

X-rays in children with suspected asthma

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Abstract

Background: The Southern Health Quality Committee expressed concern that across Southern Health there is wide variation in the use of x-rays in children with suspected asthma. The Women's & Children's Program wanted to identify best practice in order to standardise the use of x-rays in these children.

Clinical Question: In children with suspected asthma, does use of x-rays contribute to clinical decision-making or affect clinical outcomes such as length of stay?

Methods: We searched The Cochrane Library, including The Cochrane Database of Systematic Reviews, DARE, CENTRAL and HTA in July 2006. We also searched Medline and CINAHL and key guideline websites.

We included all relevant trials in children aged >1 year, published in English. We excluded trials where the selection criteria were unclear or selected for children not comparable to those routinely seen in Southern Health Emergency Departments.

Results: No studies were identified which compared the clinical outcomes of children with asthma randomised to receive an x-ray or not. A small number of studies were identified which evaluated the impact of x-ray on diagnosis of complicating conditions or the accuracy of assessment of severity of asthma

Conclusions: Chest x-rays are not required to diagnose asthma or to classify severity as these assessments are clinical. However chest x-rays may be of use in identifying complications of asthma. X-rays should not be routinely ordered, but rather ordered where there is a clinical suspicion of a complication or alternative diagnosis based on symptoms and signs or failure to respond to treatment.

Implications for Practice: Children with uncomplicated asthma that respond appropriately to treatment do not require chest x-ray. Consider chest x-rays in children with asthma-like symptoms if there are symptoms or signs not explained by asthma, evidence of a significant complication or if the child does not respond to asthma treatment.

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Background

The role of x-rays in paediatric asthma has changed considerably over time. Once recommended by some for almost all asthma presentations, they are now used more sparingly, although practice varies between institutions and clinicians. The Southern Health Quality Committee expressed concern that across Southern Health there is wide variation in the use of x-rays in children with suspected asthma. The Women's & Children's Program wanted to identify best practice in order to standardise the use of x-rays in these children. The Paediatric Evidence Centre was asked to investigate the evidence for the use of x-rays in this population.

Clinical Question

In children with suspected asthma, does use of x-rays contribute to clinical decision-making or affect clinical outcomes such as length of stay?

There are at least three potential theoretical reasons for undertaking an x-ray in children with suspected asthma:

1. To confirm a diagnosis of asthma
2. To rule out alternative diagnoses or complications
3. To assess the severity of asthma

Methods

Study Selection Criteria

Patient	Children (aged >1 year) with suspected asthma				
Intervention	Chest x-ray				
Comparison	Any				
Outcomes	Any				
Study Type	Any	Publication Date	Any	Language	English

Search Strategy

Evidence Source	Date of Search	Evidence Source	Date of Search
The Cochrane Library *	31 st July 2006	CINAHL (Ovid)	31 st July 2006
Medline (PubMed)	31 st July 2006	Guidelines sites	31 st July 2006

*(including The Cochrane Database of Systematic Reviews, DARE, CENTRAL and HTA)

Search Terms in Medline

Patient	((child\$ OR pediatric\$ OR paediatric\$ OR adolescen\$ OR teenage\$ OR teen-age\$).mp. OR adolescent/ Or exp child/) AND (exp Asthma/ OR asthma\$.mp.)
Intervention	(exp X-Rays/ OR radiography/ OR radiography, thoracic/ OR bronchography/ OR Radiology/ OR (xray\$ OR x-ray\$ OR radiograph\$ OR radiolog\$ OR roentgenogra\$).mp.)
Comparison	-
Outcomes	-

Data Collection & Analysis

Our searching identified over 600 potentially relevant citations, 41 of which we reviewed in full text. Studies were selected and appraised by one reviewer who consulted with colleagues where there was uncertainty.

We initially sought research studies which compared the clinical outcomes of children with asthma randomised to receive an x-ray or not, however when no studies of this type were identified, we broadened our criteria to include studies that provided evidence on the impact of x-ray on diagnosis of alternative or complicating conditions or on accuracy of assessment of severity of asthma.

After excluding references that did not meet inclusion criteria or which evaluated the use of x-rays in a group of children where the selection criteria were unclear or the study population was not comparable to those routinely seen in Southern Health Emergency Departments, four journal articles were included.^{2,3,4,6}

The Southern Health Evidence-Based Guideline for the Management of Asthma in Children¹ was also included as it is locally developed and the most recent and relevant evidence-based guideline for asthma management. The National Asthma Council of Australia Asthma Management Handbook⁵ was also included as it is a widely accepted guide to best practice in those areas of asthma management which cannot be directed by research evidence.

Results

1. Use of x-rays to confirm a diagnosis of asthma

The diagnosis of asthma is clinical. The Southern Health Evidence-Based Guideline for the Management of Asthma in Children¹ states that: *“The diagnosis of asthma in children <5 years old is entirely clinical. In children ≥5 years old, bronchodilator responsiveness, PEF variability or tests of bronchial hyperreactivity may be used to confirm the diagnosis”*.

The guideline recommends that clinicians:

“Base the diagnosis of asthma in children on:

- *the presence of key features and careful consideration of alternative diagnoses*
- *assessment of the response to trials of treatment, and ongoing assessment*
- *repeated reassessment of the child, questioning the diagnosis if management is ineffective”*

Given this, x-rays are not required to diagnose asthma in children.

2. Use of x-rays to rule out alternative diagnoses or complications

X-rays might be used to rule out complicating or alternative diagnoses in children with asthma-like symptoms. These potential diagnoses include pneumonia, pneumothorax and pneumomediastinum.

In a prospective study of 371 infants aged >1 year presenting with a first episode of wheezing who all had chest x-rays, 94.3% were normal.² Of the 5.7% (21) that had findings inconsistent with uncomplicated asthma, atelectasis and pneumonia were noted in seven, segmental atelectasis in six, pneumonia in five, multiple areas of subsegmental atelectasis in two, and pneumomediastinum in one. Almost all of these (20/21) could be identified clinically by a combination of tachypnoea, tachycardia, fever, and localized rales or localised decreased breath sounds.

Another prospective study included 128 children admitted to hospital for acute asthma who all had a chest x-ray.³ In each case the admitting officer was asked to record the treatment plan before reviewing the x-ray. After the patient's discharge the subsequent treatment was reviewed by one of the researchers to determine whether the treatment plan was altered by the x-ray results. In this group of patients 65.6% had been previously admitted for asthma. Seven patients had significant abnormalities on x-ray; defined as pneumonia, possible pneumonia or pneumothorax. The treatment plan was altered in only three cases, each time because blood was taken for culture and in one case to start ampicillin.

There are several reasons to question the usefulness of x-rays to rule out these diagnoses in most children with asthma.

- These conditions are relatively rare in this population group.^{2,3}
- In many cases these diagnoses can be distinguished from uncomplicated asthma by clinical signs or symptoms.²
- In most cases the x-ray findings do not affect the treatment plan.³

3. Use of x-rays to assess the severity of asthma

Assessment of severity of asthma is clinical. Table 5 in the Southern Health Evidence-Based Guideline for the Diagnosis and Management of Asthma in Children¹ (below) outlines the classification of severity of asthma in children.

Table 5: Clinical features for assessment of severity of acute exacerbation

Mild	Moderate	Severe	Life threatening
<ul style="list-style-type: none"> • Normal mental state • Subtle or no accessory muscle use • SpO₂ ≥ 95% • Able to talk and/or feed 	<ul style="list-style-type: none"> • Normal mental state • Minor accessory muscle use • SpO₂ 92-95% • Some limitation of ability to talk and/or feed 	<ul style="list-style-type: none"> • Agitated • Moderate/marked accessory muscle use • SpO₂ <92% • Too breathless to talk and/or feed • Tachycardia • Increased respiratory rate 	<ul style="list-style-type: none"> • Confused/drowsy • Maximal accessory muscle use/exhaustion • SpO₂ <92% • Silent chest • Poor respiratory effort • Altered consciousness • Cyanosis
<p>NB. If a patient has signs and symptoms across categories always treat according to their most severe features</p>			

It is interesting to note that findings on x-ray do not correlate well with clinical assessment of severity.⁴ Given that the reference standard for assessment of severity is clinical, even if x-ray findings correlated perfectly with clinical assessment, they would not be providing any additional information to that provided by a clinical assessment.

In a study of 117 hypoxaemic children with asthma (oxygen saturation ≤93% in room air) who had chest x-rays, x-ray findings were not associated with any of the clinical outcomes measured, including duration of hypoxaemia, length of hospital stay or likelihood of admission to the paediatric intensive care unit.⁶

Discussion

There are other reasons not to routinely x-ray children with asthma. Routine use of x-rays in children with asthma might needlessly increase prescription of antibiotics. In the study of 371 first time wheeze presentations discussed above,² 22 x-rays considered by radiologists to reflect uncomplicated asthma, were misinterpreted as indicating pneumonia by the junior medical staff, who then gave the children antibiotics. Given that only 12 x-rays of the 371 were truly positive for pneumonia, this is a substantial false positive rate, and resulted in overall antibiotic prescription at three times the appropriate rate.

Routine use of x-rays in this population will also result in unnecessary exposure to radiation and may delay appropriate treatment or put the child at risk by removing them from the clinical setting in which they can most effectively be treated.

So when should children with asthma be x-rayed?

The Southern Health Evidence-based Guideline for the Management of Asthma in Children states that: “Chest x-rays and arterial blood gas (ABG) measurements rarely provide additional useful information and are not routinely indicated.”

This is in line with the National Asthma Council of Australia Asthma Management Handbook⁵ which states that:

A chest X-ray is not routinely required. It should be sought if:

- *the diagnosis is uncertain*
- *there are symptoms not explained by asthma*
- *there is evidence of a significant complication such as mucus plugging, atelectasis, pneumothorax or*
- *symptoms persist despite appropriate treatment.*

Conclusions

In summary, most children with asthma will not require a chest x-ray, and should be managed according to their clinical condition. Chest x-rays may be appropriate in children who do not respond to asthma treatment, or who have signs or symptoms which are not consistent with a diagnosis of uncomplicated asthma.

Implications for Practice

Children with uncomplicated asthma that responds appropriately to treatment do not require chest x-ray. Consider chest x-rays in children with asthma-like symptoms if there are symptoms not explained by asthma, evidence of a significant complication or if the child does not respond to asthma treatment.

References

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Disclaimer

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Characteristics of included studies:

Study	Study Type	N (total)	Setting	Patients	Exposure	Comparison	Outcomes
Gershel et al ²	Prospective case series	371	Paediatric ED	>1 year of age with first episode of wheezing	Clinical assessment		X-ray findings
Brooks et al ³	Prospective case series	128	Children's Hospital	Children admitted because of acute asthma unresponsive to ED treatment who had x-rays	Clinical assessment		X-ray findings
Gillies et al ⁴	Cohort	33 cases	Paediatric ED	Children aged 6-15 with an acute asthmatic episode	X-ray assessment of severity		Clinical assessment of severity
Tsai et al ⁶	Cohort	445 (117 relevant here)	Paediatric ED	Children aged 1-17 with an asthma exacerbation, 117 of whom were hypoxaemic	X-ray assessment of severity		Duration of hypoxaemia, LOS, PICU admission

Quality of included studies:

Study:	Appropriate sampling method	Appropriate sampling frame	Adequate sample size	Objective, standard criteria for measurement of health outcome	Adequate response rate	Refusers described	Comments
Gershel et al ²	Yes	Yes	Yes	Mostly	Yes – 100%	Not applicable	X-rays were read by a paediatric radiologist blind to the patient's clinical status and response to ED treatment. All positive x-rays and every 15 th negative x-ray were read by a second radiologist to assess reliability. Standard definitions are not provided
Brooks et al ³	Yes	Yes	Yes	Mostly	Yes 128/129	No	X-rays were read by a paediatric radiologist blind to the patient's clinical status. Some definitions are provided. The reason for x-ray not being taken in one patient is not described

	Specified inclusion/exclusion criteria	Groups similar at baseline except for exposure	Outcomes assessed blind to exposure	Adequate duration of follow-up	Minimal proportion lost to follow up	Objective & independent assessment of outcomes & exposure	Comments
Gillies et al ⁴	Some	Unclear	Unclear	Unclear	Unclear	Unclear	Some definitions of x-ray interpretation given.
Tsai et al ⁶	Mostly	Unclear	Unclear	Yes – until discharge	Yes – 0%	Yes	All patients with O ₂ ≤93% in room air were x-rayed and included in the study (250 non-hypoxaemic patients were also included, it is not clear how they were selected and their data is not included here). Radiologists interpreting x-rays were blind to O ₂ saturations and clinical status. Definitions of x-ray interpretations provided.

Results of included studies:

Gershel et al ²	<ul style="list-style-type: none"> 94.3 % of x-rays compatible with uncomplicated asthma, 5.7% (21) had findings not normally seen in uncomplicated asthma (7 segmental atelectasis and pneumonia, 6 segmental atelectasis, 5 pneumonia, 2 multiple areas of subsegmental atelectasis, 1 pneumomediastinum). 22 radiographs showing uncomplicated asthma were misread by junior medical staff as being positive for pneumonia The combination of RR ≥60 or HR ≥160 or temp ≥38.3°C or localised rales or localised decreased breath sounds had a sensitivity of 95% and a specificity of 53%
Brooks et al ³	<ul style="list-style-type: none"> 7 patients (5.5%) had significant abnormalities on x-ray; consistent with pneumonia (2), possible pneumonia (4) or pneumomediastinum (1) 15 patients had clinical suspicion of pneumonia, 3 of these had pneumonia n x-ray, one suspected case each of pneumothorax and pneumomediastinum were ruled out on x-ray Treatment plan outlined before x-ray findings were known was altered in light of x-ray findings in only 3 patients, blood was drawn for culture in all three, and ampicillin started in one of these.
Gillies et al ⁴	<ul style="list-style-type: none"> No correlation between clinical severity and degree of hyperinflation.
Tsai et al ⁶	<ul style="list-style-type: none"> No association between any of the x-ray findings an any of the clinical outcomes.