Bordetella pertussis PCR positivity, following onset of illness in children under 5 years of age

Cheryn M Palmer, Brad McCall, Kari Jarvinen, Michael D Nissen

Abstract

Bordetella pertussis is a significant cause of respiratory illness and an ongoing public health problem. Pertussis polymerase chain reaction (PCR) testing has been widely utilised since 2001, especially in infants. Uncertainty exists as to how long PCR remains positive following symptom onset. Further information on the time frame for pertussis PCR testing would assist diagnosis, epidemiological research and disease control. The Brisbane Southside Population Health Unit (BSPHU) conducted a retrospective analysis of enhanced surveillance data from pertussis notifications between January 2001 and December 2005, in children less than 5 years of age, in the BSPHU reporting area with the aim to determine the possible range of duration of *Bordetella pertussis* PCR, from symptom onset for this age group.. Of 1,826 pertussis notifications to BSPHU between January 2001 and December 2005, 155 (8.5%) were children under 5 years of age, with 115 pertussis PCR positive results. Analysis indicated a range of PCR positivity from day one to day 31 from the onset of catarrhal symptoms with most (84%) being within 21 days from onset of catarrhal symptoms. The range of PCR positivity following onset of paroxysmal cough was from day one to day 38 with most (89%) being within 14 days from the onset of paroxysmal cough. This review of pertussis PCR data in young children showed that PCR positive results generally mirrored the understood length of infectivity with regard to both catarrhal symptoms and paroxysmal cough; namely that PCR positive results were obtained at least 21 days following onset of catarrhal symptoms and at least 14 days following onset of paroxysmal cough. *Commun Dis Intell* 2007;31:202–205.

Keywords: *Bordetella pertussis,* disease management, epidemiology, laboratory testing

Introduction

Bordetella pertussis infects the respiratory tract and the disease can have an insidious onset with catarrhal symptoms and later a paroxysmal cough.[1] Morbidity and mortality is greatest in young children, especially infants. Vaccination has reduced the incidence and mortality from pertussis infection, since the introduction of mass immunisation in 1942. However, pertussis continues to be a significant public health problem, with epidemics occurring every 3–4 years. While the majority of pertussis notifications occur in adult populations and vaccination uptake has been good among child populations; waning immunity and circulation of pertussis among adults continues to place younger children, especially under-vaccinated children, at risk of infection with potentially serious sequelae.[2,3,4]

Sensitive and specific laboratory investigations are vital for accurate diagnosis of pertussis. Available tests include bacterial culture, polymerase chain reaction (PCR) (nasopharyngeal aspiration or throat swabs) and serological assays (mainly to pertussis toxin). Culture can be fastidious and time consuming, while serology has several limitations, including the delay inherent in collecting paired sera to detect an antibody rise.[5] PCR is being used more frequently, especially in infants, and has a shorter turn-around time and higher sensitivity than culture.[5] Currently, there is no agreed inter-laboratory standardisation of PCR assays for *Bordetella pertussis*. In Queensland health laboratories, PCR methods for pertussis diagnosis have been utilised since 2000.[6,7]

Uncertainty exists as to how long PCR remains positive following symptom onset. A literature review, on the subject of pertussis PCR positivity, did not locate any publications addressing or resolving the issue of how long this test remains positive from the onset of infection. One Australian study in a boarding school outbreak, found PCR was more likely to be positive when specimens were collected within a week either side of symptom onset.[8] More definitive information on the time frame for pertussis PCR testing would assist diagnosis, epidemiological research and disease control.

Methods

In Queensland, pertussis PCR testing has been available since 1999–2000 and in wider use from 2001. Two PCR methods have been utilised for diagnosis of pertussis by Queensland Health; initially a PCR-Elisa-based method was utilised and from 2004 a real-time PCR assay has been in use.[6,7] Pathology laboratories in Queensland are mandated to notify population health units of definitive and suggestive evidence of pertussis infection; according to established notification criteria.[9] Definitive laboratory evidence is isolation on culture or detection by nucleic acid testing and suggestive laboratory evidence is based on serology. Pertussis notification data are recorded on the Notifiable Conditions System (NOCS) database; including demographic information and mode of diagnosis, whether culture, PCR or serological assay. The Brisbane Southside Population Health Unit (BSPHU) conducts enhanced surveillance of pertussis notifications in children less than 5 years of age. This surveillance includes collecting information on the date of onset of symptoms (catarrhal and paroxysmal cough), vaccination status, treatment received and contacts requiring prophylaxis.

Pertussis notification data from the BSPHU area between January 2001 and December 2005 were extracted from the NOCS database. These were further analysed with regard to PCR positive results in children less than 5 years of age. All data were entered into a purpose designed Excel® database for analysis.

Results

There were 1,826 pertussis notifications made to BSPHU between January 2001 and December 2005 and 155 (8.5%) of these notifications were in children under 5 years of age. Epidemics of pertussis infection occurred in 2002 and 2005 (Figure 1). Most notifications occurred in the youngest age groups. The proportion of notifications has increased in adult females, over the study period and the proportion of notifications in infants under 12 months increased in epidemic years.

Since 2001 information on pertussis notifications on the NOCS database has included the method of laboratory diagnosis. Most diagnoses were by serological assay (83%) but PCR use, almost exclusively in infants, had increased since 2001 (Figure 2).

Figure 1. Age distribution and annual trends pertussis notifications, Brisbane Southside Public Health Unit area, 2001 to 2005

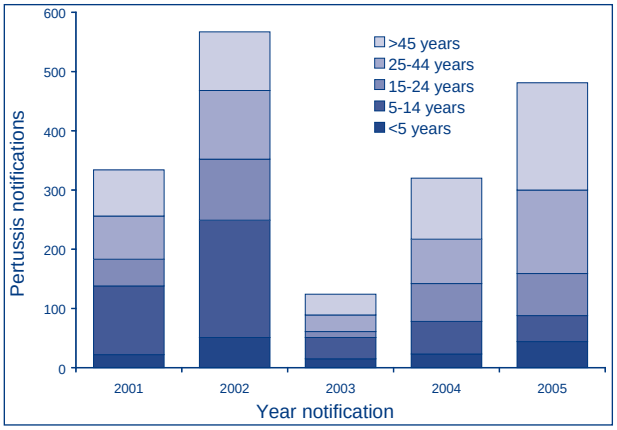


Figure 2. Age distribution of positive pertussis tests, Brisbane Southside Public Health Unit area, 2001 to 2005, by type

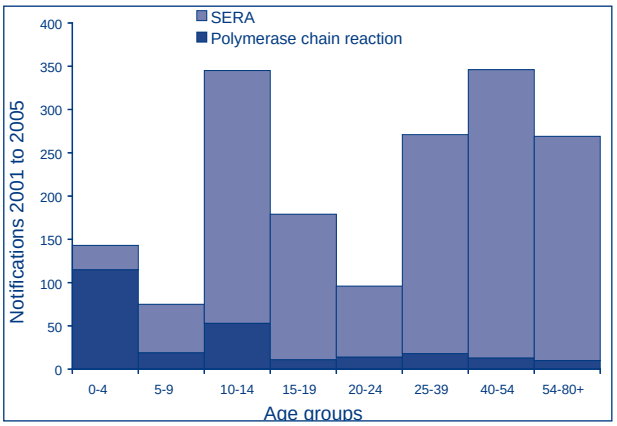
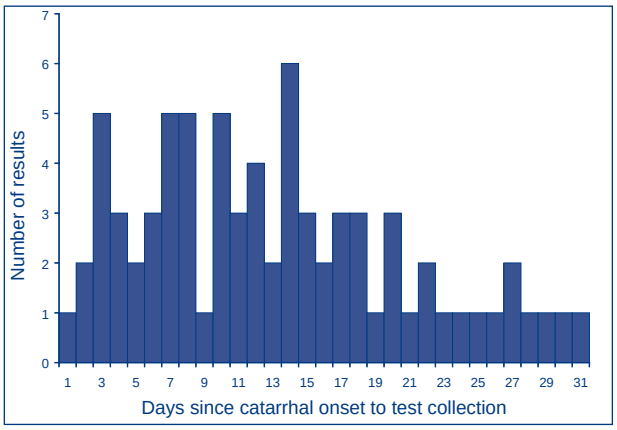
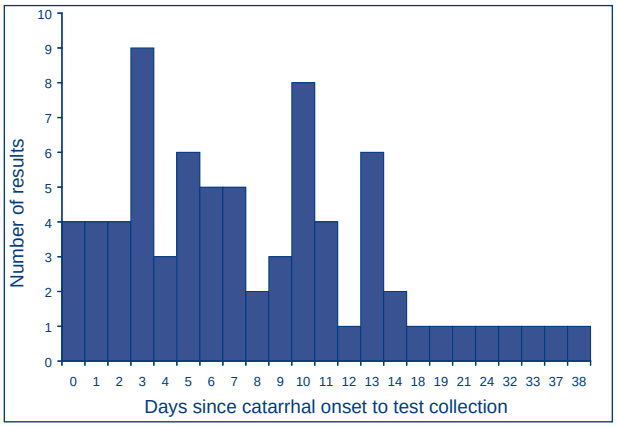


Figure 3. Polymerase chain reaction positive results by time (days) since catarrhal onset (<5 years age) N=75



Culture and antigen testing were infrequent. There were 115 PCR positive pertussis notifications during 2001 to 2005, in children aged under 5 years. Information was available on the date of onset of catarrhal symptoms in 75 (65%) of these notifications, the date of onset of paroxysmal cough in 74 (64 %) of these notifications and both pieces of information were available for 67 (58%) notifications. Analysis of these data indicated a range of PCR test positivity from day one to day 31 from the onset of catarrhal symptoms with most (84%) being within 21 days from onset of catarrhal symptoms (Figure 3).The range of PCR positivity following onset of paroxysmal cough was from day one to day 38 with most (89%) being within 14 days from the onset of paroxysmal cough (Figure 4).

Figure 4. Polymerase chain reaction positive results by time (days) since cough onset (<5 years age) N=74



Discussion

Over the last 5 years, pertussis notifications in the BSPHU have shown a shifting burden of illness toward older age groups and a recent increase in notifications in infants aged less than 12 months during epidemic years. The epidemiology of pertussis is evolving with a greater burden of disease among adults, including adults in contact with vulnerable under-vaccinated children. This shift in the age-related epidemiology of *Bordetella pertussis* has been noted across the western world, with increasing proportions of cases reported in adolescents and adults.[10,11] The limited duration of vaccine efficacy, complicated by changes in the methods and frequency of laboratory diagnosis may underlie the changing pattern. Interestingly, the cyclical pattern of pertussis epidemics has persisted since the pre-vaccine era to the present time.[11]

The review of pertussis PCR data in children under 5 years of age (between 2001 and 2005), showed that PCR positive results were associated with the length of infectivity with regard to both catarrhal symptoms and paroxysmal cough: PCR positive results were obtained at least 21 days following onset of catarrhal symptoms and at least 14 days following onset of paroxysmal cough. Positive results were infrequently recorded outside those time periods, with few positive results beyond 5 weeks from the onset of any symptoms.

There were several limitations to this study, including the retrospective nature and limitations of a selected cohort of pertussis positive notifications and a lack of detailed information about testing rates for pertussis. Results for children under 5 years of age may not be applicable to other age groups. The accuracy of data records relating to symptom onset may also be problematic, as it relies upon parent or care-giver recall.

Vaccination status would have been of interest but due to difficulties with data linkage was not possible. The lack of information in the medical literature and the preliminary findings of this study support the need for further investigation to determine the length of time PCR reliably remains positive from the onset of clinical illness.

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