Importance of the Pneumococcus in Community-acquired Pneumonia in Tender-age Infants on the Background of Vaccination

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Abstract

AIM: The aim of the study was to study the role of pneumococcus in community-acquired pneumonia in young tender-age infants on the background of vaccination.

MATERIALS AND METHODS: In this research, 82 children with community-acquired pneumonia we examined. They were treated at the Regional Children’s Clinical Hospital of the Karaganda city. The age of the patients ranged from 2 months up to 3 years. A comprehensive examination of the patients was carried out and included a detailed collection of anamnesis, objective examination, laboratory studies, and methods of instrumental diagnostics. The patients were divided into two groups, the first group included 42 (51.2%) vaccinated children with community-acquired pneumonia. The second one included 40 (48.8%) children with impaired immunization who had received pneumococcal vaccine at the stationary level, to improve the individual prognosis of the disease course.

CONCLUSION: Thus, the applied microbiological research methods make it possible to improve the efficiency of timely diagnosis of community-acquired pneumonia in vaccinated infants with pneumococcal vaccine at the stationary level, to improve the individual prognosis of the disease course.

Introduction

Community-acquired pneumonia is the most common form of pneumonia and remains one of the leading causes of the death. According to the World Health Organization (WHO), the mortality rate of children in the first 5 years of life due to pneumonia is up to 20–25% [1, 2]. All this determines the significance of the problem of pneumonia in children not only for pediatrics, but also for clinical medicine in general.

According to the WHO, about 150 million cases of pneumonia in children under 5-years-old are registered annually in the world, from which 20 million are severely requiring hospitalization [3, 4]. In developed countries, the incidence is 3.3/1000 children under 5-years-old and 1.5 when calculating the indicator per 1000 children aged 0–16 years [5].

According to the statistical data [6] in the Republic of Kazakhstan, the absolute incidence of pneumonia in children from 0 to 5-years-old was 42,236/1000 children in 2013 year (24.0), in 2014 - 40,078 (22.8). Considering these data, it should be noted that the incidence of pneumonia in children of 0–5-years-old has been decreased by 2158 cases (1.2) compared to 2013 year, but an upward trend also prevails in Akmola (1501 case-18.1), West Kazakhstan (282 case-4.4), and North Kazakhstan (113 case-3.9) regions.

In Kazakhstan, despite the successes achieved in pediatrics, the incidence of the respiratory diseases does not tend to decrease (2016 year - 1143.3 cases, 2017 - 1468.3) [7]. Despite significant progress in the diagnosis and treatment of community-acquired pneumonia, complications and mortality are still increasing.
Streptococcus pneumoniae remains the main causative agent of community-acquired pneumonia in all age groups [8], [9]. Pneumococcal infections -- are the group of widespread anthroponotic diseases caused by S. pneumoniae, representing an urgent problem for practical healthcare in all countries of the world. S. pneumoniae is the main cause of morbidity and mortality from respiratory infection worldwide, which contributed to increasing mortality in 2016 year - 1,189,937 cases more than all other etiologies combined [10]. In this regard, to create specific immunity, to ensure the prevention of pneumococcal infection is vaccination [11], [12]. In May 2020 year, WHO, once again, issued a warning about the importance of immunization coverage [13], considering vaccination to be the only way to significantly affect the incidence of pneumococcal disease. At the same time, since 2010 year, it has been recommended that routine vaccinations against pneumococcus be included in the national calendars of all countries.

The increase of community-acquired pneumonia mortality is due to the frequency of complications development and cases of severe inflammatory process that develops as a result of changes in the pathogenicity of microorganisms, altered premorbid immune status of the macroorganism and a number of other factors.

**Aim**

The aim of the study was to study the role of pneumococcus in community-acquired pneumonia in young tender-age infants on the background of vaccination.

**Materials and Methods**

In this research, 82 children with community-acquired pneumonia we examined. They were treated at the Regional Children’s Clinical Hospital of the Karaganda city.

The age of the patients ranged from 2 months up to 3 years. A comprehensive examination of the patients was carried out and included a detailed collection of anamnesis, objective examination, laboratory studies, and methods of instrumental diagnostics. The patients were divided into two groups, the first group included 42 (51.2%) vaccinated children with community-acquired pneumonia. The second one included 40 (48.8%) children with impaired immunization to community-acquired pneumonia.

**Clinical and laboratory research**

The diagnosis and severity of the disease were established according to the recommendations of the WHO for the diagnosis and treatment of community-acquired pneumonia. They were taken as the base for the national clinical protocols of the Republic of Kazakhstan [14]. The exclusion criterion was the presence of concomitant lung diseases.

To establish the etiology of community-acquired pneumonia in all patients underwent sputum analysis for microflora using microscopic and bacteriological methods before antibiotic therapy. Informed consent was obtained from the parents of each patient. Clinical and laboratory studies were carried out on the basis of the Regional Children’s Clinical Hospital of the Karaganda city and at the research center of the Karaganda Medical University.

**Statistical analysis**

Calculations and evaluation of the obtained results were carried out on an IBM-compatible computer with the operating system Windows XP using the MS Excel 2017 software package (Microsoft), SPSS 12.0.2 and Statistica 20. Statistical analysis was carried out using the STATISTICA package. Relative frequency of occurrence of the trait in different groups (proportion) p was determined by the confidence interval statistically significant differences were considered at p < 0.05.

**Ethical issue**

The study was approved by the ethics committee of Karaganda Medical University and was conducted in accordance with the Declaration of Helsinki. Information received from all legal representatives of sick children for research. While sick children are in the pulmonary department, they are all standard therapy, corresponding to the diseases.

**Results and Discussion**

To establish etiology of the CAP in all children was underwent a microbiological study before antibiotic therapy. Sputum was collected in compliance with standard requirements and used as material for microbiological examination. A total of 82 children were examined with an established diagnosis of community-acquired pneumonia of various localization. Of these, 42 (51.2%) vaccinated children and 40 (48.8%) children with impaired immunization at the age from 2 months to 3 years old.

The results of isolated strains of microorganisms from the sputum of vaccinated infants from 2 months to 1 year old with severe pneumonia (Table 1) indicate the prevalence of mixed infections: Haemophilus influenza + Staphylococcus aureus - 16.7% (95% CI 0; 60.01), (p < 0.032), and also, Klebsiella pneumonia + Streptococcus beta hemolytic Group B - 16.7% (95% CI
Table 1: The structure of the causative agents of community-acquired pneumonia in infants from 2 months up to 3 years old

| Etiologic agent | Vaccinated infants against pneumococcal infection, n = 42 | Infants with violation of the terms of immunization against pneumococcal infection, n = 40 | p |
|----------------|---------------------------------------------------------|---------------------------------------------------------------------------------|---|
| Gram-positive bacteria | Absolute number, Relative share (%), 95% CI | Absolute number, Relative share (%), 95% CI |
| Streptococcus | 12, 25.57 (0; 67.04) | 25, 82.5% (30.4; 89.6) | 0.029 |
| S. pneumoniae | 8, 19.04% (0; 60.01) | 18, 45% (0; 72.73) | 0.031 |
| Streptococcus beta-hemolytic Group B | 3, 7.14% (0; 52.81) | 15, 37.5% (0; 72.73) | 0.027 |
| Streptococcus pyogenes | 4, 9.5% (0; 52.81) | 7, 17.5% (0; 52.63) | 0.360 |
| Staphylococcus aureus | 4, 9.5% (0; 52.81) | 5, 12.5% (0; 58.15) | 0.595 |
| Staphylococcus haemolyticus | 0, 0 | 2, 5% (0; 54.4) | 0.144 |
| Gram-negative bacteria | 12, 28.55 (0; 67.04) | 12, 30% (0; 72.73) | 0.560 |
| Klebsiella oxytoca | 0, 0 | 0 | 0.145 |
| Enterobacter aerogenes | 0, 0 | 0 | 0.144 |
| K. pneumoniae | 2, 4.76% (0; 28.55) | 1, 2.5% (0; 54.4) | 0.069 |
| H. influenzae | 3, 7.14% (0; 56.44) | 3, 7.5% (0; 58.15) | 0.139 |
| N. meningitidis | 3, 7.14% (0; 56.44) | 3, 7.5% (0; 50.62) | 0.311 |
| P. aeruginosa | 0, 0 | 1, 2.5% (0; 50.62) | 0.032 |
| Concurrent infection | 18, 42.9% (8.45; 77.27) | 3, 7.5% (0; 50.62) | 0.003 |
| Combined infection: S. pneumoniae + P. aeruginosa | 2, 4.76% (0; 49.17) | 1, 2.5% (0; 50.62) | 0.972 |
| Streptococcus beta-hemolytic Group B + P. aeruginosa | 3, 7.14% (0; 52.81) | 1, 2.5% (0; 50.62) | 0.145 |
| H. influenzae+S. aureus | 7, 16.7% (0; 60.01) | 0 | 0.145 |
| Staphylococcus aureus | 6, 14.2% (0; 52.81) | 1 | 2.5% (0; 50.62) | 0.145 |

In case of CAP in children with impaired immunization, the majority of gram-positive microflora was represented by S. pneumoniae - 37.5% (p < 0.05). Our analysis confirms the existing information that pneumococcus is the most frequently isolated causative agent of community-acquired pneumonia in children (Figure 2).
Conclusion

Our research revealed that the etiological structure of CAP in vaccinated children is represented by pathogenic strains of Streptococci, S. pyogenes were more often detected and Streptococcus beta-hemolytic Group B were detected less often. The Staphylococcus family was represented with such pathogenic strains as: S. aureus, and less 01) - Staphylococcus haemolyticus. Gram-negative flora was mainly represented by H. influenzae e, M. pneumoniae, E. coli, K. pneumoniae, less often E. aerogenes, and K. oxytoca. The etiological structure of CAP in young children was characterized by the predominance (62.5%, p < 0.001) of Gram-positive flora in the group of children with impaired immunization. Gained results are consistent with the data of Ploskireva et al. [15], where H. influenzae and S. pneumoniae are the most significant pathogens both in monoinfections in children and in the development of concurrent infections.

Similar results were obtained by Rohde et al. [16], when this pathogen dominated the etiology of CAP, regardless of the disease severity. In the group of infants with severe pneumonia on the background of impaired immunization, S. pneumoniae was detected in 37.5% of cases, which proves the effect of vaccination on the etiological structure of community-acquired pneumonia.

Significant differences are found between groups of children. Therefore, in vaccinated children, concurrent infection was prevailed (42.9%). And in the group of infants with impaired immunization was detected S. pneumoniae (37.5%). Aforecited indicates the effect of pneumococcal vaccination on the etiological structure of CAP in tender-age infants.

Thus, the applied microbiological research methods make it possible to improve the efficiency of timely diagnosis of community-acquired pneumonia in vaccinated infants with pneumococcal vaccine at the stationary level, to improve the individual prognosis of the disease course.

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