

The Effect of Pneumococcal Polysaccharide Vaccine in Preventing Recurrent Upper Respiratory Infections in an Allergic Child: A Case Report

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Abstract

One of the most common causes of pediatric medical visits is recurrent respiratory infections, which may become harmful for physical and mental health of growing children. The most common bacterial respiratory pathogen is *Streptococcus pneumoniae*, found in the nasopharynx with a potential to cause a broad spectrum of diseases, particularly if children are not immunized against it. Allergy may also lead to pathologic alterations in the airways and thus impaired clearance of pathogenic bacteria. Furthermore, allergy might depress the pneumococcal antibodies to certain serotypes of this microorganism. This is a report of an immunocompetent girl with recurrent respiratory infections as well as an allergic background. She underwent immunologic workup with a suspicion of primary immunodeficiency, yet unexpectedly showed a favorable response to the injected pneumovax in the immunodeficiency screening evaluation. It could be logically concluded that pneumococcal polysaccharide vaccine may be specifically useful for allergic children with recurrent respiratory disorders who are not routinely immunized against *Streptococcus pneumoniae*.

Keywords: Allergy; Recurrent infections; Pneumococcal polysaccharide vaccine.

Introduction

One of the most common causes of pediatric medical visits is recurrent respiratory infections, the results of which would be a socioeconomic burden on families and communities [1]. By definition, recurrent upper respiratory tract infection is diagnosed when a child experiences one of the following conditions: seven or more episodes of infections per year in children aged 0 to 2 years, six or more in those aged 3-5 years, and five or more in those aged 5 to 14 years [2].

Recurrent lower respiratory infections are defined as two or more lower respiratory infections per year [2]. In both the abovementioned conditions the interval between two separate episodes should be longer than 7 days to be considered distinct

infections. These recurrent respiratory infections may become harmful for physical and mental health of growing children. It seems that the pathogenesis of recurrent respiratory infections is complex and multifactorial, among which the disrupted barrier function of the respiratory tract and impaired immune function are the two conditions that may be in close relation with the occurrence of these recurrent infections.

The most common bacterial respiratory pathogens are species such as *Streptococcus pneumoniae*, *Mycoplasma pneumoniae*, *Haemophilus influenzae*, and *Streptococcus pyogenes*, sometimes occurring with a synergistic effect between viral and bacterial infections [3]. *Streptococcus pneumoniae* is found in the nasopharynx with a potential to cause a broad spectrum

of diseases including otitis media and sinusitis, nonbacteremic pneumonia as well as invasive pneumococcal disease [4]. Recurrent respiratory infections are one of the most common reasons for pediatric visits in preschool years, while they are likely to improve gradually by the age of 12 [1]. Allergy, in addition, may lead to pathologic alterations in the airways and therefore impaired clearance of pathogenic bacteria.

This is a case study about an immunocompetent girl with recurrent respiratory infections and a history of underlying allergy, who successfully responded to a pneumovax immunization. Soon after pneumococcal immunization, the infections subsided, although it was not administered for prophylactic purposes, and yet was merely used to detect selective antibody deficiency.

Case study

An 8-year-old girl, born to non-consanguineous parentage, presented with fever, chills, and chronic cough to Allergy and Immunology Clinic of Amir Hospital in October 2023. She was found to have recurrent upper respiratory tract infections nearly 5 to 6 times a year after the age of 2, which was every time treated with broad-spectrum antibiotics, such as amoxicillin-clavulonic acid, with a favorite response at the beginning and early relapse of the symptoms soon after termination of the medication. She lost many days of school because of the fever and chronic cough. In addition to the above-mentioned treatment, she also received inhaled corticosteroids several times in her visits to different physicians because of her underlying allergic background. The clinical features included frequent respiratory infections (sinuses and lungs), inefficiency of long-lasting treatment with antibiotics, and inability to gain weight, which were collectively suggestive of a primary immunodeficiency. A comprehensive immunologic screening was therefore performed, the results of which were within normal limits, except for an inadequate tetanus antibody titer, which could be attributed to the lack of administration of the booster dose of the tetanus vaccine at the age of 5 to 7 before going to school (Table 1). Diagnostic workup also included specific pneumococcal antibody evaluation after injecting a pneumovax vaccine (23-valent pneumococcal vaccine) to investigate specific antibody formation after vaccination.

Soon after pneumococcal vaccination, most of her symptoms subsided and the need for constant use of antibiotics was significantly declined. She gained weight in a short span of time, without experiencing any new upper or lower respiratory infections. There was also significant improvement in her performance in school. In view of the fact that there was no definitive evidence of primary immunodeficiency in lab tests as specific antibody formation was intact, the reason for her symptoms improvement could be attributed to the vaccination and prevention of pneumococcal infections.

Discussion

Multiple parameters may affect the susceptibility and severity of respiratory infections [5]. Some predisposing conditions may have detrimental roles in the patients' susceptibility to respiratory infections, such as underlying allergic conditions, known as a risk factor for recurrent respiratory infections. The pathophysiological basis of this increased susceptibility seems to be due to individuals' constitutional state accompanied by CD4+ T helper type 2 cells and increased levels of IgE production, subsequently leading to inflammation [6]. Inflammation is

Table 1: A summary of the patient's laboratory tests.

Test	Result	Reference Intervals
WBC	9.1 10 ³ /μL	5-13
Neutrophil	57.6%	38-80
Lymphocyte	32.8%	22-50
Monocyte	7.6%	2-12
Eosinophil	1.4%	0-5
Basophil	0.6%	0-2
Hb	13.5%	11.5-15.5
Platelet	300 10 ³ / μL	170-450
Vitamin D3	59 ng/mL	30-70
Sweat Chloride Test	37 mmol/L	Positive for CF: More than 80
IgG	974 mg/dL	600-1300
IgA	187 mg/dL	51-297
IgM	156 mg/dL	31-208
IgE	63.1 IU/mL	Up to 280
IgG1 subclass	545.8 mg/dL	288-918
IgG2 subclass	204 mg/dL	44-375
IgG3 subclass	40.8 mg/dL	15.5-85
IgG4 subclass	60.1 mg/dL	0.4-99
Isoagglutinin titer, Anti A	1:164	>1:8 (Blood group: O+)
Isoagglutinin titer, Anti B	1:256	>1:8 (Blood group: O+)
Tetanus Ab (IgG)	<0.01 IU/mL	>0.1
C3	98 mg/dL	90-180
C4	23 mg/dL	10-40
CH50	85.6 mg/dL	42-100
NBT	100%	>90%
CD3%	69.5	60-76 (2085 cells/ μL)
CD4%	44.7%	31-47 (1341 cells/ μL)
CD8%	24.6%	18-35 (738 cells/ μL)
CD19%	18.7%	13-27 (561 cells/ μL)
CD20%	18.3%	18-27 (549 cells/ μL)
CD16%	7.1%	5-19
CD56%	5%	3-15

an important hallmark of both respiratory allergic diseases and infections, yet with the dominance of different cell types in each condition [5]. In addition, atopic children often show decreased ciliary motion as well as defective epithelial cell barrier function due to their atopic state, leading to easier microorganism colonization [6].

Song et al. have shown that 60-70% of younger children with recurrent upper respiratory infections have lower baseline antibody levels to the serotypes included in PPV23 and PCV13 vaccines and suggested that the presence of allergy might depress the pneumococcal antibodies to certain serotypes of this microorganism [7]. They have also concluded that younger children may respond to additional PPV more readily, which was also true in this case study, in which the patient showed a favorite response to injected PPV23 vaccine administered for diagnostic purposes.

In their review, Li et al. described some potential biologic mechanisms to explain the increased susceptibility of pneumococcal infections in allergic airways. Accordingly, abnormal collagen deposition and goblet cell hyperplasia caused by chronic inflammation may lead to increased mucin production as well as altered mucus secretion, abnormal viscosity and mucociliary clearance, and finally increased sputum secretion. This impaired clearance of debris may serve as a nidus of localized infection. Therefore, the inflammation induced by sensitization to allergens may be associated with an increased frequency of pneumococcal infection [4]. Considering the positive impact of PPV on reduction of recurrent infections in their study, Quezada in 2016 recommended the use of this vaccine in children who do not receive the conjugated vaccine before they are two years old [8].

The same result was obtained in this study as the patient showed a favorable response to the injected pneumovax in the screening evaluation with the aim of diagnosing the probable primary immunodeficiencies.

Conclusion

Given the aforementioned immune alterations resulting from allergic inflammation and the subsequent risk of recurrent pneumococcal infections, this study indicates that PPV may be specifically useful for allergic children with recurrent respiratory disorders who are not routinely immunized against *Streptococcus pneumoniae*.

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