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The correlation between incidence rate of pertussis and vaccination rate of children from 1998 to 2016 in Poland

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Abstract

Introduction and purpose: Pertussis is becoming a more and more common problem among Polish children and youth. In the group of newborns and infants the pertussis course can be severe and lead to serious complications even including death from the disease (~1% <2. month old, ~0,5% 2.–11. month old). The epidemiologic analysis will allow to estimate how important and prevailing this problem is in the Polish health care system.

The aim of the study is to analyse the current epidemiologic situation concerning the relationship between the vaccination and incidence rate of pertussis from 1998 to 2016.

Materials and method: The data used for the epidemiologic analysis were taken from the *Choroby zakaźne, zakażenia i zatrucia w Polsce*, raport conducted by the National Hygiene Institute.

Results: In 2010 vaccination rate was 99.6% with incidence rate of pertussis about 3.32/100000. In 2016 vaccination rate dropped to 98.7% and incidence rate of pertussis reached the level of 17.77/100000.

Conclusions: The dropping rate of vaccination among children and youth who are involved in the obligatory vaccination program is disturbing. The rate correlates with the increase in the pertussis incidence rate. In order to cope with this situation, the awareness among parents regarding the herd immunity and possible complications after pertussis must be increased. Herd immunity is the key to prevent spreading this disease.

Keywords: vaccinology; *Bordetella pertussis*; pertussis;

Introduction

Pertussis is acute, contagious, bacterial disease, which affects only humans. The etiological factor is the gram negative, aerobic bacterium *Bordetella pertussis*. Pertussis toxin plays a key role in the pathogenesis of the disease. It causes necrosis of the airway epithelium almost all along its length. Pertussis strains vary depending on the expression of pertactin. Strains that do not express pertactin are more likely to cause disease, however, recent scientific studies show that the currently available vaccine significantly reduces the likelihood of developing pertussis caused by both strains of bacteria [1]. Being infected, as well as vaccination, does not provide permanent immunity. Dangerous epidemiological feature is high disease infectivity - it can affect up to 80% of people in contact with the patient [2]. Before the introduction of mass vaccination against pertussis in 1960, tens of thousands of cases were reported every year in Poland [3]. Pertussis was a frequent cause of death in children under one year of age. In newborns and infants, it may be a cause of severe course and a high risk of death (~ 1% <2 months of age, 0.5% 2.-11 months of age) and complications [3]. In 2016 the highest number of pertussis cases was recorded since about 40 years [4].

The aim of the study is to analyse the current epidemiologic situation concerning the relationship between the vaccination and incidence rate of pertussis from 1998 to 2016.

Materials and method

The data used for the epidemiologic analysis were taken from the *Choroby zakaźne, zakażenia i zatrucia w Polsce*, raport conducted by the National Hygiene Institute.

Results

In 1998 the number of new cases was about 2871 (incidence rate accounted for 7,43/100 000). In 2003 morbidity rate and the amount of new disease cases dropped (respectively 5,33/100 000 and 2034). In 2010 the number of new cases was even lower than in 2003 – only 1266(3,32/100 000). In 2013 the number of new reported disease cases started to increase comparing to 2010 -2182 (5,67/100 000). In 2014 the number of new cases was 2102(5,46/100 000) whereas in 2015 it doubled and reached 4955 (12,89/100 000). In 2016 incidence rate and the number of new reported disease cases reached its peak throughout compared years – 6828 (17,77/100 000).

Vaccination rate from 1998 to 2010 rose (98,90% in 1998 to 99,60% in 2010). On the other hand from 2010 to 2016 it started to drop (99,60% in 2010 to 98,70% in 2016). In figure 1 we can see growing vaccination rate accompanied by dropping morbidity rate from

1998 to 2010. Starting from 2010 up to 2016 vaccination rate is dropping with rising pertussis morbidity rate.

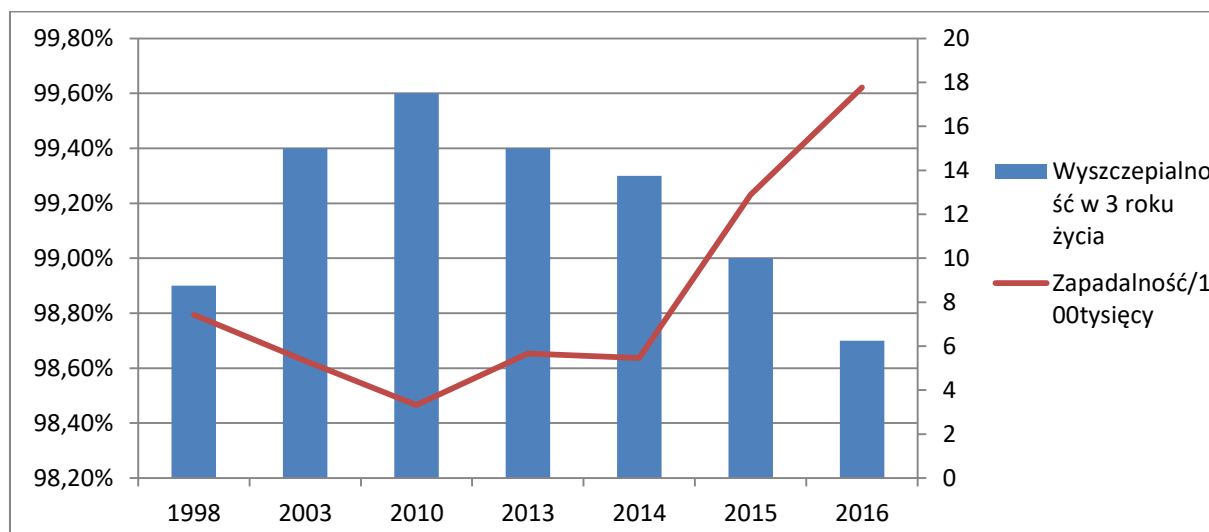


Figure 1. The correlation between pertussis vaccination rate and incidence rate of this disease from 1998 to 2016

In fig.1 we can observe that highest morbidity rate (17,77-100 000) accompanies the lowest vaccination rate (98,7%). Along with the vaccination rate increase there is a decrease in the pertussis morbidity rate and vice versa.

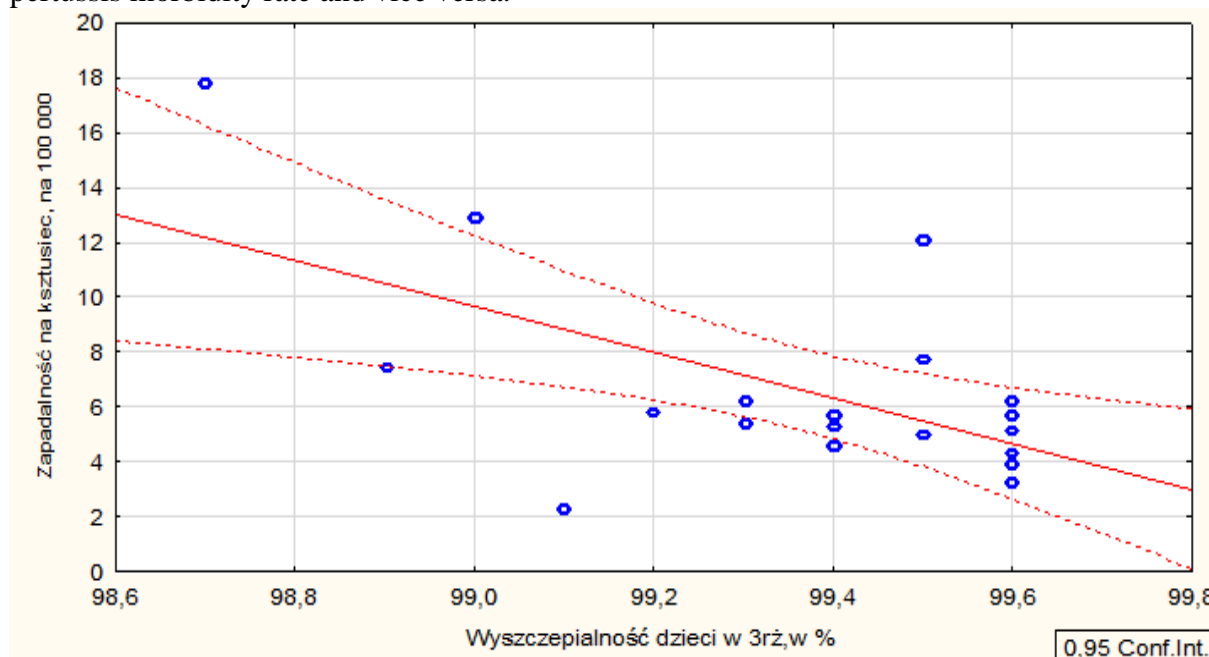


Figure 2. Statistical dispersion : vaccination rate among children in 3 years old { % } vs incidence rate of pertussis per 100 000 (Pearson's r correlation coefficient is $r = - 0.59$, $p < 0.05$)

Pearson's correlation coefficient is $r = 0,59$; $p < 0,05$, correlation is statistically relevant. It means that there is a statistically significant correlation between those two variables. The relationship is strong because the coefficient correlation factor is from 0,5-1 range.

Discussion

The correlation between dropping vaccination rate among children and high number of pertussis cases is significant. However, it is impossible to clearly indicate that vaccination rate is the only cause of this situation. The outbreak amount adults who are diagnosed with pertussis should be taken under consideration. The largest increase of cases is observed among 10 – 20-year-old people who were vaccinated in their childhood. In this age group whooping cough symptoms can be limited to chronic cough without any other symptoms, chronic upper respiratory tract inflammation with mild cough, bronchitis with a persistent and tiring cough or - more rarely – pneumonia. It might cause the diagnostic problems and be the reason of underestimating the true number of cases of the disease. [4].

The great epidemiological threat turns to be anti-vaccine movements, the popularity of which is growing year by year, which results in an increase in refusal of vaccination of children (3437 refusals in 2010 and 23 147 in 2016) [5]. This dangerous phenomenon might be a challenge to medical staff, who should educate society about vaccination nowadays, as never before. Following the fact that prevention is cheaper than treatment, it is worth observing and trying to control the number of people evading vaccinations, and calling doctors attention to the fact that pertussis is not only a disease of childhood.

Other causes of an increasing number of pertussis cases are: changes in *Bordetella pertussis* strains, lower efficacy of acellular vaccines (extinction of immunity), greater stimulation of Th2 than Th1 by Pa vaccines, accumulation of unvaccinated children in some regions (particularly sensitive to infection) [6].

Two types of vaccines are used in Poland, - whole cell and non-cellular ones [3]. According to the mandatory vaccination program, the child should be vaccinated with four doses of DTwP (full cell) vaccine at the age of 2, 3-4, 5-6 and 16-18 months. The booster dose given at the age of 6 is a cell-free DTaP vaccine. Another booster dose of vaccination against diphtheria, tetanus and pertussis Tdap (with reduced content of diphtheria and pertussis antigens) is given to adolescents at the age of 14 and 19. In contrast to a full-cell vaccine, after which the post-vaccination immunity lasts 10-12 years, the acellular vaccine provides

a protection period of about 5 years. Despite the lower reactogenicity which ensures less frequent occurrence of adverse post vaccination reactions, it seems that the shorter protection period of the acellular vaccine might be the cause of an increased incidence of pertussis in recent years [7, 8]

The rate of vaccination at the age of 3 was 98.7% (data of 2016). According to Narodowy Instytut Zdrowia Publicznego, the threshold for herd immunity to pertussis is estimated at 92-94%. If the immunization drops below the threshold of population immunity, the unvaccinated or non-immune persons will be exposed to the disease (for example as a result of the vaccinated response expiry), which can cause massive illnesses. The vaccination rate dropping tendency may contribute to an increase in the incidence of pertussis in coming years [8].

Conclusions

The vaccinations rate for pertussis in the years 2010-2016 is getting lower systematically. In those years, the incidence rate of pertussis increased - from 3.32 / 100,000 in 2010 to 17.77 / 100,000 in 2016. The decrease in the vaccination rate correlates with higher number of recorded cases of the disease.

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