TO DETERMINE THE DIAGNOSTIC ACCURACY OF THE CLINICAL CRITERIA OF PNEUMONIA IN DETECTION OF RADIOLOGICAL PNEUMONIA IN CHILDREN WHO ARE 01-05 YEARS OF AGE

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ABSTRACT

Background: Pneumonia is one of the major causes of morbidity and mortality in children of the developing world. Physicians require optimum quality of clinical criteria for early diagnosis of pneumonia and its prompt treatment to reduce the associated mortality and morbidity.

Objective: To determine the diagnostic accuracy of the clinical criteria of pneumonia in detection of radiological pneumonia in children who are 01-05 years of age.

Study Design: Cross Sectional (validation) study

Setting: Pediatrics unit, Hayatabad Medical Complex, Peshawar

Duration: 6 months from 1st September, 2017 to 1st March, 2018.

Subjects and Methods: Total of 204 patients presenting with clinical features of pneumonia were subjected to plan radiographs of chest to confirm the findings on clinical examination. The data was analyzed with SPSS version 10. Sensitivity, Specificity, positive predictive value, negative predictive value was determined by taking chest x rays report as gold standard.

Results: The overall mean age was 22.09 months ± 11.06SD. On clinical examination, True Positive and True Negative patients for pneumonia were 46 (22.55 %) and 113 (55.39 %) respectively while False Positive and False Negative patients were 34 (16.67 %) and 11 (5.39 %) respectively. The sensitivity and specificity of clinical examination of chest for detection of pneumonia was 80.71% and 77.03% respectively while Positive and Negative predictive values were 57.50% and 91.20% respectively. The diagnostic accuracy was 78.43%.

Conclusion: Clinical criteria for radiological pneumonia has better sensitivity than specificity and high negative predictive value. Its accuracy in detecting radiological pneumonia is 78.43%.

Key words: Pneumonia; Radiological pneumonia; chest X rays; Diagnostic Accuracy.

INTRODUCTION

Pneumonia is one of the major causes of morbidity and mortality in children of the developing world [1]. The incidence of pneumonia in children is on the rise worldwide with increasing complications [2]. Pneumonia is the leading cause of illness and death in children worldwide. It is estimated that pneumonia has a global annual incidence of 150 to 156 million cases in children, 5 years of age, of whom 11 to 20 million of cases need hospitalization and 1.1 million die of this condition. Pneumonia accounts for 18% of the total number of deaths in children, 5 years worldwide, more than tuberculosis, AIDS, and malaria combined.[3] The annual death toll of pneumonia in children under the age of five years is more than three million and out of these deaths 90-95% occurs in the developing countries [4]. Childhood pneumonia is mainly a disease of poverty and results from sub-optimal child rearing and care seeking practices compounded by lack of access to healthcare [5]. Risk factors for pneumonia in the developing countries are mainly inadequate nutrition, inadequate breast feeding, inadequate immunization, passive smoking, large family size, poor maternal and paternal education and poor housing [6].

Viruses, atypical, and typical bacteria cause the vast majority of childhood pneumonia. The distribution of pathogens varies with age and clinical setting. Atypical bacterial microorganisms,such as Mycoplasma and Chlamydia usually occur in children between the ages of five and 15 years, while the incidence of viral infections typically decreases with age.[7] In hospitalized children, the most frequently diagnosed bacteria are the typical pathogens, such as Streptococcus pneumonia. It can be difficult to identify whether the cause of pneumonia in a given patient is bacterial or nonbacterial. Classic

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signs unique to bacterial or nonbacterial pneumonia can be helpful in coming to a diagnosis.[8]

The pneumonia patients present in majority of cases with cough, difficulty in breathing , fast breathing, crackles on auscultation and in case of severe pneumonia chest wall in-drawing is added or in case of very severe pneumonia danger signs like central cyanosis, inability to feed, convulsions ,unconsciousness, severe respiratory distress (e.g head nodding) can be found[5]. The clinical criteria for diagnosis of pneumonia as advised by WHO and modified and adapted by IMCI (age specific fast breathing and definite crackles on auscultation for pneumonia) correlates with the radiological findings of the condition in most of the cases[4].

The estimated incidence of pneumonia in children is 0.3 episodes per child per year in the developing countries and 0.03 in the developed countries [1]. Out of the total 156 million yearly new cases of pneumonia worldwide, 61 million cases occur in the South East Asian Region [5]. Recent community-based estimates report 70% of the childhood morbidities among children aged less than 5 years are due to pneumonia [1].

Pediatric pneumonia still remains a diagnostic challenge in resource limited settings[9]. Signs and symptoms of pneumonia vary depending on a child's age and the etiology of infection[9]. Moreover, presenting signs and symptoms have poor diagnostic specificity, which may further complicate the diagnosis. The sensitivity and specificity for the clinical criteria for diagnosis of pneumonia in children ranges from 78-99% and 65-95% respectively but studies have reported the range of sensitivity from 52-99% and specificity from 20 to 100%, which highlights the lack of uniformity. [4]

This study is aimed to determine the diagnostic accuracy of the clinical criteria in detection of radiological pneumonia among children in our setup with the rationale that if the clinical criteria turns out sensitive and specific, it will help expedite the diagnosis and make it more cost effective without exposure to radiations and therefore, early management of pneumonia will be possible and thus decreasing patient morbidity and financial burden on the healthcare system. And at the same time if the clinical criteria is followed thoroughly, it will avoid overtreatment and also avoid misuse of antibiotics in patients who present with cough or other respiratory problems but do not have pneumonia.

MATERIALS AND METHODS

This was cross-sectional (validity) study, conducted in Department of Pediatric, Hayatabad Medical Complex, Peshawar. The study duration was six months from 1st September 2017 to 1st March 2018. The sample size was calculated to be 204, using 78% sensitivity, 65% specificity, 70% incidence of pneumonia cases in children under 5 years and 10% margin of error (both for sensitivity and specificity) and 75% confidence interval. The sample technique was consecutive (non probability).

All children of either sex between the ages of 01 – 05 years, who presented with acute respiratory symptoms like cough, difficulty in breathing and fast breathing and with no history of recurrent wheezy chest and no wheezes on auscultation were included in the study.

Children with Congenital Heart Disease, patient with history of Foreign Body Inhalation or poisoning, children with renal failure, children with moderate to severe malnutrition and patient with severe pallor were excluded from the study

DATA COLLECTION PROCEDURE

After approval from the research and ethical committee, all patients (either gender) between the age of 01-05 years who present to the pediatrics unit, Hayatabad Medical Complex, Peshawar through OPD and emergency with acute respiratory symptoms like cough, difficulty in breathing and fast breathing were included in the study. Patients with high grade fever were included in the study after their temperature is brought down to normal by the use of cold sponging and antipyretics as patients with high grade fever have fast breathing than the normal levels. Relative investigations of the patient like full blood count, urea and creatinine levels, serum electrolytes, urine routine examination, x-ray chest and ECHO were performed to strictly follow the exclusion criteria to control confounders and exclude bias in study result.

The demographic information like name, age, sex and address were recorded. Thorough history was taken from the parents/attendants of the patients and physical examination. The clinical examination was performed by a single experienced pediatric fellow of College of Physicians and Surgeons, Pakistan and confirmed by another experienced fellow .The method of obtaining a respiratory rate was use of a timing device, either a wall clock or a hand held watch or timer. The respiratory rate was counted for one full minute when the child was calm and quiet. The clinical examination results were recorded.

The final conclusion of the presence of pneumonia was based on the findings of chest radiographs as ascertained by two radiologists who were blind of the clinical features and characteristics of the patient. The clinical examination results were compared with the radiologic findings to confirm the findings on clinical examination.

DATA ANALYSIS PROCEDURE

The collected data was entered in SPSS version 10 and analyzed through it, study variable were the age, clinical pneumonia and radiological pneumonia. Mean + standard deviation was calculated for continuous

variables like age of the patient. Sensitivity, Specificity, positive predictive value (PPV), negative predictive value (NPV) were determined by taking Chest x-ray as gold standard from 2x2 table below. All the data was presented in the form of table and charts / groups.

		Chest X rays (Radiological Pneumonia)	
		+	-
Clinical Examination	+	a	b
(Clinical Pneumonia)	-	c	d

Sensitivity of clinical examination (age specific fast breathing) = (a / a+c) x100

Specificity of clinical examination (age specific fast breathing)= (d / b + d) x 100

Positive predictive value (PPV) = (a / a +b) x100

Negative predictive value (NPV) = (d / c +d) x100

Accuracy of Clinical examination = (d + a) /overall patients

a = True positive, b = False positive, c = False negative, d = True negative

RESULTS

The total number of patients presenting with clinical features of pneumonia were 204 comprising of 125 (61.27%) males and 79 (32.46%) females. (Graph No.1). The mean age of male patients was 22.04 months ± 10.03D and females patients was 21.99 months ± 10.99SD with overall mean age of 22.09 months ± 11.06SD.

Maximum number of patients presenting with clinical pneumonia were 69 (33.82 %) from the age group of 48-60 months followed by 66 (32.35 %) patients from 24-35 months age group. Patients from the age group of 12-23 and 36-47 months were 23 (11.27 %) and 46 (22.53 %) respectively.

On Clinical examination, pneumonia was detected in 80 (39.21%) patients while on Chest radiography; it was reported in 57 (27.94%) patients. No pneumonia was found in 124 (60.78%) on clinical examination while Chest Plan radiographs (Chest X rays) showed no pneumonia in 147 (72.06%) patients. On clinical examination, True Positive and True Negative patients for pneumonia were 46 (22.55 %) and 113 (55.39 %) respectively while False Positive and False Negative patients were 34 (16.67 %) and 11 (5.39 %) respectively. The sensitivity and specificity clinical examination of chest for detection of pneumonia 80.71% and 77.03% respectively while Positive and Negative predictive values were 57.50% and 91.20% respectively. The diagnostic accuracy was 78.43%. (Table No. 1) Age wise distribution of sensitivity, specificity, PPV, NPV and diagnostic accuracy is shown in table 2.

DISCUSSION

Childhood pneumonia remains a leading killer of children in developing countries where it accounts for up to 21% of deaths in children under the age of five years. The mortality rates of children under the age of five years in most developing countries ranges from 60 to 100 per 1000 live births, one fifth of these deaths are due to pneumonia.[10]

The main diagnostic challenge of facing children with pneumonia is selecting the right patients for chest x rays and laboratory investigations. Also general practionars (GPs) have the difficult task of balancing the fear of missing the diagnosis of pneumonia against their duty not to contribute to the growing problem of bacterial resistance by routine prescription of antibiotics. Therefore, it would be useful to have diagnostic tools in general practice that enabled GPs to differentiate between pneumonia and other LRTIs rapidly, i.e. during one consultation, without the need to refer a patient for chest X-rays or laboratory tests.[11-14]

The utility of simple clinical signs like rapid breathing and chest indrawing to diagnose pneumonia in infants and young children has been well established. During the 1980s, pediatricians and public health physicians recognized that it was necessary to define, in terms easily memorable to primary HCWs, the clinical features that justified antibiotic use in children with potential pneumonia. A series of studies was undertaken in developing countries to examine the sensitivity and specificity of clinical symptoms and signs of pneumonia: these included a history of cough or breathlessness, inability to feed, raised respiratory rate, lower chest wall indrawing, fever, and tachycardia.[15-18]

In our study, on clinical examination, pneumonia was detected in 39.21% patients while on chest radiography; it was reported in 27.94% patients. On clinical examination, True Positive and True Negative patients for pneumonia were 22.55 % and 113 55.39 % respectively while False Positive and False Negative patients were 16.67 % and 11 5.39 % respectively. The sensitivity and specificity of clinical examination of chest for detection of pneumonia was found to be 80.71% and 77.03% respectively. The Positive and Negative predictive values were 57.50% and 91.20% respectively. The diagnostic accuracy was 78.43%. Clinicians typically assess the presence or absence of many clinical findings in order to reach an accurate diagnosis of pneumonia. The use of multiple indicators at the same time in parallel (considering the presence of any criterion as a positive diagnosis) increases the sensitivity and reduces the false negative diagnosis. This would increase the negative predictive value. That's why our study sensitivity was more i.e. 80.71% than specificity i.e. 77.03%.

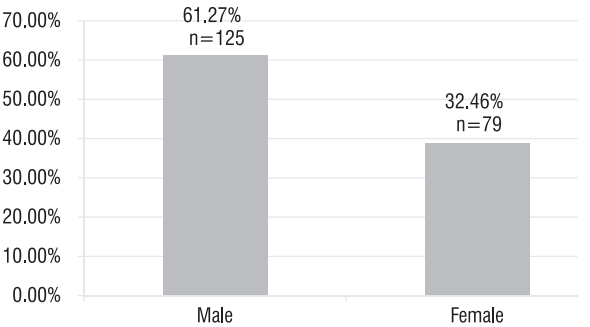
Table 1: Frequency of Pneumonia on Clinical Examination and Chest X- Rays N=204

Clinical Examination (Clinical pneumonia)	Chest X-Rays		
	Radiological Pneumonia (+ ve)	Radiological Pneumonia (- ve)	Total
Clinical pneumonia (+ ve)	46 (22.55 %)	34 (16.67 %)	80 (39.21%)
Clinical pneumonia (- ve)	11 (5.39 %)	113 (55.39 %)	124 (60.78%)
Total	57 (27.94%)	147 (72.06%)	204

Sensitivity = 80.71%, Specificity = 77.03%,
Positive Predictive Value = 57.50%,
Negative Predictive Value = 91.20%,
Diagnostic Accuracy = 78.43%

Table 2: Age Wise Stratification Of Diagnostic Accuracy Of Pneumonia On Clinical Examination Taking Chest Radiographs As Gold Standard (N=204)

	Age in months			
	12-23 n = 23	24-35 n=66	36-47 n=46	48-60 n=69
True Positive	4 (17.39%)	14 (21.21%)	10 (21.74%)	18 (26.09%)
False Positive	4 (17.39%)	10 (15.15%)	10 (21.74%)	10 (14.49%)
True Negative	13 (56.52%)	40 (60.61%)	23 (50%)	37 (53.62%)
False Negative	2 (8.70%)	2 (3.03%)	3 (6.52%)	4 (5.80%)
Sensitivity	66.67 %	87.50 %	76.92%	81.82 %
Specificity	76.47 %	80.00 %	69.70 %	78.72 %
PPV	50 %	58.33 %	50 %	64.28 %
NPV	86.66 %	95.23 %	88.46 %	90.24 %
Diagnostic accuracy	73.91 %	81.81%	71.74 %	79.71 %



Graph 1: Gender Distribution Of Children With Clinical Features Of Pneumonia N=204

In a Brasilian study of 390 children, Cardoso MRA et al investigated WHO criteria for defining pneumonia (cough or difficulties in breathing and tachypnoea) and found to have sensitivity of 94% for children less than 2 years of age and 62% for children ≥2 and specificities of 20% and 16% respectively. Adding fever improved specificity to 44% and 50%.[19]

In Mexico, Palafox et al found that tachypnea, chest indrawing and crackles were the clinical signs that, alone or combined, showed a sensitivity of greater than 40% for identifying pneumonia. The combination of tachypnea and chest indrawing improved specificity upto 69% but sensitivity was 68% and relatively low. Further combinations of crackles with tachypnea or chest indrawing or a combination of these three signs improved specificity to 80-84% but these three in combination yielded low sensitivity of 43-46%.[20]

In a study by Al-Dabbagh SA, all symptoms such as cough, difficult breathing, fast breathing, noisy breathing, fever and poor feeding had high sensitivity with very low specificity. The best positive predictive values for symptoms were for fast and difficult breathing. However, the signs of Crackle, Tachypnoea, nasal flarring and chest indrawing yielded the best sensitivity estimates. Moreover, a body temperature of ≥38 °C was the best single predictor of pneumonia with a sensitivity of 67% and specificity of 75.8%. The absence of the 3 signs i.e. nasal flaring, chest indrawing and crackles ruled out pneumonia effectively and sensitivity of these three signs in combination was 98.6%. Detecting a body temperature ≥38 °C and grunting simultaneously was adequate to confirm the disease.[21]

Sensitivity and specificity values may be more useful than predictive values. The *sensitivity* of a test represents the number of the total group of patients with the condition who had a positive test result. This measure of true positive results indicates the degree

to which a positive clinical test truly represents the presence of the condition. Expressed as a percentage, the higher the sensitivity, the better the chance that a positive test confirms the presence of the condition. According to Fritz and Wainner that a negative test finding for a test with high sensitivity provides a strong indication that the condition is indeed absent, whereas a positive test finding for a test with high specificity rules in the condition. *Specificity* represents the number of patients without the condition who had a negative test result. This measure of true-negative results indicates the degree to which a negative clinical test truly represents the absence of the condition. Again expressed as a percentage, the higher the specificity, the better the chance that a negative test result reflects the absence of the condition.[22]

To our knowledge, this was the first study conducted on the diagnostic accuracy of clinical criteria of pneumonia in detection of radiological pneumonia in children who are 01-05 years of age. We performed the study in a community setting with patients of various socioeconomic classes. Participants' compliance was high and our radiologist was expert in reporting chest X rays. In our study, statistical analyses were straightforward, and missing data analysis was not required.

The study suggests that a combination of clinical criteria improve the prediction of diagnosing of pneumonia. Respiratory rates greater than or equal to 40 per minute in a child aged 01 to 05 years who present with acute respiratory symptoms like cough , difficulty in breathing and fast breathing and with no history of recurrent wheezy chest and no wheeze on auscultation will indicate the presence of pneumonia. This type of examination is simple and less time consuming and easy for physicians to use. This approach will markedly improve the validity of signs and symptoms in predicting pneumonia. This was a pilot study and further research is required to elaborate clinical examination for pneumonia in children.

CONCLUSION

Form the results of our study, it is concluded that; In our set up, the sensitivity and specificity of clinical criteria in radiological pneumonia are 80.71% and 77.03% respectively while Positive and Negative predictive values are 57.50% and 91.20% respectively. The diagnostic accuracy is 78.43%.

High negative predictive value indicates that clinical criteria is more accurate in ruling out radiological pneumonia.

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