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## Antibiotic therapy in children with pneumonia treated in hospital

### Antybiotykoterapia u dzieci z zapaleniem płuc leczonych w warunkach szpitalnych

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#### Abstract

**Introduction:** Pneumonia is one of the most common causes of paediatric hospitalisations. **Aim of the study:** To analyse antibacterial treatment of pneumonia in children hospitalised in 2017 at the Department of Paediatrics, Paediatric Nephrology and Allergology of the Military Institute of Medicine in Warsaw. **Material and methods:** Medical documentation data of 360 children with clinical diagnosis of pneumonia was subjected to a retrospective analysis. Age, gender, antibiotics used before and during hospitalisation and time of treatment were considered. **Results:** Of all the children hospitalised at the Department (2,207), 360 pneumonias were reported (16.3% of all hospitalisations). The mean total time of antibiotic therapy was  $10.76 \pm 3.57$  days. Out of 176 children (48.9% of all pneumonias) who reported to a general practitioner 91 (51.7%) received symptomatic treatment and 85 (48.3%) – antibiotic. On admission to hospital the type of antibiotic treatment was modified for 63/85 children (74.1%) and the form of antibiotic delivery was changed from oral to intravenous for 74/85 (87.1%). Antibacterial treatment in general practice was compliant with recommendations in 18/85 children (21.2%) and during hospitalisation – in 69/360 patients (19.2%). **Conclusions:** The most common infectious cause of paediatric hospitalisations was pneumonia. In general practice a significant problem is to diagnose community-acquired pneumonia with bacterial aetiology because of an uncharacteristic onset of symptoms. There is significant discrepancy between the everyday practice and recent guidelines on antibiotic use.

**Keywords:** pneumonia, hospitalisation, child, antibiotic therapy, primary health care

#### Streszczenie

**Wstęp:** Zapalenie płuc stanowi jedną z najczęstszych przyczyn hospitalizacji dzieci. **Cel pracy:** Analiza sposobu leczenia przeciwbakteryjnego dzieci z zapaleniem płuc w Klinice Pediatrii, Nefrologii i Alergologii Dziecięcej Wojskowego Instytutu Medycznego w Warszawie, hospitalizowanych w 2017 roku. **Materiały i metody:** Przeanalizowano dane medyczne 360 dzieci z rozpoznaniem klinicznym zapalenia płuc i oceniono: wiek, płeć, rodzaj zastosowanej antybiotykoterapii przed hospitalizacją i w jej trakcie oraz czas leczenia. **Wyniki:** Spośród 2207 dzieci hospitalizowanych w Klinice odnotowano 360 przypadków zapalenia płuc (16,3% wszystkich hospitalizacji). Całkowity średni czas antybiotykoterapii stosowanej zarówno ambulatoryjnie, jak i w trakcie hospitalizacji wynosił  $10,76 \pm 3,57$  dnia. Do lekarza podstawowej opieki zdrowotnej zgłosiło się 176 dzieci (48,9% wszystkich zapaleń płuc), z czego 91/176 (51,7%) otrzymało leczenie objawowe, a 85/176 (48,3%) – leczenie przeciwbakteryjne. Przy przyjęciu do szpitala zmieniono rodzaj stosowanej antybiotykoterapii u 63/85 (74,1%) dzieci oraz drogę podania z doustnej na dożylną u 74/85 (87,1%). Leczenie przeciwbakteryjne w warunkach ambulatoryjnych zastosowano zgodnie z aktualnymi zaleceniami u 18/85 (21,2%) dzieci, a podczas hospitalizacji – u 69/360 (19,2%) pacjentów. **Wnioski:** Najczęstszą przyczyną hospitalizacji dzieci wymagających leczenia przeciwbakteryjnego było zapalenie płuc. W podstawowej opiece zdrowotnej istotnym problemem dla lekarzy jest rozpoznanie infekcji bakteryjnej ze względu na niecharakterystyczny początek objawów. Występują znaczne rozbieżności między stosowanym leczeniem a aktualnymi rekomendacjami.

**Słowa kluczowe:** zapalenie płuc, hospitalizacja, dziecko, antybiotykoterapia, opieka ambulatoryjna

## INTRODUCTION

Pneumonia is an inflammatory disease of the peripheral respiratory system usually caused by infection<sup>(1)</sup>. The most sensitive and specific symptoms of pneumonia in children are: tachypnoea, fever over 38°C and retraction of intercostal spaces as well as the presence of dry rales and crepitations on auscultation, particularly unilateral<sup>(2)</sup>.

The incidence of pneumonia depends on the child's age and region of residence. Children who are most likely to develop pneumonia are those up to 5 years of age and those from developing countries, where the mortality rate is the highest. In developed countries the mortality rate is below 1:1,000 cases per year. The aetiological factors for pneumonia depend primarily on the age of the child. The most commonly detected bacteria are *Streptococcus pneumoniae*. Viral pneumonia dominates among children below 2 years of age.

The majority of children with community-acquired pneumonia (CAP) have moderately severe symptoms and can be treated in outpatient settings. The primary indications for hospitalisation are severe course of the disease and the lack of clinical improvement despite treatment. The remaining indications include: age below 6 months, saturation <92%, tachypnoea, severe general condition, dehydration, cardiorespiratory failure, neurological symptoms, chronic diseases (e.g. diabetes, cancer, immunological disorders, kidney diseases, liver diseases), granulocytopenia, extensive lesions on chest radiograph, pneumonia complications, social considerations<sup>(1)</sup>.

Chest radiography is the primary method to visualise inflammatory lesions in the lungs. It is not routinely recommended in children treated for CAP in outpatient settings. However, it should be performed in children with fever below 5 years of age with significant leucocytosis, even if no symptoms of respiratory infection are present.

β-lactam or macrolide antibiotics are most commonly used for treatment. In severe cases antibiotics from both these groups can be combined. The Polish National Program for

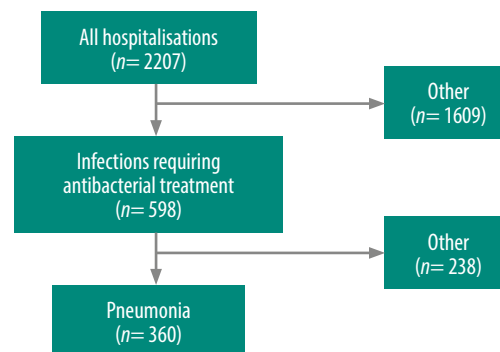


Fig. 1. Selection of children for the study group

Protection of Antibiotics of 2016 recommends the following treatment for community-acquired respiratory infections:

- in children between 3 weeks and 3 months old: cefuroxime, amoxicillin with clavulanate;
- in children between 4 months and 5 years old: amoxicillin;
- in children between 5 and 15 years old: amoxicillin or ampicillin; combination of β-lactam and macrolide antibiotics.

If the clinical presentation supports the diagnosis of atypical pneumonia, macrolides are the first-line treatment. Ceftriaxone or cefotaxime should be used in children with suspected severe pneumonia.

If there is no improvement after the treatment, the second-line antibiotic should be chosen based on the child's age, the antibiotic used so far and the complications observed<sup>(2)</sup>. The optimal antibiotic therapy for pneumonia usually lasts 5–10 days, regardless of the antibiotic's route of administration<sup>(3)</sup>.

## AIM OF THE STUDY

The aim of the study was to analyse antibacterial treatment of pneumonia in children hospitalised in 2017 at the Department of Paediatrics, Paediatric Nephrology and Allergology of the Military Institute of Medicine in Warsaw, Poland.

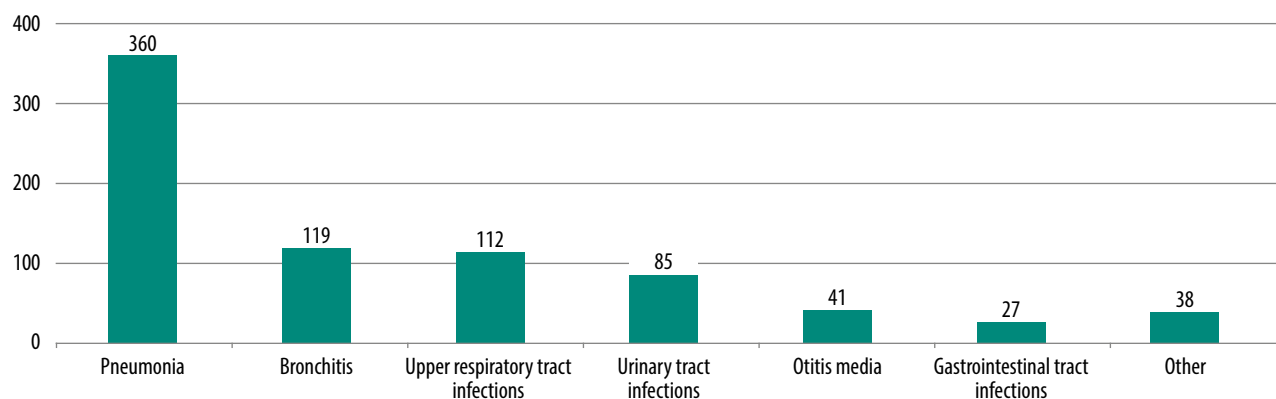


Fig. 2. Diagnoses in children requiring antibacterial treatment hospitalised in 2017 at the Department of Paediatrics, Paediatric Nephrology and Allergology, Military Institute of Medicine, Poland

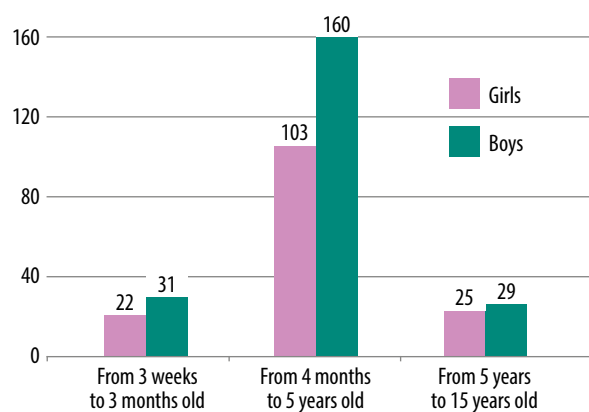


Fig. 3. Number of hospitalisations due to pneumonia with regard to age and gender

## MATERIAL AND METHODS

Retrospective analysis was performed of the medical records of 2,207 children hospitalised in 2017 at the Department of Paediatrics, Paediatric Nephrology and Allergology. Antibacterial treatment was necessary in 598 cases (27.1% of all hospitalisations). Pneumonia was diagnosed in 360 patients (16.3% of all hospitalisations) (Fig. 1). In these children, age, gender, antibiotics used before and during hospitalisation and the duration of treatment were analysed. The study group included 150 girls and 210 boys (mean age: 2 years and 6 months  $\pm$  2 years and 10 months). The analysed variables were also studied with regard to age ranges proposed by the National Program for Protection of Antibiotics experts<sup>(2)</sup>:

- from 3 weeks to 3 months old;
- from 4 months to 5 years old;
- from 5 years to 15 years old.

## RESULTS

Among 598 children hospitalised at the Department in 2017 due to infections requiring antibiotic therapy, pneumonia was diagnosed in 360 children (60.2%). Other reasons for using antibacterial treatment included: bronchitis (119), upper respiratory tract infections (112) and urinary tract infections (85) (Fig. 2). Among 360 patients with pneumonia 53 (14.7%) were in the age range of 3 weeks to 3 months old, 263 (73.1%) – in the age range of 4 months to 5 years old and 44 (12.2%) – in the age range of 5 years to 15 years old (Fig. 3).

The mean total duration of antibiotic therapy (outpatient and inpatient) was  $10.76 \pm 3.57$  days. The duration of antibacterial treatment with regard to age group is presented in Tab. 1.

Based on the analysis of outpatient treatment data it was found that 176/360 children (48.9%) received treatment at a primary health care facility. In this group, 91/176 children (51.7%) received symptomatic treatment and

Age	Mean total duration of treatment [days]
From 3 weeks to 3 months old	9.11
From 4 months to 5 years old	10.73
From 5 years to 15 years old	12.91

Tab. 1. Mean total duration of antibiotic therapy with regard to age

Age	Outpatient symptomatic treatment [number of children] (n = 91)	Outpatient antibiotic therapy [number of children] (n = 85)
From 3 weeks to 3 months old (n = 53)	13 (14.3%)	2 (2.3%)
From 4 months to 5 years old (n = 263)	72 (79.1%)	65 (76.5%)
From 5 years to 15 years old (n = 44)	6 (6.6%)	18 (21.2%)

Tab. 2. Type of outpatient treatment with regard to age

Age	Combination therapy [number of children]
From 3 weeks to 3 months old (n = 53)	8 (15.1%)
From 4 months to 5 years old (n = 263)	25 (9.5%)
From 5 years to 15 years old (n = 44)	16 (36.4%)

Tab. 3. Number of children receiving more than one antibiotic

Age	Outpatient antibiotic therapy	Number of children
From 3 weeks to 3 months old (n = 53)	Amoxicillin	2
From 4 months to 5 years old (n = 263)	Amoxicillin with clavulanic acid	23
	Amoxicillin	18
	Clarithromycin	16
From 5 years to 15 years old (n = 44)	Cefuroxime	9
	Amoxicillin with clavulanic acid	5

Tab. 4. Outpatient antibiotic therapy with regard to age

Age	Inpatient antibiotic therapy	Number of children
From 3 weeks to 3 months old (n = 53)	Cefuroxime	25
	Ceftriaxone	14
	Amoxicillin with clavulanic acid	13
From 4 months to 5 years old (n = 263)	Cefuroxime	116
	Amoxicillin with clavulanic acid	66
	Clarithromycin	66
	Ceftriaxone	33
From 5 years to 15 years old (n = 44)	Ceftriaxone	16
	Clarithromycin	16
	Cefuroxime	13
	Amoxicillin with clavulanic acid	11

Tab. 5. Inpatient antibiotic therapy with regard to age

85/176 (48.3%) – antibacterial treatment. Detailed analysis with regard to age group is presented in Tab. 2.

Outpatient antibiotic therapy was administered to 2/85 children aged between 3 weeks and 3 months (2.3%), to 65/85 children aged between 4 months and 5 years (76.5%) and to 18/85 children aged between 5 and 15 years (21.2%).

On admission to hospital the antibiotic therapy used in outpatient settings was changed in 63/85 children (74.1%): in 2 patients aged between 3 weeks and 3 months (100%), in 46 patients aged between 4 months and 5 years (70.8%) and in 15 children aged between 5 and 15 years (83.3%).

The route of administration was changed from oral to intravenous in 74/85 patients (87.1%): in 2 children aged between 3 weeks and 3 months (100%), in 55 children aged between 4 months and 5 years (84.6%) and in 17 children aged between 5 and 15 years (94.4%).

In 49/360 children (13.6%) at least two antibacterial medicines were used; a combination of  $\beta$ -lactam and macrolide antibiotics was most commonly administered (Tab. 3). The analysis of the outpatient and inpatient antibiotic therapy in different age groups is presented in Tabs. 4 and 5.

In outpatient settings, 18/85 children (21.2%) received treatment in line with the recommendations for community-acquired respiratory tract infection management of 2016; these were children aged between 4 months and 5 years.

In hospital, treatment consistent with recommendations was provided to 69/360 children (19.2%): 53 patients aged between 3 weeks and 3 months (100%), 0 patients aged between 4 months and 5 years and 16 children aged between 5 and 15 years (36.4%).

## DISCUSSION

There are few available studies on the causes of hospitalisations at paediatric wards in the literature. A study by Służewski et al. regarding the characteristics of admissions to paediatric wards in the town of Trzcianka, Poland (1990) found that the main reasons for hospitalisation were upper respiratory tract infections (31.2%), lower respiratory tract infections (22.5%) and diarrhoea (11.5%)<sup>(4)</sup>. In a hospital in Słupsk, Poland, lower respiratory tract infections accounted for 21.4%, diarrhoea for 18.5% and upper respiratory tract infections for 10.9% of admissions<sup>(5)</sup>. At the Department of Paediatrics, Paediatric Nephrology and Allergology of the Military Institute of Medicine lower respiratory tract infections constituted 60.2% of all diseases requiring antibiotic therapy.

Senstad et al. observed that children below 5 years of age were the largest group of patients hospitalised for pneumonia (83.7%)<sup>(6)</sup>. At the Department of Paediatrics of the Janusz Korczak Provincial Specialist Hospital in Słupsk, Poland, this figure was 75.4%<sup>(5)</sup>. Similar results were obtained at the Department of Paediatrics of the Military Institute of Medicine: as many as 87.8% of children were aged below 5 years.

An important factor which supports the efficacy of respiratory tract infection therapy is the use of symptomatic medication<sup>(7)</sup>. In the present study, 91 children reporting to

a general practitioner (51.7%) received only symptomatic treatment. The reason for not administering an antibiotic may be the lack of abnormal auscultatory findings at the onset of a bacterial infection<sup>(8)</sup>. Another important problem for primary care physicians is the differentiation between atypical respiratory tract infections and viral infections since clinical symptoms can be uncharacteristic<sup>(9,10)</sup>. Epidemiological research demonstrated that viruses were the cause of 45–77% cases of CAP in children. Viruses may be an exclusive aetiological factor for CAP; however, 10–20% of cases are multiple viral or mixed viral and bacterial infections<sup>(11)</sup>. In the author's research, the majority of children aged between 5 and 15 years treated in outpatient settings received an antibiotic instead of symptomatic treatment. This may be due to the fact that auscultatory abnormalities characteristic for pneumonia such as crepitations are easier to detect in older children. Due to more difficult cooperation with the youngest children these abnormalities may be inaudible in them. This may be supported by the observation from the present study that symptomatic medication is more commonly used in the age group of 3 weeks to 3 months.

The mean total duration of antibiotic therapy both in outpatient and inpatient settings was longer with age. The reason for this may be failure of treatment at home. Many physicians emphasise the widespread problem of parental non-compliance, most commonly involving earlier termination of antibiotic therapy<sup>(7)</sup>. It is also important to inform parents that improvement can be expected within 48 hours from the administration of an antibiotic. If the treatment fails, a number of most important factors need to be considered such as the correct diagnosis, the aetiological factor, the type and dose of antibiotic, superinfection with a new pathogen, incorrect medicine administration and patients' non-compliance<sup>(12)</sup>.

Berner et al. observed that the behaviour of general practitioners regarding the use of antibiotics in children deviates from the current recommendations in many respects<sup>(7)</sup>. In their study, the present authors found that only 24.6% of children treated in outpatient settings received treatment consistent with recommendations. Physicians' decisions may be determined by the patient's positive history of chronic diseases, pneumonia recurrence of unknown cause as well as hypersensitivity to a recommended antibiotic<sup>(7)</sup>.

Oral antibiotics are effective in children with CAP; however, when administered intravenously they guarantee quick achievement of therapeutic levels in the lungs of severely sick children<sup>(13)</sup>. On admission to the Department of Paediatrics, Paediatric Nephrology and Allergology of the Military Institute of Medicine the type of antibiotic therapy was changed in 63 out of 85 children (74.1%) and the route of administration was changed from oral to intravenous in 74 out of 85 children (87.1%).

As Launay et al. noted, 48.5% of doctors in France did not use antibiotics in hospitalised children in line with recommendations. The most common problem was that

antibiotics with too broad a spectrum were administered (amoxicillin with clavulanic acid, third generation cephalosporins), unjustified combination therapy was used, intravenous antibiotics were administered for no reason and macrolides were used instead of amoxicillin, which is the first-line treatment<sup>(14)</sup>. The administration of macrolides alone does not ensure sufficient coverage of bacteria causing CAP, since *S. pneumoniae* display significant resistance to these antibiotics<sup>(15)</sup>. During hospitalisation at the Department of Paediatrics, Paediatric Nephrology and Allergology of the Military Institute of Medicine 69/360 patients (19.2%) received treatment consistent with recommendations. One of the reasons for this may be the fact that in the majority of cases a medicine with a broader spectrum of action should have been administered than the one prescribed in general practice which did not display appropriate therapeutic efficacy. In some cases the infection was not limited to the respiratory system, but it also affected the urinary tract or the meninges, or developed into complicated pneumonia.

#### Conflict of interest

*The authors do not report any financial or personal affiliations to persons or organisations that could affect the content of or claim to have rights to this publication.*

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