

Chest Radiograph in the Pediatric Inpatient: A chart review

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ABSTRACT

Objective: To determine the usefulness of the chest radiograph in reaching a clinical diagnosis in the pediatric inpatient population at a tertiary care centre in Karachi, Pakistan.

Methodology: This was a retrospective chart review of pediatric inpatients (1 month -14 years) at Aga Khan Hospital, Karachi between April and June 2009. Radiographs ordered to assist diagnosis of disease, or as 'routine', were selected samples (n=326). For each radiograph, the clinical indication, the radiological diagnosis and the final clinical diagnosis were recorded and analyzed for frequencies and by cross-tabulation for concurrence.

Results: The largest proportion of the clinical indications was the routine chest x-ray, at 39.3%. The most common diagnosis in radiology reports was 'no chest pathology' (39.9%). The second most common was 'pulmonary infection'. Almost 46.3% of the patients who had chest x-rays had no chest pathology in the clinical diagnosis. The greatest concurrence was found between the clinical indication 'fever and cough' with a radiological and clinical diagnosis of pulmonary infection (62.3% and 49.1% respectively).

Conclusions: A significant proportion of the radiographs ordered for pediatric inpatients were normal and not associated with chest pathology on clinical diagnosis. Strong clinical suspicion of pulmonary infection, denoted by fever and cough, had the highest likelihood of giving the same radiological and clinical diagnosis.

KEY WORDS: Chest radiograph, Pediatric, Clinical diagnosis.

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INTRODUCTION

The chest x-ray is one of the oldest and most common diagnostic techniques in use today. Despite the advent of more accurate modalities such as CT and MRI, the radiograph continues to be an important radiologic investigation for the chest. Being inexpen-

sive, portable and fast, it is commonly used as a diagnostic test in the evaluation of children with signs and symptoms pertaining to the respiratory system and cardiovascular system. It is also frequently ordered (as the 'routine' radiograph) to rule out any pathology relating to these systems in pediatric patients with non-specific clinical features, such as fever.

The chest radiograph is recommended as an adequate initial diagnostic tool for pneumonia¹, pulmonary tuberculosis² and pediatric trauma³ among many other conditions. It is also recommended as a routine investigation in some circumstances, such as for the febrile patient with leukocytosis.⁴ However, its utility in the diagnosis of some other conditions, such as cardiac lesions⁵ or reactive airway disease⁶ is receding in the presence of alternative diagnostic techniques and guidelines.

In a developing country like Pakistan, where private hospitals cater to the majority of the

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population, financial grounds alone are a significant cause of anxiety to parents when admitting children to the hospital. Unnecessary investigations add to the total hospital costs. A sound understanding of which investigations are necessary under particular clinical indications can help restrict the number of investigations to a minimum, much to the benefit of the patient.

The objective of this study was to determine the significance of the chest radiograph in reaching the clinical diagnosis in the setting of different clinical indications in the pediatric inpatient population at a tertiary care centre in Karachi. We also wanted to determine which clinical indications warrant confirmation or exclusion from a radiograph in making the definitive clinical diagnosis. A proper understanding of the indications for asking for a radiograph can reduce unnecessary radiographs ordered in the hospital, which expose the child to radiation and add to the total costs.

The study was done to look at the concurrence between the clinical indication mentioned while asking for chest x-rays, the radiological diagnosis, and the final clinical diagnosis pertaining to chest pathology.

METHODOLOGY

The study was based on a retrospective clinical chart review. After obtaining permission from the Ethical Review Committee, chest x-rays that were requested in the months of April, May and June 2009 for inpatients at the pediatric ward (age 1 month to 14 years) Aga Khan Hospital, Karachi were reviewed. For those x-rays that fulfilled inclusion criteria, the *clinical indication* for asking x-rays and *clinical diagnoses* were obtained by reviewing the medical charts of the corresponding patients.

Inclusion criteria: Those radiographs that had been ordered for inpatients in the pediatric ward aged one month and above with a given clinical indication to assist diagnosis of disease, or as 'routine' to rule out disease, were selected as samples. In cases where the first x-ray was followed by multiple follow-up x-rays to follow disease progress, only the first x-ray was selected as a sample. However, if during one hospital stay, one x-ray was followed by another with the second one ordered with a new clinical indication, then the second x-ray was also included as a new sample.

Exclusion criteria: All follow-up x-rays were excluded. All chest x-rays ordered following surgical or technical procedures such as cardiac surgery and after tube and catheter insertions, were excluded.

Sample size: As no prior directly comparable study could be found in literature, using our best judgment, considering $50\% \pm 10\%$ concurrence between clinical indication and radiological diagnosis, and using computer program Epi Info version 6.0 WHO/CDD, the sample size selected was 300 x-rays. In the review of a 3-month period, the actual sample size used in this study stood at 326.

The Clinical and Radiological Diagnoses were grouped into the following categories:

1. *Pulmonary infection:* On radiology, atelectasis was also counted in this category. Clinical diagnoses of pneumonia, pneumonitis, viral pneumonia, aspiration pneumonia, pulmonary tuberculosis, and cystic fibrosis were all included in this category.
2. *Reactive airway disease:* This category included asthma and bronchiolitis.
3. *Cardiac abnormalities:* This category included all diagnoses pertaining to the heart including ASDs, VSDs, TOFs, pericardial effusion, congestive heart failure, etc. 'Pulmonary edema' and 'pulmonary plethora' mentioned in radiology reports were also counted in this category.
4. *Miscellaneous:* This category included unusual chest diagnoses on radiology reports and clinical records such as pulmonary hemosiderosis, chronic interstitial lung disease, etc.
5. *No chest pathology:* This category was for radiographs pronounced normal, and for clinical diagnoses not pertaining to the chest.

Expressions such as 'could be' or 'indicative of' used in radiological reports, were counted as positive diagnoses.

The data was computerized and analyzed using SPSS v.16.0. Frequencies were calculated for clinical indications, radiological diagnoses and clinical diagnoses. 2x2 tables were used to compare clinical indications with the other two. Chi square test was used to look at significant relationships amongst them.

RESULTS

Mean age of the children was 4.0 years (48.06 months). 59.5% of the participants were male and 40.5% were female.

After completing data collection, the clinical indications were grouped into the following categories for analysis. Their frequencies are presented in Table-I.

1. *Pulmonary infection:* Fever, cough, fever plus cough, queries for pneumonia and pulmonary TB, cystic fibrosis, and croup were all grouped

Table-I: Clinical indications reported for ordering a chest x-ray.

Clinical indication	Frequency	Percent
Routine	137	41.0
Pulmonary infection	142	42.5
Reactive airway disease	10	3.0
Trauma	7	2.1
Miscellaneous.	13	3.9
Cardiac abnormalities	12	3.6
Malignancy	13	3.9
Total	334	100.0

in this category, based on the assumption that they raise the suspicion of chest infection and that all radiographs ordered in such cases were directed towards it.

2. *Reactive airway disease*: This included queries of asthma and bronchiolitis.
3. *Cardiac abnormalities*: This category included all diagnoses pertaining to the heart including congenital heart and great vessel anomalies, pericardial effusion, congestive heart failure, pericarditis, etc.
4. *Trauma*: History of falls, road traffic accidents and such were included here.
5. *Malignancy*: Radiographs ordered with indications prominently of AML, ALL, CML and bone tumors were included here.
6. *Routine*: Also included here were radiographs ordered without a clinical indication.
7. *Respiratory distress*: This also included 'shortness of breath'. Since this clinical feature can be associated with a number of etiologies, including pulmonary infection and cardiac problems, it was analyzed as a separate clinical indication.
8. *Miscellaneous*: Included here were all indications with a frequency of three or less, such as abdomino-thoracic pain, cyanosis, neuro-muscular disorder, epilepsy, ascites, etc.

Using the categorization described above, the largest proportion of the clinical indications was the routine chest x-ray, at 39.3% (128 cases). Pulmonary infection with 34.4% (112 cases) was, amongst the rest, the most common clinical indication.

The diagnosis most commonly given in the radiology reports in this study was 'no chest pathology' with

Table-II: Radiological diagnoses reported by the pediatric radiologist.

Radiological diagnosis	Frequency	Percent
Pulmonary infection	114	35.0
Reactive airway disease	26	8.0
Cardiac abnormalities	41	12.6
Miscellaneous	15	4.6
No chest pathology	130	39.9
Total	326	100.0

130 cases (39.9%). The second most common radiological diagnosis was 'pulmonary infection' (35%, 114 cases).

The clinical records in this study showed that 46.3% of the patients who had chest x-rays, were discharged without any chest pathology in the clinical diagnosis. 72 cases (22.1%) were diagnosed with pulmonary infection.

In the 128 chest radiographs ordered as routine, the majority were reported to be normal (54 cases, 42.2%) and were not associated with chest pathology in the clinical diagnosis (60 cases, 46.9%). 40 x-rays (31.2%) revealed a diagnosis of *pulmonary infection* on the radiology report, but only 17 (13.3%) had a clinical diagnosis of *pulmonary infection*. Reactive airway disease was reported in 6 (4.7%) x-rays, while it was the clinical diagnosis in a larger number of cases -23 (18.0%).

In the 112 x-rays ordered with a clinical indication of *pulmonary infection*, only 50 (44.6%) had the radiological diagnosis and 42 (37.5%) had the clinical diagnosis of pulmonary infection.

Since *fever* and *cough* were two major reasons for asking chest x-rays to diagnose pulmonary infection, these were looked at individually as well. Among the 24 x-rays ordered due to *fever* without cough, only 4 (16.7%) yielded a radiological diagnosis of pulmonary infection. Similarly, among 17 x-rays ordered with *cough* as the sole indication, only 5 (29.4%) showed pulmonary infection on radiology. However, in cases having *fever and cough* together, 33 (62.3%) out of 53 x-rays showed pulmonary infection on radiograph, and 26 (49.1%) were clinically diagnosed with pulmonary infection.

Table-III: Comparison of some clinical indications and their respective radiological diagnoses.

Clinical Indication	No. of x-rays ordered	Radiological diagnosis confirmed	
		Yes (N) = (%)	No (N) = (%)
Pulmonary infection	112	50 (44.6%)	62 (55.4%)
Reactive airway disease	7	1 (14.3%)	6 (85.7%)
Cardiac abnormalities	18	12 (66.7%)	6 (33.3%)

In the 26 X-rays ordered with the indication of respiratory distress, the most common radiological diagnosis was pulmonary infection (10 cases, 38.5%) while clinically, most had no chest pathology (9 cases, 34.4%).

DISCUSSION

Although the x-ray is the oldest imaging modality, the fastest, easily accessible and one of the least expensive, research into its utility and usefulness continues in order to define its indications. This is because the rampant use of x-rays in settings where it is not likely to yield much information or affect patient management is undesirable, because it translates into unnecessary x-ray exposure and expense for the patient.

The radiograph is the universal first-line investigation for pneumonia. This study showed that in this centre, when a radiograph was ordered for an inpatient with suspicion of pulmonary infection, an actual infection that would be treated was present in less than half the cases. Strong indicators of pulmonary infection namely *fever with cough and/or respiratory distress* showed pneumonia on radiology and clinical diagnosis 61% and 48% of the time, respectively. However, weaker indications of infection such as *fever alone, or cough alone, or chest congestion, or cystic fibrosis*, were far less likely to be confirmed as pneumonia on radiology or on clinical diagnosis with values of 33% and below. These results are similar to another study that reported a low diagnostic yield of pneumonia on the radiograph in children suspected of having pneumonia.⁷

Radiography is discouraged in patients with strong clinical features of reactive airway disease⁸ as it is unlikely to contribute to patient management. In this study, seven patients were suspected to have reactive airway disease and got a radiograph, and out of these six were treated clinically as such, however, only in one case did the radiology report affirm it. Also, among the 51 cases in this study that were clinically diagnosed as RAD, 6 (11.8%) were radiologically diagnosed with it. These results support the recommendation that a chest x-ray is unnecessary in a patient suspected of reactive airway disease.⁸

In this study almost 40% of the x-rays reviewed were routine x-rays and an additional 4% were for miscellaneous indications including hemoptysis, neuromuscular disorder, lymphadenitis, epilepsy, 'lump in the left side', abdomino-thoracic pain, cyanosis, wheeze. Since about 40% of the routine x-rays were reported as normal, this indicates that

when physicians are not clear about the clinical diagnosis and seek assistance from radiology, the radiograph is often normal.

The radiograph has been reported to have a low sensitivity (58%) in detecting cardiac enlargement, which would limit its utility as a screening test.⁹ In this study 18 patients had radiographs with the clinical indication of a cardiac abnormality, which was confirmed radiologically in 14 cases (77.8%) and was a clinical diagnosis in 16 cases (88.9%). The sensitivity of the radiograph for cardiac abnormalities in this study was thus 87.5%.

CONCLUSIONS

A significant proportion of the radiographs ordered for pediatric inpatients are reported normal and are not associated with any chest pathology on clinical diagnosis. Strong clinical suspicion of pulmonary infection, denoted by *fever and cough*, has the highest likelihood of giving a diagnosis of the same on radiology and as a clinical diagnosis. Radiography is irrelevant under a clinical suspicion of reactive airway disease.

Limitations: It is a retrospective review and the available data was not enough to look into other confounding variables. A prospective study should be done to confirm the findings of the study.

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