

## PEDIATRICS

# Prevalence of pneumonia in children under 12 years of age who undergo abdominal radiography in the emergency department

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**ABSTRACT**

**Objective:** Pneumonia is a well-known cause of acute abdominal pain in children. However, the utility of chest radiography in this setting is controversial. We sought to determine the prevalence of pneumonia in children under 12 years of age who had abdominal pain and underwent abdominal radiography when visiting an emergency department (ED). We also aimed to describe the signs and symptoms of children diagnosed with pneumonia in this context.

**Methods:** We conducted a retrospective analysis of electronic data from ED visits to a tertiary care centre by children 12 years of age and under who were seen between June 1, 2001, and June 30, 2003, and who underwent both an abdominal and a chest radiograph during the same visit, or an abdominal x-ray at a first visit as well as a chest x-ray in the 10 days following the initial visit.

**Results:** Of 1584 visits studied, 30 cases of pneumonia were identified, for a prevalence of 1.89% (95% confidence interval 1.22%–1.56%). If chest radiography had been limited to children who presented with fever, cough and symptoms of an upper respiratory tract infection (URTI), the diagnosis of pneumonia would have been missed in only 2/1584 visits (0.13%).

**Conclusion:** Children aged 12 years and under presenting to the ED with acute abdominal pain and in whom an abdominal radiograph is requested need only undergo a chest radiograph in the presence of cough, fever or other symptoms of a URTI.

**Key words:** abdominal pain, children, emergency, pneumonia, chest x-ray

**RÉSUMÉ**

**Objectif :** La pneumonie est une cause bien connue de douleur abdominale aiguë chez les enfants. L'utilité de la radiographie pulmonaire dans ce contexte est toutefois controversée. Nous avons cherché à déterminer la prévalence de la pneumonie chez les enfants de moins de 12 ans qui souffraient de douleur abdominale et ont eu une radiographie abdominale à l'urgence. Nous voulions aussi décrire les signes et les symptômes des enfants chez lesquels on a diagnostiqué une pneumonie dans ce contexte.

**Méthodes :** Nous avons procédé à une analyse rétrospective des données électroniques tirées des visites effectuées à l'urgence d'un centre de soins tertiaires par des enfants de 12 ans et moins examinés entre le 1er juin 2001 et le 30 juin 2003 et qui ont eu une radiographie abdominale et pulmonaire au cours de la même visite, ou une radiographie abdominale au cours d'une première

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Received: Feb. 5, 2006; revisions received: Aug. 23, 2006; accepted: Oct. 15, 2006

*This article has been peer reviewed.*

*Can J Emerg Med 2007;9(5):347-51*

visite et une radiographie pulmonaire dans les 10 jours suivant la visite initiale.

**Résultats** : Sur les 1584 visites étudiées, on a repéré 30 cas de pneumonie, ce qui représente une prévalence de 1,89 % (intervalle de confiance à 95 %, 1,22 %–1,56 %). Si on avait limité la radiographie pulmonaire aux enfants qui avaient de la fièvre, toussaient et présentaient des symptômes d'infection des voies respiratoires supérieures (IVRS), on aurait raté le diagnostic de pneumonie dans seulement 2 cas sur 1584 (0,13 %).

**Conclusion** : Les enfants de 12 ans et moins qui se présentent à l'urgence avec une douleur abdominale aiguë et pour lesquels on demande une radiographie abdominale n'ont besoin que d'une radiographie pulmonaire s'ils toussent, ont de la fièvre ou présentent d'autres symptômes d'IVRS.

## Introduction

Pneumonia is a well-known cause of abdominal pain in children.<sup>1–8</sup> A review of the literature suggests that there is still disagreement about the necessity of performing a chest radiograph in children who present to the emergency department (ED) with abdominal pain. While some authors favour this approach,<sup>9–12</sup> others do not recommend that a chest radiograph be performed routinely.<sup>13–17</sup>

In November 2000, the Centre hospitalier universitaire de Sherbrooke (CHUS), Hôpital Fleurimont, instituted a policy concerning children 12 years of age or under presenting to the ED with abdominal pain. This policy mandated a chest radiograph with every abdominal series in order to rule out pneumonia in these children.

The objectives of this study were to determine the prevalence of pneumonia in children who presented to the ED with abdominal pain and who underwent abdominal radiography, and to describe the signs and symptoms found in those with positive chest x-rays.

## Methods

A retrospective analysis was carried out using the hospital's computerized database (Nucleus). The study targeted children 0 to 12 years of age who presented to the ED with a chief complaint of abdominal pain between June 1, 2001, and June 30, 2003, and who underwent a chest and abdominal radiograph at the time of the ED visit (group 1), or who underwent an isolated abdominal radiograph performed at the time of the ED visit and had a chest radiograph performed in the 10 days following the initial visit (group 2).

The final radiologist's report was reviewed by the main investigator in order to determine the number of cases of pneumonia. There was no review of x-rays by a second blinded radiologist at the time of the data collection. For each case of pneumonia, the following information was gathered: the age of the patient, the type of radiograph that established the diagnosis of pneumonia (abdominal or

chest), the location of the pneumonia, the patient's white blood cell and granulocyte count, the date of the visit and the encrypted medical record number.

Data were entered into distinct Excel files (Microsoft). The first file (group 1) consisted of patients who underwent chest and abdominal radiography at the initial visit ( $n = 1603$ ). The second (group 2) consisted of cases in which a chest radiograph was performed in the 10 days following the ED visit ( $n = 31$ ).

In cases where the radiologist's interpretation was not diagnostic (e.g., there was a presence of non-specific retrocardiac opacity that could represent atelectasis or the beginning of a pneumonia), the chart was reviewed to confirm or refute the possibility of pneumonia. This approach permitted the retrieval of clinical information, such as the presence and localization of abdominal pain, vital signs at triage, history of fever, presence of cough and symptoms of an upper respiratory tract infection (URTI) (i.e., rhinorrhea, nasal congestion, sore throat and otalgia). In total, 60 charts were reviewed. The findings were discussed and consensus was reached among researchers.

Fever at triage was defined as a temperature greater than 38.5°C rectally or 38°C orally. Normal white blood cell and granulocyte counts as a function of age were provided by the CHUS (Hôpital Fleurimont) in July 2003 for the purpose of defining abnormal values. Age-specific tachypnea was defined according to the reference range provided in the *Guide de l'examen clinique*.<sup>18</sup>

There were no statistical analyses performed in this study.

## Ethical considerations

This study was approved by the director of professional services at the CHUS in the context of a quality improvement project.

## Results

In group 1, we identified 1401 children aged 0 to 12 years, who made 1603 visits to the ED between June 1, 2001,

and June 30, 2003, and underwent both an abdominal and a chest x-ray during the same visit. Nineteen visits were excluded because of missing radiographic reports. Ten additional cases were excluded without chart review because they represented nosocomial pneumonias or because they were already being treated for pneumonia at the time of presentation. Three additional cases were excluded after record review; 2 because they were already being treated for pneumonia, and the other because there was no documentation of abdominal pain in the physician's notes.

In group 2, 31 children underwent abdominal radiography at the time of the ED visit, followed by chest x-rays in the 10 days following the initial visit. Two charts were excluded from this group because the radiographic reports were missing. A single case of pneumonia was identified among the 29 remaining charts. This case was excluded because it involved the transfer from another institution of a patient who had undergone x-rays at the referring hospital. An overview of the study methods is represented in Table 1. All of these exclusions were based on criteria established a priori as part of the study protocol.

Of the 1584 visits analyzed in group 1, 30 cases of pneumonia were identified, providing a prevalence of 1.89% (95% confidence interval [CI] 1.22%–1.56%). Four of these radiographically-diagnosed cases of pneumonia were

initially missed by the emergency physician. Table 2 provides descriptions of the patient characteristics, signs and symptoms of the 30 children with pneumonia.

The prevalence of URTI symptoms (i.e., cough, fever, tachypnea, low oxygen saturation, and WBC and granulocyte counts) were abstracted for the 30 children with pneumonia in group 1 (Table 3). Fever was the sign most closely associated with pneumonia and was present in 83% of the cases.

Missing data for each sign and symptom were considered negative, and prevalence was calculated by dividing the number of cases demonstrating those signs and symptoms by 30 and then converting this value into a percentage. This strategy was employed to minimize the impact of these indicators.

Clinical characteristics noted in this study and listed in decreasing order of prevalence are fever, URTI symptoms and cough. If a chest x-ray, in addition to an abdominal x-ray, had been restricted to those children with either fever or cough, or URTI symptoms, only 2 of 1584 visits (0.13%) with a final diagnosis of pneumonia would have been missed.

## Discussion

The prevalence of pneumonia reported in this study is 1.89% (95% CI 1.22–1.56%) and corresponds to what is reported in the literature. Sims and Alexander<sup>19</sup> reported a prevalence of 2%; Jones<sup>20</sup> noted 2.2%; and Ravichandran and Burge<sup>15</sup> found 1.6%. Given the low prevalence of pneumonia in children with abdominal pain, we suggest, as do Hayes,<sup>13</sup> Spencer,<sup>14</sup> and Ravichandran and Burge,<sup>15</sup> that routine chest x-rays in those children presenting with isolated abdominal pain are unnecessary.

Three less recent studies recommend that all children with abdominal pain undergo chest radiography.<sup>9–11</sup> Two of these studies reported a higher prevalence of pneumonia in their setting (4.8% and 4.2%).<sup>10,11</sup> The third study does not report prevalence nor does it report the age of the children in the study.<sup>9</sup>

Neither Spencer<sup>14</sup> nor Vendargon and colleagues<sup>16</sup> support the notion of obtaining chest x-rays in children with acute abdominal pain, although their view is supported only by case reports. Ravichandran and Burge<sup>15</sup> are of the same view, but failed to identify a gold standard for diagnosis in their work. Our study refutes the need for routine chest x-ray, thereby strengthening the position in the existing literature and providing a more recent perspective on this subject.

Certain study limitations warrant discussion. As in any

**Table 1. Incidence of pneumonia in children aged 12 years and under who underwent an abdominal radiograph in the emergency department\***

Variable	No. of patients†	
	Group 1	Group 2
Radiography, no. of cases‡	1603	31
Exclusions§	19	2
Total	1584	29
Radiographic interpretations		
Pneumonia	43	1
Exclusions without chart review¶	10	0
Total	33	1
Additional exclusions after chart review	3**	1††
Total	30	0

ED = emergency department.

\*Groups 1 and 2 include all children aged 0 to 12 years with abdominal pain who were seen in the ED during the study period and who underwent radiographic examination.

†Unless otherwise indicated.

‡1603 patients in group 1 underwent abdominal and chest radiography at the index visit; 31 patients in group 2 underwent abdominal radiography at the initial visit and pulmonary radiography in the 10 subsequent days.

§Missing radiology reports.

¶Patients had nosocomial pneumonia and were hospitalized or already being treated for pneumonia on presentation to the ED.

\*\*2 patients were excluded because they had nosocomial pneumonia and were hospitalized or already being treated for pneumonia on presentation to the ED; the other patient was excluded because of the absence of abdominal pain, as noted in the chart.

††Radiographs were obtained from another hospital.

retrospective study, chart data will be incomplete. It is possible that in some cases, the policy was not well applied and that a small number of children with abdominal pain had abdominal radiography without a chest

x-ray. Furthermore, this study was completed in a single centre, thus limiting external validity. A prospective trial in multiple hospitals would permit confirmation of these results.

**Table 2. Characteristics, signs and symptoms among the 30 cases of pneumonia in group 1**

Characteristics, signs or symptoms	No. of patients*	Characteristics, signs or symptoms	No. of patients*
Sex		Cough	
Male	20	Presence	20
Female	10	Absence	1
Age		Information not documented	9
Mean	4.7 yr	URTI symptoms (rhinorrhea, congestion, sore throat or otalgia)	
Range	9 mo–12 yr	Presence of symptoms	23
Diagnosis of pneumonia		Absence of symptoms	2
Visible on chest radiograph only	28	Information about symptoms not documented	5
Also visible on abdominal radiograph	2	Fever (> 38.5°C rectal or > 38°C orally) as per history or documented in triage	
Lobar involvement		Presence	25
Left lower lobe	13	Absence	5
Left middle lobe	4	Oxygen saturation	
Right lower lobe	4	< 95%	6
Other	9	> 95%	17
Abdominal pain		Not documented	7
Present as per chart	29	Respiratory rate‡	
No abdominal pain documented†	1	Increased for age	5
Location of abdominal pain		Normal for age	11
Diffuse	7	Not documented	14
Periumbilical	5	WBC count and granulocytes§	
Right lower quadrant	4	Abnormal WBC and granulocyte count	6
Other	6	Normal WBC and abnormal granulocyte count	7
Location not documented	8	Normal WBC and granulocyte count	8
		No values available	9

URTI = upper respiratory tract infection; WBC = white blood cell.

\*Unless otherwise indicated.

†This patient was 1 year old.

‡Normal values taken from the *Guide de l'examen clinique*.<sup>15</sup>

§Normal values for WBC and granulocyte count from the hematology lab at the Centre hospitalier universitaire de Sherbrooke (Hôpital Fleurimont) in July of 2003.

**Table 3. Prevalence of signs and symptoms among the 30 cases of pneumonia in group 1**

Sign or symptom	Available data from group 1 (n = 30)	No. of children presenting with sign or symptom	Prevalence of sign or symptom
Cough	21	20	67%
URTI	25	23	77%
Fever	30	25	83%
Tachypnea	16	5	17%
Decreased saturation	23	6	20%
Increased WBC and/or granulocyte count	21	12	40%
URTI or cough	26	26	87%
URTI or fever	30	27	90%
Cough or fever	30	28	93%
URTI or cough or fever	30	28	93%

URTI = upper respiratory tract infection; WBC = white blood cell.

## Conclusion

In this study, the prevalence of pneumonia among children aged 0 to 12 years presenting to the ED of a tertiary care centre and having undergone abdominal radiography related to a chief complaint of abdominal pain between June 1, 2001, and June 30, 2003, was 1.89% (95% CI 1.22–1.56%). Fever was the sign most closely associated with pneumonia and was present in 83% of the cases. Children of this age who present to the ED with isolated abdominal pain need not be subjected to a chest x-ray in addition to abdominal radiography in a systematic manner. Instead, the chest x-ray may only be required if the child also shows evidence of cough, fever or a URTI.

**Acknowledgements:** We wish to acknowledge Hassan Diab, PhD, Chief Administrator, Decision Support System, Centre de recherche clinique du CHUS for his important contributions to the fruition of this research project.

**Competing interests:** None declared.

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