

CASE REPORT

Rapid Diagnosis of a Family Cluster of Pertussis Starting from a Child: a Case Report

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SUMMARY

Background: Pertussis, caused by *Bordetella pertussis* (*B. pertussis*), is a highly transmissible, acute respiratory disease that occurs in many countries. Diagnosis of pertussis continues to be a challenge using traditional tests due to their turn-around time and sensitivity. Herein, we rapidly and accurately screened a family cluster of pertussis from a child and her mother.

Methods: We used an automated nested multiplex PCR system which included *B. pertussis*, influenza A virus, and 19 other respiratory pathogens.

Results: We detected *B. pertussis*, influenza A virus H1-2009 (FluA-2009), adenovirus, and respiratory syncytial virus (RSV) in the child, and the mother of the child was positive for *B. pertussis* and FluA-2009.

Conclusions: Active and timely screening for pertussis of adult family members should be considered. The detection of multiple respiratory pathogens may guide effective antibiotic therapies. This could be a novel test for the prevention of pertussis.

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KEY WORDS

pertussis of family cluster, *Bordetella pertussis*, influenza A virus

LIST OF ABBREVIATIONS

B. pertussis - *Bordetella pertussis*
FluA-2009 - influenza A virus subtype H1-2009
RSV - respiratory syncytial virus
PCR - polymerase chain reaction
FilmArray RP - FilmArray Respiratory Panel
ARIs - acute respiratory infections
DTaP - diphtheria-tetanus-acellular pertussis
CRP - C-reactive protein

CASE DESCRIPTION

A fifteen-month-old female patient from Daxing District, Beijing, was presented to the emergency department of infectious diseases in Ditan Hospital, a specialized hospital for infectious diseases in Beijing, China. The patient exhibited symptoms 20 days previously. She had been in contact with a baby who had symptoms of cold, and subsequently she herself developed a mild cough and runny nose. Two days later, she developed a severe cough and had trouble breathing. After a 4-day treatment of intravenous azithromycin administered by a local community hospital, the cough persisted though was alleviated. However, her symptoms worsened again two weeks later. She exhibited episodes of progressive and continual paroxysmal coughing 3 - 4 times per hour for approximately 5 minutes with associated post-tussive emesis and inspiratory whooping. Other symptoms included sneezing, runny nose, and cyanosis. Her temperature was 39.5°C, white blood cell count was 15,790 per cubic millimeter with 53.7% neutrophilic granulocytes, 39.3% lymphocytes, and a normal level of C-reactive protein (CRP). She was administered cephalosporin intravenously at the local community hospital, though her respiratory status did not improve.

Examination of vital signs on the day of admission showed that the patient's temperature was 38.4°C, the blood pressure 95/62 mm Hg, the pulse 132 beats per minute, the respiratory rate 26 breaths per minute, and the oxygen saturation at 99% while she was breathing ambient air. Other examinations were normal for her age. Her parents reported that she was not fully immunized with childhood vaccines due to the severe eczema all over of her body; only two doses of diphtheria-tetanus-acellular pertussis (DTaP) vaccine were administered.

Testing revealed a leukocyte count of 28,300 cells per cubic millimeter with 22.1% neutrophilic granulocytes, and 71.6% lymphocytes, while CRP levels were 0.10 mg/dL (Table 1). As the child had a history of severe cough and fever, a nasopharyngeal swab sample was tested using an automated nested multiplex PCR system. The sample tested positive for *B. pertussis*, FluA-2009, adenovirus, and RSV. Furthermore, radiograph examination of the chest demonstrated increased lung markings and, as such, a presumptive diagnosis of bronchopneumonia was given.

On hospital day 1, the child was given intravenous azithromycin and peramivir against *B. pertussis* and influenza, as well as mucosolvin, ipratropine, and budesonide. High fever persisted with convulsions for the following 3 days with a peak body temperature of 39.7°C. She still had cough post-tussive emesis and inspiratory whooping but both were abating. On hospital day 4, azithromycin and peramivir were continued, while intravenous cefmetazole and gamma-globulin were also administered at which point the child's body temperature stabilized and her respiratory status improved. Ten days following admission, the child was discharged.

The child's mother, a 25-year-old, displayed symptoms of fever, cough, runny nose, and sore-throat on the night of her daughter's admission. Her temperature was 37.8°C, white blood cell count was 7,180 per cubic millimeter composed of 86.81% neutrophilic granulocytes and 7.42% lymphocytes, CRP level of 0.08 mg/dL, and a normal chest radiograph. Although a test for influenza A virus antigen was negative, a presumptive diagnosis of influenza was made according to the patient's symptoms and she was treated with intravenous peramivir for chemoprophylaxis. The patient's temperature appeared normal on the second day but with progressive cough, and *B. pertussis* and FluA-2009 were detected from a nasopharyngeal swab sample using the PCR System. In addition to peramivir, one course of oral azithromycin was administered for treating the pertussis. After 5 days, another course of oral azithromycin was prescribed. After one month, the symptom of cough abated.

Ethics

The Ethics Committee of Beijing Ditan Hospital approved the protocol in this study and a written consent from the child's mother has been obtained for the publication of this case report.

DISCUSSION

We used an automated nested multiplex PCR system to screen for *B. pertussis* in a nasopharyngeal swab of a 15-month-old child. *B. pertussis* was also detected in a nasopharyngeal swab taken from the patient's mother. Given the medical history and clinical symptoms of both patients, we speculated that the mother was infected with *B. pertussis* when caring for her daughter. Pertussis infection often occurs within familial aggregation, with the majority of reports demonstrating child-to-child and adult-to-child transmissions [1]. However, there are few studies researching child-to-adult transmission due to limitations of traditional diagnostic techniques and adults often present with no obvious symptoms [2,3]. Interestingly, the incidence of pertussis has increased over the last two decades even in high vaccination-rate countries, a phenomenon known as "pertussis reappearance" [4]. Since 2014, the incidence of pertussis has increased significantly in China and adults play an important role in its transmissions [5,6]. Medical staff must pay attention to adult relatives of infected individuals and a sensitive and quick detection method for *B. pertussis* should be employed, especially for those who have close contact with the patients [7]. In this case report, FilmArray RP completed the detection of *B. pertussis* within 65 minutes, which provided etiological basis for the patients' therapies and timely quarantines [8].

In addition to *B. pertussis*, FluA-2009, adenovirus, and RSV were also detected in the infant's nasopharyngeal swab. The infection of influenza virus, adenovirus or RSV among infants can also lead to pertussis-like

Table 1. Child's parameters during the course of the disease.

Parameter	Day 1	Day 4	Day 16	Day 21	Day 24 ^a	Day 25	Day 32
T (°C)	36.8	36.6	38.6	37.4	38.8	39.4	36.8
WBC (10 ³ /μL)	12.32	15.08	15.17	24.23	28.30	21.69	13.49
n% (%)	57.86	52.61	53.70	35.30	22.10	26.74	10.78
L% (%)	36.50	37.70	39.90	59.50	71.60	62.64	75.73
Hb (g/L)	106.0	107.0	105.0	103.0	127.0	112.0	116.0
PLT (10 ³ /μL)	253.8	255.4	267.0	308.0	364.0	278.4	255.5
CRP (mg/dL)	0.10	0.10	0.10	0.10	0.10	0.37	0.00
ALT (IU/L)	-	-	-	-	19.1	20.0	20.6
AST (IU/L)	-	-	-	-	35.2	46.1	42.2

^a - The day of admission. T - body temperature, WBC - white blood cell count, n% - neutrophil percentage, L% - lymphocyte percentage, Hb - hemoglobin, PLT - platelet count, CRP - C-reactive protein, ALT - alanine aminotransferase, AST - aspartate aminotransferase.

**Figure 1. Radiograph of the child's thorax after admission.**

symptoms, which makes it difficult to determine the individual role of these four pathogens in this report case. In a descriptive study of hospitalized infants with pertussis, 25/53 (47%) had a respiratory viral co-detection, although associations of clinical pertussis severity with or without co-detections were not clearly explained [9]. In addition to *B. pertussis*, Flu-2009 was also detected in the nasopharyngeal swab sample from the infant's mother, though adenovirus and RSV were not detected.

This difference may relate to the infectivity in adults of those two respiratory viruses. While the influence of *B. pertussis* and influenza virus co-detected in the adult patient was not described in this report, it highlights the fact that pertussis cases in adults have significantly increased, and therefore the effect of viral co-infections on disease severity require better understanding [10].

CONCLUSION

Here we present a case study demonstrating a familial aggregation of pertussis initiated by a child. In such family cases, we strongly recommend an active monitoring of adult family members especially when adult relatives exhibit with cough. Such early detection supports effective antibiotic therapy for adults together with timely quarantine and, thus, provides novel prevention strategies for pertussis.

Ethics Approval and Consent to Participate:

This study was approved by the ethics committee of Beijing Ditan Hospital with the reference 2017ZX10103004. After informing the infant's parents of the use of samples and the aim of testing, written informed consent was obtained from the child's parents.

Consent to Publish:

Written informed consent was obtained from the infant's parent for publication of this case report and any accompanying images.

Availability of Data and Materials:

All data generated during this study are included in this published article.

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Authors' Contributions:

YSY and LW conceived and designed the study; YSY contributed the molecular diagnostic experiments; ZHM and PL organized the database; YSY drafted the manuscript; PL and WLH revised part of the discussion and had useful suggestions for this case report. All the authors have read the manuscript and approved the final version.

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Not applicable.

Declaration of Interest:

All authors declare that they have no competing interests.

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