Original Article

Does working in hospital increases seroprevalence and carrier state against *Bordetella pertussis*?

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Abstract

Background: Health care environments have been the setting for a number of pertussis outbreaks. Immunity after vaccination wanes overtime leading to a growing population of susceptible adolescents and adults. A number of pertussis outbreaks have occurred in hospitals resulting in transmission to health care workers (HCWs), and other patients. The aim of this study was to assess immunity status of a group of basic medical students and interns who worked in hospitals for about 4 years.

Materials and Methods: In a cross-sectional study, we measured the serum antibody titer of cases by enzyme-linked immunosorbent assay test. All 70 subjects have received pertussis vaccine in the routine childhood vaccination schedule. All cases were healthy and had no symptoms of any respiratory diseases. We also obtained a pharyngeal culture on Bordet-Gengou Agar for isolating *Bordetella pertussis*.

Results: The results of *B. pertussis* pharyngeal culture was positive for 5 (7.1%) cases and negative for 65 (92.9%). The IgM, IgA, and IgG serum antibody was positive in 1.4%, 7.1%, and 11.4% of cases, respectively. The mean age of cases had no significant effect on serum antibody titers ($P = 0.23$).

Conclusions: This study showed that majority of cases do not have protective serum antibody against *B. pertussis*. Working in hospitals does not affect seroprevalence and carrier state of *B. pertussis*. Immunization schedules that include no booster doses are at increased risk of pertussis. Due to the importance of the transmission in health care settings, vaccination of HCWs is a priority.

Key Words: *Bordetella pertussis*, health care workers, immunity, pertussis vaccine

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INTRODUCTION

Pertussis is a highly communicable respiratory disease. It was named whooping cough in the medicine literature. The attack rate of this acute respiratory infection has been reported to be 80–100% in susceptible household contacts and 20% in vaccinated persons.[1] Pertussis is a preventable disease by the vaccine. In spite of worldwide immunization, *Bordetella pertussis* is still a health problem in

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developing and developed countries.[2] As reported by World Health Organization, near 50 million pertussis disease cases and about 300,000 deaths by this respiratory infection has been reported.[3] The case fatality rate of pertussis in infants in developing countries is about 3%.[4] By introducing the whole cell pertussis vaccine in 1940, a dramatic decrease of disease happened. In recent years, an increase of pertussis was seen in youths and adults in many parts of the world.[5] The increase in the incidence of this disease between young people is partly due to waning of immunity in vaccinated persons.[6] Adults are a considerable source of infection for infants and children.[7] Nasopharyngeal carrier state by this organism has been reported in vaccinated children. Immunization by triple diphtheria, tetanus, and whole-cell pertussis vaccine has been applied in Iran for almost 50 years.[8,9] Nowadays diphtheria, tetanus, pertussis vaccine is being used by injection route. Universal immunization with this vaccine is recommended for children under 6 years of age and is typically delivered as a five-dose series (2, 4, and 6 months of age with boosters at 18 months and 6 years). After that immunization against pertussis is interrupted. Developed countries use diphtheria, tetanus, acellular pertussis vaccine and continue it by using tetanus, diphtheria, acellular pertussis (Tdap) with 10 years intervals.[10] Hospital transmission of *B. pertussis* between health care workers (HCWs) might be a source of infection for infecting unimmunized neonates and immunocompromised children and adults.[11] The aim of this study was to determine the immune status and nasopharyngeal carrier state of vaccinated preclinical medical students and interns.

MATERIALS AND METHODS

This was a cross-sectional survey that was conducted in 2013. Cases group were interns working in a university hospital (Al-Zahra hospital, Isfahan, Iran) and control group were preclinical medical students (1st and 2nd year medical student) who did not have exposure to hospital environment. The study was approved by the Ethics Committee of Isfahan University of Medical Sciences (research project number: 393237). Both cases and control groups had received pertussis-containing vaccines in the routine childhood vaccination. All students and interns had no history of human immunodeficiency virus infection, no known immunodeficiency disease, and no recent known *B. pertussis* infection. We took 5 ml venous blood from each person for serology test. The used test was enzyme linked immunosorbent assay (ELISA) kit, Abnova, Taiwan. Pertussis Toxin ELISA Kit is a quantitative ELISA for the determination of specific antibodies to *B. pertussis* toxin. Following the interpretation of results <0.9 IU/ml was considered as negative, ≥1 IU/ml as intermediate, and ≥1.2 IU/ml as positive. We obtained one pharyngeal culture by dacron swab and immediately transferred on Bordet-Gengou Blood Agar medium (BD Difco™, Australia). Bordet-Gengou Agar is a type of agar plate optimized to isolate *Bordetella* from clinical specimens, containing blood, potato extract, and glycerol, with an antibiotic cephalexin. All tests were supervised by our clinical pathologist colleague. Collected data were analyzed by SPSS software version 22, IBM, USA. Student's *t*-test and Chi-square test were used to compare variables. Statistical significance was defined as $P < 0.05$.

RESULTS

In this survey, 70 cases (35 female and 35 male) were studied. The mean age of cases was 25.1 ± 1.8 years old (range: 22–30). Results of pharyngeal culture for *B. pertussis* were positive for 5 (7.1%) and negative for 65 (92.9%) [Table 1]. *T*-test showed no significant differences between the age of patients and positive pharyngeal culture ($P = 0.71$). Fisher exact test also showed no significant differences between gender and positive pharyngeal culture ($P = 0.18$). Working in hospitals also had no effect on positive pharyngeal culture ($P = 0.63$). The IgM, IgA, and IgG antibody serum results are shown in Table 2. It means that majority of cases did not have protective serum antibody against *B. pertussis*. The IgM, IgA, and IgG was positive in 1.4%, 7.1%, and 11.4% of cases respectively. The mean serum titer of IgM, IgA, and IgG was 1.39 ± 0.17 IU/ml, 1.2 ± 0.2 IU/ml, 6.92 ± 082 IU/ml [Figure 1]. The mean age of cases had no significant effect on serum antibody titers ($P = 0.23$). There was also no significant difference between sex and antibody titer. There was no significant difference between serum antibody titer among students and interns. Interpretations of antibody profiles are shown in Table 3.

DISCUSSION

In this study, 5 (7.1%) cases had a nasopharyngeal positive culture for *B. pertussis*, two students, and

Table 1: Frequency distribution of demographic data based on culture result

Culture result variables	Positive	Negative	*P*
Age (mean±SD)	25.09±1.74	25.4±2.3	0.71
Sex *n* (%)			
Male	4 (80)	31 (47.7)	0.18
Female	1 (20)	34 (52.3)	
Cases *n* (%)			
Student	2 (40)	19 (29.2)	0.63
Intern	3 (60)	46 (70.8)	

SD: Standard deviation

Table 2: Frequency distribution of antibody results based on demographic data's

Antibody results variables	IgA			IgG			IgM		
	Positive	Negative	*P*	Positive	Negative	*P*	Positive	Negative	*P*
Mean age	25.05±1.74	26±2	0.25	25.13±2.23	25.11±1.72	0.99	23±1	25.14±1.76	0.23
Sex									
Male	3 (60)	32 (49.2)	0.99	5 (62.5)	30 (48.4)	0.71	1 (100)	34 (49.3)	0.99
Female	2 (40)	33 (50.8)		3 (37.5)	32 (51.6)		0 (0)	20 (29)	
Curse									
Student	1 (20)	20 (30.8)	0.53	3 (37.5)	18 (29)	0.69	1 (100)	20 (29)	0.3
Intern	4 (80)	45 (69.2)		5 (62.5)	44 (71)		0 (0)	49 (71)	

IgA: Immunoglobulin A, IgG: Immunoglobulin G, IgM: Immunoglobulin M

Table 3: Interpretation of antibody profiles

IgM	IgA	IgG	Interpretation
Negative	Negative	Negative	No indication for *Bordetella pertussis* infection
Intermediate	Negative	Negative	No recent infection
Intermediate or negative	Positive	Positive	Indication of recent infection
Positive	Negative or positive	Negative or positive	Indication of recent infection

IgA: Immunoglobulin A, IgG: Immunoglobulin G, IgM: Immunoglobulin M

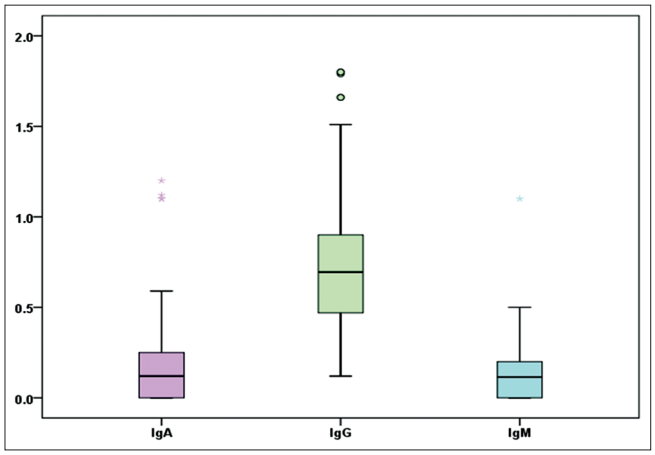

Figure 1: Mean, range and percent of antibody titers

three interns. Although this percent of the carrier state is high in this population, working in the hospital does not affect this colonization. In one study conducted on 391 healthy adults, only 1 nasopharyngeal carrier was found.[12] Lambert reported obtained positive cultures in four asymptomatic child contacts of a whooping cough. They all remained well for the next 4 weeks but had received erythromycin after the positive result was obtained.[13]

We recommend a course of antibiotic therapy to eradicate *B. pertussis* colonization because they might transmit this organism to other HCWs or patients specially infants and children in whom serious morbidity and mortality may occur.[14,15] However, erythromycin prophylaxis is not practiced uniformly throughout the world.[4] In our study, majority of cases had not protective serum antibody titer against *B. pertussis*. Immunity after childhood vaccination wanes overtime leading to a growing population of susceptible adolescents and adults. Advisory Committee on Immunization Practices recommends that an acellular pertussis vaccine (Tdap) which has been approved by Food and Drug Administration for adults and adolescents be given as soon as feasible to HCWs employed in hospitals and ambulatory settings who have direct patient contact.[16] Acellular pertussis vaccines are safe and immunogenic in adults. Antibody responds in adults to single doses of vaccine as large as those generated following a three-dose series given to infants.[17] Goins *et al*. demonstrated that Tdap vaccination of HCWs does not obviate the need for postexposure antibiotic prophylaxis.[18] The serum IgM and IgA were positive in 1.4% and 7.1% of cases. A positive IgA or IgM result has only been observed in natural infections, not in vaccinated patients. Repeated testing in 10–14 days might be helpful when initial results are equivocal.

CONCLUSIONS

Despite childhood pertussis vaccination, waning of vaccine immunity is a matter of concern in adults and adolescences. As considered by Global Pertussis Initiative, HCWs are a specific higher risk group and in priority for a booster dose of acellular pertussis vaccine to reduce the risk of pertussis transmission to infants. Given the impact of exposures on healthcare institutions, routine vaccination for HCWs might be beneficial.

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Conflicts of interest
There are no conflicts of interest.

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