THE VALIDITY OF CLINICAL CRITERIA IN DIAGNOSING PNEUMONIA AMONG CHILDREN UNDER FIVE YEARS OF AGE

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ABSTRACT

Background: Pneumonia and other lower respiratory tract infections are the leading causes of death in children worldwide. Chest x-ray is used to confirm the presence of pneumonia, including the extent and location of the infection and its complications. But in resource-poor settings without access to these technologies, suspected cases of pneumonia are diagnosed by their clinical presentation. **Objectives:** Is to study the validity of association between historical and physical examination findings and radiographic pneumonia in children who present with suspicion for pneumonia in the primary health center. **Methods:** This case sectional study was carried out in Al Hamdanyia city at Al Hamdanyia, Debaga and Baghdada primary health centers, from beginning of April 2023 to the end of April 2025. Conventional method of sampling was used to include children aged from 1 month to 60 months presented with symptoms and signs of lower respiratory tract infection. Patients with congenital heart disease, foreign body inhalation and children with chronic respiratory diseases such as cystic fibrosis, asthma or bronchopulmonary dysplasia were excluded. The questionnaire form was consisted from three parts. Part one for sociodemographic information such as name, age and sex. Part two for patients' clinical symptoms such as; cough, difficult breathing, fast breathing, noisy breathing, fever, poor feeding. Part three for the clinical signs such as heart rate, respiratory rate, body temperature, drowsiness, central cyanosis, grunting and strider, nasal flaring, chest in drawing, diminished breath sounds, bronchial breath sounds, wheezes and crackles. Depending on the x-ray findings, patients were categorized into two groups: group 1 (pneumonia) and group 2 (no pneumonia). **Results:** The study was conducted on 106 children aged between 1 month and 60 months. Male constituted 63 (59.4 %) and female 43 (40.6%) with male to female ratio 1.47:1. Pneumonia was diagnosed by radiographic evidence of infiltrate in 72 (67.9%) subjects, the other 34 (32.1%) subjects did not have radiographic evidence of infiltrate. Up to 50% of patients with pneumonia under 6 months old and up to 55.9 % of patients with no pneumonia under 6 months also. With no statically significant difference regarding ages (P value =0.600). Moreover; no symptom was significantly associated with pneumonia, while; the signs that were found to be significantly associated with pneumonia are tachypnea (P<0.001), tachycardia (P=0.007), temperature $\geq 38C°$ (p=0.002), grunting (p=0.001) and crackles (p<0.001). Furthermore and regarding symptoms; cough has the highest sensitivity 93.1% followed by difficult breathing 91.7 %. Fast breathing and poor feeding have the highest specificity 32.4% for each. Fast breathing and fever have the highest positive PPV 71.6, 71.4 % respectively. Difficult breathing and fever have the highest NPV 50.0%, 45.5 % respectively. While regarding signs; tachypnea and chest in drawing have the highest sensitivity among the reported signs 75.0% and 72.2% respectively. Tachycardia, strider and grunting have the highest specificity among the reported signs 94.1%, 94.1% and 88.2% respectively. Tachycardia, grunting and crackle have the highest positive predictive value 91.3%, 88.6% and 86.8%. While; tachypnea, crackles and temperature >38° have the highest negative predictive value 53.8%, 50.9% and 44.3%. **Conclusion:** In the present study none of the clinical criteria has the satisfactory high level of all performance characteristics concurrently. The following signs: tachypnea, tachycardia temperature $\geq 38°$ C, grunting and crackles were significantly associated with pneumonia.

Depending on the finding of the current study it is recommended to use a combination model of signs and symptoms reported in this study by physician to evaluate children under 5 years of age for diagnosis of pneumonia.

KEYWORDS: Al Hamdanyia, Iraq, Lung infection, Pediatrics, Prediction.

1- INTRODUCTION

Community-acquired pneumonia (CAP) is the term used to describe pneumonia that was acquired outside of a hospital by a previously healthy individual.[1] Pneumonia is defined as the presence of certain respiratory symptoms or signs, in addition to the appearance of infiltrates on a chest radiograph.[2] The World Health Organization (WHO) establishes a set of pneumonia clinical syndromes based on the patient's history and the clinical manifestations upon presentation in order to determine the necessity for hospitalization and to choose which antibiotic therapy is necessary.[3] Pneumonia syndrome is defined as a cough or difficulty in breathing, an increased respiratory rate for age and no evidence of severe pneumonia syndrome.[4] A history of coughing or breathing difficulties, together with lower chest wall indrawing or nasal flaring in the absence of symptoms of very severe pneumonia syndrome, is considered severe pneumonia syndrome.[5] Very severe pneumonia syndrome is defined by coughing or difficulty breathing together with any of the following symptoms: convulsions, cyanosis, lethargy, unconsciousness, or feeding difficulties.[6]

Although radiographic findings are typically used to make the diagnosis in developed countries, the WHO has defined pneumonia based only on clinical data gathered by visual inspection and respiratory rate.[7] Given the prevalence of pneumonia and its substantial morbidity and death rate, it is critical to accurately diagnose the illness, identify any complications or underlying disorders, and treat patients accordingly.[8] One of the most prevalent and dangerous illnesses in children is community-acquired pneumonia, which affects 34 to 40 children out of every 1,000 in North America and Europe each year.[9] Children die from pneumonia more often than from any other disease, including measles, AIDS, and malaria combined.[10] Nearly one in five deaths in children under five globally are caused by pneumonia, affecting the lives of over 2 million children annually.[11] According to WHO estimates, 156 million children under five have pneumonia annually, with up to 20 million of those cases being severe enough to necessitate hospitalization.[12] After the pneumococcal conjugate vaccine was added to the regular childhood vaccination schedule in 2000, the number of hospitalizations for pneumonia among children under two years old in the United States dropped from 12–14 per 1000 population to 8–10 per 1000 people.[13]

The clinical manifestation of pediatric pneumonia varies according on the pathogen, host, and severity.[14] The presenting signs and symptoms are vague; no single symptom or sign is pathognomonic for pediatric pneumonia.[15] In children, rapid respiratory rate and lower chest in-drawing are more sensitive than hearing chest crackles with a stethoscope.[16]

This study aimed to study the validity of association between historical and physical examination findings and radiographic pneumonia in children who present with suspicion for pneumonia in the primary health center.

2-PATIENTS AND METHODS

This case sectional study was carried out in Al Hamdanyia city at Al Hamdanyia, Debaga and Baghdada primary health centers, from beginning of April 2023 to the end of April 2025. After obtaining ethical approval from the ethical committee of Nineveh Health directorate and parents' consent.

Conventional method of sampling was used to include children aged from 1 month to 60 months presented with symptoms and signs of lower respiratory tract infection such as (wheezes, tachypnea, crackles fever or dyspnea) for whom chest x-ray was performed. Patients with congenital heart disease, foreign body inhalation and children with chronic respiratory diseases such as cystic fibrosis, asthma or bronchopulmonary dysplasia were excluded.

A questionnaire form was consisted from three parts. Part one for sociodemographic information such as name, age and sex. Part two for patients' clinical symptoms such as; cough, difficult breathing, fast breathing, noisy breathing, fever, poor feeding. Part three for the clinical signs such as heart rate, respiratory rate, body temperature, drowsiness, central cyanosis, grunting and strider, nasal flaring, chest in drawing, diminished breath sounds, bronchial breath sounds, wheezes and crackles. Depending on the x-ray findings, patients were categorized into two groups: group 1 (pneumonia) and group 2 (no pneumonia).

The results were analyzed by using SPSS version 30. sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+) and negative likelihood ratio (LR-) were estimated for each clinical criterion.

3. RESULTS

This study was conducted on 106 children aged between 1 month and 60 months. Male constituted 63 (59.4 %) and female 43 (40.6%) with male to female ratio 1.47:1. Pneumonia was diagnosed by radiographic evidence of infiltrate in 72 (67.9%) subjects, the other 34 (32.1%) subjects did not have radiographic evidence of infiltrate.

Table 3.1 shows the age distribution of the study sample, up to 50% of patients with pneumonia under 6 months

old and up to 55.9 % of patients with no pneumonia under 6 months also. With no statically significant difference regarding ages (P value =0.600).

Table 3.1: Distribution of the study participants according to their age.

Age (months)	Pneumonia		No Pneumonia		Total		P value
	No.	%	No.	%	No.	%	
<3	20	27.8	10	29.4	30	28.3	
3-6	16	22.2	9	26.5	25	23.6	
7-9	10	13.9	7	20.6	17	16.0	
10-12	9	12.5	2	5.9	11	10.4	0.600
13-24	11	15.3	2	5.9	13	12.3	
>24	6	8.3	4	11.8	10	9.4	
Total	72	100.0	34	100.0	106	100.0	

Table 3.2 shows the frequency and percent of various symptoms in the study sample. No symptom was significantly associated with pneumonia.

Table 3.2: Distribution of the study participants according to their symptoms.

Symptoms	Pneumonia		No Pneumonia		P value
	Number=72	%	Number=34	%	
Cough	67	93.3	32	94.1	1.000
Difficult breath	66	91.7	28	82.4	0.193
Fast breath	58	80.6	23	67.6	0.144
Noise breath	62	86.1	29	85.3	1.000
Fever	60	83.3	24	70.6	0.131
Poor feeding	55	76.4	23	67.6	0.341

Table 3.3 shows sensitivity, specificity, predictive values of each symptom. Cough has the highest sensitivity 93.1% followed by difficult breathing 91.7 %. Fast breathing and poor feeding have the highest specificity 32.4% for each. Fast breathing and fever have the highest positive PPV 71.6, 71.4% respectively. Difficult breathing and fever have the highest NPV 50.0%, 45.5 % respectively.

Table 3.3: The sensitivity, specificity and predictive value for the reported symptoms.

Symptoms	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Cough	93.1	5.9	67.6	28.6
Difficult breath	91.7	17.6	70.2	50.0
Fast breath	80.6	32.4	71.6	44.0
Noise breath	86.1	14.7	68.1	33.3
Fever	83.3	29.4	71.4	45.5
Poor feeding	76.4	32.4	70.5	39.3

Table 3.4 shows the frequency and percent of various signs in the study sample. The signs that were found to be significantly associated with pneumonia are tachypnea (P<0.001), tachycardia (P=0.007), temperature ≥ 38C° (p=0.002), grunting (p=0.001) and crackles (p<0.001).

Table 3.4: Distribution of the study participants according to their signs.

Signs	Pneumonia		No Pneumonia		P value
	Number=72	%	Number=34	%	
Tachypnea	54	75.0	13	38.2	<0.001
Tachycardia	21	29.2	2	5.9	0.007
Temperature >38°	38	52.8	7	20.6	0.002
Drowsiness	21	29.2	11	32.4	0.739
Cyanosis	14	19.4	5	14.7	0.553
Grunting	31	43.1	4	11.8	0.001
Strider	6	8.3	2	5.9	1.000
Nasal flaring	36	50.0	11	32.4	0.088

Bronchial breathing	25	34.7	6	17.6	0.071
Ronchi	42	58.3	25	73.5	0.130
Chest in drawing	52	72.2	21	61.8	0.278
Crackles	46	63.9	7	20.6	<0.001
Diminished breath	16	22.2	5	14.7	0.365
Hypoxia	37	51.4	21	61.8	0.316

Table 3.5 shows the sensitivity, specificity, predictive values of the reported signs. Tachypnea and chest in drawing have the highest sensitivity among the reported signs 75.0% and 72.2% respectively. Tachycardia, strider and grunting have the highest specificity among the reported signs 94.1%, 94.1% and 88.2% respectively.

Tachycardia, grunting and crackle have the highest positive predictive value 91.3%, 88.6% and 86.8%. While; tachypnea, crackles and temperature >38° have the highest negative predictive value 53.8%, 50.9% and 44.3%.

Table 3.5: The sensitivity, specificity and predictive value for the reported Symptoms.

Signs	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Tachypnea	75.0	61.8	80.6	53.8
Tachycardia	29.2	94.1	91.3	38.6
Temperature >38°	52.8	79.4	84.4	44.3
Drowsiness	29.2	67.6	65.6	31.1
Cyanosis	19.4	85.3	73.7	33.3
Grunting	43.1	88.2	88.6	42.3
Strider	8.3	94.1	75.0	32.7
Nasal flaring	50.0	67.6	76.6	39.0
Bronchial breathing	34.7	82.4	80.6	37.3
Ronchi	58.3	26.5	62.7	23.1
Chest in drawing	72.2	38.2	71.2	39.4
Crackles	63.9	76.4	86.8	50.9
Diminished breath	22.2	85.3	76.2	34.1
Hypoxia	51.4	38.2	63.8	27.1

Table 3.6 shows the likelihood ratios of the reported symptoms. Fast breath has the highest positive likelihood ratio (1.17), while difficult breath has the lowest negative likelihood ratio (0.53).

Table 3.6: Likelihood ratios for the reported symptoms.

Symptoms	Likelihood ratio +	Likelihood ratio -
Cough	0.97	1.4
Difficult breath	1.09	0.53
Fast breath	1.17	0.62
Noise breath	1	1
Fever	1.16	0.58
Poor feeding	1	1

Table 3.7 shows the likelihood ratios of the reported signs. Tachycardia, grunting and crackles have the highest positive likelihood ratio (4.83, 3.58 and 3.00), while tachypnea, crackles and temperature >38° have the lowest negative likelihood ratio (0.40, 0.46 and 0.60).

Table 3.7: Likelihood ratios for the reported sign.

Signs	Likelihood ratio +	Likelihood ratio -
Tachypnea	1.92	0.40
Tachycardia	4.83	0.75
Temperature >38°	2.47	0.60
Drowsiness	0.87	1.05
Cyanosis	1.26	0.95
Grunting	3.58	0.64
Strider	1.33	0.97
Nasal flaring	1.51	0.74
Bronchial breathing	2.83	0.80

Ronchi	0.78	1.61
Chest in drawing	1.16	0.73
Crackles	3.00	0.46
Diminished breath	1.49	0.91
Hypoxia	0.80	1.28

4. DISCUSSION

In this study, the age factor was shown to be not significant for having pneumonia, this is similar to Vivi Ninda Sutriana et al study findings.[17] Moreover; in the current study 50% of patients with pneumonia were under six months of age and 57.9% of patients with no pneumonia were under six months of age; as infants under six months are potentially underdeveloped immune systems or other age-related factors.[18]

Symptoms reported in this study have no significant association with radio-graphically diagnosed pneumonia. Among the reported symptoms, difficult breathing, fast breathing, fever and poor feeding (as reported by the mother) had the highest LR+ and Lowest LR-, they were still considered insufficient to rule in or rule out pneumonia. As these symptoms are subjected to variation according to the parents' educational level, awareness and judgment of the mother about these symptoms. Katy Stokes et al was conducted a meta-analysis about the role of artificial intelligence in the diagnosis of pneumonia depending on the signs and symptoms, he concluded that there is huge heterogeneity among studies to detect pneumonia based on symptoms and signs.[19] From the other hand; cough was found in this study to have the highest sensitivity which is comparable to Youngbeen Chung et al study finding.[20] Fast breath had the highest specificity and positive predictive value, while difficult breathing had the highest negative predictive value. Anyhow; in spite of that, they still low and not meaningful until a combination of symptoms and signs are analysis, Chris A Rees et al reached to the same conclusion.[21]

On the other hand; pneumonia in children was found in this study to be significantly associated with tachypnea, tachycardia, temperature $\geq 38C°$, grunting, and crackles. In same way, Thomas A. Hooven et al[22] and S.Thangavelu et al had consistent findings.

5- CONCLUSION

In the present study none of the clinical criteria has the satisfactory high level of all performance characteristics concurrently. The following signs: tachypnea, tachycardia temperature $\geq 38°$ C, grunting and crackles were significantly associated with pneumonia. Depending on the finding of the current study it is recommended to use a combination model of signs and symptoms reported in this study by physician to evaluate children under 5 years of age for diagnosis of pneumonia.

Conflict of interest

About this study, the authors disclose no conflicts of interest.

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