Clinical characteristics and incidence of bacterial and viral pathogens in patients hospitalized with community acquired pneumonia in childhood in Konya between October 2008 and February 2010

Konya'da Ekim 2008 - Şubat 2010 tarihleri arasındaki çocukluk çağında toplum kökenli pnömoni tanısı ile hastaneye yatırılan hastalarda bakteriyel ve viral etkenlerin insidansı ve klinik özellikleri

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ABSTRACT

Objective: It was aimed to investigate clinical characteristics and incidence of bacterial and viral pathogens in patients who were hospitalized with the clinical diagnosis of community acquired pneumonia (CAP).

Method: In this study 91 patients at the ages between one month and six years who required hospitalization and were admitted to pediatrics clinics and pediatric emergency services of the Selçuk University Meram Medical Faculty, and also who did not use antibiotics for 48 hours before hospital admission and had the clinical diagnosis of CAP were investigated from October 2008 to February 2010. Demographic and clinic characteristics of the patients were recorded. Blood samples for complete blood count, erytrocyte sedimentation rate, C-reactive protein, procalcitonin, blood culture and nasopharyngeal aspirate samples for detection of the viral etiologies by real time polymerase chain reaction (RT-PCR) were taken at the time of hospital admission. Initial posteroanterior (PA) chest X-rays of all patients were checked.

Results: The agents of pneumonia were detected in 24.2% (22/91) but not in 75.8% (69/91) of our patients. Of 91 patients, 11 (12.1%) were positive for viral infections, 9 (9.9%) were positive for only bacterial infections, 3 (3.3%) had viral coenfection, 2 (2.2%) were positive for both viral and bacterial infections. Out of 11 viral positive patients, 7, 2, 1, 2, and 1 patients

ÖZET

Amaç: Bu çalışmada; toplum kökenli pnömoni tanısı (TKP) ile hastaneye yatırılan hastalarda bakteriyel ve viral etkenlerin insidansı ve klinik özellikleri araştırılması amaçlanmıştır.

Yöntem: 1 Ekim 2008-28 Şubat 2010 tarihleri arasında Selçuk Üniversitesi Meram Tıp Fakültesi Çocuk Poliklinikleri ve Çocuk Acil Servisine başvuran ve yatırılarak tedavi edilmesi gereken, başvurudan 48 saat öncesine kadar antibiyotik kullanmayan, klinik olarak TKP tanısı olan, yaşları 1 ay ile 16 yaş arasındaki toplam 91 hasta çalışma kapsamına alındı. Bu hastaların demografik ve klinik özellikleri kaydedildi. Hastane başvurusu esnasında tam kan sayımı, eritrosit sedimantasyon hızı, C-reaktif protein, prokalsitonin, kan kültürü için kan numuneleri ve viral etiyolojiyi gerçek zamanlı polimeraz zincir reaksiyonu (RT-PCR) ile saptamak amacıyla nazofaringeal aspirat numuneleri alındı. Tüm hastaların PA akciğer radyografileri kontrol edildi.

Bulgular: Hastaların %24,2 (22/91)'sinde pnömoni etkeni saptanırken, %75,8 (69/91)'inde herhangi bir pnömoni etkeni saptanamadı. 91 hastanın 11 (%12,1)'inde viral enfeksiyon, dokuzunda (%9,9) sadece bakteriyel enfeksiyon, üçünde (%3.3) viral koenfeksiyon, ikisinde (%2,2) hem virus hem de bakteri vardı. Virus tespit edilen 11 hastanın yedisinde Parainfluenza (PIV) 2, ikisinde PIV 3, birinde adenovirus, ikisinde hem PIV3 hem

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were detected to have parainfluenza virus (PIV) 2, PIV 3, adenovirus, both PIV 3 and adenovirus, both PIV 2 and PIV 3, respectively. RSV, PIV 1 and human metapneumovirus (hMPV) were not detected in any of cases. Out of 11 bacteria positive patients, 5, 2, 1, 1, 1, and 1 patients were detected to have S*taphylococcus epidermidis*, *S. saprophyticus*, *S. hominis*, *S. capitis*, *S. sobrinus* and *S. mitis*. Also mixed viral-bacterial agent presence were detected in 2 (2.2%) of our patients. Out of ninety one pneumonia patients those having their diagnosis clinically, 59 (64.7%) had radiological signs.

Conclusion: Our study demonstrated the etiological influence of viral agents in CAP. Parainfluenza virus 2 was the most common viral agent among detected viruses in all age groups. Improving the etiological diagnosis of viral infections may avoid unnecessary the use of antibiotic. Further comprehensive and randomized controlled studies are needed to confirm our results.

Key Words: Childhood, etiology, community acquired pneumonia, real time-PCR

adenovirus, birinde hem PIV2 hem de PIV3 tespit edildi. Hastaların hiçbirinde RSV, PIV1, hMPV saptanmadı. Bakteri tespit edilen 11 hastanın beşinde *Stafilokokus epidermidis*, ikisinde *S. saprophyticus*, birinde *S. shominis*, birinde *S. capitis*, birinde *S. sobrinus* ve birinde *S. mitis* tespit edildi. Hastaların ikisinde de viral-bakteriyel karma etken olduğu saptandı. Klinik olarak pnömoni tanısı alan 91 hastanın 59 (%64,7)'unda radyolojik olarak pnömoni varlığı belirlendi.

Sonuç: Çalışmamız TKP'de viral etkenlerin etiyolojik etkisini gösterdi. Parainfluenza virus 2 tüm yaş gruplarında en sık tespit edilen viral etkendi. Viral enfeksiyonların etiyolojik tanılarının iyileştirilmesi ile gereksiz antibiyotik kullanımından kaçınılabilir. Sonuçlarımızı doğrulamak için daha kapsamlı ve randomize kontrollü çalışmalara gereksinim vardır.

Anahtar Kelimeler: Çocukluk çağı, etiyoloji, toplum kökenli pnömoni, gerçek zamanlı PZR

INTRODUCTION

Childhood community-acquired pneumonia (CAP) remains a leading cause of morbidity and mortality worldwide. The aetiological agents, patient age, clinical manifestations and seasonal occurrence of childhood CAP vary between countries. Rational antibiotic treatment requires knowledge of the most likely pathogens in each geographical region (1). Recent estimates from the World Health Organization (WHO) suggest that pneumonia is responsible for 20% of deaths in <5 years of age group, leading to 3 million deaths per year. Of these deaths, two thirds occur during infancy and more than 90% occur in the developing countries (2). There have been relatively few comprehensive studies of the viral and bacterial etiology of CAP in children. Identifying the cause of CAP in children is difficult for several reasons. The procedures used to confirm the pathogen, such as bronchoalveolar lavage and lung puncture for bacterial culture, are too invasive. The positive rate for blood cultures in pneumonia is only 0 to 5% in cases in developed countries (3-6).

Viral pathogens are gradually recognized as playing a major role in the etiology of lower respiratory tract infections (LRTIs), and are considered the predominant pathogens in CAP in preschool children (7). As these respiratory viral pathogens cause very similar clinical symptoms, differential diagnosis of the pathogens is required in appropriate sample. Monospecific PCR assays require separate amplification of each target and are therefore expensive and resource intensive. For clinical diagnosis, multiplex PCR has a significant advantage, as it permits simultaneous amplification of several viruses in a single reaction mixture, facilitating cost-effective diagnosis (8). Real-time PCR method was found to be more sensitive than cell culture on a range of different respiratory samples.

The specificity of the real-time PCR was reported to be as high as 93% and the sensitivity as 100% (9). Thus, in our study we used multiplex real-time PCR method for diagnosis and differentiation of different viral agents.

Comprehensive information on the etiology of CAP is required for the formulation of treatment recommendations and the introduction of preventive measures. Evaluation of mixed infections and the relative importance of each potential pathogen may also contribute to improved understanding of the etiopathogenesis of CAP (10).

We aimed to investigate clinical characteristics and incidence of bacterial and viral pathogens in children aged one month to 16 years who were hospitalized for CAP.

MATERIAL AND METHODS

Study design

The study was a 17-months study. We evaluated to investigate clinical characteristics and incidence of bacterial and viral pathogens among children who were diagnosed and hospitalized for CAP. Patients aged one month to 16 years old diagnosed as CAP by inclusion criteria were recruited into the study. The study was approved by the local ethics committee, and written informed consent was obtained from parents of all patients. A patient was enrolled in the study if she/he met the following criteria (11). Fever with body temperature >37.8 ºC, respiratory rate more than average per age by WHO criteria, abnormal chest x-ray together with signs of respiratory distress. Children were excluded if they were currently on antibiotic therapy or were admitted to hospital for more than 48 hours. Upon enrolment, demographic characteristics and baseline clinical data were recorded. Pulmonary auscultation findings of each patient were recorded with detailed physical examination.

Study population

From October 2008 to February 2010, 91 children aged one month to 16 years (44 girls and 47 boys, median age: 11 months) who were diagnosed as CAP and were hospitalized at department of pediatrics, Selcuk University Hospital, Konya, Turkey were included in the study.

Radiology

A senior radiologist, unaware of clinical and laboratory findings, reviewed all chest radiographs. Chest x-rays were interpreted and recorded radiological findings such as normal chest radiography, consolidation, interstitial infiltration, peribronchitis, hiler/mediastinal lymphadenopathy, atelectasis, air broncogram, pleural effusion, and hyperinflation by the radiologist.

Microbiology

A nasopharyngeal sample was aspirated through a nostril and kept under -80°C until virologic tests (n =91) were done. Existence and genotyping of viruses (PIV type 1, 2 and 3, respiratory syncytial virus (RSV), adenovirus and human metapneumovirus) causing viral CAP were investigated with RT-PCR. Viral DNA isolation of a nasopharyngeal sample was made by using High Pure PCR Template Preparation (Cat.No. 11 796 828 001, Roche Diagnostic, Germany). RT-PCR device (LightCycler®, Roche Diagnostic, Germany) was used for detection of pathogens. The virologic studies were carried out at the Department of Microbiology, Selcuk University Hospital, Konya.

Serum procalcitonin (PCT) levels were measured with BRAHMS PCT reactive (BRAHMS- Diagnostica, Berlin/ Germany). Assays were performed with Lumat LB 9501 immünoassay device (Roche Diagnostics GmbH, Mannheim, Germany) by using immünoluminometric method.

Serum C-reactive protein (CRP) levels were measured using Nephelometer 100 Device (Dade Behring Marburg, Germany).

Erythrocyte sedimentation rate (ESR) measurements were performed by using fully automated ESR assay device (Diesse Ves Cube 200, Diesse Diagnostica Senese SpA, Italy).

Complete blood count (CBC) assays were performed with fully automated CBC device (Cell-Dyne 3700, Abbott Diagnostics Division, Abbott Laboratories, Abbott Park IL, USA).

Blood cultures were obtained via BD Bactec Peds Plus/F vials before initiation of parenteral antibiotic therapy among all patients and incubated in automated blood culture system (Bactec 9240 BD, Becton Dickinson and Company, Sparks MD, USA). Isolated strains were also identified by using automated bacteria identification system (VITEK 2, Biomerieux, Marcy l'Etoile, France).

Statistical analysis

Data were reported as mean ± SD, minimum-maximum (range) or percent. After testing for normality with a one sample Kolmogorov-Smirnov test, differences in the means of variables were evaluated using both parametric (Student's t-test) and nonparametric tests (Mann-Whitney U-test) depending on the distribution of the variables. Categorical data were analysed with the chi-square test or Fischer's exact test. Results were considered significant if $p<0.05$. Statistical analyses were performed with the Statistical Package for Social Science program (SPSS version 15.0 for Windows; Chicago, IL).

RESULTS

The demographic and clinical features of the patients with CAP were shown in Table 1. The study included 47 (51.6%) boys and 44 (48.4%) girls. The median age of the patients was 11 months, ranging from 1 to 192 months. Nasal congestion and rhonchi were significantly frequent than in patients with viral infection when compared to those with bacterial pneumonia ($p=0.049$, $p=0.028$). The agents of pneumonia were detected in 24.2 % (22/91) with nasopharyngeal aspirate and blood culture but not in 75.8 % (69/91) of our patients. Of 91 patients, 11 (12.1%) were positive for viral infections, 9 (9.9%) were positive for only bacterial infections, 3 (3.3%) had viral coinfection, 2 (2.2%) were positive for both viral and bacterial infections. Out of 11 viral positive patients, 7, 2, 1, 2, and 1 patients were detected to have parainfluenza virus (PIV) 2, PIV 3, adenovirus, both PIV 3 and adenovirus, both PIV 2 and PIV 3, respectively. RSV, PIV 1 and human metapneumovirus virus were not detected in any of cases. Out of 11 bacteria positive patients, 5, 2, 1, 1, 1, and 1 patients were detected to have *Staphylococcus epidermidis*, *Staphylococcus saprophyticus*, *Staphylococcus hominis*, *Staphylococcus capitis*, *Streptococcus sobrinus* and *Streptococcus mitis*. Also mixed viral-bacterial agent presence were detected in 2 (2.2%) of our patients. Table 2 shows viral and bacterial agents causing CAP in hospitalized children.

The mean body temperature on admission was 37.9 ±1.05 ^{o}C. Considering the pulmonary auscultation findings of the patients, crackles, rhonchi and wheezing were found in 85 (93.4%), 54(59.3%) and 38 (41.8%) children, respectively. The median leukocyte count, CRP, PCT and ESR values were 9000/mm^3, 10.7 mg/L, 0.13 ng/mL, 13 mm/h, respectively.

The distributions of etiologic agents of community-acquired pneumonia according to different age groups were shown in Table 3. PIV-2 had the highest rate among detected viruses in all age groups. Adenovirus was detected only in one patient in 2-11 months of age group. Parainfluenza 3 were found in <2 and 2-11 months of age group. PIV-2 was the most common viral agent among <2 and 2-11 months of age group. Positive blood culture was detected the higher in <2 months of age group than those in other groups.

There was no statistically significant difference between viral and bacterial pneumonia groups with regard to ESR values ($p=0.669$). Also, there was no statistically significant difference between viral and bacterial pneumonia groups with regard to PCT values ($p=0.993$). The radiological findings of patients with CAP were shown in Table 4. Chest x ray showed notable alveolar

Table 1. The demographic and clinical features of the patients with CAP

Demographic features	
Gender	
Boy	47 (51.6) †
Girl	44 (48.4)
Age (Month)	
Median (Range)	11 (1-192)
Residential area	
Urban	70 (76.9)
Rural	21 (23.1)
Underlying diseases	14 (15.4)
Vaccination	
Appropriate according to age	91 (100)
At least one time hospitalising for lower respiratory tract infection	18 (19.8)
Antibiotic therapy in the last month	51 (56)
Age of mother (Year)	
Mean	28.4 ±5.6
Median (Range)	28 (18-47)
Age of father (Year)	
Mean	31.5± 5.6
Median (Range)	31 (22-49)
Family history of atopy	11 (12.1)
Upper respiratory tract infection in family during the last month	61 (67)
Environment related to smoking	39 (42.9)
Clinical presentation	
Fever	90 (98.9)
Cough	90 (98.9)
Wheezing	71 (78)
İrritability	65 (71.4)
Poor feeding	61 (67)
Dyspnea	58 (63.7)
Vomiting	44 (48.4)
Cyanosis	34 (37.4)
Rhinorrhoea	30 (33)
Nasal congestion	24 (26.4)
Productive cough	23 (25.3)
Headache	13 (14.3)
Sore throat	13 (14.3)
Chest pain	11 (12.1)
Abdominal pain	11 (12.1)
Findings of physical examination	
Body temperature (°C)	
Median (Range)	38 (36.2-40)
Mean	37.9 ± 1.05
Crackles	85 (93.4)
Tachypnea	62 (68.1)
Rhonchi	54 (59.3)
Cyanosis	40 (44)
Tachycardia	39 (42.9)
Nasal flaring	39 (42.9)
Wheezing	38 (41.8)
Chest retraction	36 (39.6)
Underweight (<% 3)	13 (14.3)
Short stature (<% 3)	7 (7.7)

†: n (%), Data are shown as mean ±standard deviation, median (range) or percent

Table 2. The laboratory and microbiological features of the patients with CAP

Leukocyte count (/mm³)	
Median (Range)	9000 (2100-37600)
CRP (mg/L)	
Median (Range)	10.7 (1.3-106.7)
Procalcitonin (ng/ml)	
Median (Range)	0.13 (0.02-75.3)
ESR (mm/h)	
Median (Range)	13 (2-80)
RSV	-
PIV 1	-
PIV 2	7 (7.7) †
PIV 3	2 (2.2) †
Adenovirus	1 (1.1) †
hMPV	-
Viral coinfection	
PIV3+adenovirus	2 (2.2) †
PIV2+PIV3	1 (1.1) †
Positive blood culture	11 (12.1)†
Staphylococcus hominis	1 (1.1) †
Staphylococcus epidermidis	5 (5.4) †
Staphylococcus saprophyticus	2 (2.2) †
Staphylococcus capitis	1 (1.1) †
Streptococcus sobrinus	1 (1.1) †
Streptococcus mitis	1 (1.1) †

†: n (%), Data are shown as median (range) or percent

Table 3. The distributions of etiologic agents of community-acquired pneumonia according to age groups

Age (Month)	Number of patients (%)			Total
Etiology	Virus	Positive blood culture	Unknown etiologic agent	
<2	2 (12.5)	4 (25.1)	10 (62.5)	**16 (17.6)**
2-11	6 (19.4)	4 (12.9)	21 (67.7)	**31 (34.1)**
12-23	1 (6.7)	1 (6.7)	13 (86.7)	**15 (16.5)**
24-59	0 (0)	2 (12.5)	14 (87.5)	**16 (17.6)**
>59	2 (15.4)	0 (0)	11 (84.6)	**13 (14.3)**
Total	**11 (12.1)**	**11 (12.4)**	**69 (75.8)**	**91 (100)**

infiltration in 24 (26.3%) of the 91 patients and interstitial infiltration in 35 (38.4%). There was no statistically significant difference between viral and bacterial pneumonia groups with regard to length of hospitalization (p=0.252). None of the children required mechanical ventilation or died.

DISCUSSION

Table 4. Chest x-ray findings of the patients with CAP

Radiological findings	n (%)
Normal	28 (30.8)
Intercystitial infiltration	23 (25.3)
Consolidation	19 (20.9)
Peribronchitis	12 (13.2)
Air bronchogram	5 (5.5)
Pleural effusion	2 (2.2)
Hiler/ mediastinal lymphadenopathy	1 (1.1)
Atelectasis	1 (1.1)
Hyperinflation	-

The present study showed causative infective agents and characteristics of hospitalized children with pneumonia. Real time-PCR as molecular diagnostic technique was used in our study to comprehensively study the viral etiology of CAP in hospitalized children who were 1 month to 16 years old. Using this method, infection with 6 viruses was investigated, and the presence of viral infection was identified in 12.1% of the patients. Bacterial infection was detected in 9 (9.9%) of 91 patients. These results were less than previously reported etiological rates; in previous studies, the rate has been reported as 43% to 85% (6, 12, 13). Epidemiologic data related to pneumococcal diseases are very limited in Turkey, despite the fact that pneumococcus is the most important organism causing childhood bacterial diseases. The emergence and spread of resistant

pneumococcal strains have led to an emphasis on the prevention of pneumococcal disease by vaccination. Routine vaccination with 7-valent pneumococcal conjugated vaccine (PCV-7) for children <1 year of age was agreed upon in Turkey at the end of 2008 and was included in the National Immunization Schedule in 2009. PCV-7 was used for 2 years in Turkey before being replaced by PCV-13 in November 2011. In 2010 and 2011, 96% and 97% of the target population, respectively, were vaccinated with PCV-7 (14). In our study, Streptococcus pneumoniae was not detected in any of the blood cultures. It can depend on the Vaccine Schedule.

In clinical practice, it is important to distinguish between contamination and bloodstream infections to prevent unnecessary prescription of antimicrobial agents leading to a selection of antimicrobial-resistant organisms (15, 16). Contamination is usually presumed if only one of at least two sets of blood cultures is positive for Coagulase-negative staphylococci, whereas true bloodstream infection is assumed if at least two blood cultures yield Coagulase-negative staphylococci (17, 18). Thus, we made the discrimination of yielding and contamination according to these data.

Iwane et al (19) showed that younger age (particularly <1 year), male gender, and presence of chronic underlying illness were associated with higher hospitalization rates for viral acute respiratory illness. In our study, the ratio of male to female was closed to 1 and 51.7% of patients were younger than 1 year of age. Our results were in accordance with previous studies' findings (20).

In a previous study by Juven et al (21), the most common symptoms were fever in 96%, cough in 76%, rhinorrhea in 48% and dyspnea in 37% of the patients with pneumonia. In this study, twenty-four percent of the patients had typical pneumonic rales/crackles on auscultation. Decreased breathing sounds were found in 15% of patients, wheezing in 20% and rhonchi in 33% of the patients. Auscultation was normal in 28% of the patients. In our study, the most common symptoms were fever in 98.9% and cough in 98.9% of the patients. Auscultation findings of the patients, crackles, rhonchi and wheezing were found in 85 (93.4%), 54(59.3%) and 38 (41.8%) children, respectively.

Viruses have been most commonly associated with CAP diagnosed in infants and younger children (22). However, recent evidence suggests that, when sensitive detection methods are used, the prevalence of viral infections in older children with CAP is higher than previously thought (6). In our study, 12.1% of the patients were found to be infected with viruses. Cilla et al. had investigated 14 respiratory viruses in children aged less than 3 years old with CAP using molecular or immünochromatographic techniques and/or viral culture. In their study, at least one virus had been detected in 66.9% of the episodes (23).

Juvén et al. (6) reported a very high rate (62%) of viral etiology in pediatric CAP. In their study, rhinovirus, detected by PCR, accounted for a large proportion of viral pneumonia. In our study, rhinovirus was not investigated.

RSV is accounted for an estimated 13, 3, and 0.4 RSV-associated hospitalizations per 1000 children who were younger than 1 year, 1 year of age, and in children 2 to 5 years of age, respectively (23). In our study, RSV was not detected. The cause for this is clearly unknown.

A recent study showed that the positive detection rate of adenovirus by RT-PCR was 0.63% in children with pneumonia (24). Similarly, in our study, adenovirus was detected only in one patient in 2-11 months of age group. However, this ratio is lower than in that reported in a study by Samransamruajkit et al. (25) in which adenovirus was detected in 6.6 % of pneumonia patients.

Predictable parainfluenza-related hospitalization rates in the New Vaccine Surveillance Network study were 3.2, 1.5, and 0.4 per 1000 children younger than 1 year, 1 year, and 2 to <5 years of age, respectively (19). In our study, PIV-2 had the highest rate among

detected viruses in all age groups. Parainfluenza 3 were found in <2 and 2-11 months of age group. PIV-2 was the most common viral agent among <2 and 2-11 months of age group.

Human metapneumovirus, a respiratory virus first isolated in the Netherlands in 2001, has been increasingly recognized as a common cause of acute respiratory tract infection in young children worldwide. Human metapneumovirus infection has been associated with a spectrum of clinical manifestations, ranging from influenza-like illness to bronchiolitis and pneumonia. Among children hospitalized for acute LRI in southern Israel during a 1-year period, human metapneumovirus was detected in 13% of the patients and was the third most common viral pathogen (26). In our study, human metapneumovirus was not detected.

In a previous study, in 27% of the episodes of childhood CAP multiple viral infections were detected. Infection severity was more in multiple viral infections than single viral infection due to the greater frequency of hospitalization (23). We also detected viral co-infection in 3 patients. In our study population, mixed infections were uncommon (3.1 %), although in previous studies mixed infections were reported as high as 23 % of pneumonia cases in children (27).

The usefulness of PCT for distinguishing between bacterial and viral pneumonia has been analyzed in children but the data are also conflicting. Moulin et al. found that a PCT value of 1 ng/ml or greater had better specificity and sensitivity and higher positive and negative predictive values than CRP, IL-6 or white blood cell count for discriminating between bacterial and viral CAP in untreated children admitted to hospital (28). In a similar study Toikka et al. also reported high values of PCT in children with bacterial pneumonia, but with a large overlap between bacterial and viral pneumonia (29). In their study, Don et al. (30) concluded that the four non-specific inflammatory markers, CRP, PCT, ESR, WBC count and their combinations have a limited role in the separation of bacterial from viral pneumonia in children. In particular, low levels considered as typical for viral infections were not able to rule out bacterial infection. In our study, we also found no statistically significant difference between viral and bacterial pneumonia groups with regard to ESR and PCT values.

In clinical practice, alveolar infiltrations on chest radiograph are often considered to indicate bacterial etiology of pneumonia, but clinical studies have failed to confirm this concept (31, 32). Virkki et al.(33) recently found that most children with alveolar infiltrates and, in particular, with lobar infiltrates, had bacterial pneumonia, whereas interstitial infiltrates were present in both viral and bacterial cases. In our study, there were alveolar infiltration in 24 (26.3%) and interstitial infiltration in 35 (38.4%) of the 91 patients.

This study, like others that investigated viral and bacterial pneumonia, has three major limitations: First of all, documentation of infection in the upper respiratory tract does not necessarily prove the etiological agent of pneumonia. However, in 69 of 91 cases no etiological agent was detected. The RT-PCR method is an extremely powerful and useful tool; however, if we had been included other viral agents including rhinovirus and human bocavirus detected by RT-PCR, numbers of diagnosed cases might be higher. We also did not investigate *Mycoplasma pneumoniae* serologically. Second, month-to-month variations in the prevalence of different pathogens may affect their association with CAP. Third, the other important limitation is that we only studied hospitalised patients, and the results cannot be generalised to outpatients with pneumonia.

In conclusion, our study demonstrated the etiological influence of viral agents in CAP. Parainfluenza virus 2 was the most common viral agent among detected viruses in all age groups. Improving the etiological diagnosis of viral infections

may avoid unnecessary antibiotics and allow for preventive isolation of infected patients. Further larger and randomized controlled studies are needed to confirm our results.

CONFLICTS of INTEREST

The authors declare no conflicts of interest.

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