Available online at www.sciencedirect.com
SCIENCE DIRECT®
Vaccine 22 (2004) 594–596
Vaccine
www.elsevier.com/locate/vaccine

Letter to the Editor

Loss of immunity to pertussis in a rural community in Senegal

Recent household studies have shown that both vaccine- and infection-induced immunity to pertussis may not be permanent, with significant implications for its potential eradication. Currently, little is known about the frequency of loss of immunity and the average duration of the immune period, induced either by infection or vaccination. Here, we present long-term clinical pertussis case data from the Niakhar community in rural Senegal, and use them to explore these key epidemiological parameters.

Despite concerted mass vaccination programmes in many countries, pertussis remains a substantial public health burden, accounting for an estimated 200,000–400,000 annual fatalities world-wide [1]. Over the last two decades, many countries have reported an increase in the incidence of pertussis, despite very high vaccine coverage [2]. A possible explanation for this observation is the waning of immunity to pertussis and subsequent re-transmission [3]. This flies in the face of population dynamics evidence suggesting dramatically reduced transmission in the modern era [4]. A resolution of this issue urgently requires the analysis of appropriate data to estimate the likelihood of loss of immunity and the mean duration of protection, be it from natural infection or vaccine-induced. In this study, we aim to suggest estimates for these parameters from reported pertussis cases in Niakhar, a small community in rural Senegal, approximately 150 km East of Dakar. The surveyed region is composed of 30 villages, with a total population size of 30,452 inhabitants in 2000. Mean ages at infection were compared with the non-parametric Kruskall–Wallis test.

Detailed demographic and epidemiological data have been collected since 1983. Definitions of cases and methods used to collect information were previously described by Préziosi et al [5]. The pertussis vaccination campaign was implemented at the end of 1986 and outbreak episodes occur every 3–4 years. The mean annual vaccine coverage (receiving at least two doses) for the period 1987–2000 was around 43%, though there is substantial variation in this figure, depending on age [5].

During 1983–2000, 8629 cases were reported, with 9% of cases under one year of age and only 1.7% over 15. Nearly 73% of cases were in unvaccinated children, and 27% in those previously vaccinated. A total of 210 children were subsequently confirmed with pertussis for a second time, 137 (1.6% of total cases) were unvaccinated and 73 were previously vaccinated children (0.8%).

In Fig. 1, we demonstrate the distribution of age at first infection (A) and age at second infection (B). The overall mean age at first infection is 5.8 years (95% CI 5.7–5.9) among unvaccinated children and 5.3 years (5.2–5.4) in vaccinated children. Those mean ages are not significantly different ($P = 0.072$). It is interesting to note that those children who suffered two episodes of pertussis infection had a mean age at first infection of only 2.9 years (2.4–3.3) in unvaccinated children and 3.1 years (2.7–3.6) among vaccinated children. Mean ages at second infection are 9.9 years (9.4–10.5) and 8.2 years (7.7–9.3) (Fig. 2). The mean age at second infection in unvaccinated children is significantly different from vaccinated children ($P = 0.0006$). Hence, the mean gap between successive pertussis episodes is longer ($P = 0$), 7.1 years (6.6–7.6), in unvaccinated children than in vaccinated children 5.1 years (4.5–5.7).

Our study suggests two qualitative conclusions. First, only a small fraction of children were diagnosed with a second episode of pertussis. This estimate clearly neglects asymptomatic infections, though the contribution of these to transmission remains a contentious issue. Second, the mean age at (first) infection is substantially lower for those children who subsequently get re-infected (e.g. 2.9 years, as opposed to 5.8, $P = 0$). It will be important to explore the roles played by exposure and genetic susceptibility in this disparity.

These results, from a uniquely detailed study in a developing country, are perhaps encouraging from a public health perspective because they suggest that few children develop multiple episodes of pertussis, however this scenario is probably overly optimistic. The Niakhar data are complicated by under-reporting due to two processes. First, there is significant flux of children in and out of Niakhar, making it difficult both to track those secondary episodes that occurred outside the community and to obtain accurate epidemiological information for those incoming children. Second, historically, pertussis has predominantly affected children, therefore data collection methods in Niakhar typically do not involve the monitoring of adults, clearly introducing a bias into the data. Nevertheless, we hope that the acquisition

0264-410X/$ – see front matter
doi:10.1016/j.vaccine.2003.07.018

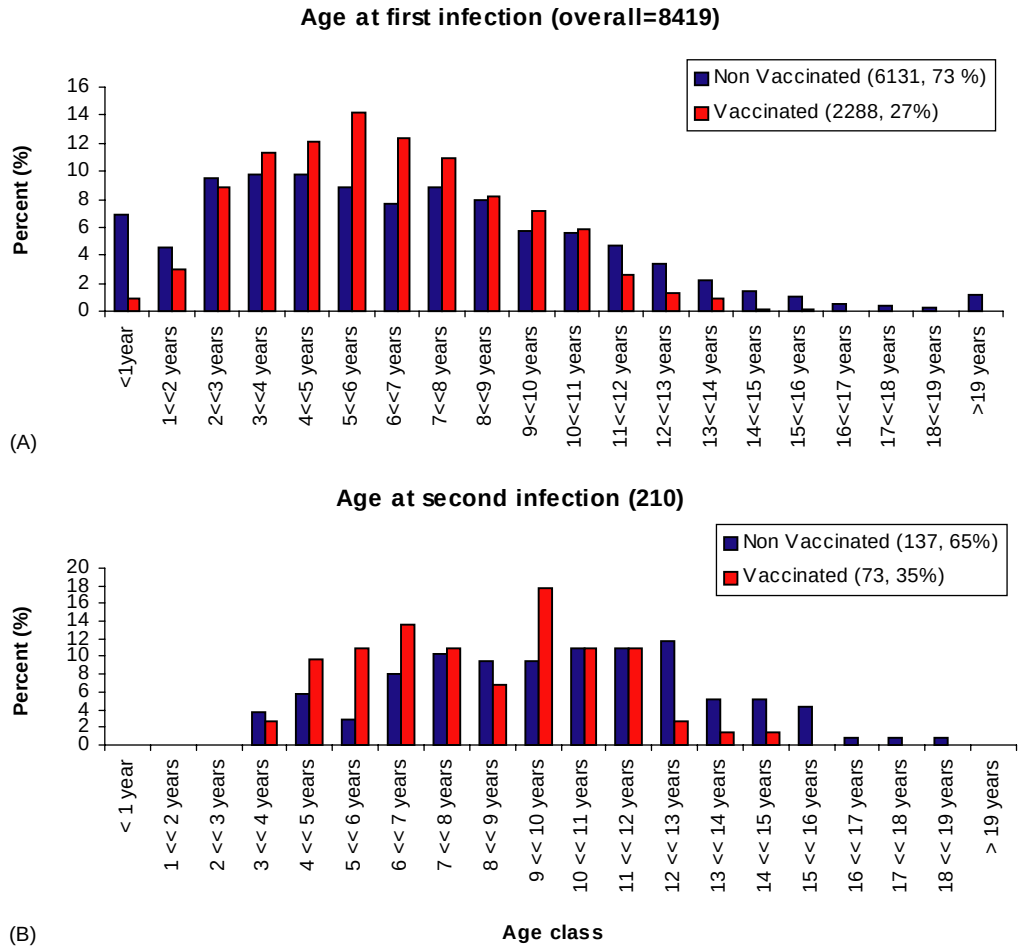

Fig. 1. Distribution of ages at first infection (A) and at second infection (B). (A) Ages at infection were calculated for the 8419 cases reported between 1983 and 2000. (B) Ages at infection were calculated for the 210 children who got two pertussis infections within the duration of the study.

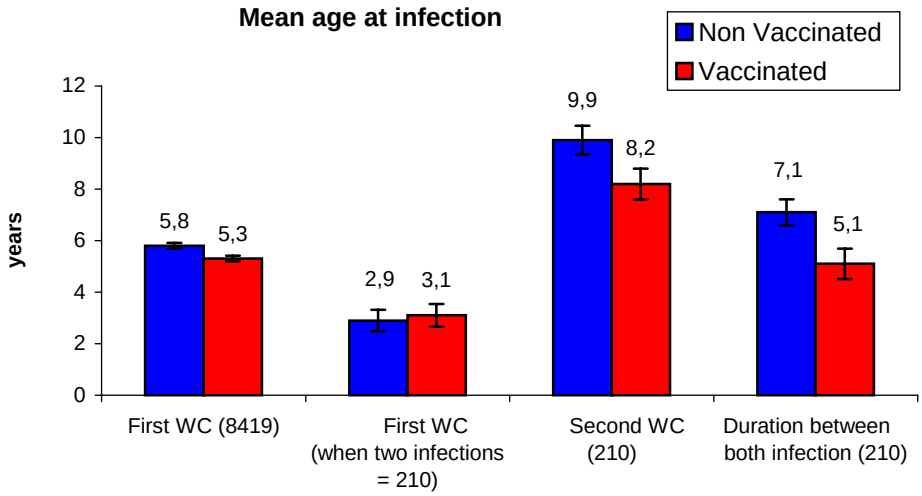

Fig. 2. Mean age of pertussis infection in Niakhar, an area consisting of 30 villages with approximately 30,000 inhabitants with 45% under 15 years old. Up to the year 2000 13,000 children were vaccinated (receiving at least two doses). Mean age at first infection was calculated for all children (8419): 3131 (73%) unvaccinated children, 2288 (27%) vaccinated. Mean age at first infection, at second infection and then mean duration between both infections were calculated for the 210 children who got pertussis infection twice: 137 (65%) unvaccinated, 73 (35%) vaccinated.

of long-term and similarly detailed data can help to provide more accurate information on the natural history of pertussis infection and its epidemiological consequences in different environments.

Acknowledgements

We thank both Aventis Pasteur and the Centre National de la Recherche Scientifique for providing fellowship (H.B.). F.S. and J.F.G. thank the Institut de Recherche pour le Développement (France and Senegal). B.G. thanks the Wellcome Trust for financial support. Epidemiological surveillance was supported by successive grants from EEC TDR Grant 36, Task Force for Child Survival (428), Aventis Pasteur and IRD. We thank the many people which were engaged in surveillance over the epidemiological survey.

References

[1] Crowcroft NS, Britto J. Whooping cough—a continuing problem. BMJ 2002;324(7353):1537–8.
[2] WHO, 2003, http://www.who.int/vaccines/en/pertussis.shtml.
[3] Wirsing von Konig CH, Postels-Multani S, Bock HL, Schmitt HJ. Pertussis in adults: frequency of transmission after household exposure. The Lancet 1995;346(8986):1326–9.
[4] Rohani P, Earn DJ, Grenfell BT. Impact of immunisation on pertussis transmission in England and Wales. The Lancet 2000;355(9200): 285–6.
[5] Préziosi MP, Yam A, Wassilak SG. Epidemiology of pertussis in a West African community before and after introduction of a widespread vaccination program. Am J Epidemiol 2002;155(10):891–6.

Hélène Broutin
UR 024 Epidémiologie et Prévention
Institut de Recherche pour le Développement (IRD)
911, Avenue Agropolis BP 64501
34394 Montpellier Cédex 5, France

CEPM, UMR CNRS-IRD 9926, 911
Avenue Agropolis BP 64501
34394 Montpellier Cédex 5, France

Corresponding author. Tel.: +33-467416158
fax: +33-467416299
E-mail address: helene.broutin@mpl.ird.fr
(H. Broutin)

François Simondon
UR 024 Epidémiologie et Prévention
Institut de Recherche pour le Développement (IRD)
911, Avenue Agropolis BP 64501
34394 Montpellier Cédex 5, France

Pejman Rohani
Institute of Ecology, University of Georgia
Athens, Georgia 30602-2202, USA

Jean-François Guégan
CEPM, UMR CNRS-IRD 9926, 911
Avenue Agropolis BP 64501
34394 Montpellier Cédex 5, France

Bryan T. Grenfell
Department of Zoology, University of Cambridge
Downing Street, CB2 3EJ, UK

Broutin Hélène, Simondon François, Rohani P., Guégan Jean-François, Grenfell B.T. (2004)

Loss of immunity to pertussis in a rural community in Senegal

Vaccine, 22, 594-596

ISSN 0264-410X