Original Research Article

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Can chest x-ray predict pneumonia severity and its outcome in children aged 2 months - 5 years?

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ABSTRACT

Background: Worldwide 16% of death in children under the age 5 years is only due to pneumonia every year. Among the diagnostic modality x-ray chest is simple tool to diagnose the pneumonia especially in developing country like in India. Aims of study was to know the incidence of radiologically proven pneumonia and to see the correlation between x-rays findings and clinical severity of pneumonia, so as to predict the severity of pneumonia on the basis of x-ray chest done on first day of hospitalization.

Methods: We did the study in department of pediatrics at tertiary care centre, total 150 patients of pneumonia (2 months to 5 years age) enrolled on clinical basis. X-ray chest done in all patients on first contact.

Results: Out of 150 patients, 54% of patient having radiologically proven pneumonia while 46% were normal x-ray findings. We found that interstitial pneumonia were more common in younger children, but lobar pneumonia were more common in older children, but in severe and very severe pneumonia cases most common radiologically proven pneumonia were bronchopneumonia in all age group, which was statistically significant.

Conclusions: So the basis of start of treatment should be on the clinical background and clinical severity, not only on the basis of x-ray chest findings. Late x-ray films give more chance of positive findings, multilobar infiltration or diffuse heterogeneous opacity in lungs positively correlated with clinical severity and gives idea about course and duration of hospitalization.

Keywords: Bronchopneumonia, Chest x-ray, Interstitial, Severe pneumonia

INTRODUCTION

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. Pneumonia can be classified according the part of lung affected:²⁻⁴

- Lobar pneumonia- Consolidation confined to segmental boundaries.
- Bronchopneumonia- More widespread or ill-defined consolidation.

 Interstitial pneumonia- It is characterized by an ongoing and progressive process with variable distribution of interstitial change within the lung.

Common symptoms in children and infants include cough, fever, chills, loss of appetite and wheezing, stuffy nose. Children under five with severe pneumonia may experience respiratory distress which is characterized by tachypnea, chest indrawing, grunting, flaring of the nose, cyanosis, and respiratory fatigue. Other symptoms are convulsions, unconsciousness and hypothermia.⁴

Physical examination should include an assessment of the child's general appearance, respiratory rate measurement, evaluation of the work of the breathing, and chest auscultation. A child's general appearance may provide important leads like presence and severity of a bacterial illness thus factors to be evaluated or assessed include; being attentive to the environment, ability to breastfeed or drink, ability to sustain sucking, vocalization, smiling, color and consolability.⁵ Confirmatory chest radiography is important as two main patterns of pneumonia are recognized: interstitial and alveolar. 6-8 Viral infections are associated with diffuse interstitial infiltrates. hyperinflation, alveolar filtrates and peribronchial thickening while bacterial pneumonia is associated with lobar infiltrates, alveolar infiltrates and pulmonary abscesses.9,10

Aims

- To find the incidence of radiological changes in cases of pneumonia in children.
- To correlate the severity of pneumonia in children with chest x-ray findings.

METHODS

Study design

It was a Prospective study to correlate severity of pneumonia with chest x-ray findings in children of two months to five years of age who were attended department of pediatrics in tertiary care center. A detailed history of the relevant symptoms such as fever, cough, rapid breathing, and refusal to feeds, wheezing etc. had been taken and data were collected in pre designed structured proforma. Chest x-ray had been taken for every case on first contact and reported by radiologist in department of radiology. Findings on x-ray chest have been correlated with patient's clinical findings. Total 150 cases of all type of pneumonia were studied from Indoor/outdoor.

Inclusion criteria

All children 2 months to 5 years attended department of pediatrics, were having clinical sign and symptoms of pneumonia included in the study.

Exclusion criteria

- Children with known chronic disease like congenital heart disease, malabsorption-syndrome, chronic kidney disease, chronic pulmonary disease and immuno-compromised patients were excluded from the study.
- Infant less than 2 months were excluded from the study.

Based on WHO ARI criteria, children were considered fast breathing if respiratory rate (RR):

- RR 60 or more than 60 in <2 months (0 to 59 days)
- RR 50 or more than 50 in 2 months-1 year (60-364 days)
- RR 40 or more than 40 in 1 year-5 years (365 days to 5 years)

RESULTS

Table 1 shows there were total of 150 patients enrolled and 89 (59.33%) were male and 61 (40.67%) were female; male to female ratio was 1.5:1. Patient divided in 2 groups, 2 months to 1 year and 1year to 5 years, because etiology of pneumonia, radiological change and severity of pneumonia is somehow different in both age groups. In 2 months to 1 year patients enrolled were 41 (27.33%) and in age group 1-5 years 109 patients enrolled (72.66%). Out of 41 infants, 56.1% were male as compared to 43.9% female. Children between 1-5 years were 109, out of which 60.55% were male and 39.45% were females. But there were no significant difference in age and sex wise distribution of patients (p-value>0.5).

Table 1: Age and sex wise distribution of patients.

Age	Male	Female	Total
2 months- 1 year	23(56.10%)	18(43.90%)	41
1 year- 5 years	66(60.55%)	43(39.45%)	109
Total	89(59.33%)	61(40.67%)	150(100%)

p-value=0.621 (insignificant association).

Table 2: Distribution of patient on the basis of chief complaints.

Complaints	Number of subjects (n=150)	Percentage
Fast breathing	150	100
Fever	138	92
Cough	144	96
Chest indrawing	56	37.33
Nasal flaring	123	82
Refusal to feed	22	14.66

Table 2 shows most common complain of patients was fast breathing (100%) followed by cough, fever and nasal flaring and 144(96 %), 138(92%), 123(82%) respectively, Chest in-drawing was present 37.33% of patients, refusal to feed present in 14.66%. Refusal to feed was present in very severe pneumonia, no any patient presented with convulsion and unconsciousness Thus, most common symptoms of pneumonia are fever and cough and fast breathing, irrespective of their age. Nasal flaring was present in 123(82%) patient that indicate use of accessory muscle of respiration, found in most of the cases of pneumonia. Chest indrawing were present in 56 patients (37.33%) and indicate severity of disease, intercostals and sub-costal retractions were taken in chest indrawing.

As we took fast breathing with respiratory symptoms for the diagnosis of pneumonia as per WHO criteria so that fat fast breathing found in 100% patients.

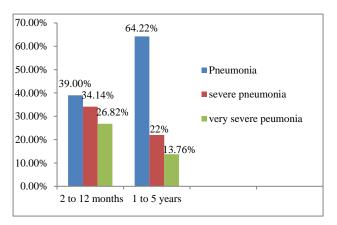


Figure: 1 Distribution of patients according to grade of pneumonia.

Figure 1 shows that Out of total 150 patients of total pneumonia, if we see severity according to WHO classification, 86 (58%) were having pneumonia, 38 (25%) were having severe pneumonia and 26 (17%) patients were having very severe pneumonia.

As Table 1 shows us that out of total no of 150 patients, 41 (27.33%) patients were in age group 2 months to 12 months, and rest 109(72.66%) patients were from the age group 1 to 5 years but this bar diagram also shows that among the total patient of pneumonia, percentage of severe pneumonia were more (34.14%) in infants as compare to 1-5 years age groups [(22.01%) (Red bar)]. Like this, very severe pneumonia were more in this as group (infants) 26.82% as compare to 13.76% in 1-5 years age group (Green bar).

This shows severity of disease is more in younger patient, younger the child more severe the disease (p-value <0.05).

Table 3: Auscultatory findings in relation to severity of pneumonia.

Type of findings	Pneumonia	Severe pneumonia	Very severe pneumonia	Total
No findings	8 (9.30%)	2 (5.26%)	-	10 (6.67%)
Crepitation	60 (69.77%)	30 (78.95%)	22 (84.62%)	112 (74.67%)
Wheeze	6 (6.98%)	2 (5.26%)	1 (3.85%)	9 (6.00%)
Wheeze and crepitations	12 (13.95%)	4 (10.53%)	3 (11.54%)	19 (12.67%)
Total	86 (100%) (57.33%)	38 (100%) (25.33%)	26 (100%) (17.34%)	150 (100%) (100%)

Chi square value = 4.104, p value = 0.663 (insignificant association)

Table 3 shows crepitations were the most common finding in all type of pneumonia, 69.76% of patient of pneumonia, 78.90% in severe pneumonia and 84.61% in very severe pneumonia. Next common findings were wheeze and crepitations both are found in 13.95% patients of pneumonia, 10.53% cases of severe pneumonia and 11.54% patient of very severe pneumonia.

Isolated wheezing is present in only 6.9% of pneumonia cases, 5.26% of severe pneumonia cases and 3.86% of very severe pneumonia cases with average in 6.0% of all

patients. Neither crepitations nor wheeze were associated with severity of pneumonia. That shows crepitation and wheezing are commonly found in pneumonia case but it had no any relation to severity of pneumonia (p-value-0.663).

Table 4 shows that out of total 150 patients of pneumonia, 81(54%) patients showing changes suggestive of pneumonia in x-ray findings (radiological proven pneumonia), and 69(46.0%) having no findings in x-ray chest film.

Table 4: Severity of pneumonia and x-ray chest findings.

X-ray findings	Pneumonia	Severe	Very severe	Total
Lobar pneumonia	16 (18.60%)	8 (21.05%)	5 (19.23%)	29 (19.33%)
Bronchopneumonia	2 (2.33%)	12 (31.58%)	12 (46.15%)	26 (17.33%)
Interstitial	10 (11.63%)	9 (23.68%)	3 (11.54%)	22 (14.66%)
Pneumonia with	-	1 (2.63%)	3 (11.54%)	4 (2.66%)
Normal x-rays	58 (67.44%)	8 (21.05%)	3 (11.54%)	69 (46%)
Total	86 (100%)	38 (100%)	26 (100%)	150 (100%)

Chi square value= 61.404, p-value<0.001(significant association)

Out of total 81 cases of radiologically proven pneumonia, most common radiological pneumonia were lobar pneumonia 29 (35.80%), followed by bronchopneumonia 26 (32%) and interstitial pneumonia 22 (27.16%). Empyema with consolidation in 4 (4.93%) cases.

If we see according to severity classification of pneumonia given by WHO, we find that out of 86 patient of pneumonia 16 (18.60%) were lobar pneumonia, 10 (11.60%) were interstitial pneumonia, 2 (2.32%) patients were having bronchopneumonia and 58 (67.0%) patient were having normal x-ray chest at time of presentation.

Out of 38 patient of severe pneumonia 12 (31.57%) were bronchopneumonia, 9 (23.68%) interstitial pneumonia, 8 (21.05%) were lobar pneumonia, 1 (2.63%) patient had effusion and 8(21.05%) were having normal chest x-ray.

Out of 26 patients of very severe pneumonia were 26, 12 (46.15%) were bronchopneumonia, 5 (19.20%) were lobar pneumonia, and 3(11.50%) interstitial pneumonia, 3 (11.50%) were having pneumonia with effusion and 3 (11.50%) patient were having normal x-ray.

Thus study shows bronchopneumonia were found mostly in severe (31.57%) and very severe type of pneumonia (46.15%), as compare to pneumonia (11.60%) that clues bronchopneumonia is more severe type of radiological

pneumonia [(multiple heterogeneous opacities and diffuse involvement of lungs) (p-value<0.05)].

Table 5: Duration of symptoms and x-ray findings.

Duration	Normal x-ray	Radiologically proven pneumonia	Total
<3 days	42 (28%)	9 (6.0%)	51 (34%)
4-7 days	19 (12.66%)	31 (20.6%)	50 (33.3%)
>7 days	8 (5.33%)	41 (27.3%)	49 (32.66%)
Total	69 (46.0%)	81 (54.0%)	150

p=1.13952E-10, p<0.05, significant

Table 5 shows that out of 51 patients presented within 3 days of symptoms of pneumonia, 42(82.35%) were having normal chest x-ray and rest (17.65%) were having abnormal chest x-ray, out of 50 patients presented with in 4-7 days of symptoms 19 patient (38%) having normal x-ray finding, 31 patient (62%) showing radiological pneumonia, out of 49 patients presented or admitted after the 7 days of onset of symptoms 41(83.61%) were having radiological changes and rest (16.39%) were have normal chest x-ray (p-value<0.05).

This indicate that radiological change takes time to appear in x-ray film. So late x-ray films give more chances of radiologically proven pneumonia.

Table 6: Type of radiological pneumonia versus level of care required.

X-ray findings	Routine care	Oxygen therapy	ICU care	Ventilator support	Total
Normal x-ray	60 (40.0%)	7 (4.66%)	2 (1.82%)	0 (0.0%)	69 (46%)
Lobar consolidation	16 (10.66%)	8 (5.33%)	4 (2.66%)	1 (0.91%)	29 (19.3%)
Bronchopneumonia	6 (4.0%)	12 (8.0%)	5 (3.33%)	3 (2.0%)	26 (17.3%)
Interstitial pneumonia	14 (9.33%)	6 (4.0%)	2 (1.82%)	0 (0.0%)	22 (14.6%)
Pneumonia with effusion	1 (0.91%)	2 (1.82%)	1 (0.91%)	0 (0.0%)	4 (2.66%)
Total	97 (64.6%)	35 (23.3%)	14 (9.33%)	4 (2.66%)	150

p= 1.50759E-05, p<0.05, significant

Table 6 shows that out of total 150 patients, 35 patients required O₂ inhalation, out of these 35 patients (beside the use of antibiotic and routine care) 12 (34.28%) having bronchopneumonia, 8 (22.85%) lobar pneumonia, 6 (17.14%) having interstitial pneumonia and 7(20%) patient were having normal x-ray. Patient required intensive care support (as well as O₂) were total 14 patients and out of them 5 (35.71%) of patient were having bronchopneumonia, 4 (28.57%) lobar pneumonia, 2 (14.28%) having interstitial pneumonia and 2 (14.28%) were have normal x-ray. Ventilatory support were required in 4 patients and out of them 3 (75%) were bronchopneumonia, 1 (25%) were lobar pneumonia, no single patient was having normal x-ray in this group (pvalue significant<0.05).

Bronchopneumonia (multiple heterogeneous opacity in multiple lobe of lungs are more severe type of pneumonia which is also matching severe and very severe pneumonia category class as given by WHO and these type of pneumonia also required more standard level of care like O_2 inhalation, intensive care support and ventilator support. Interstitial infiltrates was also associated with increased severity at presentation but similar length of stay and duration of O_2 requirement compared with single lobar disease.

DISCUSSION

Severe and very severe pneumonia is more common in infants as compare to older child because they were not

so immunocompetant.¹¹ Out of total 150 patients 54% patients were having radiologically proven pneumonia, 46% were having normal x ray film, so each pneumonia case does not necessarily have an abnormal x-ray. The most common complaint was fast breathing, but most common finding on auscultation were crepitations, but presence of crepitation did not correlated with severity of pneumonia. Decreased air entry on auscultation had also a positive association with severity of pneumonia.

Patient presented after 7 days of symptoms of pneumonia also had more radiologically proven pneumonia compare to patient presented earlier, because as duration of disease increases change in lung parenchyma would be more reflected in x-ray films. ^{12,13}

In present study also patient stayed more than 7 days in hospital having clinically as well as radiologically severe pneumonia as observed in other studies. ¹⁴ Right side lung involved more than left side because right bronchus is wider and shorter than left bronchus and chance of aspiration and invasion of bacteria is more in right lung compare to left lung and similar findings found radiologically.

Most common radiological pneumonia in infant was interstitial pneumonia and in older child (1 year to 5 years) was lobar pneumonia, because in infancy most common organism are viral and in viral pneumonia interstitial pneumonia are more common as seen in various studies also, like parahilar infiltration, multiple linear infiltration, peribronchial thickening. In older child more common cause organism of pneumonia is bacterial, and among the bacteria, *Streptococcus pneumoniae* and *H. influenzae* are common and they commonly presented with lobar pneumonia. ¹⁵⁻¹⁹

But most common radiological findings in severe and very severe pneumonia was bronchopneumonia (multiple heterogeneous opacity in multiple lobes of lungs), followed by multilobar pneumonia, because diffuse involvement of lungs by multiple heterogeneous opacity or multiple lobar pneumonia, more affect the gas exchange and produce clinical severe pneumonia. 20 Patient having bronchopneumonia also required more level of care like O_2 inhalation, ICU care and ventilatory support in comparison to other pneumonia and duration of hospitalization is also more in these patients.

As the duration of symptoms increases before hospitalization radiological changes will be more in lung tissue, which had reflected in x-ray film. 21,22

So late x-ray films after first onset of symptoms, there are more chances of radiologically proven pneumonia.²³

CONCLUSION

Severity of pneumonia is based on by clinical presentation of patient and his/her physical examination

at the time of admission and should be treated accordingly. Level of care like O2 inhalation, ICU care and ventilator support should be decide by clinical presentation and physical examination, like difficulty in respiration and cyanosis or fall in SPO₂ and should not be based solely on initial chest x ray findings, especially if x-ray film taken within 3 days of onset of symptoms. So treatment of pneumonia should be started as soon as sign and symptoms of pneumonia recognized and should not be delayed for the waiting of chest x-ray films. X-ray chest may give supportive evidence and it may give also idea about possible etiology like viral pneumonia having interstitial infiltration and hyperinflation of chest, more chances of spontaneous resolution unless get infected by secondary bacterial infection. Most common radiological findings in severe and very severe pneumonia are bronchopneumonia, (multiple heterogeneous opacity diffusely in both lungs) found in present study and common cause of bronchopneumonia are staphylococcus, Klebsiella and less likely by other organisms, so whenever treating severe and very severe pneumonia with bronchopneumonia these organism should be covered on priority. These patients may also require O₂ inhalation or ICU care or may also require ventilator support, so close watch must be kept on these patient and prompt treatment and appropriate antibiotic prevent complication and mortality. Immunization should be completed in each and every child by increasing the awareness in community.

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Ethical approval: The study was approved by the

Institutional Ethics Committee

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