THE CHANGING EPIDEMIOLOGY OF PERTUSSIS IN THE HUNTER NEW ENGLAND AREA AND POTENTIAL IMPLICATIONS FOR THE IMMUNISATION SCHEDULE

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Notifications of pertussis in adults have recently shown an upward trend in the Hunter New England Area, while rates in adolescents have decreased. This article presents trends in pertussis notifications and rates for the Hunter New England region for the period 1998–2005, demonstrating a shift in pertussis incidence to older age groups that peak in the 50–64 age group.

A complete understanding of the epidemiology of *Bordetella pertussis* is complicated by imperfect diagnostic methods and incomplete recognition, testing and notification of the disease. It is generally agreed that notification rates represent an under-reporting of actual incidence.[1] However, Australia has improved surveillance for pertussis since the early 1990s and currently has the highest reported pertussis incidence rates of any country in the world. Between 4,000 and 10,000 cases have been reported each year since 1993, an incidence of between 22 and 58 per 100,000 population.[2]

In most countries, infants are given three doses of pertussis vaccine within the first six months of life. But despite high immunisation rates in infants and children, pertussis remains endemic, with epidemics also occurring every two to five years.[3,4] This pattern has not changed since the pre-vaccine era prior to the 1940s, and is probably caused by the continued transmission of pertussis among adolescents and adults, with infection of susceptible infants. Five countries—Australia, Austria, Canada, France and Germany—have responded to the rising incidence of pertussis in adolescents and adults by incorporating an adolescent booster dose in their immunisation schedules.

Preventing pertussis in children is one of the aims of the NSW Immunisation Program. In 2004, high school students were also targeted for a pertussis booster as this group was most affected by the epidemics that occurred in 1997 and 2000–2002.[5]

The Hunter New England Area Health Service provides health services, including immunisation services, to approximately 826,000 people across an area of 130,000 km^2 in northeastern NSW. In Hunter New England, infant immunisation coverage against pertussis has consistently exceeded 90 per cent during the past decade. Coverage of approximately 70 per cent of adolescents was achieved in Hunter New England during 2004. The impact of this initiative on the epidemiology of the disease is unknown. In addition, the immunity that follows pertussis disease is not long lasting.[6] It is therefore necessary to consider the changing epidemiology of pertussis, which in turn should inform the development of future immunisation strategies to limit disease transmission.

METHODS

Pertussis is a statutory notifiable disease in NSW, with cases notified by doctors, hospital chief executives, laboratories, school principals and directors of childcare facilities. In Hunter New England, pertussis notifications are routinely followed-up by the public health unit in partnership with general practitioners and other health workers. The follow-up serves to limit the spread of disease through appropriate education, contact tracing, and providing antibiotic prophylaxis to contacts.

For notification purposes in NSW, a probable case of pertussis is defined as a person with a coughing illness lasting for two or more weeks and paroxysms of coughing or inspiratory 'whoop' or post-tussive vomiting. A confirmed case requires isolation of *B. pertussis* or detection of *B. pertussis* by nucleic acid testing from a nasopharyngeal specimen. All suspected, probable and confirmed cases of pertussis within NSW are entered into the NSW Notifiable Diseases Database.

Notification data of confirmed pertussis cases from the NSW Notifiable Diseases Database for the Hunter New England Area for the period 1 January 1998 to 31 December 2005 was reviewed. Pertussis notifications were analysed for the date of onset of illness and the age group of the case. The following age groups were used in the analysis: 0-4 years, 5-19 years, 20-34 years, 35-49 years, 50-64 years, and 65 years and over. The narrower 0-4 year age group was used, as this group is particularly prone to serious illness.

For each year between 1998 and 2005, the proportional contribution of each age group to the overall number of pertussis notifications was calculated. To account for demographic changes in the Hunter New England population over this period, annual pertussis notification rates per 100,000 were also calculated for each age group for the years 1998-2005, using annual Census data estimates for the Hunter New England population. Chi square tests for linear trend were used to explore variations between age groups.

RESULTS

Between 1 January 1998 and 31 December 2005 there were 4,447 notifications of pertussis ranging from 313 in 1999 to 1,233 in 2000 (Figure 1).

There has been a change in the age distribution of pertussis notifications during this period. The proportional contribution of the 5–19 age group to total notifications

FIGURE 1

PERTUSSIS NOTIFICATIONS BY MONTH, HUNTER NEW ENGLAND AREA HEALTH SERVICE, NEW SOUTH WALES: JANUARY 1998 TO DECEMBER 2005

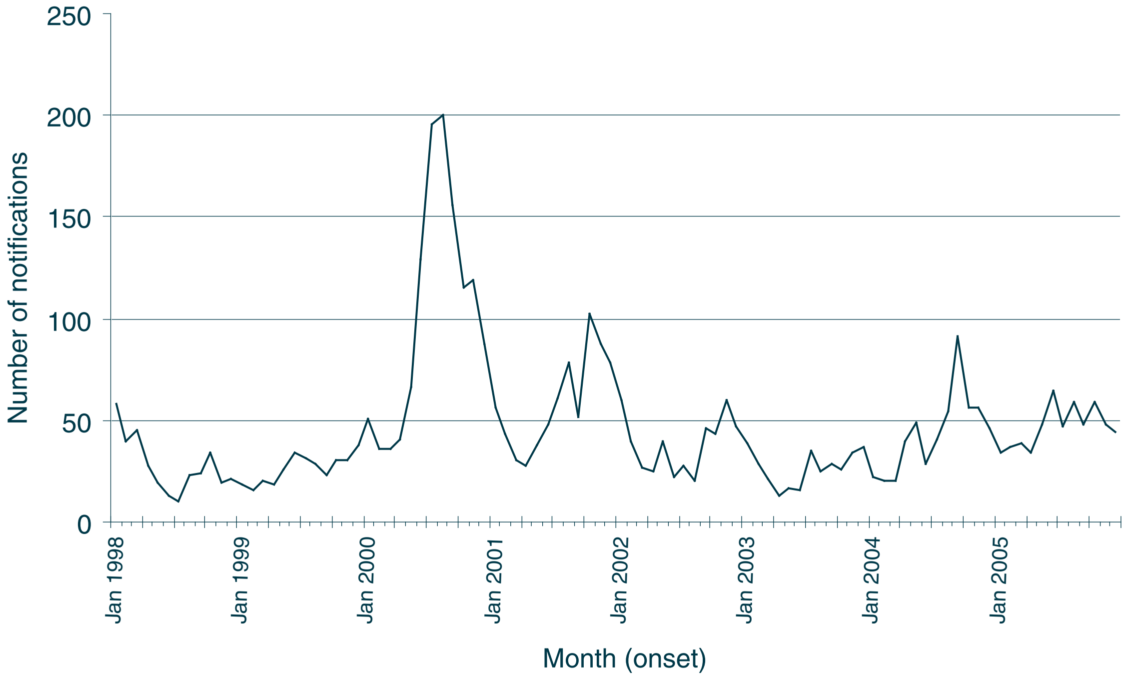


FIGURE 2

PROPORTIONAL CONTRIBUTION TO PERTUSSIS NOTIFICATIONS FOR SIX AGE GROUPS, HUNTER NEW ENGLAND AREA HEALTH SERVICE, NEW SOUTH WALES: JANUARY 1998 TO DECEMBER 2005

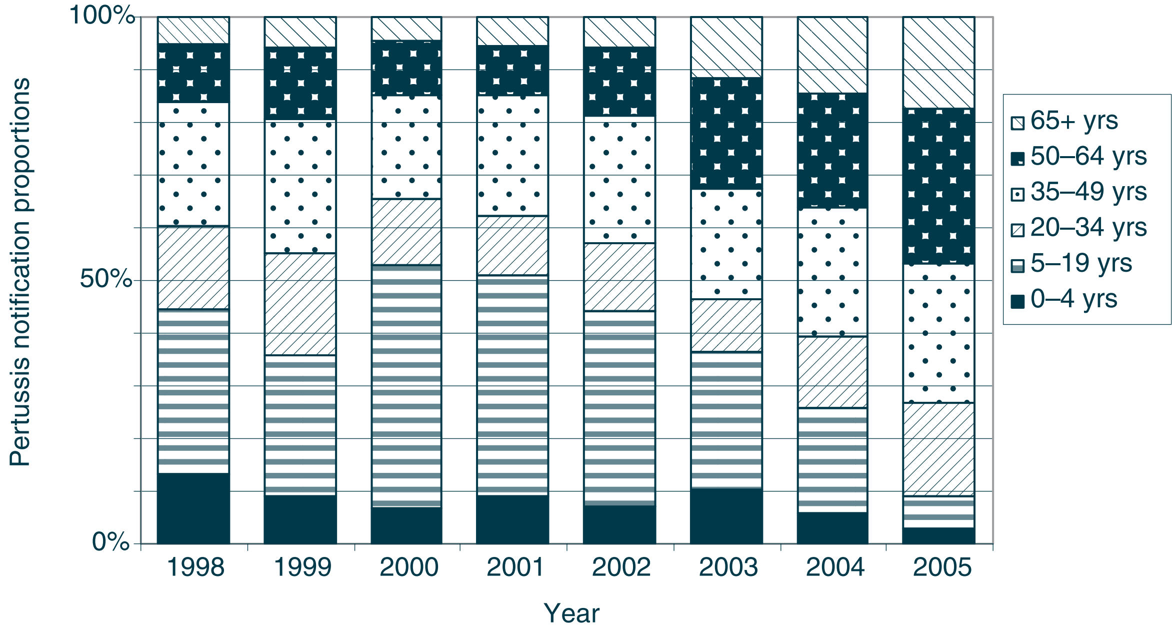
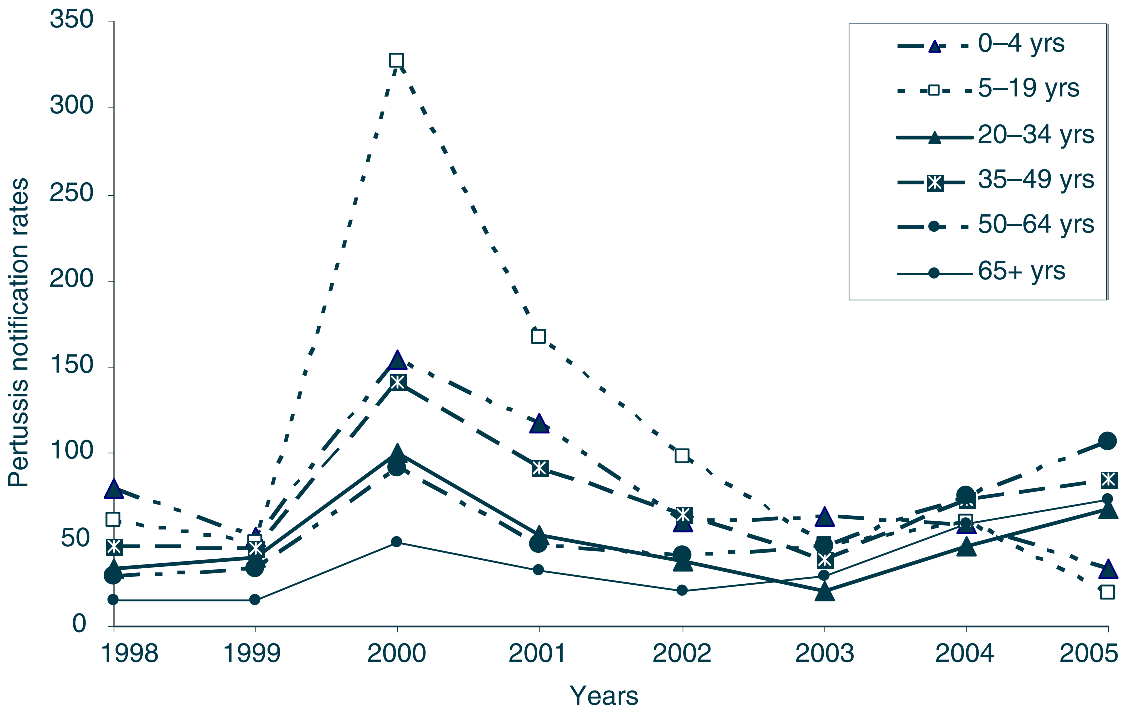


FIGURE 3

PERTUSSIS NOTIFICATION RATES PER 100,000, FOR SIX AGE GROUPS, HUNTER NEW ENGLAND AREA HEALTH SERVICE, NEW SOUTH WALES: JANUARY 1998 TO DECEMBER 2005



decreased from 46.3 per cent to 5.9 per cent during the period 2000 to 2005 (Figure 2). During the same period the proportional contribution of the 50–64 year age group increased from 10.1 per cent to 29.4 per cent (Figure 2).

Consideration of age group specific notification rates in Hunter New England from 1 January 1998 to 31 December 2005 demonstrated that the notification of pertussis in children aged 0–4 years peaked during 2000 at approximately 150 per 100,000, it then stabilised at approximately 60 per 100,000 per annum over the years 2002–2004, and has decreased further to 33.4 per 100,000 in 2005 (Figure 3). There has also been a decrease in notification rates in the 5–19 year age group from the epidemic level of 328 per 100,000 in 2000, to a low of 19 per 100,000 in 2005, a rate which is less than a third of the 2004 rate.

There have been important changes in the notification rates in older age groups since the 2000 epidemic, with a 6.9 per cent decrease in notified cases in the 35–49 year age group between 2001 and 2005, and a 26.3 per cent increase in notified cases in the 20–34 year age group during the same period. However, the greatest relative increase occurred in the 50–64 year age group, where there has been a 150 per cent increase in notified cases over this period, giving a notification rate of 107 per 100,000 in 2005—currently the highest of any age group (χ^2 linear trend = 128; p<0.0001).

DISCUSSION

Hunter New England notification data suggests that in this Area Health Service adults may be emerging as an important reservoir of pertussis. During the period studied, there were no changes in diagnostic criteria or particular initiatives to encourage physicians to increase testing for pertussis amongst adults with respiratory symptoms. Although the adolescent immunisation program appears to have reduced the burden of disease in this age group, cases still occur in the vulnerable 0–4 age group. These findings, however, should be compared with other NSW Area Health Services and other Australian jurisdictions.

Humans are the only known host for *B. pertussis*, with direct transmission of the organism presumed to occur through airborne contact with aerosol droplets from the respiratory tract of an infected, coughing individual. Clinical cases are highly infectious, with a primary case resulting in a mean of 17 secondary cases in an immune-naïve population.[7]

The occurrence of pertussis disease is affected by the waning nature of pertussis immunity, with immunity due to natural disease declining after 4 to 20 years and protective immunity after vaccination declining after 4 to 12 years.[5] As disease becomes less prevalent in a population, opportunities for natural boosting are also reduced.[8]

The importance of this disease in adults has previously been neglected as it is much less severe than in infants, although not inconsequential.[9] There has recently been acknowledgement that a greater understanding of pertussis epidemiology in adults must inform control strategies as transmission in older age groups may expose vulnerable infants and children to infection.[10] Older age groups are recognised as playing an important role in transmitting *B. pertussis* infection to incompletely immunised infants.[11]

The administration of acellular pertussis vaccine boosters to adolescents and adults, if appropriately timed, should decrease the circulation of *B. pertussis* in the community.[12] Although the newly available pertussis vaccine is currently not on the Australian Standard Vaccination Schedule for adults, the National Health and Medical Research Council recommends a booster dose of dTpa (diphtheria and tetanus toxoids, and acellular pertussis vaccine) on a single occasion for any adult expressing an interest and suggests that dTpa may be considered at 50 years of age instead of ADT (adult diphtheria tetanus toxoids).[13] The high pertussis notification rates in adults, persisting severe disease, hospitalisation and deaths in infants despite high childhood and adolescent immunisation coverage, and availability of adult-formulated pertussis vaccines, make alternate strategies for vaccine control of pertussis, which are informed by mathematical modeling, of critical importance in Australia.[14] Control efforts need to take account of the dynamic epidemiology of pertussis, with due consideration of the cyclical epidemic pattern.

CONCLUSIONS

To optimally control pertussis in our community and reduce the risk of infection in the most vulnerable groups, it is essential not only to maximise pertussis immunisation rates in children and adolescents but also to consider expanding pertussis booster immunisation to include adults. This should be preceded by careful modeling of the impact of adult vaccination strategies on pertussis epidemiology, utilising techniques that take account of heterogeneous population mixing.

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