High Incidence of Pertussis among Hajj Pilgrims

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Prolonged cough occurs in a large proportion of the 2 million pilgrims who participate in the annual Hajj in Saudi Arabia. In a prospective seroepidemiological study to determine the incidence of pertussis among 358 adult pilgrims, 5 (1.4%) were found to have acquired pertussis (defined as prolonged cough and a >4-fold increase in the level of immunoglobulin G to whole-cell pertussis antigen). Of the 40 pilgrims who had no pre-Hajj immunity to pertussis, 3 (7.5%) acquired pertussis. Administration of acellular pertussis vaccine to pilgrims before the Hajj should be considered to address this problem.

Pertussis is a highly communicable, vaccine-preventable respiratory disease and is a frequent but often underestimated cause of illness involving prolonged cough in adults [1]. Although pertussis is characterized by paroxysmal cough, whooping cough, and posttussive vomiting in children, the disease is often atypical in adults and sometimes manifests only as a protracted, nondistinctive cough [2]. High pertussis attack rates have been observed among adults during community outbreaks of pertussis, even in populations with a high rate of immunization; this is thought to reflect waning of immunity conferred by childhood vaccination [3].

During the annual Hajj pilgrimage, >2 million pilgrims from all over the world congregate for religious rituals in Mecca and Medina, Saudi Arabia [4]. The vast majority of pilgrims are adults; pilgrims often are elderly and have underlying medical conditions. This 1-month-long event is characterized by severe overcrowding, which facilitates transmission of airborne infections. Cough is a common complaint during this pilgrimage and often affects >50% of the pilgrims [4, 5]. We hypothesized that this might in part reflect transmission of pertussis among pilgrims. We therefore conducted a prospective seroepidemiological study to determine the incidence of pertussis among adult Hajj pilgrims.

Methods. Pilgrims were recruited consecutively at a Muslim center in Singapore that performs mass vaccinations with the quadrivalent meningococcal and influenza vaccine for pilgrims referred by numerous national Muslim travel agencies. Venous blood samples were obtained at the time of vaccination in this center in January 2002 (~1 month before their departure for the pilgrimage), and pilgrims were asked to supply a second sample ~3 months after their return. Pilgrims were questioned about the duration of their stay, their accommodation arrangements, and the occurrence and duration of cough (>1 week or ≤1 week) during the Hajj and also about the occurrence and duration of cough before their departure for and since their return from the Hajj. For individuals who were born in or after 1959 (when Singapore introduced pertussis as part of the childhood immunization program), a history of pertussis vaccination was recorded.

IgG antibodies to pertussis whole-cell antigen (containing pertussis toxin and filamentous hemagglutinin) were measured, and the results were interpreted according to the manufacturer’s instructions (Bordetella Pertussis IgG ELISA; Immuno-Biological Laboratories). We defined acquisition of pertussis as prolonged cough (lasting >1 week) and a >4-fold increase in IgG. Logistic regression models were used to identify both univariate and multivariate risk factors associated with acquisition of pertussis. Data analysis was done using Stata statistical software (version 6.0), and all statistical tests were conducted at the 5% level of significance. The study was approved by the ethics committee of the Tan Tock Seng Hospital, Singapore. All subjects gave written informed consent.

Results. Four hundred ninety pilgrims, all Malay Muslims, were recruited before the Hajj, of whom 358 (73%) returned to supply a post-Hajj blood sample. Paired pre- and post-Hajj samples from these 358 pilgrims were analyzed. The median age was 48 years (range, 16–75 years); 129 (36.0%) were male. The median duration of stay during the Hajj was 34 days (range, 13–43 days), and 204 pilgrims (57.0%) complained of prolonged cough during the Hajj.

Before the Hajj, the results of tests for IgG to pertussis antigen were negative for 40 pilgrims (11.2%), intermediate for 25 (7.0%), and positive for 293 (81.8%). There was no difference in...
in the rate of positivity between those who had received childhood pertussis vaccination and those who had not (83.8% vs. 81.3%).

Five of 358 pilgrims (1.4%; 95% CI, 0.5%–3.2%) had a >4-fold increase in the level of IgG, and all 5 reported developing a prolonged cough during the Hajj, thus meeting the criteria we defined for acquisition of pertussis. None of these 5 had symptoms of cough before their departure for or after their return from the Hajj. Of the 40 pilgrims who had no pre-Hajj immunity to pertussis, 3 (7.5%; 95% CI, 1.6%–20.4%) acquired pertussis. Among 204 pilgrims with prolonged cough, pertussis was present in 2.5% (5 pilgrims).

On univariate analysis, age, sex, pertussis vaccination status, and the number of people with whom the pilgrim shared accommodations were not associated with acquisition of pertussis. Univariate risk factors associated with the acquisition of pertussis were absence of immunity to pertussis before the Hajj (OR, 7.04; 95% CI, 1.15–43.02; \( P = .035 \)) and duration of stay during the Hajj (\( P = .034 \)); the odds of acquiring pertussis increased by 24.68 (95% CI, 1.28–477.29) for every doubling of duration of stay. In the multivariate analysis, the adjusted OR for absence of immunity to pertussis was 6.68 (95% CI, 1.06–42.24), which was still significant (\( P = .044 \)). The odds of acquiring pertussis increased by 16.79 (95% CI, 0.997–282.68) for every doubling of duration of stay (\( P = .050 \)).

**Discussion.** The overall incidence of pertussis (1.4%) that we found among our subjects during this 1-month-long event is higher than that of most other vaccine-preventable travel-related diseases (with the exception of influenza) [6]. It is also higher than that reported in other groups at high risk for pertussis, such as health care workers (annual incidence, 1.3%, which is equivalent to a monthly incidence of 0.1%) [7], and is much higher than the estimated annual incidence in the general population in the United States (0.5%) [8]. Among nonimmune pilgrims, the incidence of pertussis was 7.5%, which indicates that the overall incidence of pertussis will be much higher among pilgrims from countries without pertussis vaccination coverage or with less exposure to pertussis. The level of pre-Hajj pertussis seropositivity was relatively high in our cohort, but this is most likely a result of the older age of these pilgrims (pertussis seropositivity increases with age) [9, 10]. Pertussis seropositivity was independent of a history of childhood pertussis vaccination; it is likely that pertussis is acquired later in life.

Although we demonstrated a high incidence of pertussis, only 2.4% of pilgrims with prolonged cough had pertussis. This prevalence is far lower than that reported in adolescent and adult populations of individuals in industrialized countries presenting with prolonged cough (19%–26%) [1, 2, 11]. Influenza-like illness has been reported to occur in 22% of pilgrims [12]. However, all pilgrims in our cohort were vaccinated against influenza. Further studies would, therefore, need to investigate other causes of our reported high incidence of cough among pilgrims.

It is likely that our results are generalizable to the whole Hajj population, because overcrowding is universal during the Hajj. The acquisition rate of pertussis may be influenced by pre-existing levels of immunity in different pilgrim populations, but these are unlikely to vary greatly from the 80% seen in Singapore. Thus, the incidence of 1.4% would translate into ~28,000 cases of pertussis during this pilgrimage. This not only is a matter of concern for the pilgrims but also constitutes a public health problem, because pilgrims may present a reservoir and may transmit the disease to others on return to their countries of origin. Susceptible infants usually acquire pertussis from an infected adult [13], and many pilgrims return to countries where pertussis vaccination may not be part of the childhood immunization program.

Adult-type acellular pertussis vaccine confers safe and effective protection against pertussis [14]. The recent recommendations of the International Consensus Group on Pertussis Immunisation state that public health policy-makers should target pertussis boosters at adult risk groups [14]. Our findings suggest that departing Hajj pilgrims would be one risk group that might benefit from immunization against pertussis.

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**References**