Pertussis outbreak in Papua New Guinea: the challenges of response in a remote geo-topographical setting

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Introduction: A large outbreak of pertussis was detected during March 2011 in Goilala, a remote district of the Central Province in Papua New Guinea, characterized by rugged topography with no road access from the provincial headquarters. This outbreak investigation highlights the difficulties in reporting and responding to outbreaks in these settings.

Method: The suspected pertussis cases, reported by health workers from the Ononge health centre area, were investigated and confirmed for the presence of *Bordetella pertussis* DNA using the polymerase chain reaction (PCR) method.

Results: There were 205 suspected pertussis cases, with a case-fatality rate (CFR) of 3%. All cases were unvaccinated. The Central Province conducted a response vaccination programme providing 65% of children less than five years of age with diphtheria–pertussis-tetanus-HepB-Hib vaccine at a cost of US$ 12.62 per child.

Discussion: The incurred cost of vaccination in response to this outbreak was much higher than the US$ 3.80 per child for routine outreach patrol. To prevent further outbreaks of vaccine-preventable diseases in these areas, local health centres must ensure routine vaccination is strengthened through the "Reaching Every District" initiative of the National Department of Health.

Pertussis is a highly contagious bacterial disease of the respiratory tract caused by *Bordetella pertussis*. It remains one of the world's most important causes of infant mortality, even in countries with high vaccination coverage.[1] Globally, 20–40 million cases of pertussis occur each year, 90% of which are in developing countries.[2] In 2008, pertussis caused an estimated 195 000 deaths worldwide.[3] Severe disease and death are reported mainly in non-immune, very young infants.[1] The case-fatality rates in developing countries are estimated to be as high as 4%.[4] High immunization coverage with an effective vaccine is the mainstay of prevention.[4] In areas with low vaccination rates, the disease mainly affects infants and young children,[1] and community-wide outbreaks are common. Infant immunization programmes using pertussis vaccines have been highly successful in preventing severe pertussis in infants all over the world.

Pertussis is common among children in Papua New Guinea with more than 70 000 clinically suspected cases reported to the World Health Organization (WHO) since 1980.[5] According to data on vaccine-preventable diseases collected through the WHO/United Nations Children's Fund (UNICEF) Joint Reporting Form, around 5000 suspected cases of pertussis were reported in syndromic surveillance by health workers in Papua New Guinea in 2010. That same year, 70% of children less than one year of age in Papua New Guinea received three doses of diphtheria-pertussis-tetanus vaccine (DPT).[6] In Papua New Guinea, DPT has been provided as diphtheria–pertussis-tetanus-hepatitis B-Haemophillus influenza B (pentavalent) vaccine since 2008. However, the pentavalent and other infant vaccination coverage in Papua New Guinea varies widely between and within the provinces.

On 30 March 2011, the health workers of Ononge health centre, through the Health Secretary of Catholic Health-Diocese of Berenia, informed the Central Provincial Health Office about a suspected outbreak of pertussis in several villages of the Goilala district. There was evidence of an increase in the number of fever and cough cases in the preceding two months in

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the outpatient unit of the Goilala health centre, but no report was made to the provincial surveillance team or to the national surveillance system. On 2 April 2011, 16 health staff members from the provincial and the district health office were grouped in six teams and dispatched to the affected villages to investigate and respond to the outbreak. The aim of this report is to highlight the difficulties of reporting surveillance data in these settings and the response to this outbreak.

METHODS

Goilala district is one of the remote districts in the Central Province of Papua New Guinea characterized by very rugged topography with more than 70% of the district comprised of deeply dissected valleys and mountains.[7] There is no road access to the Goilala district from provincial headquarters in Port Moresby, so the communities in the district are usually serviced by light aircraft landing on treacherous mountaintop airstrips. The affected villages in the Goilala district were near the Fane and Ononge health centres, which are accessible either by aircraft from the nearest health centre of Tapini or a two-week trek by foot. The district has a total population of 30 798 (2011 census), while the affected local-level government area (LLG) of Woitape has a population of 18 493 (2011 census). In the Central Province, 52% of children less than one year of age were vaccinated with three doses of DPT-HepB-Hib in 2010.[8] However, the vaccination coverage in Goilala district (13%) was lowest among all districts of the Central Province.[8]

The affected district, Goilala, is divided into three LLGs, Woitape, Guari and Tapini. The outbreak mainly affected the Woitape LLG and therefore this LLG was the focus of this investigation and response. The investigation team visited the affected villages in the Woitape LLG, prepared the line-list of children with a history of cough for at least two weeks duration since 14 March 2011 with at least one of the following: (1) paroxysms of coughing, (2) inspiratory whooping, and (3) post-tussive vomiting as per WHO-recommended standards for surveillance of selected vaccine-preventable diseases.[4] The response team also collected information about deaths among children with similar symptoms within the previous two months. Nasopharyngeal swabs (Eiken Kizai Co., Ltd., Tokyo, Japan) were collected from five children less than two years of age who had symptoms of acute respiratory illness and transported at 4°C to the Central Public Health Laboratory in Port Moresby for the usual bacterial culture. Samples were later sent to PathWest Laboratory Medicine, Western Australia, Australia for testing for the presence of *Bordetella pertussis* DNA using polymerase chain reaction (PCR) assays. PCR assay was done for *Bordetella* as it is considered more sensitive than the usual bacterial culture which requires selective culture media and can be performed on the same biological samples used for cultures.[3]

The provincial health authorities conducted response vaccination along with prophylactic antibiotic treatment in the affected villages of Woitape between 3 April and 9 April 2011.

RESULTS

During the month of March 2011, 171 suspected pertussis cases were reported from 11 villages of the Woitape LLG with six deaths (case-fatality ratio: 3%); all of them were unvaccinated for routine immunizations. Most (83%) of the cases were below the age of five years; the predominant age-group was however less than one year. The overall attack rate among the under-five population in these villages was 15% (171/1131). Three of the five naso-pharyngeal swabs tested at PathWest Laboratory Medicine, Australia were positive for *Bordetella pertussis* DNA.

The response teams vaccinated 736 children in the affected villages of the Woitape LLG with pentavalent vaccine, resulting in 65% vaccination coverage. All children under the age of one year in these villages were also vaccinated with all routine vaccines. The response activities also included case and contact management and provision of erythromycin where appropriate, according to the standard treatment guidelines for children in Papua New Guinea.

The cost of these response activities for all children less than five years in the affected villages was about US$ 12.62 per child. This includes the cost of hiring helicopters and using staff from other health centres to implement the vaccination of all children less than five years in the affected areas.

DISCUSSION

Low vaccination coverage in the Goilala district can be attributed to the remoteness of the area characterized by rugged topography, a shortage of heath care workers in the health care facilities and the lack of regular outreach immunization activities. This outbreak in the Woitape LLG in Goilala, especially its high case-fatality rate, resulted from low immunization coverage and is comparable to pertussis outbreaks in other developing countries. In 2000, an outbreak in the Democratic Republic of the Congo involved 1136 cases with 23 (2%) deaths. Vaccination coverage (DPT1) of infants less than 12 months in the affected area was estimated to be 32%.[1] Another outbreak of pertussis in the Democratic Republic of the Congo in 2001 involved 2633 cases with 17 (0.6%) deaths. Eighty-nine per cent of those cases were 5 years of age or younger.[1] An outbreak of pertussis in Afghanistan in 2003 involved 115 cases and 17 (14.8%) deaths in an isolated border population with estimated vaccination coverage of less than 40%.[1] Another outbreak of pertussis in southern Sudan in 2005 involved 419 cases, including 13 (3.1%) deaths.[1]

The expenditure incurred by the vaccination of all children less than five years in the affected villages in this outbreak was about US$ 12.62 per child. This is much higher than the cost of conducting regular outreach immunization services (US$ 3.80) in these LLGs. To prevent future outbreaks in these areas, the district needs to strengthen their immunization programme using the "Reaching Every District" to reach every child initiative with cost-effective local-level intervention to improve the access of communities to immunization.

Several limitations were apparent in this outbreak investigation including the failure of the district health centre staff to detect and notify appropriate disease surveillance authorities of the pertussis outbreak in a timely manner, the inability to perform laboratory testing within the country and the lack of critical data including date of onset and age of the cases collected by the response team. The reporting delays were also influenced by the geo-topography and lack of effective communication systems in the affected area. As a result of these, the source of infection in this area could not be established. There have been no major pertussis outbreaks confirmed in the recent past in Papua New Guinea, so circulation of *Bordetella pertussis* in other parts of the country is unknown. The Central Public Health Laboratory at Port Moresby and other laboratories in the country including the Pathology Laboratory at Port Moresby General Hospital lack a PCR facility for *Bordetella pertussis*; hence the nasopharyngeal samples were tested in Australia. These limitations highlight the weaknesses of the surveillance and laboratory systems in this area and therefore the need to strengthen the existing vaccine-preventable disease surveillance and laboratory system in Papua New Guinea.

In conclusion, a laboratory-confirmed pertussis outbreak occurred in the Goilala district of Papua New Guinea with documented deaths during March 2011. The outbreak occurred due to exceedingly low coverage of diphtheria–pertussis-tetanus vaccine in the district. As an immediate control measure, the provincial health authorities conducted intensified vaccination with all routine Expanded Programme on Immunization vaccines, including wider vaccination coverage with diphtheria–pertussis-tetanus-HepB-Hib vaccine for all children less than one year of age. The cost incurred to undertake this response vaccination was fairly high in comparison to regular outreach immunization. This necessitates the strengthening of the district-level immunization programme using the "Reaching Every District" initiative to prevent any potential outbreak of vaccine-preventable diseases.

Conflicts of interest

None declared.

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