

Outbreak of pertussis in a neonatal intensive care unit—Louisiana, 2004

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Background: On November 12, 2004, a 5-month-old infant, admitted in the neonatal intensive care unit (NICU) of a Louisiana regional hospital since birth, was diagnosed with pertussis. Measures to prevent further transmission, in the NICU and beyond, were immediately put into place.

Methods: Exposed contacts were identified among other patients of the NICU, health care workers, and family members. All were offered pertussis testing and prophylactic treatment.

Results: The source of the outbreak was not identified. Despite the immediate implementation of control measures, a total of 37 additional NICU patients, 198 health care workers, and 15 family members were identified as potentially exposed contacts. Three more infants were diagnosed with pertussis, one of them after having been transferred to the NICU of another hospital in the state.

Conclusion: The source of this outbreak was believed to be an adult, either a hospital worker or an outside visitor. The incident clearly illustrates the infection control challenges for hospital units serving newborns and young infants in an era of changing epidemiology of pertussis. (*Am J Infect Control* 2006;34:550-4.)

On November 12, 2004, a 5-month-old infant, admitted in the neonatal intensive care unit (NICU) of a Louisiana regional hospital since birth, was diagnosed with pertussis. During the investigation that followed, 3 additional cases of pertussis were diagnosed.

Pertussis, or whooping cough, named after its characteristic inspiratory whoop following a series of continuous paroxysms, is a highly communicable disease caused by *Bordetella pertussis*.¹⁻³ Secondary attack rates among susceptible persons (ie, those who never had pertussis or have not been vaccinated) have been reported to be 80% or greater.³⁻⁵ Before introduction of pertussis vaccination in the 1940s, almost every child in the United States contracted pertussis at an early age, most commonly from transmission within the household or at school. Immunity after natural disease was lasting; certain researchers wrongly believed

that it was lifelong. Pertussis among adults was considered relatively rare.^{3,4,6}

However, with the introduction of pertussis vaccines, the epidemiology has changed.^{3,4,6} Pertussis incidence gradually decreased from an average of 175,000 cases/year in the prevaccine era to 15,000 reported cases/year by 1960 and <5000 reported cases/year by 1970. During 1970-1990, an average of 2000 cases/year (~1/100,000 population) were reported.^{4,7,8}

Since 1976, however, pertussis incidence has gradually increased. In 2003, a total of 11,647 new cases (~4/100,000 population) were reported, the largest number since 1964.⁹ Many of these cases (19%) were still among infants aged <1 year. However, comparing the surveillance data for 1994-1996 and 1997-2000, the most marked increases were among adolescents and adults, 62% and 60%, respectively.^{7,8} It has been argued that this increase might reflect a change in diagnosis and reporting of adolescents and adults, especially since the introduction of the polymerase chain reaction (PCR) technique for confirmation of pertussis. However, there is also increased recognition that the immunity acquired from vaccination does not last as long as naturally acquired immunity and that protection wanes over time (5-10 years after the last vaccination).^{7,10,11} As a result, substantial numbers of adolescents and adults, often unrecognized patients, might be maintaining pertussis circulation in the community.^{7,10,12}

METHODS

For almost 2 weeks, the index child had episodes of acute choking, with gagging and vomiting, initially perceived to be related to a gastrointestinal problem. The

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child developed a slight fever and increasingly severe cough several days after the onset of the first symptoms. An initial diagnosis of pertussis was made at the Louisiana regional hospital by means of PCR. The diagnosis was later confirmed at the Louisiana State Public Health Laboratory by means of a *Bordetella pertussis* culture. The case was reported to the Louisiana Office of Public Health on the same day, electronically, through the Louisiana State Reportable Disease Database, and an investigation was initiated.

To determine the source of infection, the investigators established the approximate time frame of the infant's exposure, taking into account an average communicability period of 21 days and an average incubation period of 7 days (Fig 1).^{1,13} All health care workers at the NICU who had attended the infant or had close contact (defined as having been within 3-6 feet of the infant) during that time frame were identified, interviewed for recollection of signs and symptoms of pertussis, and administered a nasopharyngeal swab for pertussis testing.

Consequently, the period of communicability of pertussis in the index infant was established, defined as starting 2 days before onset of symptoms and lasting 21 days or, alternatively, 5 days after initiation of adequate antibiotic treatment (Fig 1).^{1,13} Three types of contacts, possibly exposed during that time frame, were identified: (1) other patients in the NICU, (2) hospital personnel, and (3) family members.¹³ For the other patients in the NICU, recalling proximity was impossible; therefore, having spent time in the same room as the index infant was considered as the criterion for being a contact. This information was extracted from a daily log that was kept at the NICU. Among hospital personnel, those who had cared for the infant or had come into close proximity were considered exposed; this information was partly extracted from nursing records but was established mainly through interviews with the staff. Last, all family members who had visited the infant at the hospital were considered exposed; the infant's mother provided a list of those family contacts.

When pertussis was diagnosed in additional infants, the communicability period was extended accordingly (Fig 1), and additional contacts were identified as described previously. Because one of the infants was transferred to the NICU of another hospital in the state, before being identified as having pertussis, identification and management of contacts were extended to the second facility as well.

All contacts were investigated for signs and symptoms of pertussis disease, were offered optional pertussis testing by means of PCR, culture, or direct immunofluorescence assay (DFA) of a nasopharyngeal smear and were encouraged to take a course of pertussis

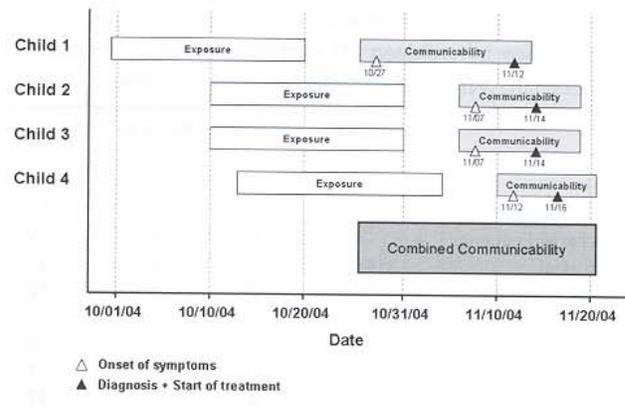


Fig 1. Estimated *Bordetella pertussis* communicability period, combined for all children (4) with confirmed pertussis at a Louisiana NICU, October-November, 2004.

prophylaxis or treatment based on erythromycin (2 weeks) or azithromycin (5 days).¹³

RESULTS

The source of this pertussis outbreak was not identified. During the initial investigation, we were able to collect nasopharyngeal swabs from 45 hospital workers. It was not possible, however, to include everyone who had interacted closely with the index infant during the estimated time frame of his exposure; collection and testing of samples were not pursued aggressively because the primary focus of the intervention was the prevention of further transmission by means of prophylactic treatment. Collecting nasopharyngeal swabs from all the infant's visiting family members, except for the mother, was also impossible. The available nasopharyngeal samples from hospital workers ($n = 45$) were tested by means of PCR, *Bordetella pertussis* culture, or DFA, but all were negative.

At the first NICU, staff reported that patients were frequently moved around because of changing staffing situations and patient conditions; therefore, multiple contacts were identified. A total of 33 infants were identified as possibly exposed to the index patient. Of those, 11 were still hospitalized at the time of the investigation. All were treated with azithromycin for 5 days, after collection of nasopharyngeal samples: all tested negative for pertussis by PCR. The remaining 22 infants had been discharged or transferred to other health care facilities and were therefore more difficult to follow. Parents or treating pediatricians were informed, and appropriate recommendations were made. Only 9 of the 22 were tested by PCR, *Bordetella pertussis* culture, or DFA. Of these, 6 were negative, and 3 were positive (1 culture, 2 DFA). Eighteen of the infants, including

Table 1. Summary of contact testing and treatment, combined for all children (4) with confirmed pertussis at a Louisiana NICU, October–November 2004

	Contacts	Tested*	Positive	Treated†
NICU 1				
Hospitalized patients	11	11	0	11
Discharged patients	19	6	0	15
Personnel	144	53	0	132
Family members	12	0	0	12
NICU 2				
Hospitalized patients	2	2	0	2
Discharged patients	5	0	0	4
Personnel	54	6	0	43
Family members	3	0	0	3

*Tests by means of *Bordetella pertussis* culture, polymerase chain reaction, or direct immunofluorescence assay.

†Treated with treatment regimens based on erythromycin (2 weeks) or azithromycin (5 days).

the 3 patients with laboratory-confirmed pertussis, were treated with erythromycin or azithromycin. All 3 laboratory-confirmed cases had signs and symptoms compatible with pertussis prior to diagnosis (1 mild and 2 severe), but the differential diagnosis of pertussis had not been considered in any of the cases.

A total of 144 hospital workers at the first hospital was considered contacts. They were identified among workers from the NICU but also among visiting staff from other departments, including other nursing units, emergency department, physiotherapy, radiology, and the social service department. In addition to those who were examined as potential sources of infection, nasopharyngeal samples from 8 more persons, who had symptoms suspicious for pertussis, were collected and tested. None of these tests were positive. All exposed workers were strongly recommended to take prophylactic treatment with erythromycin or azithromycin. Only 12 of them declined, and they were not excluded from work because none of them were having signs or symptoms, but all were ordered to wear a mask while on duty.

At the second NICU, in which one of the infected infants from the first NICU was admitted after transfer, but before the suspicion and diagnosis of pertussis, patients were commonly kept in the same room throughout their admission. As a result, fewer contacts were established. Seven infants shared the room with the infected infant: 2 were still hospitalized at the time of the investigation. Both infants tested negative for pertussis and were given prophylactic treatment with erythromycin. Five infants had been discharged, and their parents or treating pediatricians were contacted and informed. None of those are known to have been tested, and 4 were prescribed erythromycin or azithromycin chemoprophylaxis.

In total, 54 staff members from the second NICU and other hospital departments were identified as contacts. All of them were examined at the hospital's occupational medicine department: 6 had signs and symptoms suspicious for pertussis and were tested, and all tests were negative. All 54 staff members were recommended prophylactic treatment with erythromycin or azithromycin. Forty-three staff members were treated: 4 of those, with signs and symptoms compatible with pertussis, were excluded from work for 5 days from the start of treatment. Eleven staff members declined treatment: 2 were excluded from work for 21 days because of possible pertussis illness, and the remaining 9 were required to wear masks while on duty.

Finally, among the index infant and the 3 subsequent patients, 15 exposed family members were identified. All of them were contacted and strongly encouraged to see their family doctor. None of them were observed to have symptoms or were tested, but all were reported to have been given prescriptions for treatment with erythromycin or azithromycin. A complete summary of contacts, including contact testing, test results, and treatment, combined for all 4 laboratory-confirmed cases, is available (Table 1).

DISCUSSION

Despite the availability and widespread use of pertussis vaccines, pertussis is far from controlled. Because of the waning vaccine-acquired immunity (5–10 years after the last vaccination), pertussis is common among adolescents and adults. Even though infections in adolescents and adults are typically less symptomatic and often unrecognized, they do represent a considerable source of infection in the community.^{7,8,10,12} Young infants, especially those aged <4 months who are too young to be fully vaccinated, are highly susceptible to infection and are at the highest risk for severe, complicated disease and death.^{1–5}

This outbreak illustrates how the changing epidemiology of pertussis constitutes a serious challenge for hospital units serving newborns and young infants. The outbreak in the first NICU probably was caused by exposure to an adult, either a hospital worker or an outside visitor, who might have had a nonspecific cough that was never suspected to be pertussis. The transfer of the infected infant to the second NICU illustrates how the transfer of infants among units or hospitals can contribute to further interhospital transmission.

The outbreak was reviewed retrospectively by the hospital infection control staff. Consensus was reached that an increased index of suspicion for pertussis would be necessary to mount a more timely and adequate response in the future. One of the pediatricians at the first NICU reported that he had not seen a case

of pertussis in the past 15 years. Failing to include pertussis in the differential diagnosis of the severe cough of the index infant led to a considerable delay in testing and diagnosis. In addition, after diagnosis was confirmed, insufficient institutional experience was available regarding the immediate steps required to control adequately further transmission in the NICU or hospital setting, apart from treating the infant.

The best protection against severe illness and complications of pertussis among infants remains adequate vaccination at ages 2, 4, and 6 months, which is considered 80% to 85% effective.^{4,13} No pertussis vaccine for infants aged <6 weeks is available. In addition, full protection from the vaccine is apparently not immediate but builds with each additional dose of vaccine administered.¹⁴ This might explain why the index infant, despite having received the first DTaP vaccination (diphtheria, tetanus, pertussis), nevertheless experienced pertussis illness.

In the NICU in which this outbreak occurred, a more rigorous approach to the exclusion or reassignment of ill workers and a systematic screening and interviewing process of visiting family members was implemented. However, with a substantial proportion of pertussis among adults being less symptomatic and unrecognized, but infectious nonetheless, these measures might not be sufficient to prevent similar outbreaks of pertussis in the future.

In 2005, the Food and Drug Administration (FDA) approved 2 combination vaccines that provide a booster immunization against pertussis in combination with tetanus and diphtheria ([1] Tetanus Toxoid [T] and [2] Reduced Diphtheria Toxoid [d] and Acellular Pertussis Vaccine [ap]) for 10 to 18 and 11 to 64 years of age people, respectively.¹⁵⁻¹⁷ As a result, targeted revaccination of adolescents and adults, especially those with increased opportunity for contact with unvaccinated infants (ie, health care personnel, and NICU personnel in particular) can now be considered.⁴ Routine use of these vaccines might reduce the overall disease burden and transmission to children in the long run.¹⁸

CONCLUSION

With the changing epidemiology of pertussis, especially the increase of pertussis among adolescents and adults, this type of outbreak in institutions serving newborns and young infants might become increasingly difficult to prevent in the future. Until recently, in addition to rigorous adherence to standard infection control precautions, maintaining a heightened index of suspicion for pertussis among hospital personnel and outside visitors who enter newborn care units, as well as among the patients themselves, was the only preventive measure available. However, with the recent FDA approval of 2 new vaccines that provide a booster

immunization against pertussis in adolescents and adults, we might now have access to a better way to sustain and, indeed, improve the current levels of control of pertussis.

RELEVANCE TO PRACTICE

Pertussis is a seldom-seen disease, yet the incidence is increasing. Like all communicable diseases, there is great potential for health care-associated transmission of pertussis. As this paper describes, the resources needed for managing an outbreak are considerable. Proactive steps the ICP should consider include:

- Education of health care workers in emergency rooms and pediatric department to ensure early suspicion of disease.
- Minimize intraunit transfer of pediatric patients to decrease disease exposure to serial roommates and families.
- Consider administration of Tdap to healthcare workers in ER and pediatrics.
- Develop or review Outbreak Investigation Plan with a multidisciplinary team.

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