Clinicoradiological correlation of children between 2 months to 5 years with clinical features of pneumonia in emergency settings

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Abstract

The role of chest radiography in all the children who present with cough and fast breathing for the diagnosis of pneumonia still remains an enigma. A cross-sectional study was conducted in pediatric emergency of a tertiary care, teaching hospital of North India to study the association between clinical and radiological features among children aged 2 months to 5 years presenting with features of "pneumonia". A total of 150 children aged 2 months- 5 years presenting with cough and fast breathing in the preceding 7 days [*World Health Organisation definition of pneumonia*] were enrolled in the study. The baseline clinical features at presentation were recorded. The enrolled participants were subjected to chest skiagram and based on the radiological presence of consolidation and/or asymmetric infiltrates were divided into two groups-"CXR positive pneumonia" and "CXR negative pneumonia". The clinical features were compared between the groups. The prevalence of radiographic pneumonia was found to be 40/150 (26.7%). Presence of nasal flaring ($p=0.038$), grunt ($p<0.001$), decreased breath sounds ($p<0.001$), crepitations ($p=0.002$) and wheeze ($p=0.013$) were associated with radiographic pneumonia. On regression analysis, decreased breath sounds [OR (95% CI): 0.021 (0.006-0.075)] ($p<0.001$) and presence of crepitations [OR (95% CI): 0.868 (0.182-4.149)] ($p=0.859$) were significant predictors of pneumonia. In our study the yield of CXR in detecting pneumonia among children presenting with cough and fast breathing was 26% and presence of radiographic pneumonia were predicted by clinical presence of decreased breath sounds and crepitations.

Key words: Children, CXR-Chest X-Ray, Pneumonia, Predictors

INTRODUCTION

In children, CAP (Community acquired pneumonia) is one of the most common problem in the emergency department. As the World Health Organization (WHO) has proposed for developing countries, the clinical suspicion and radiological confirmation of alveolar infiltrates, together with different parameters of the history of the disease and physical examination, leads to the diagnosis of CAP in the emergency department [1-3].

The World Health Organization defines pneumonia as an acute disease episode with cough combined with fast breathing with age specific cut-values for increased respiratory rate. This case definition of childhood pneumonia is widely used in poor-resource settings to guide the management of pneumonia [4].

The accurate diagnosis of pneumonia in children remains an important yet difficult clinical problem. The chest x-ray (CXR) remains the diagnostic test of choice in tertiary care centers. Given that the decision to pursue a diagnostic chest radiograph in the context of suspected pneumonia is largely influenced by clinical predictors of pediatric pneumonia, it is important to determine these adequately.

Hence, we designed the present study with an aim to determine the need of CXR and to determine clinical predictors of radiographic pneumonia among children aged 2 months to 59 months presenting with clinical features of pneumonia in the emergency department.

METHODOLOGY

This was a cross-sectional study conducted at department of Pediatrics, Pt B D Sharma Postgraduate Institute of Medical Sciences, Rohtak, Haryana from June 2012 to June 2013. It is a tertiary care, government funded, teaching hospital that caters to referral from urban area of Rohtak and the surrounding rural districts of Haryana. Clearance was obtained from the institutional ethical committee. The study protocol was fully explained to the parents/guardian, and informed written consent was obtained.

Children from 2 months to 5 years of age presenting with cough and fast breathing in the preceding 7 days [*World Health Organisation definition of pneumonia*] were enrolled in the study. Children who had a chest radiograph taken and had history of pneumonia in last 1 month or use of antibiotics during the last 2 weeks were excluded from the study. Children with severe undernutrition, chronic respiratory disease [asthma, cystic fibrosis, bronchopulmonary dysplasia] and coexisting systemic illness were also excluded.

All eligible children were recruited consecutively in the study. Following demographic baseline data were collected: age, gender, address, telephone number. Duration and grading of fever was noted. History of fast breathing, cough, decreased appetite, chest pain and irritability was also elicited. Complete physical examination was performed including respiratory system examination. Signs like nasal flaring, grunt, intercostals retractions, decreased breath sounds, crepitations and wheeze were also noted.

A digital chest x-ray was performed in all eligible children. The presence of consolidation or asymmetrical infiltrates was considered radiographic pneumonia. Based on CXR, study subjects

were divided into two groups, “CXR positive pneumonia” and “CXR negative pneumonia”. Clinical and demographic features were analyzed and compared between the two groups.

STATISTICAL ANALYSIS

All the data were entered in MS Excel 2007 and was cross checked with original data. The categorical variables and continuous variables were compared between two groups [“CXR positive pneumonia” and “CXR negative pneumonia”] by Chi-square test. All the variables found significant on univariate analysis were subjected to multivariate logistic regression to assess the independent predictors of meningitis. The sensitivity, specificity, positive predictive value and negative predictive value of variables found significant on univariate analysis were also calculated. All the statistical analysis was performed using SPSS 20.0 version. *P* value <0.05 was considered to be significant.

RESULTS

A total of 150 children were enrolled in the present study (five groups were made and each group included 30 children) after applying inclusion and exclusion criteria as mentioned. 40 children (26.7%) had a clinical diagnosis of community-acquired pneumonia (CAP) with radiological confirmation (confirmed or positive CXR cases), and 110 children (73.3%) had presumptive clinical diagnosis of CAP without radiological confirmation (non confirmed or negative CXR cases). There was diagnostic agreement between the evaluating paediatrician and radiologist in all the cases. Majority of cases were males [M:F::1.8:1] and belonged to rural background

(67.33%). Among clinical features, poor feeding was found in majority of cases [124(82.6%)]. Fever was present in 89 cases (59.3%).

Table 1 shows a summary of characteristics of children assessed in the present study and signs and symptoms informed by mother and evaluated by paediatrician. From the data in table 1 we observe that there is no significant difference in children with CXR positive and CXR negative pneumonia in terms of fever (p=0.394), poor feeding (p=0.313), chest pain (p=0.056) , irritability (p=0.460) and intercostals retractions (p=0.089).

However, we observe from the table that proportion of pneumonia was higher in children with presence of nasal flaring (p=0.038), grunt (p<0.001), decreased breath sounds (p<0.001), crepitations (p=0.002) and wheeze (0.013).

Table 2 shows sensitivity, specificity, positive predictive value and negative predictive value of the 6 statistically significant variables. The sign with the greatest sensitivity and specificity for CXR positive pneumonia was decreased breath sounds at 92% and 84% respectively. It has also a negative predictive value of 97%. Crepitations were associated with 85% sensitivity and 89% negative predictive value.

On multivariate logistic regression, it was observed that decreased breath sounds was an independent significant predictor of radiographic pneumonia in children (p<0.001) [Table 3]

Table 1.Frequency and statistical comparison of 10 epidemiological and clinical variables between children with "CXR positive pneumonia" (n=40) [group A] and "CXR negative pneumonia" (n=110) [group B]

Variable	Condition	Number	CXR positive pneumonia [n(%)]	CXR negative pneumonia [n(%)]	*p* value (chi square test)
Fever (temp.>100.5^{0}F)	Present	89	26(29)	63(71)	0.394
	Absent	61	14(23)	47(77)	
Poor feeding	Present	124	31(25)	93(75)	0.313
	Absent	26	9(35)	17(65)	
Irritability	Present	75	22(29)	53(71)	0.460
	Absent	75	18(24)	57(76)	
Chest pain	Present	70	13(19)	57(81)	0.056
	Absent	80	27(33)	53(67)	
Nasal flaring	Present	88	29(33)	59(67)	0.038*
	Absent	62	11(18)	51(82)	
Intercostals retractions	Present	88	28(32)	60(68)	0.089
	Absent	62	12(19)	50(81)	
Grunt	Present	55	24(44)	31(56)	<0.001*
	Absent	95	16(17)	79(83)	
Decreased breath sounds	Present	55	37(67)	18(33)	<0.001*
	Absent	95	3(3)	92(97)	
Crepitations	Present	97	34(35)	63(65)	0.002*
	Absent	53	6(11)	47(89)	
Wheeze	Present	96	13(13)	83(87)	0.013*
	Absent	54	27(50)	27(50)	

Table 2.Validity of significant variables

Variable	**Sensitivity (%)**	**Specificity (%)**	**Positive predictive value PPV (%)**	**Negative predictive value NPV (%)**
Grunt	60	72	44	83
Nasal flaring	72	46	33	82
Decreased breath sounds	**92**	**84**	67	**97**
Crepitations	85	43	35	89
Wheeze	32	25	14	50

Table 3.Predictors of radiographic pneumonia

Characteristics	**Odds ratio(95% CI)**	**P value**
Nasal flaring	0.792(0.252-2.490)	0.690
Grunt	0.491(0.163-1.485)	0.208
Decreased breath sounds	0.021(0.006-0.075)	<0.001*
Crepitations	0.868(0.182-4.149)	0.859
Wheeze	3.220(1.133-9.154)	0.239

DISCUSSION

In our study the prevalence of radiographic pneumonia in study subjects is 26.7% (40/150) with maximum number of cases among the youngest age group of 2 months to 11 months [40% (12/30)]. This can be attributed to our relatively small sample size and stratification of age group among the samples. We believe that our rate of radiographic pneumonia is within

range of other studies in children aged 2 months to 59 months which may make our findings more generalizable to a population of children for whom a CXR is obtained to evaluate for pneumonia in an emergency department (ED) setting. The difference in rate of radiographic pneumonia in given studies may be due to difference in inclusion criteria i.e. the clinical variables applied [5-7].

Our study revealed that presence of grunt, nasal flaring, decreased breath sounds, wheeze and crepitations were significant predictors of radiographic pneumonia among children less than five years. On further analysis, decreased breath sounds came out to be an independent predictor of "CXR positive pneumonia" which further supports our study.

On testing the validity of clinical variables, it was observed that decreased breath sounds has a sensitivity of 92% with a specificity of 84% and a negative predictive value of 97%. So, by these values we interpret that radiographic pneumonia can be ruled out in the absence of decreased breath sounds and also has a high chance of "CXR positive pneumonia" in its presence. It is a significant ($p<0.001$) independent predictor among all the clinical variables. In other studies decreased breath sounds as a predictor of pneumonia has not been mentioned separately and mentioned in association with tachypnea, fever and crepitations [11].

So, by these findings it implies that a complete respiratory examination with auscultation is absolutely necessary to prevent the misdiagnosis and overenthusiastic use of CXR in small children.

Tachypnea as a sign of pneumonia has been used by WHO in resource limited countries but can be misleading because tachypnea is common in other viral illnesses like bronchiolitis and wheeze associated lower respiratory tract infection (WALRI) [8].

In some studies, fever history in past 24 hours and maximum temperature has been mentioned as a predictor of pneumonia [6,7]. But our study do not support this variable as an independent predictor. Instead, fever if present can be used along with significant variables to improve the outcome.

Crepitations as a clinical sign of pneumonia is not always associated with radiographic pneumonia. Crepitations can be present prior to consolidation or asymmetric infiltrates on CXR. In our study, crepitations has a sensitivity of 85%, poor specificity of 43% but a negative predictive value of 89%. In the absence of crepts, radiographic pneumonia can be easily ruled out.

The present cross-sectional study provides an insight into factors that predict radiographic pneumonia among Indian children aged less than 5 years. Radiography is an invasive investigation indicated for children suspected of pneumonia. So, the risk of radiography should be balanced against the benefit in Indian context in order to avoid unnecessary use of CXR for the diagnosis of pneumonia.

In our study we can correlate the findings of other studies in which predictors of pneumonia in children have been investigated. The major strength of our study lies in its cross-sectional data

collection and stratification of age groups among the sample size. This helps in predicting CXR positive pneumonia in different age groups in which pneumonia is clinically suspected. We observed that 40% of children among study subjects (30) had pneumonia in younger age group i.e. 2 months to 11 months. This is a significant finding as in this age group other illness like bronchiolitis is very common and the diagnosis of pneumonia can be easily missed without proper clinical examination and radiography. So, it should be properly addressed and radiography if required should be correlated clinically in order to avoid misdiagnosis. History of recurrent respiratory infections and nebulisation from a reliable parent should be sought in younger children to rule out wheeze associated lower respiratory tract infection and to avoid unnecessary use of antibiotics.

In our study, 10 clinical variables were selected which can predict radiographic pneumonia. Initially, 5 variables came out to be significant which were analysed individually to find out the significant predictors of radiographic pneumonia.

Other strengths include the study period of 13 months, which minimized seasonal variation. Consensus agreement of chest radiograph interpretation by the radiologist involved in the study limited the error associated with inter-observer agreement. This was possible because of good quality digital chest x-ray. This study focused on the use of predictive variables about which information is readily available to physicians when patients present.

Majority of children were from rural background (67%) which represents true picture of prevalence of pneumonia in our society.

Limitations of our study include small sample size. The study was conducted in a single ED of a tertiary care hospital, which may limit the generalizability to other practice settings. The entry

criteria for our study required the clinical suspicion of pneumonia that prompted the decision to obtain a radiograph. We were also unable to evaluate the reliability of specific physical examination findings because patients were only examined once by the physician and did not undergo follow up examination for the purpose of this study.

Decreased breath sounds as a clinical sign found significant predictor for radiographic pneumonia is a subjective finding and may be missed. To avoid the problem, the child should be cross examined in case of any doubt on clinical examination.

In our study, the oxygen saturation for each patient was not systematically recorded. Therefore, no analysis could be performed accurately on that variable.

Hence, we conclude that the predictors of radiographic pneumonia were decreased breath sounds and crepitations in which decreased breath sounds was found to be an independent significant predictor of radiographic pneumonia among children aged less than five years who presented with clinical features of pneumonia in emergency department.

The yield of CXR in detecting pneumonia among children presenting with cough and fast breathing was 26% and presence of radiographic pneumonia were predicted by clinical presence of decreased breath sounds and crepitations.

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