

Overdiagnosis of pneumonia in children

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The aim of this study was to reevaluate patients diagnosed as pneumonia in our outpatient clinic in an effort to determine whether these patients really had pneumonia and needed antibiotic therapy. Over a 14-month period, 119 children who were diagnosed as pneumonia were prospectively evaluated. In order to find a relationship, specificity and sensitivity were defined. The diagnosis of pneumonia was ruled out in 48 of the 119 (40%) patient included. An incorrect diagnosis of pneumonia was made in 40% of cases and antibiotics were prescribed unnecessarily in 85%. Tachypnea, which had a specificity of 99% and sensitivity of 61%, was the most important criteria in diagnosing pneumonia. We believe that children who present with cough only do not always need antibiotic treatment. Tachypnea and auscultation findings are important criteria for diagnosing and treating pneumonia.

Key words: overdiagnosis, pneumonia.

Acute lower respiratory tract infections (RTIs) cause considerable morbidity and mortality in children¹. In less developed countries, the mortality of these infections is 50 to 100 times greater, and every year more than 4,000,000 children under five years old die because of pneumonia^{2,3}.

The evaluation of an acutely ill child in whom pneumonia is a possibility is difficult. A major problem is the absence of a definitive "gold standard" for the diagnosis. Blood cultures are positive in only a small percentage of patients (10-20%), and in 30-40% of hospitalized patients⁴. Invasive techniques such as bronchoalveolar lavage, lung puncture and open lung biopsy are only applicable to a small group of patients. Therefore, determination of the precise etiology of pneumonia is very complicated in children. Furthermore, it is still not known which clinical or laboratory findings in lower RTIs can lead to the diagnosis of pneumonia and predict the need for antibiotics.

The aim of this study was to reevaluate patients diagnosed as pneumonia in our outpatient clinic in an effort to determine whether these patients really had pneumonia and needed antibiotic therapy.

Material and Methods

Over a 14-month period, 126 children who were diagnosed as pneumonia and were prescribed antibiotics in the outpatient department of Hacettepe University İhsan Doğramacı Children's Hospital were prospectively evaluated at the Pediatric Chest Disease Department. Patients had no history of recurrent bronchopneumonia or immune deficiency. Seven patients who were excluded, failed to come to the hospital regularly for visits, so only 119 patients were included in the study.

Every patient was physically examined initially. Tachypnea was defined as respiratory rate ≥ 50 /minute in infants between one and 11 months of age, ≥ 40 /minute in infants between one and four years of age, and ≥ 30 /minute in children aged five years and more⁵. Crackles, bronchial breath sounds or diminished breath sounds led to the diagnosis of pneumonia. Chest radiograph studies and complete blood cell counts were performed in every patient. Throat cultures were taken in all but 18 patients.

After being evaluated based on clinical findings, chest radiographs and complete blood cell counts, new treatment plans were made. No serologic or microbiological study was performed to determine the infectious agent.

Patients were examined in the Pediatric Chest Disease Unit every day for the first three days, and then in intervals depending on the patients' condition, at least in every 10 days, until the symptoms subsided.

After the evaluation and treatment of the patients were completed, a radiologist independently reviewed the radiographs without knowledge of any patient's clinical history, therapy plan or prognosis.

In order to find a relationship between antibiotic therapy and pulmonary symptoms, chest radiographs, complete blood cell counts, and specificity and sensitivity were defined in the standard manner (Table I)^{6,7}.

Table I. Definitions Used to Evaluate Diagnostic Tests

True positives	
Sensitivity	= $\frac{\text{True positives}}{\text{True positives} + \text{False negatives}}$
Specificity	= $\frac{\text{True negatives}}{\text{True negatives} + \text{False positives}}$

Results

Among 119 children analyzed, 74 were male (62.2%) and 45 were female (37.8%). Most patients (41.3%) were between two and five years old. Two patients (1.7%) were less than two months, 31 (26%) were between two and 12 months, and 37 (31%) were more than five years old.

The most common presenting symptoms were cough (94%), nasal discharge (79%), fever (70%) and wheezing (50%). Those symptoms were present both in patients with and without infiltration in their radiographs. Chest pain was absent among patients with normal radiographs but present in 7% of patients with infiltration. Of patients with infiltration, 19.3% had respiratory distress, which was described as difficulty in breathing, whereas only 2% of patients with no infiltration had this complaint. A comparison of presenting symptoms with chest radiographs is seen in Table II. Five patients with chest pain and seven patients with respiratory distress were treated with antibiotics.

Time between initiation of symptoms and admission was 8.5 days in patients with normal chest radiograms, 6 days in patients with

infiltration who were not treated with antibiotics, and 3.7 days in patients who were given antibiotic therapy.

Table II. Presenting Symptoms

Symptom	Number of patients with normal radiograph (%)	Number of patients with infiltration in radiograph (%)
Fever	30 (62)	53 (74.6)
Cough	47 (98)	65 (91.5)
Wheezing	24 (50)	35 (49.2)
Nasal discharge	41 (84)	53 (74.6)
Sore throat	7 (14.5)	5 (7)
Chest pain	—	5 (7)
Respiratory distress	1 (2)	13 (19.3)
Vomiting	3 (6.2)	6 (8.4)
Sputum expectoration	3 (6.2)	6 (8.4)
Convulsion	1 (2)	1 (1.4)
Same history in family	19 (40)	24 (33.8)

The physical examination findings of patients in relation with chest radiographs and treatment are shown in Table III. History of fever was absent in 36 patients (30%). Tachypnea was not detected in five patients with a history of respiratory distress. None of the patients with tachypnea had normal radiographs; 11 of them were treated with antibiotics and one had no antibiotics.

Table III. Physical Examination Findings

Findings	A n: 48	B n: 53	C n: 18
Fever: 36.5-36.9 °C	29	27	5
Fever: 37-37.4 °C	11	13	1
Fever: 37.5-38.5 °C	5	8	8
Fever: 38.6 °C and more	3	5	4
Tachypnea	—	1	11
Dyspnea	—	—	6
Abnormal auscultation findings*	—	6	15

A : Patients with normal radiograph.

B : Patients with infiltration on radiograph treated without antibiotics.

C : Patients with infiltration on radiograph treated with antibiotics.

*: Crackles, bronchial breath sounds, localized diminished breath sound.

With auscultation, lung sounds were normal in 52 patients. One patient with normal breath sounds had tachypnea with infiltration at the right upper segment and was treated with antibiotics. Chest radiograph findings and antibiotic treatment according to auscultation findings are shown in Table IV.

When chest radiographs were taken into consideration, it was determined that 48 (40%) patients with normal chest radiographs were not

treated with antibiotics; auscultation findings were normal in 28 of them. Fifty-two patients (44%) with peribronchial infiltration, linear atelectasis and interstitial infiltration were also not treated with antibiotics except for a patient who had fever, tachypnea and respiratory distress whose radiographs revealed consolidation on the 8th day of follow-up. The remaining 19 patients (16%) had consolidation and pleural reaction in radiographs and 17 of them were treated with antibiotics.

Table IV. Chest Radiograph Findings and Antibiotics Treatment According to Auscultation Findings

Findings	n	A	B	C	Antibiotic treatment
Normal	52	28	23	1	1
Course crackles	42	20	19	3	2
Fine crackles	12	-	3	9	9
Bronchial sounds	4	-	-	4	4
Diminished sounds	5	-	3	2	2
Prolonged expirium	4	-	4	-	-
Total	119	48	52	19	
Antibiotic treatment		-	1	17	18

A : Patients with normal radiograph.

B : Patients with peribronchial thickening, infiltration, linear atelectasis, and interstitial infiltration in radiographs.

C : Patients with consolidation, segmentary infiltration and pleural reaction in radiographs.

Leukocyte count was below 10,000/mm³ in 66 (56%), between 10,000/mm³ and 14,999/mm³ in 32 (27%), between 15,000/mm³ and 19,999/mm³ in 10 (8%) and more than 20,000/mm³ in 11 patients. Among 66 patients who had less than 10,000/mm³ leukocytes, only five were treated with antibiotics, whereas nine out of 21 patients with more than 15,000/mm³ leukocytes were prescribed antibiotics. There were 12 patients with more than 80% polymorphonuclear leukocytes, and eight of them had antibiotic therapy. Only one patient with more than 60% lymphocytes was treated with antibiotics.

Throat cultures revealed beta hemolytic streptococcus in two patients and they were treated with penicillins, and staphylococcus coagulase negative was present in two other patients. The remaining cultures yielded normal pharyngeal flora.

Table V summarizes the antibiotics prescribed in the outpatient clinics and the patients' compliance with the drug treatment. After being reevaluated in our department, 18 of 119 patients decided to continue their recommended therapies for seven days.

Table V. Antibiotics Prescribed in Outpatient Clinic

Prescribed antibiotic in outpatient clinic	Number of patients	A	B	C	D
Procaine penicillin	103	40	52	8	3
Cotrimoxazole	7	5	1	1	-
Amoxicillin	4	2	2	-	-
Sulbactam-ampicillin	5	5	-	-	-
Patients whose antibiotics were continued	18	5	10	1	2

A : Patients who did not use the prescribed antibiotic.

B : Patients who used the prescribed antibiotic for 1 day.

C : Patients who used the prescribed antibiotic for 2 days.

D : Patients who used the prescribed antibiotic for 3 days.

As a result, the diagnosis of pneumonia was ruled out in 48 (40%) of 119 patients who had normal chest X-rays, no tachypnea, no dyspnea and normal auscultation findings or only coarse crackles, as can be seen in Tables III and IV. Although only 18 patients (15%) were treated with antibiotics, every patient included in the study recovered. There was an overdiagnosis of pneumonia in 40% of patients and unnecessary use of antibiotics in 85%.

Sensitivity and specificity for defining correlations between antibiotic therapy and symptoms, radiographs, leukocytes and peripheral blood cell count are shown in Table VI.

Table VI. Sensitivity and Specificity

Findings	Sensitivity	Specificity
Tachypnea	.61	.99
Auscultation findings	.83	.94
Chest radiographs*	.94	.98
Leukocytes < 15,000/mm ³	.50	.88
Leukocytes < 20,000/mm ³	.22	.93
Polymorphonuclear leukocytes	.44	.96

* Segmentary infiltration, consolidation, pleural reaction.

Discussion

Respiratory tract infections are one of the most common diseases worldwide. According to one study from the United States, children aged less than two years old had acute RTIs six times a year⁸.

It is known that upper and lower RTI symptoms may mimic each other. Moreover, there is always a risk for addition of a bacterial infection to a viral infection. As a result, there have always been difficulties in treating this disease. In our country, there is a tendency to prescribe antibiotics to patients with upper RTIs. However, it should be kept in mind that viral pathogens are the most commonly encountered microorganisms responsible for lower RTIs in children less than

four years old, except in the neonatal period^{8,9}. In a study from our department, it was shown that viruses, especially respiratory syncytial virus (RSV), were the most common causes of lower RTIs in children⁹.

There are numerous reports about diagnosing pneumonia with symptoms as well as with clinical and radiological findings^{6,8,9,11,12}. The diagnostic symptoms of pneumonia are cough, sputum expectoration, tachypnea, dyspnea, cyanosis, retractions, chest pain, and clinical findings like crackles and sometimes bronchial sounds. In our study, cough, fever, nasal discharge and wheezing were the most common symptoms both in patients with and without pneumonia diagnosed clinically and radiologically. These were not enough for discrimination of upper and lower RTIs, but the presence of chest pain and respiratory distress only in patients with pneumonia was noticeable.

There has always been disagreement in the published literature about the relationship between fever and the etiologic agent. Some authors believe that the reliability of high fever in diagnosing bacterial infection is low¹³⁻¹⁵. It has been shown that even fever of more than 40 °C is not a factor for identifying viral and bacterial pneumonia¹². In our study, 38% of patients with fever between 37.5-38.5 °C, and 33% of patients with fever of more than 38.6 °C were treated with antibiotics. Three patients with fever of more than 38.6 °C were not diagnosed to have pneumonia and were not given antibiotic therapy. As fever is a symptom of both upper and lower RTIs, we believe that patients who have only fever should not be treated with antibiotics unless there are other symptoms and findings indicating pneumonia; presence of fever alone should not indicate lower RTI. High fever is not a safe criteria for identifying viral or bacterial infection; only four patients with a fever of 38.6 °C needed antibiotic therapy. Our results showed that clinical remission was achieved only with supportive therapy in 101 patients, although most of them had fever by history or physical examination.

Tachypnea and respiratory distress are considered to be safe criteria for pneumonia by the World Health Organization^{1,16}. In different studies, the sensitivity and specificity of tachypnea were found to be very high^{1,17}. In our study, tachypnea was a very important criterion for diagnosing

pneumonia, with a sensitivity of 61% and specificity of 99%. Our findings suggest that the respiratory rate can be used to decide which patients with cough should be treated with antibiotics.

Crackles are the main auscultation findings of pneumonia; however, bronchial and tubular sounds are also possible. In our study, the sensitivity and specificity of auscultation findings for antibiotic therapy was very high, in accordance with the published studies⁶. There were auscultation findings including crackles, bronchial breath sounds and localized diminished breath sounds in 15 patients out of 18 who were prescribed antibiotics.

Although radiological findings are not always helpful in differentiating viral from bacterial pneumonia, consolidation located in one lobe, pleural effusion and abscess are indicators of bacterial pneumonia, whereas perihilar infiltrations in more than one lobe generally indicate viral infection¹⁸. In our study, 51 patients with perihilar and peribronchial infiltration, overexpansion, atelectasis and interstitial infiltration were not given antibiotics, and clinical and radiological remission were achieved in all of them. Radiological findings like segmentary infiltration, consolidation and pleural reaction were found to be the most sensitive and specific criteria for starting antibiotic therapy, and 17 patients with those findings were prescribed antibiotics.

There are published reports about the relationship between clinical and radiological findings which point out normal chest radiographs in infants without respiratory distress, and suggest that there is even no need for chest radiographs in such patients^{19,20}. Our results support these findings, as only one of 52 patients with normal auscultation findings and only two patients without respiratory distress were given antibiotics.

In our study, 7.5% of patients with less than 10,000/mm³ leukocytes were given antibiotics, whereas 54.5% of patients with more than 20,000/mm³ leukocytes had antibiotics. Our findings are in accordance with another study, which showed that patients with pneumonia who had a leukocyte count of more than 15,000/mm³ recovered earlier with antibiotics when compared to others with a leukocyte count less than 10,000/mm³.²¹

In our study, we accepted that antibiotics taken by patients when they were first diagnosed in the outpatient clinic did not improve their clinical findings, because procaine penicillin and oral antibiotics were not expected to have reached therapeutic blood levels in just a few days. In any case, 52 patients were recruited for the study before taking their prescribed drugs, and 47 of them improved without antibiotics.

In conclusion, we found that overdiagnosis of pneumonia and unnecessary antibiotic use are very common. We believe that children who present with cough alone do not always need antibiotic treatment. High fever is also not a good indicator of pneumonia. However, tachypnea and auscultation findings are important criteria for diagnosing and treating pneumonia. Therefore, we suggest that only patients who present with cough and fever, and who have tachypnea and positive auscultation findings together with segmentary infiltration and consolidation in their chest radiographs should be treated with antibiotics.

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