Bordetella pertussis Booster Vaccination for Health Care Personnel Immediately Following a Pertussis Outbreak in a Hospital?

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(See the report by Kirkland et al on pages 584–7)

Pertussis, caused by the small gram-negative bacterium *Bordetella pertussis*, is a life-threatening disease in young infants. Although almost all mortalities occur in children aged <6 months, the bacterium causes significant morbidity in all age groups [1], and adolescents and adults are often the source of infection in small children. Symptoms may be the classic ones, with paroxysmal cough and post-tussive vomiting. However, symptoms in adult may be less characteristic, with only milder or more prolonged cough. Studies performed worldwide on the etiology of prolonged cough in adults have shown that pertussis is the causal agent in 12%–32% of cases [1, 2]. The true incidence of pertussis is poorly defined and may vary because of epidemic cycles of 3–4 years [3]. However, active pertussis surveillance studies that have tested adolescents and adults with cough through culture, polymerase chain reaction (PCR), and serology have demonstrated an incidence of pertussis of ~400 cases per 100,000 persons annually [4, 5].

*B. pertussis* is transmitted by droplets produced during coughing, sneezing, or talking. It is highly contagious, and before implementation of vaccination programs, 80% of the population had experienced pertussis during childhood and 95% had been infected at the age of 19 years. At one time, it was believed that immunity from natural infection was nearly lifelong. The current estimates of the duration of infection-acquired immunity range from 7–20 years [6]. Pertussis vaccines have been included in the childhood vaccination program since the 1940s. In the 1990s, the pertussis vaccine was changed from the whole-cell vaccine to an acellular vaccine that causes fewer adverse reactions. The duration of immunity after whole-cell pertussis vaccination is 4–12 years; 3 studies have estimated the duration of protection after acellular vaccine to be ~6 years [6]. The pertussis vaccination programs in different countries are not quite similar, and the amount of pertussis antigens (*pertussis toxin, filamentous hemagglutinin, pertactin, and fimbriae*) in vaccines from different companies are slightly different [3, 7]. This may influence the duration of immunity [8]. Most pertussis vaccination programs consist of 4–5 injections up to the age of 6 years. Some programs recommend an adolescent booster injection [3, 7]. With high vaccine coverage among children and waning immunity after 6 years, it may be expected that pertussis would be a disease of adolescents and adults. An increasing pertussis incidence among adolescents and adults, indicated in the annual report from the United States National Diseases Surveillance System, seems to confirm this suspicion [3].

The adolescent and adult population appears to be the major reservoir for the pertussis bacterium. Waning pertussis immunity among health care personnel with direct patient contact can have severe disease and economical implications. Pertussis-infected health care personnel with no awareness of the disease may transmit infection to other health care personnel and to susceptible patients, among them small infants [3]. Linnemann et al [9] described a pertussis outbreak in a hospital in the 1970s in which several newborn infants developed pertussis after exposure to infected health care personnel. Leekha et al [10] reported 2 large pertussis outbreaks at the Mayo Clinic in Rochester during the period from October 2004 through October 2005. In the second outbreak, 513 health care personnel were suspected to be infected and 64 had a positive *B. pertussis* PCR result. The resource consumption associated with the second outbreak among
health care personnel, including tests for pertussis, health care personnel visits, antimicrobial prophylaxis, and/or treatment and missed work days, amounted to $236,000 [10].

To increase pertussis immunity among adults and particularly among health care personnel, in December 2006 the Advisory Committee on Immunization Practices (ACIP) in the United States recommended an acellular pertussis vaccine combined with tetanus and diphtheria toxoid but with reduced pertussis toxin antigen and diphtheria toxoid (Tdap) for booster vaccination for adults aged 19–64 years, including health care personnel. Tdap was only licensed for single use [11]. Recipients have demonstrated good antibody response to B. pertussis antigens 4 weeks after vaccination [12], and it has been found to be safe and efficient in a large vaccination study with a 2.5-year follow-up period [5]. It will take time to get the ACIP recommendations implemented and have increased pertussis immunity among health care personnel, and pertussis outbreaks in hospitals may still be a possibility in the future. Therefore, there is need for an evaluation of the effect of immediate pertussis booster vaccination for health care personnel when a pertussis hospital outbreak is identified. In this issue of Clinical Infectious Diseases, Kirkland et al [13] report on the kinetics of the immune responses to Tdap in health care personnel and implications for outbreak control.

Soon after a hospital outbreak of a pertussis-like illness, 115 health care personnel with a median age of 45 years (23 participants were aged ≥55 years) received a pertussis booster vaccination (Tdap). Serum specimens were collected before vaccination and at 1, 2, and 4 weeks after vaccination, and respiratory illness was reported for up to 4 weeks after vaccination. The important messages from this study were: (1) ≈50% of the study population demonstrated antibody booster response to all pertussis antigens in Tdap 1 week after vaccination; (2) >87% of the population demonstrated antibody booster response to all pertussis antigens 2 weeks after vaccination; and (3) the population antibody responses to the pertussis antigens were the same at 2 and 4 weeks after vaccination. Some study participants were aged ≥65 years, but the number of participants and the immune responses in this small population were not reported. A report of immunogenicity of Tdap in adults aged >64 years could have provided a fourth message from the study, because this has not yet been examined [11]. Most of the study subjects had received a pertussis vaccination previously, but the duration of time since the last vaccination was not reported. If the period since the last vaccination was <6 years, the study participant may have been fully vaccinated and had no need for a booster vaccination. The severity of the pertussis outbreak in the hospital was not reported. It may have been relevant to report the number of patients and health care personnel who had pertussis that was proven by culture or PCR and the number of patients or health care personnel who received macrolide antibiotics after exposure during the pertussis outbreak period. None of the study subjects reported experiencing respiratory illness during the 4-week study period. With an incubation period of up to 21 days, this study period does not exclude later infection. To calculate the efficacy of the pertussis booster vaccination for this outbreak, the surveillance period should have been extended to >4 weeks, and a nonvaccinated control population should have been included. Pertussis antibody measurements and symptom surveillance in a nonvaccinated control population may have increased the impact of the study.

The study by Kirkland et al [13] is important and shows that the susceptibility to pertussis infection presumably is reduced within 1–2 weeks after booster vaccination with Tdap. The next step is to investigate whether a Tdap booster vaccination for health care personnel, with waning pertussis immunity at the time of a pertussis outbreak, can reduce the need for antimicrobial prophylaxis among health care personnel who are exposed to pertussis-infected patients, and whether a booster vaccination can reduce the duration and cost of pertussis outbreaks in hospitals. There are other challenges regarding Tdap vaccination among health care personnel. First, Tdap is not approved for persons aged >64 years, and the immunogenicity of Tdap in this age group should be examined. Second, Tdap is only licensed for a single use. The duration of protection offered by acellular pertussis vaccine is ~6 years, and thus, it may be necessary to provide a booster vaccination every 6–10 years to maintain a high level of immunity against pertussis among health care personnel.

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References

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