Bordetella pertussis Isolates, Finland

To the Editor: Pertussis, or whooping cough, is a highly contagious respiratory disease in humans caused by Bordetella pertussis. Reemergence of pertussis has been observed in many countries with high vaccination coverage. In the United States, reported cases of pertussis in adolescents and adults have increased since the 1980s, despite increasingly high rates of vaccination in infants and children (1). At the same time, clinical B. pertussis isolates have become antigenically divergent from vaccine strains (2,3). This observation has raised the question of whether vaccination has caused selection for the variant strains, and whether the reemergence of pertussis in vaccinated populations is due to vaccination not protecting against these antigenic variants as effectively as it protects against vaccine type strains. On the other hand, vaccine-induced immunity wanes over time, and pertussis is not only a childhood disease but also a frequent cause of prolonged illness in adults and adolescents today (4).

In Finland, children are vaccinated with diphtheria-tetanus whole-cell pertussis vaccine at 3, 4, and 5 months, and from 20 to 24 months of age. The whole-cell vaccine contains 2 strains and has remained unchanged since 1976. The vaccine strain 18530 contains fimbrae 3 (Fim3), pertussis toxin S1 subunit D (PtxS1D), and pertactin 1 (Prt1); the other vaccine strain, 1772, contains Fim2,3, PtxS1B, and Prtn. Ninety-six percent of Finland’s population has been vaccinated with 4 doses of pertussis. The incidence of pertussis is highest in infants <1 year of age and in schoolchildren from 6 to 14 years old, although about 30% of the cases occur in adults older than 20 years. In Finland, as in many other countries with large-scale vaccination programs, several outbreaks of pertussis occurred in the 1990s. We studied prospectively 3 pertussis outbreaks in 2 elementary schools and 1 municipality in southwestern Finland (5,6). The aim of the study was to characterize the strains circulating and causing outbreaks and to track the transmission of B. pertussis during these outbreaks.

Sample were collected and primary cultures were done as described earlier (5,6). (See online Tables 1–3 at http://www.cdc.gov/ncidod/EID/vol11no01/04-0632.htm#table1, http://www.cdc.gov/ncidod/EID/vol11no01/04-0632.htm#table2, http://www.cdc.gov/ncidod/EID/vol11no01/04-0632.htm#table3). The outbreaks took place in 3 rural municipalities: in 1992, in Paimio with 1,400 inhabitants; in 1995, in Oripää with 3,500 inhabitants; and in 1996, in Rusko with 9,900 inhabitants. The isolates were obtained from schools and local health centers. In addition, 1 isolate was obtained from a household contact (See online Table 3 at http://www.cdc.gov/ncidod/EID/vol11no01/04-0632.htm#table3). Most of the cases occurred in schoolchildren >8 years of age and in adults.

Various DNA fingerprinting techniques, such as IS1002-based restriction fragment length polymorphism (IS1002-RFLP) and pulsed-field gel electrophoresis (PFGE) have been used to study B. pertussis isolates (7–10). DNA polymorphism analysis of prn and ptxS1 has previously been used as a typing method for detecting antigenic shifts (2,3,8). In addition to prn and ptxS1, only tracheal colonization factor (tcfA), a surface-associated protein involved in the adhesion of B. pertussis to host cells, has been found to be polymorphic in recent B. pertussis isolates (3). The isolates were typed as described earlier (8,10).

Of the 46 isolates, 43 (94%) expressed Fim2, 2 (4%) expressed both Fim2 and Fim3, and 1 (2%) expressed Fim3 (See online Tables). The predominant prn allele in all 3 outbreaks was prn2, contained by 39 (85%) of the isolates. Six (13%) isolates contained prn3 and 1 (2%) isolate contained prn4. All isolates contained the ptxS1A allele. The predominant tcfA allele was tcfA2, contained by 42 (91%) of the isolates. Four (9%) isolates contained tcfA3. The tcfA3 allele was observed only in isolates with prn3. All but 1 of the 27 isolates subjected to the IS1002-RFLP analysis had the same pattern.

Seven PFGE patterns were found among the 46 isolates studied. The isolates were considered to be closely related, as the differences between the patterns were small, differing by 1 or 2 bands. Three PFGE patterns were found in both Paimio and Rusko. A major pattern was circulating in each of the schools A, B, and C, which indicates that pertussis is effectively transmitted in schools. However, in school D, the isolate from the index patient had PFGE pattern 5, whereas the rest of the isolates from patients in school D had pattern 6. In addition, the 1 isolate obtained from a household contact had a distinct PFGE pattern, 7. Similarly, in Paimio, the isolate from the index patient had a distinct PFGE pattern, 1. These findings, as well as the fact that 3 PFGE patterns were found in both Paimio and Rusko, indicate that several B. pertussis strains may have been circulating simultaneously in these small communities.

Our results suggest that ptxS1 is not a useful marker in outbreaks to detect antigenic shifts. IS1002-RFLP was less discriminative than XbaI PFGE, which agree with results of previous studies (8). Most cases occurred in schoolchildren and adults, confirming epidemiologic findings from other countries with vaccination programs. Our results support the earlier observation that the recent B. pertussis isolates are antigenically different from vaccine strains. Several B. pertussis strains could circulate...
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simultaneously even in small communities, and only some strains, possibly with increased fitness, are capable of spreading effectively.

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Johanna Mäkinen,*† Jussi Mertsola,‡ Frits R. Mooi,§ Shirley Van Amersfoorth,‡ Heikki Arvilommi,* Matti K. Viljanen,‡ and Qiushui He*

*National Public Health Institute, Turku, Finland; †Turku Graduate School of Biomedical Sciences, Turku, Finland; ‡University of Turku, Turku, Finland; and §National Institute of Public Health and the Environment, Bilthoven, the Netherlands

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Address for correspondence: Johanna Mäkinen, Mycobacterial Reference Laboratory, National Public Health Institute, Kiinamyllynkatu 13, 20520 Turku, Finland; fax: 358-2-331-6699; email: johanna.makinen@ktl.fi

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