Chest radiography in children aged 2-59 months diagnosed with non-severe pneumonia as defined by World Health Organization: descriptive multicentre study in Pakistan

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Abstract

Objectives To evaluate the chest radiographs of children diagnosed with non-severe pneumonia on the basis of the current World Health Organization guidelines (fast breathing alone) for radiological evidence of pneumonia.

Design Descriptive analysis.

Setting Outpatient departments of six hospitals in four cities in Pakistan.

Participants 2000 children with non-severe pneumonia were enrolled; 1932 children were selected for chest radiography.

Interventions Two consultant radiologists used standardised WHO definitions to evaluate chest radiographs; no clinical information was made available to them. If they disagreed, the radiographs were read by a third radiologist; the final classification was based on agreement between two of the three radiologists.

Main outcome measures Presence or absence of pneumonia on radiographs.

Results Chest radiographs were reported normal in 1519 children (82%). Radiological evidence of pneumonia was reported in only 263 (14%) children, most of whom had interstitial pneumonitis. Lobar consolidation was present in only 26 children. The duration of illness did not correlate significantly with the presence of radiological changes (relative risk 1.17, 95% confidence interval 0.91 to 1.49).

Conclusion Most children diagnosed with non-severe pneumonia on the basis of the current WHO definition had normal chest radiographs.

Introduction

Acute respiratory illnesses, primarily pneumonia, are the main cause of mortality in children under 5 years in most developing countries—they result in 1.9 million deaths each year.[1] To help reduce mortality from these diseases, the World Health Organization introduced case management guidelines based on simple clinical signs for diagnosing pneumonia followed by empirical treatment with antibiotics.[2] These guidelines are based on studies that compared the sensitivity and specificity of clinical signs with radiographic evidence of pneumonia, and the results showed that most of these children had fast breathing.[3–5]

However, some children with fast breathing do not have pneumonia.[6–9] WHO guidelines recommend that the respiratory rate is measured when the child is afebrile, calm, or feeding,[2] but this may not always be possible.

Concern has therefore been voiced about using fast breathing as the only clinical sign for diagnosing pneumonia in children.[10 11] Children diagnosed in this way may receive antibiotics unnecessarily, which could lead to increased resistance to antibiotics in the community. We analysed the chest radiographs of children aged 2-59 months who presented to a health facility with fast breathing and were diagnosed with non-severe pneumonia using WHO guidelines.[2]

Materials and methods

We analysed the radiological data from a previous trial in the outpatient departments of six hospitals in four cities in Pakistan.[12] All children had community acquired non-severe pneumonia, defined according to WHO guidelines. Chest radiographs were taken at enrolment. All chest radiographs were read independently by two paediatric radiologists who were given no clinical information. In case of disagreement chest radiographs were read by a third radiologist. Radiological findings were classified as pneumonia, bronchiolitis, and normal.

We defined radiological evidence of pneumonia as radiologically appreciable pneumonia reported by at least two of the three radiologists, who used a standardised case report form developed by WHO for classifying parenchymal changes into predefined radiological categories.[13] These radiological changes were then further defined according to the quadrants in the right and left lung fields. Parenchymal changes were classified into nine categories (see bmj.com). No radiological evidence of pneumonia was defined as normal. See bmj.com for details of data collection and statistical analysis.

Results

In total, 2000 children were enrolled in the study, and 1848 chest radiographs were available for assessment. Radiologists disagreed on 371 radiographs, which were then analysed by a third radiologist (table 1). Radiologists 1 and 2 agreed about 1477 radiographs ($\kappa = 0.46$).

The final classification of the radiographs was based on agreement between two of the three radiologists. Of the 1848 chest radiographs examined, 263 (14%) were reported as having radiological evidence of pneumonia. Lobar consolidation was present in only 26 children and most of the others had interstitial

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Table 1 Radiological assessments of children diagnosed with non-severe pneumonia by the three radiologists. Values are number (%)

Radiological classification	Radiologist 1 (n=1848)	Radiologist 2 (n=1848)	Radiologist 3 (n=371)	Overall agreement
Normal	1496 (80.9)	1366 (73.9)	270 (73)	1519
Pneumonia	259 (14.1)	416 (22.5)	87 (23)	263
Bronchiolitis	93 (5.0)	66 (3.6)	14 (4)	66

parenchymal changes. A further 66 (4%) radiographs were thought to be consistent with the diagnosis of bronchiolitis. The remaining 1519 (82%) radiographs were reported as normal.

We found no statistically significant differences in the baseline characteristics of children with and without evidence of radiological pneumonia (table 2). Of the 415 children who had wheeze at enrolment, 350 (84%) had normal chest radiographs. The duration of illness did not correlate significantly with the presence of radiological changes (relative risk 1.17, 95% confidence interval 0.91 to 1.49).

Discussion

Most children who were diagnosed with non-severe pneumonia on the basis of fast breathing had no radiological evidence of pneumonia. Chest radiographs are thought by many to be the best method for diagnosing pneumonia.[14] Chest radiographs are not recommended for diagnosing pneumonia in most developing countries because the facilities are often not available. The interpretation of radiographs is difficult in young children and is affected by the radiographer's experience and the amount of clinical information available.[15] Moreover, chest radiography cannot reliably distinguish between viral and bacterial pneumonia and is often unable to detect early changes of pneumonia.[16] Drawbacks of chest radiography include exposure to ionising radiation, cost, and the time and space used. WHO case management guidelines therefore still recommend the use of simple clinical signs to diagnose pneumonia.

Table 2 Baseline characteristics of children with and without radiological evidence of pneumonia (n=1782). Values are number (%) unless stated otherwise

	Radiological evidence of pneumonia		
Characteristic	**Present (n=263, 15%)**	**Absent (n=1519, 85%)**	**Relative risk (95% CI)**
Sex			
Male	158 (60%)	972 (64%)	0.87 (0.69 to 1.09)
Age (months)			
2-5	59 (22%)	391 (26%)	0.83 (0.63 to 1.11)
6-11	73 (28%)	428 (28%)	0.92 (0.71 to 1.20)
12-59	131 (50%)	700 (46%)	
History and signs			
Fever	253 (96%)	1421 (94%)	1.63 (0.89 to 2.98)
Cough	260 (99%)	1498 (99%)	1.18 (0.41 to 3.43)
Difficult breathing	234 (89%)	1388 (91%)	0.80 (0.56 to 1.13)
Vomiting	36 (14%)	188 (12%)	1.10 (0.80 to 1.52)
Diarrhoea	34 (13%)	156 (10%)	1.24 (0.90 to 1.73)
Past history of wheeze	17 (7%)	73 (5%)	1.30 (0.83 to 2.02)
Duration of illness:			
3 days	187 (71%)	1135 (75%)	
>3 days	76 (29%)	384 (25%)	1.17 (0.91 to 1.49)
Presence of wheeze	65 (25%)	350 (23%)	1.08 (0.84 to 1.40)
Season			
October to March	188 (72%)	1188 (78%)	0.74 (0.58 to 0.94)

What is already known on this topic

Chest radiographs are the best method for diagnosing pneumonia, but they are often not available in developing countries

World Health Organization guidelines therefore use fast breathing alone for the diagnosis of non-severe pneumonia, but fast breathing can have causes other than pneumonia

What this study adds

Most children diagnosed with non-severe pneumonia on the basis of fast breathing alone have normal chest radiographs, and many of these children may receive antibiotics unnecessarily

WHO definitions of pneumonia need to be more specific

These guidelines are designed to help reduce mortality from pneumonia by standardising management of children with acute respiratory illness and to rationalise the use of antibiotics. After the introduction of standard case management of acute respiratory illnesses, both a reduction in mortality and an improvement in appropriate use of antibiotics were seen.[17 18]

Some argue that chest radiographs cannot detect early changes of pneumonia and, therefore, radiographs can be normal in some children with pneumonia. Our data do not support this argument. The incidence of radiological changes was similar in children whose illness lasted longer than three days and those who presented much earlier. Our data therefore indicate that most children with normal radiographs probably did not have pneumonia.

Previous data show that a proportion of non-severe pneumonia is viral in origin, so that the use of antibiotics could be reduced by improving the specificity of WHO definitions of non-severe pneumonia.[14 19] Fever has been identified as the best predictor of infection that requires treatment with antibiotics as children with fever were sicker, had a higher incidence of radiological changes, and stayed in hospital longer.[20] Current WHO guidelines do not include fever as a sign for classifying pneumonia or assessing prognosis. The value of this clinical sign for identifying those children who would benefit from treatment with antibiotics should be assessed.

In our study most children with wheeze had a normal chest radiograph. Wheeze is associated with respiratory syncytial virus,[19] and antibiotics in children infected with this virus are of little benefit.[19 21] It is important to improve the assessment and management of children with wheeze. This will also help increase the specificity of diagnosing pneumonia and improve the rational use of antibiotics.

Conclusion

Most children diagnosed with non-severe pneumonia on the basis of fast breathing alone had normal chest radiographs and many of them may not have had bacterial pneumonia. The clinical assessment of pneumonia needs to be more specific. Better and cheaper technology is needed to identify bacteria and other agents that cause pneumonia. This will help reduce the pressure on the development of resistance to antimicrobials by rationalising the use of antibiotics.

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Ferrous musings from the CABG patch

Just over a fortnight ago I had a two vessel coronary artery bypass graft. I was back home on the sixth day after the operation, and the community cardiac nurse visited six days later. Among other things, she took a blood sample because she thought I looked anaemic. This was not a surprise, because my wife had commented for a few days on my pallor, and I had that very morning checked my conjunctivas and found them pale.

My haemoglobin concentration came back at 86 g/l, while red cell volume was in the normal range. The community nurse duly asked my general practitioner to prescribe iron supplementation, my GP did so (as I would have done in her place), and I happily started taking ferrous sulphate 200 mg twice daily. However, having time on my hands, I started thinking about the use of iron in this context. I now question the clinical logic.

Consider. The usual mean lifespan for red blood cells in the circulation is 120 days. On average then, 0.83% (1/120) of the red blood cell population dies every 24 hours and, to maintain the normal steady state, is replaced from bone marrow haemopoiesis. The cardiopulmonary bypass pump is a traumatic environment for red blood cells. Some are destroyed, and the mean survival time of the surviving population is reduced. Cell lifespan is reduced by a mean of 33-50% (personal communication, G Bertoni, vascular surgery research fellow, Oxford). Therefore, when I came off the pump, my red blood cells had a mean survival of 60-80 days and were thus dying off at the rate of 1.25-1.67% of the total every 24 hours.

For this argument, let's take a mean of 70 days, or 1.43% loss per 24 hours. Intraoperative blood loss was replaced by transfusion (also red blood cells with reduced survival time), and let's ignore loss of cells during the pump period. Also, set aside for now any compensatory haemopoietic response, and assume marrow replacement continues at 0.83% of total per day. Therefore, by 70 days after I came off the pump, 100% of my surviving red blood cell population will have been cleared from my circulation. During this time, my bone marrow will have generated 0.83% of the total cell population a day, leaving me with 58.3% (70/120) of my "usual" cell population. No mystery as to how normocytic anaemia arises after coronary artery bypass grafting.

In reality, of course, there is a compensatory erythropoietin and bone marrow response, which increases the red blood cell replacement rate. This shortens the duration of postoperative anaemia and lessens the dip in cell population. By the way, can anyone say whether this crude mathematical model of my convalescent musings comes anywhere near the observed dynamics of anaemia after coronary artery bypass grafting?

And now to iron. In the postoperative anaemia there must be plenty of recycled iron from the prematurely senescent red blood cells. As far as I recall, in the absence of iron deficiency the absorption ceiling for dietary iron does not change. Oral iron supplements remain unabsorbed and do not affect haemopoiesis. There is no evidence that my preoperative iron stores were other than normal, so there was no benefit to me in taking ferrous sulphate. There was a disbenefit, because it made my piles hurt. I stopped taking the ferrous sulphate after two days, and have continued to convalesce well.

What I have not yet done is find the courage to tell this to my GP, the community cardiac nurse, or indeed my wife.

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