Toronto, Canada; and §Department of Diagnostic Imaging, Ichilov Hospital, University of Tel Aviv, Israel.

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Reprints: Miguel Marcelo Glatstein, MD, Division of Pediatric

Emergency Medicine, Dana-Dwek Children's Hospital, Sackler School of Medicine, Tel Aviv University, 6 Weizman St, Tel-Aviv 64239, Israel (e-mail: Nopasara73@hotmail.com).

I.A. and M.M.G. contributed equally to this work.

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**TABLE 1.** Characteristics of the Study Population (n = 525)

| Patient Characteristic                  | Total    | No Pneumonia | Pneumonia    | P              |
|-----------------------------------------|----------|--------------|--------------|----------------|
| General                                 |          |              |              |                |
| Mean age, y                             | 2.9      | 2.7          | 3.4          | 0.001          |
| Mean temperature, °C                    | 39.5     | 39.5         | 39.6         |                |
| Age groups, n (%)                       |          |              |              |                |
| <1 y old                                | 95 (18)  | 71/344 (13)  | 24/181 (13)  | 0.21           |
| 1–6 y old                               | 358 (68) | 234/344 (68) | 124/181 (68) |                |
| >6 y old                                | 72 (14)  | 39/344 (11)  | 33/181 (18)  |                |
| Duration of fever                       |          |              |              |                |
| Mean, d                                 | 2.83     | 2.86         | 2.81         |                |
| 1 d, n (%)                              | 55 (10)  |              |              |                |
| 2 d, n (%)                              | 174 (33) |              |              |                |
| 3 d, n (%)                              | 104 (20) |              |              |                |
| 4 d, n (%)                              | 192 (36) |              |              |                |
| >4 d, n (%)                             | 2 (<1)   |              |              |                |
| Symptoms, n (%)                         |          |              |              |                |
| Rhinorrhea                              | 275 (53) | 185/344 (54) | 90/181 (50)  | 0.35           |
| Cough                                   | 382 (73) | 240/344 (69) | 142/181 (78) | 0.034          |
| Emesis                                  | 142 (27) | 88/344 (25)  | 54/181 (30)  | 0.29           |
| Diarrhea                                | 50 (9)   | 33/344 (9)   | 17/181 (9)   | 0.94           |
| Chills                                  | 26 (5)   | 14/344 (4)   | 12/181 (6)   | 0.2            |
| Weakness                                | 28 (5)   | 13/344 (4)   | 15/180 (8)   | 0.02           |
| Dyspnea                                 | 62 (12)  | 32/344 (9)   | 30/181 (17)  | 0.014          |
| Vital signs, n (%)                      |          |              |              |                |
| Tachycardia                             | 142 (28) | 78/344 (23)  | 64/180 (36)  | 0.0017         |
| Tachypnea                               | 76 (15)  | 35/344 (10)  | 41/181 (22)  | 0.0011 <0.0001 |
| Oxygen saturation, n (%)                |          |              |              |                |
| >95%                                    | 471 (92) | 323/338 (95) | 148/176 (84) |                |
| 90%–95%                                 | 41 (8)   | 14/338 (4)   | 27/176 (15)  |                |
| <90%                                    | 2 (<1)   | 1/338 (<1)   | 1/176 (<1)   |                |
| Physical examination, n (%)             |          |              |              |                |
| Ill appearance                          | 128 (24) | 55/344 (16)  | 72/181 (40)  | <0.0001        |
| Cyanosis                                | 4 (<1)   | 1/344 (<1)   | 3/181 (2)    | 0.09           |
| Use of accessory muscles of respiration | 72 (14)  | 30/344 (9)   | 42/181 (23)  | <0.0001        |
| Ala nasi                                | 11 (2)   | 6/344 (2)    | 5/181 (3)    | 0.43           |
| Subcostal                               | 36 (7)   | 17/344 (5)   | 18/181 (10)  | 0.029          |
| Abdominal                               | 51 (10)  | 19/344 (6)   | 31/181 (17)  | P < 0.0001     |
| Suprasternal                            | 13 (2)   | 5/344 (1)    | 8/181 (4)    | 0.037          |
| Wheezing                                | 42 (8)   | 25/344 (7)   | 17/181 (9)   | 0.390.55       |
| Rales                                   | 69 (13)  | 43/344 (12)  | 26/181 (14)  | <0.0001        |
| Crackles                                | 105 (20) | 51/344 (15)  | 54/181 (30)  | 0.13           |
| Bronchial breathing                     | 20 (4)   | 10/344 (3)   | 10/181 (5)   | <0.0001        |
| Decreased breath sounds                 | 141 (27) | 70/344 (20)  | 71/181 (39)  |                |
|                                         | 0 (0)    | 0/344 (0)    | 0/181 (0)    |                |

features and signs and symptoms with *P* values from univariate analysis are shown in Table 1. Findings on chest radiography consistent with pneumonia were found in 181 (34%) of patients. Signs and symptoms associated with radiographically defined CAP on multivariate analysis were fever (*P* = 0.001), lowered oxygen saturation (*P* = 0.04), the presence of rales (*P* = 0.03), crackles (*P* = 0.003), and decreased breath sounds (*P* = 0.013) (Table 2). The presence of normal breath sounds or findings limited to wheeze, prolonged expiration, cough, and/or rhonchi on chest examination did not predict CAP on chest radiography. Thirty-four of the patients with radiographic CAP (19%) had no

symptoms other than fever (this includes the absence of tachypnea, accessory muscle use, or cough).

We found that older patients (>6 years) with radiographic CAP were easier to diagnose by physical examination (Table 3).

Agreement between residents' and radiologists' readings of chest radiographs was moderate to substantial ( $\kappa$  = 0.6). Pediatric residents had the same interpretation in 85% of cases in which radiographic CAP was diagnosed by the radiologist and in 76% of cases in which radiographic pneumonia was excluded by the radiologist. There was a much higher level of agreement between senior residents with the pediatric radiologist's

**TABLE 2.** Symptoms and Findings on Physical Examination in Patients Suspected of Having CAP Found to Be Significant on Multivariate Logistic Regression

| Symptoms and Physical Examination Findings | P      | Odds Ratio (95% Confidence Interval) |
|--------------------------------------------|--------|--------------------------------------|
| Increased age                              | 0.02   | 1.09 (1.013–1.164)                   |
| Higher fever                               | 0.001  | 2.14 (1.208–2.138)                   |
| Ill appearance                             | 0.0009 | 2.3 (1.406–3.781)                    |
| Lower oxygen saturation                    | 0.04   | 2.4 (1.035–5.645)                    |
| Use of accessory breath muscle             | 0.02   | 2.17 (1.126–4.203)                   |
| Presence of rales                          | 0.03   | 1.96 (1.046–3.683)                   |
| Presence of crackles                       | 0.003  | 2.2 (1.312–3.694)                    |
| Presence of decreased breath sounds        | 0.0013 | 2.18 (1.355–3.504)                   |

interpretation of chest roentgenograms compared with junior residents ( $\kappa = 0.75$  vs  $0.57$ , respectively).

## DISCUSSION

Pneumonia is a frequent concern in the ambulatory setting. Diagnosis should be prompt as delay in the institution of treatment has been associated with a worse prognosis<sup>8</sup>; however, empiric antibiotic treatment of all patients suspected of having pneumonia is unwarranted and can lead to antibiotic resistance.<sup>9</sup> Consistent with previous studies, our study showed that the presence of rales and crackles and decreased breath sounds on chest auscultation, general “ill-looking” appearance, higher temperatures, lower oxygen saturation rates (<95%), and use of accessory muscles of respiration were significantly related to the presence of radiologically confirmed CAP. Although the World Health Organization defines tachypnea, cough, fever, chills, loss of appetite, and wheezing as classic signs identifying pneumonia in areas with limited access to radiography,<sup>10</sup> some of these symptoms, that is, tachypnea and wheezing, were not significantly related to CAP in the current study.

We also demonstrated that reliance on physical examination findings alone in the ED setting does not exclude the existence of pneumonia: 28% of patients with radiographic CAP had no abnormalities on auscultation, and CAP would have been “missed” had a chest radiograph not been performed. Some studies have shown that the absence of any vital sign abnormalities or any abnormalities on chest auscultation reduces the likelihood of pneumonia to a point where further diagnosis evaluation may be unnecessary,<sup>6–11</sup> and a recent guideline published by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America<sup>12</sup> rejected the routine use of chest radiographs to confirm suspected CAP in patients well enough to be treated in the outpatient setting. This position was

based on the lack of impact of chest radiographs in deciding on the need for hospitalization, and the lack of impact on clinical outcome.<sup>13</sup> Chandra et al<sup>14</sup> found that the likelihood of CAP increases with increasing duration of cough with fever. We suggest that a chest radiograph be performed on patients with fever lasting more than 4 days and/or cough, even in the absence of tachypnea or respiratory distress, because of the possibility of “occult” pneumonia (ie, the presence of radiographic infiltrates in the absence of clinical signs of lower respiratory tract infection). The Canadian Paediatric Society recommends the use of chest x-ray confirmation because of the lack of agreement between clinical pneumonia and radiologically confirmed pneumonia and to prevent unnecessary antibiotic use when a more likely diagnosis is viral bronchitis.<sup>15</sup> Decisions regarding when to use antibiotics, and what kind to use, are indeed challenging and mostly depend on epidemiological and clinical criteria not addressed in this study. Consistent with the Infectious Diseases Society of America guidelines published on 2011, we believe that “chest radiographs cannot reliably distinguish viral from bacterial CAP and do not reliably distinguish among the various possible bacterial pathogens.”

We found that patients older than 6 years, with radiographic CAP, were much more likely to present with abnormal auscultatory findings (crackles and decreased breath sounds) compared with younger children. We believe that this age-specific difference is mostly as a result of older children’s better ability to cooperate during a physical examination.

It should be borne in mind that this study was performed in the setting of an ED, and because of factors such as physician and self-referral biases, it may not represent the spectrum of CAP found in primary care settings.

In conclusion, although pneumonia is considered a clinical diagnosis based on medical history and physical findings, our data demonstrate the significant added value of performing a chest radiograph in selected febrile children, especially among infants and toddlers. Chest radiographs should be strongly considered as part of the routine evaluation of a febrile child presenting to the ED with a history of fever lasting more than a few days without a source, even if there are no clinical signs suggesting pneumonia.

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**TABLE 3.** Presence of Crackles or Decreased Breath Sounds in Radiographically Proven CAP by Age Group

| Age, y | Roentgenographically Proven Pneumonia With Crackles or Decreased Breath Sound on Physical Examination, n (%) | P    |
|--------|--------------------------------------------------------------------------------------------------------------|------|
| <1     | 12/27 (48)                                                                                                   | 0.09 |
| 1–3    | 45/79 (57)                                                                                                   |      |
| 3–6    | 28/48 (58)                                                                                                   |      |
| >6     | 21/27 (78)                                                                                                   |      |

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