The outbreak that had to happen: *Bordetella pertussis* in North-West Western Australia in 1999

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Abstract

In late 1999, an outbreak of *Bordetella pertussis* occurred in a small town in North-West Western Australia. We undertook an investigation to describe the outbreak and to identify strategies to minimise the impact of future pertussis outbreaks in Australia. In November, people with respiratory symptoms were reviewed in an emergency pertussis clinic, which provided antibiotic treatment or prophylaxis. We conducted a school survey to enhance case ascertainment and followed up those attending the clinic by telephone. Fifty-nine cases of confirmed or probable *B. pertussis* infection were identified from 124 households (482 persons). Ages ranged from 5 months to 67 years, with children aged 9 to 11 years comprising 24 cases (41%). Early missed diagnoses and a school camp in September attended by 2 symptomatic children appeared to facilitate spread of infection, with the outbreak peak occurring in November. From immunisation records, childhood vaccine coverage in this sample was estimated at 96 per cent. All 21 cases of pertussis among the group under 10 years of age were at least partially vaccinated. There was only one laboratory confirmed case in the high-risk, under one-year of age category. Even in highly immunised populations periodic pertussis outbreaks are inevitable reflecting a vaccine efficacy of about 80 per cent and waning immunity with increasing age. Prevention of pertussis outbreaks depends not only on high vaccination coverage among young children but also early diagnosis and management of cases and their contacts. Clinicians should consider pertussis in the differential diagnosis of persistent cough illness in people of all ages – even those previously immunised. *Commun Dis Intell* 2000;24:375-379.

Keywords: pertussis, outbreak, chronic cough, immunisation

Introduction

Whooping cough, caused by the bacterium *Bordetella pertussis*, is a highly contagious respiratory disease that can cause serious illness or death among infants and young children. Transmission is by airborne contact with respiratory secretions and the incubation period is 6 to 20 days. Communicability is high during the early catarrhal period, but becomes negligible about 3 weeks after the onset of coughing paroxysms.[1] In Australia, childhood immunisation, consisting of a primary course at 2, 4 and 6 months followed by boosters at 18 months and 4 to 5 years, is recommended.[2] The school entry dose was introduced in August 1994 and acellular pertussis vaccines replaced whole cell ones for booster doses in Western Australia (WA) in February 1997 (Source: Perth Immunisation Clinic).

In April 1999, within a remote community in the Gascoyne region of WA, an elderly male with a history of chronic cough was diagnosed as having *B. pertussis* by IgA serology. On 24 November, after a woman and her daughter presented with a persistent cough, a local general practitioner concerned about pertussis contacted the Gascoyne Public Health Unit (PHU) and organised nasopharyngeal aspirates. On 26 November, *B. pertussis* was confirmed in both cases by polymerase chain reaction (PCR). It was subsequently discovered that another 30 individuals, including school children, teachers and household contacts, had been affected during preceding months.

To achieve disease control and reduce the risk of infection to the very young, we established a short-term pertussis clinic for the diagnosis and management of cases and their household contacts.[3,4] A public forum was held and an information bulletin distributed to raise community awareness of the illness. Concurrently, non-immunised or incompletely immunised children under 8 years of age were vaccinated by the community health nurse, and accelerated childhood immunisation of infants with the first dose at 4 to 6 weeks and the second and third at 4-week intervals was undertaken.[3] This immunisation program was continued until Christmas 1999.

This paper describes the epidemiology of the outbreak and outlines strategies for minimising the impact of future pertussis epidemics.

Methods

Setting

The setting was a small coastal town, population about 2600 (Source: Australian Bureau of Statistics 1998). It has one school, which provides primary and high school education.

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Epidemiological investigation

Interviews with hospital staff, general practitioners, the community health nurse and the school principal were conducted to gather information on the circumstances and extent of the outbreak. Standardised pertussis data collection forms[3] detailing demographic and illness characteristics were completed for those who presented to the short-term clinic with presumptive pertussis. Where possible, to clarify illness progress and confirm the diagnosis on the basis of the case definition, those attending the clinic were followed up 2 weeks later by telephone interview.

In early December, because clinical pertussis had been identified among children, we undertook a school survey to review progress of the outbreak. To ascertain cases, describe the illness characteristics, determine the pattern of spread and obtain vaccination data for the under 10 years age group, a written questionnaire was developed and distributed to school children. As a low response rate was expected, telephone interviews of every fifth family on the school's roll were also conducted to review the presence of disease among a systematic sample of the school community. Data were entered and analysed in Epi Info 6.04c and descriptive statistics are presented.

The immunisation status for the sample of children under 10 years of age was verified by review of the community health nurse's vaccination records and the vaccine coverage for those aged between 1 and 9 years was estimated from these records. For this calculation, vaccine coverage was defined as documented completion of the primary course of pertussis immunisation.

Case definition for *Bordetella pertussis* infection[3]

Probable

A cough illness lasting 14 days or more with one of the following: coughing paroxysms, inspiratory whoop or post-tussive vomiting without other apparent cause, or a cough illness lasting 14 days or more in a patient with *B. pertussis*-specific IgA detected in serum.

Laboratory-confirmed

Isolation of *B. pertussis* from a clinical specimen, or a positive PCR assay for *B. pertussis* undertaken in a laboratory with established expertise in this area.

Epidemiologically confirmed

A cough illness lasting 14 days or more in a patient who was epidemiologically linked to a laboratory confirmed case. Any person in close contact with a laboratory confirmed case during the infectious period and with cough onset between 30 days before and 30 days after the cough onset in the confirmed case was considered epidemiologically linked.

Microbiological sampling

A nasopharyngeal aspirate was collected from consenting patients who presented in the acute phase; this was used for *B. pertussis*-specific and Respiratory Syncytial Virus (RSV)-specific PCR testing, and viral culture. A single blood sample for *B. pertussis* IgA serology was taken from those with a prolonged-cough illness. Specimens were forwarded to the Western Australian Centre for Pathology and Medical Research (PathCentre) for processing.

Results

Epidemiological investigation

Data were collected from a total of 124 households or 482 people (Table 1). Seventy-one households, comprising 285 people, returned the survey (response rate: 28.5%). Of the households systematically sampled from the school's roll, 14 (28%) had already returned their questionnaires and a further 28 were successfully contacted on 17 December by telephone.

Table 1. Sources of information regarding households sampled during the investigation

Method	No. of households	People represented
Pertussis clinic:		
seen at clinic only	7	10
followed up by telephone interview	18	73
School survey questionnaire returned	71	285
School-roll telephone interview	28	114
Total	124	482

Of the 482 persons, 259 (53.7%) were female, ages ranged from 5 months to 67 years (median: 16 y, mode: 9 y) and the number of household members varied from 2 to 7 (mean/mode: 4).

Case characteristics

From this sample, 59 people had a cough illness that fulfilled the case definition for pertussis as follows. Five (9%) were laboratory-confirmed by PCR, 11 (19%) were epidemiologically confirmed and 43 (73%) were probable cases. Among the probable cases, 4 had positive *B. pertussis* IgA serology and a further 16 were close contacts of these.

Twenty-six (44%) were identified in the pertussis clinic at presentation or on telephone interview follow up. Forty-one (70%) cases were female and ages ranged from 5 months to 67 years (median and mode: 11y). There were 24 cases (41%) among children aged 9 to 11 years and 14 cases (24%) among adults, both teachers and parents. Incidence estimates of whooping cough by school year and age group are shown in Tables 2 and 3, respectively. There was only one case in the under 1-year-old category (Figure 1).

All cases had a history of cough illness lasting at least 2 weeks; 57 (97%) complained of coughing paroxysms or inspiratory whoop and 15 (25%) of post-tussive vomiting. By 17 December, complete recovery had been documented in 21 (36%) cases, persistent cough remained in 32 (54%) and status was unknown in 6 (10%). Forty-eight (81%) had seen a medical practitioner and 32 (54%) received a course of erythromycin or roxithromycin. No cases required hospitalisation.

Extent of the outbreak

The epidemic curve for the pertussis outbreak is shown in Figure 2. The first case of pertussis was identified in an

Table 2. Pertussis outbreak in a remote Western Australian town, 1999. Incidence rate per 100 persons by school grade

School class	No. of pupils	Incidence
Preschool	37	0.0
Kindergarten	34	8.8
Year 1	32	6.3
Year 2	36	8.3
Year 3	36	8.3
Year 4	40	20.0
Year 5	29	17.2
Year 6	37	29.7
Year 7	27	11.1
Year 8	26	11.5
Year 9	30	0.0
Year 10	27	4.2

Table 3. Pertussis outbreak in a remote Western Australian town, 1999. Incidence estimates per 100 persons by age group

Age group (years)*	No. of people	Incidence†
0-4	170	2.4
5-9	194	8.8
10-14	162	13.0
15-19	96	2.1
20-24	124	0.0
25-29	162	0.0
30-34	233	0.0
35-39	224	2.7
40-44	187	2.1
45-49	191	1.0
50-54	172	1.2

* Those aged 55 years and over are not included, as our school survey methods did not adequately sample this age stratum which had only one documented case. The 20 to 29 year age group may have also been underestimated.

† 1996 ABS census figures used as the denominators.

elderly male with positive *B. pertussis* IgA serology in April. The epidemic reached a peak during November and the Gascoyne PHU was notified on 24 November, late in the course of the outbreak. By the end of December, the outbreak had subsided.

A Year Six camp (8-17 September) appeared to facilitate spread. Two students with persistent cough had attended this camp. During the next 2 months, a further nine 11-year-old children developed clinical pertussis. Teachers and pupils in other grades were also affected. In 15 households (12%), more than one person fulfilled the case definition for pertussis. In 7 instances, a Year Six camp participant introduced the illness into their household with siblings or parents subsequently falling ill. This resulted in 12 secondary cases.

Immunisation data

Within our total sample, there were 21 cases and 126 non-cases under 10 years of age with a vaccination status

Figure 1. Whooping cough outbreak in a remote Western Australian town, 1999. Cases by age

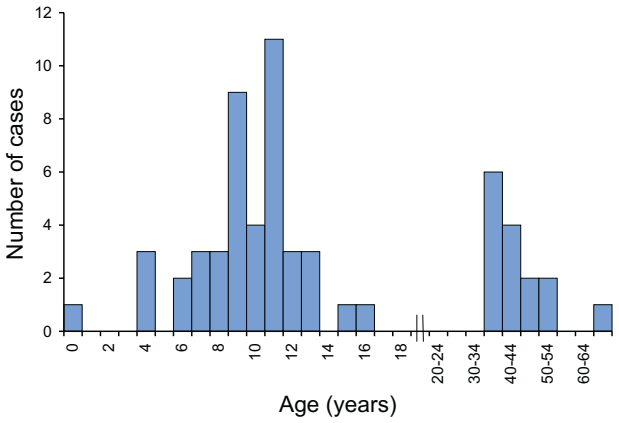
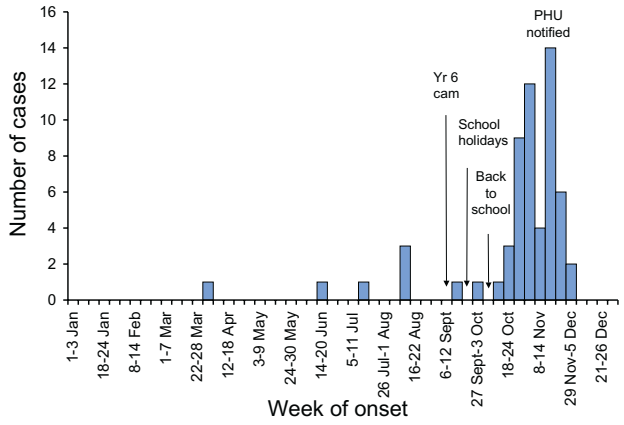


Figure 2. Whooping cough outbreak in a remote Western Australian town, 1 January to 31 December 1999, by week of onset



as shown in Table 4. There were 17 cases in the 5 to 9 year age group; 15 were fully vaccinated and 2 had received (at least) 4 triple antigen (DTP) doses. Ten of the 17 (59%) were confirmed cases: one was PCR positive and 9 were epidemiologically linked. All three 4-year-old children affected received the fifth dose of DTP after their illness had commenced. The infant aged 5.5 months had received the 2- and 4-month vaccinations but the second was given on 4 November in the midst of the outbreak: as its 2 school-aged siblings had a persistent cough in the fortnight prior to 4 November, it is probable that this baby had already been infected.

Among children aged 1-9 years in this sample, vaccine coverage was 96 per cent (139/145; Table 4). Adolescents aged 11 years and above in our cohort did not receive a school entry booster and the peak number of cases occurred among the 11-year-old children (Figure 1). Those aged 7 years and above had received whole cell vaccines. Those aged between 18 months and 6 years received one booster dose of acellular vaccine.

Table 4. Pertussis vaccination status of cases and non-cases under-10 years of age

Age (years)	Total no sampled aged <10y (n = 147)	Cases (n = 21)			Non-cases (n = 126)			
		No.	Age-appropriately vaccinated	Other*	No.	Age-appropriately vaccinated	Other*	Unknown†
<1	2	1	1	-	1	1	-	-
1	5	0	-	-	5	5	-	-
2	5	0	-	-	5	5	-	-
3	14	0	-	-	14	13	-	1
4	12	3	3	-	9	8	-	1
5	16	0	-	-	16	15	1	-
6	23	2	2	-	21	20	1	-
7	20	3	3	-	17	15	1	1
8	18	3	3	-	15	10	4	1
9	32	9	7	2	23	21	-	2

* All cases were verified to have received four doses of DTP vaccine.

† Documented evidence of immunisation was unavailable.

Microbiological sampling

Of the 59 cases, 9 had a nasopharyngeal aspirate collected for laboratory confirmation of *B. pertussis* by PCR; five (an infant, a teacher, 2 school children and a parent) were positive. The remaining 4, all sampled over one month after illness onset, were *B. pertussis*-negative on PCR testing. No other pathogens were identified. Two other cases were positive for *B. pertussis* on IgA serology. One was the first reported case, the other a school student. A further 2, both teachers with clinical symptoms, had low-positive results.

Discussion

Prior to this outbreak, there had been no notified cases of whooping cough in the community since at least 1988,[5] despite an epidemic in the rest of WA in 1997-8 (1164 notifications in 1997, 380 in 1998. Source: Health Department of WA). A cyclone in March 1999 resulted in increased mobilisation of people into and out of the town and may have led to the introduction of *B. pertussis*. Low numbers of infections occurred between April and September and we surmise that not all were detected. The number of cases rose in mid-October with a peak in mid- to late November (Figure 2).

Illness spread appeared to have been facilitated in September by the Year Six school camp attended by 2 ill children. It is possible that several children were incubating during the school holidays and then returned to school in the highly infectious catarrhal phase. Moreover, there was evidence of household transmission with secondary cases among households with camp participants. The outbreak subsided in December.

Immunisation appears to reduce disease frequency and transmission.[6] The high level of childhood immunisation coverage in this community, estimated from this sample to be 96 per cent, is likely to have protected the very young who are at highest risk for severe complications from infection. There was just one confirmed case in a partially immunised baby who fully recovered.

However, even in highly immunised communities, cyclic pertussis epidemics do occur because vaccine efficacy has been estimated at around 80 per cent in children who have received at least 3 doses and immunity is know to wane over time and may be negligible after 12 years.[1,7,8] Disease among immunised children has increasingly been described[9,10] and we report 20 cases of whooping cough (10 confirmed and 10 probable) among children under 10 years of age who had received 4 (5/20) or 5 (15/20) pertussis vaccinations. Nine (45%) of the 20 cases had been vaccinated at least 4 years previously.

Those who have been previously immunised tend to have less severe illness, but may be more difficult to diagnose.[11] In this outbreak, pertussis was only considered after early cases with chronic cough had failed to respond to various therapies for other presumed conditions. This limited the benefit of public health action as widespread community exposure had already occurred.

By our methods, misclassification by outcome is possible. Some true positive cases would have been excluded because mild illness would not have met the case definition. Indeed 8 people, 6 of whom had received antibiotic treatment, were excluded on this basis. On the other hand, the emergency pertussis clinic and public notices about the outbreak heightened awareness of pertussis. This raised the possibility that false positive clinical diagnoses were made and antibiotic treatment over-used. Fortunately, treatment resulted in only one known case of diarrhoea.

With respect to case ascertainment, telephone interviews using systematic sampling from the school roll identified just one additional case, suggesting that the reason for non-response was absence of illness among these families. However, under-ascertainment in the 20 to 30 and over 65-year age groups may have occurred because these groups were not adequately sampled by our school survey methods.

Recommendations

Childhood immunisation is the most important means of pertussis prevention. The public needs reminding regularly about the need for vaccination to protect the very young. As pertussis outbreaks still occur, general practitioners should include pertussis in the differential diagnosis of prolonged cough illnesses even in previously vaccinated individuals.

Prompt diagnosis, laboratory confirmation and notification ensures early public health intervention to minimise disease spread. Regular articles in general practice journals about the '100-day cough' are required to keep pertussis on the agenda. Additionally, public health departments should use pertussis notification data to identify towns and regions with prolonged minimal activity. Education can then be provided to medical practitioners in these areas, which may result in early detection and action when *B. pertussis* infections arise. In the outbreak setting, information dissemination, treatment of cases, prophylaxis of contacts, follow up of those attending clinics, and accelerated immunisation in the young are the public health interventions used for the prevention and control of the disease.

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