

Incidence of Hospitalization Due to Pneumonia in Children Aged Less than 3 Years

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Abstract: *Background:* The aim of this study was to determine the hospitalization rate due to pneumonia in preschool children in our region and to compare the rate found with those reported in the literature.

Methods: We performed a prospective study between October 2004 and September 2006 in patients aged less than 3 years old in San Sebastian (Spain) and the surrounding region. All children admitted to hospital for radiologically-confirmed pneumonia (presence of lobar or segmental alveolar infiltrate, interstitial infiltrate and/or pleural effusion) were included.

Results: There were 116 episodes requiring hospitalization, representing an incidence of 6.4 cases/1000 inhabitants (6.2 in infants aged less than 1 year and 6.6 in children aged 12-35 months). Admission to the intensive care unit was required in 10.3% (12/116). Alveolar infiltrate was found on chest radiograph in 62.1% (72/116), ranging from 51.4% (19/37) in infants aged less than 1 year and 69.6% (32/46) in children aged 24 months or more. Mortality at 30 days of admission was nil.

Conclusion: The incidence of hospitalization due to community-acquired pneumonia in infants and children, as well as that of pneumonia with alveolar infiltrate, was high in our region. Evaluation of the potential utility of the new pneumococcal conjugate vaccine and the influenza vaccine for children should also take into account their effectiveness in preventing pneumonia in this age group.

Keywords: Childhood pneumonia, pneumonia with consolidation, hospitalization, pneumococcal vaccine, influenza vaccine.

INTRODUCTION

Community-acquired pneumonia (CAP) in childhood is one of the most important pediatric health problems and is the leading single cause of childhood mortality worldwide [1]. In developed countries, mortality from childhood CAP has decreased in the last few-decades, but this disease continues to be a common cause of morbidity and hospitalization [2]. However, currently available data on the incidence of CAP in specific pediatric age groups and the hospitalization rate are scarce, both in Spain and elsewhere.

A conjugate vaccine against *Streptococcus pneumoniae*, the leading cause of childhood pneumonia [2], became available at the beginning of the current decade and new prototypes with a larger number of serotypes are being developed [3]. In Spain, this vaccine was licensed at the end of 2001, and coverage in recent years has been estimated as being 50% of the target population [4]. Moreover, some countries have included vaccination against influenza, another major cause of childhood CAP [5], in the pediatric population [6],

and its use will probably increase in the next few years. Therefore, data on the incidence of childhood CAP causing hospitalization is required to serve as a reference for subsequent interventions or evaluation of the preventive measures adopted. The present population-based study aimed to determine the incidence of hospitalizations due to CAP in infants and children aged less than 3 years old over a 2-year period.

MATERIALS AND METHODOLOGY

This prospective study was performed in San Sebastián and the surrounding counties, with a population of 316,254 inhabitants, of which 9,014 were aged less than 3 years old. Hospital Donostia forms part of the public health system of this region and attends approximately 97% of pediatric hospitalizations. Between October 2004 and September 2006, all infants and children aged between 1 and 35 months who were hospitalized for pneumonia (diagnosed in the Emergency Department or admission ward) and born within the study area were included. All patients had fever (temperature >38°C) and/or clinical signs suggesting pneumonia (dyspnea, tachypnea, auscultatory alterations), as well as a radiological diagnosis of pneumonia. All chest radiographs were evaluated by an experienced radiologist, and the presence of al-

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veolar infiltrate (lobar or segmental), interstitial infiltrate and/or pleural effusion was considered significant [7]. Consequently, patients who were diagnosed with bronchopneumonia only were not included, due to the difficulty of separating this entity from bronchitis without pneumonia. Equally, patients with presumed nosocomial pneumonia (hospital discharge within the previous 2 weeks or onset of pneumonia more than 48 hours after admission) were also excluded. Readmissions were considered as distinct episodes if separated by an interval of at least 2 months. To estimate the mean annual incidence of hospitalization, the total number of children aged less than 3 years old living in the same geographical area was used as the denominator (Basque Institute of Statistics, data for 2006).

RESULTS

During the 2-year period, 348 episodes of childhood CAP occurring in the study area were diagnosed. A total of 116 episodes (113 children, 64 episodes in boys) required hospital admission (33.3%), the mean annual incidence of hospitalization due to childhood CAP in children aged 1-36 months being 6.4 cases/1000 inhabitants (Table 1). Of these, 37 episodes occurred in infants aged less than 12 months, 33 in children aged 12-23 months, and 46 in children aged 24-35 months. The mean annual incidence of hospitalization for the three age groups was 6.2, 5.5 and 7.6 cases/1000 inhabitants, respectively. Twelve episodes (in 12 children) required admission to the pediatric intensive care unit (PICU), representing 10.3% of hospitalizations due to childhood CAP. The incidence of PICU admission was 0.4 cases/1000 inhabitants in the first 3 years of life. Among hospitalized children, there were 72 (62.1%) episodes of pneumonia with lobar or segmental consolidation in the chest radiograph: 19 (51.4%) in infants aged less than 1 year, 21 (63.6%) in children aged 12-23 months and 32 (69.6%) in those aged 24 months or more, representing an incidence of 3.2, 3.5 and 5.3 cases/1000 inhabitants, respectively. Pleural effusion occurred in eight children (6.7%). Mortality at 30 days of admission was nil.

DISCUSSION

In Europe, the impact of pneumonia is high with 2.5 million cases per year [2]. In the USA, lower respiratory tract infections, mainly pneumonia and bronchiolitis, have been estimated to cause 19-27% of hospitalizations in children

younger than 5 years [8, 9]. Nevertheless, the incidence of childhood hospitalizations due to pneumonia in relation to age is largely unknown [10], partly because pneumonia is not a notifiable disease and also because few studies have investigated this topic. The present study found that in our region the incidence of severe childhood pneumonia requiring hospitalization was high, being 6.2 and 6.6 cases/1000 inhabitants in infants aged less than 1 year and children aged 12-35 months, respectively.

We have no specific data on the etiology of most of the cases included in this study. However, pneumococcal pneumonia and influenza were frequently observed among children with lower respiratory tract infections in our region. Pneumonia with bacteremia was the most common manifestation of invasive pneumococcal diseases (IPD) in children aged <5 years in our region (48.4% of 91 IPD detected between 1996 and 2007) [11] and the incidence of hospitalization for virologically-confirmed influenza virus infection in children aged < 5 years in our region in 2001 and 2004 was 9/10,000 inhabitants [12]. In Spain, neither the 7-valent pneumococcal conjugate vaccine (PCV7) nor the influenza vaccine is included in the official childhood immunization schedule, as funding is available only for children in risk groups. Nevertheless, for healthy children, the PCV7 could be obtained from pharmacy shops, with an estimated coverage of 50% of the target population [4].

The present 2-year study was performed prospectively and used widely accepted radiological criteria [7]. Comparison of the results with those of other studies is not easy, mainly because the methodology of other studies has varied and few have been prospective (Table 2). Among studies performed in the last 15 years, the results obtained in developed countries have differed, partly due to differences in the nosological classification of acute respiratory infection of the lower airways, especially in infants [13]. In infants aged less than 1 year, other studies performed in Europe [13-15] reported rates that were similar to or lower than those found in the present study, although two North American studies [8, 9] reported higher rates of pneumonia. In the latter, the definition of a case of pneumonia was less strict than in the present study and included cases of bronchopneumonia. In addition, other reasons, such as the childhood vaccination programs carried out in some countries and the distinct criteria used for hospital admission, could have contributed to the variations in the incidence rates observed, even in neighbor-

Table 1. Incidence of Childhood Community-Acquired Pneumonia in the First 3 Years of Life. Incidence of Pneumonia with Alveolar Infiltrate (Lobar or Segmental) and Cases Hospitalized in the Pediatric Intensive Care Unit (PICU)

Age	Total no. Attended ⁽¹⁾	Hospitalized/ Total Diagnosed N° (Percentage)	Hospitalizations			
			Rate/ 1000 Inhabitants	Alveolar Infiltrate (Consolidation) N° (Percentage)	Rate of Pneumonia with Consolidation /1000 Inhabitants	Hospitalized in the PICU N° (Percentage)
<12m	62	37 (59.7)	6.2	19 (51.4)	3.2	5 (13.5)
12-23m	110	33 (30.0)	5.5	21 (63.6)	3.5	2 (6.1)
24-35m	176	46 (26.1)	7.6	32 (69.6)	5.3	5 (10.9)
Overall	348	116 (33.3) ⁽²⁾	6.4	72 (62.1) ⁽³⁾	4.0	12 (10.3)

¹Total number of cases of community-acquired pneumonia attended in the hospital (whether finally admitted or not).

²Chi squared test of linear tendency = 18.807; p<0.001.

³Chi squared test of linear tendency = 2.812; p=0.093.

Table 2. Studies Providing Data on the Incidence of Hospitalization Due to Childhood Community-Acquired Pneumonia, Performed Since 1995 or Including Subsequent Years and Cited in the Present Study

Reference	Geographical Area and Year	Prospective	Particular Features	Chest Radiograph as Criterion	Age Groups	Cases of Pneumonia/ /1000 Inhabitants
1.- National, Population-Based Studies, Based on Hospital Registries (Clinical Diagnostic Codes of the International Classification of Diseases [ICD-9 or ICD-10])						
Björ O <i>et al.</i> [15]	Sweden 1987-2000	No	Age < 9 years	Not specified	<1 year >1 year	5-7 (year 2000) ⁽¹⁾ not specified
Gil A <i>et al.</i> [18]	Spain 1995-1998	No	Pediatric and adult population	Not specified	0-4 years 5-9 years	4.2 1.1
Peck AJ <i>et al.</i> [9]	USA 1999-2001	No	Age < 5 years	Not specified	<1 year 1-4 years	20.8 8.0
Roxburgh CSD <i>et al.</i> [14]	Scotland 1981-2005	No	Age < 15 years	Not specified	<1 year 1-4 years	2.8-3.5 ⁽¹⁾ 2-2.8 ⁽¹⁾ data 2000-2005
2.- Hospital-Based Studies Performed in More Limited Geographical Areas						
Clark JE <i>et al.</i> [17]	England (North East), August 2001-July 2002	Yes	Age < 16 years	Yes	0-4 years	3.2
Henrickson KJ <i>et al.</i> [8]	Milwaukee, USA November 1996-October 1998	No	Based on ICD-9 codes. Age <18 years	Not specified	<1 year <5 years	11.3 6.6
Weigl JA <i>et al.</i> [13]	Kiel (Germany) 1996-2000	Yes	Cross-sectional study in children aged <16 years	Yes (96%)	<1 year 1-<2 years 2-<5 years	11.1 (4.7) ⁽²⁾ 7.3 (2.3) ⁽²⁾ 5.1 (2.0) ⁽²⁾
Garcés-Sánchez <i>et al.</i> [19]	Valencia (Spain) 1995-2001	No	Retrospective pediatric cohort	Yes (93%)	0-4	7.0
Giménez F <i>et al.</i> [20]	South of Spain 2003	Yes	Age <6 years	No	0-5	5.6
Cilla G <i>et al.</i> (present study)	Gipuzkoa (Spain) October 2004-September 2006	Yes	Age <3 years	Yes	< 1 year 1-< 2 years 2-< 3 years	6.2 5.5 7.6

¹Datum estimated on the basis of figures.

²Data referring to the total number of cases of pneumonia (between brackets excluding bronchopneumonia and central pneumonia).

ing and demographically similar regions [16, 17]. Despite these limitations, the results obtained in 1-4-year-olds are fairly homogeneous across the distinct studies (Table 2).

It is often believed that cases with radiological consolidation (alveolar infiltrate) include most cases of bacterial pneumonia [21], and this criterion is recommended by the World Health Organization for diagnosis [22], despite its limited sensitivity [23] and the lack of high quality studies to support its utility. Assuming that most cases of pneumonia with consolidation involve *Streptococcus pneumoniae*, whether originally of pneumococcal, mixed with viral, or complicated viral origin, vaccination against this pneumococcal infection could reduce the incidence of this type of pneumonia. Therefore, we included this radiological criterion (consolidation) when analyzing our results to be better able to estimate the future influence of the pneumococcal conjugate vaccine on the incidence of pneumococcal pneumonia. In our study, 60-70% of cases occurring in children aged more than 1 year old showed radiological consolidation and were therefore compatible with bacterial pneumonia, a

result similar to that found in another study recently performed in Spain [19].

In conclusion, the incidence of both childhood CAP in general and of pneumonia with radiological consolidation in our region is high. The incidence rates found should be considered as minimal, although they are probably not far from reality. The data obtained may help in decision making in prevention policies and particularly in evaluation of the potential utility of new pneumococcal and influenza vaccines for children.

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