World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

Volume 3, Number 4, 2012, Pages 1–97
p-ISSN: 2094-7321 e-ISSN: 2094-7313

Outbreak investigations in the Western Pacific

(Continued on the next page)

Patient being interviewed during the investigation of the gastroenteritis outbreak in Kampong Speu, Cambodia

Other topics

Western Pacific Surveillance and Response

Western Pacific Surveillance and Response (WPSAR) is a peer review journal on the surveillance of and response to public health events in the Western Pacific Region.

WPSAR is an open access journal, meaning it is free of charge for both readers and authors. It is also a continuous publication which means articles will be published as soon as they have completed the review and editing process.

All WPSAR articles are indexed in the Directory of Open Access Journals (DOAJ), Western Pacific Region Index Medicus (WPRIM or apamed central), EBSCO and Google Scholar.

p-ISSN: 2094-7321; e-ISSN: 2094-7313

To contact us:
Western Pacific Surveillance and Response
World Health Organization
Office for the Western Pacific Region
United Nations Avenue
1000 Manila, Philippines
wpsar@wpro.who.int
www.wpro.who.int/wpsar

Outbreak investigations in the Western Pacific Region

Michelle McPherson[a] and Ailan Li[a]

In this issue we introduce a new article type – the outbreak investigation report – with our theme *Outbreak investigations in the Western Pacific Region*. This new article type allows for concise reports on outbreak investigations and expands the role of the *Western Pacific Surveillance and Response Journal* (WPSAR) as a regional information-sharing platform, as per the *Asia Pacific Strategy for Emerging Diseases* (APSED 2010)[1] in line with the *International Health Regulation (2005)*.[2] Timely sharing of outbreak investigations may be useful in informing public health action across the Region. We received 11 outbreak investigation report submissions and one original research of an outbreak investigation from six countries and areas within the World Health Organization's Western Pacific Region.

We also publish the first risk assessment article in this issue, which followed the World Health Organization's *Rapid Risk Assessment of Acute Public Health Events*.[3] We look forward to publishing more risk assessments as their documentation becomes more routinely established.

To support the timely sharing of information within the Region, in this issue we trialled a rapid peer review process. We requested reviewers to complete their reviews within 48 hours of receipt. Several of the 22 reviewers completed these on the same day of the request, with an average review time of 2.3 days. The shortest time between submission and publication was 18 days, with the average being 44 days. Having this pool of supportive reviewers demonstrates the potential for future rapid publications, suggesting that WPSAR can be used as a regional centre for information sharing of surveillance and response articles during major public health events, rather than relying on journals from outside the Region.[4]

In this issue five foodborne or waterborne illness outbreaks are described. An outbreak of *Vibrio parahemolyticus*, detected through event-based surveillance, was linked to seafood served during a wedding in Cambodia.[5] A *Campylobacter* outbreak associated with the known risk factor of chicken liver pâté in Australia emphasizes the ongoing need for food handler education on dealing with high-risk foods.[6] Three outbreaks in China were associated with water sources – an *Aeromonas hydrophila* outbreak from vegetables washed in contaminated water,[7] a hepatitis A outbreak linked to a school well in a rural area,[8] and an outbreak of *Escherichia coli* linked to contaminated bottled water.[9]

There were five outbreaks of vaccine-preventable diseases. Two measles outbreaks, from Australia and Singapore, both occurred in unvaccinated persons and then subsequently spread to others within health care facilities, highlighting the role that such facilities can play in transmission of disease.[10,11] Two mumps outbreaks are also described, one from China suggesting that a single dose of mumps-containing vaccine may not be effective in preventing outbreaks among schoolchildren;[12] the other the first mumps outbreak since the introduction of the measles-mumps-rubella vaccine in Mongolia, although there were no cases in children eligible for vaccination, rather in the unvaccinated population.[13] A pertussis outbreak from Papua New Guinea focuses on the difficulties in investigating outbreaks in remote locations, and the additional burden of vaccinating as an outbreak response incurs, compared to conducting routine vaccination programmes.[14]

A syphilis outbreak occurring in Mongolia among young persons highlights the high risk behaviours in this group and the need for contact tracing and targeted health promotion efforts.[15] A cutaneous anthrax outbreak was reported from an area in China that has not had anthrax cases in decades.[16] Eight of the 12 outbreaks reported in this issue were conducted by Field Epidemiology Training Programme (FETP) fellows, with a further two authored

[a] World Health Organization Regional Office for the Western Pacific, Manila, Philippines.
doi: 10.5365/wpsar.2012.3.4.021

by graduates of FETP. This highlights the important role that FETP plays in the Region in both the investigation and reporting of these events.

The new outbreak investigation article type is now a permanent component of WPSAR, and we look forward to publishing more of these concise reports in the New Year.

On behalf of the Editorial team, we also thank all our peer reviewers for their contribution to WPSAR; a full list of reviewers is included in this issue.

References:

1. *Asia Pacific Strategy for Emerging Disease* (2010). Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/emerging_diseases/documents/docs/ASPED_2010.pdf, accessed 28 August 2012).
2. *International Health Regulation (2005), 2nd edition*. Geneva, World Health Organization, 2008 (http://whqlibdoc.who.int/publications/2008/9789241580410_eng.pdf, accesssed 28 August 2012).
3. *Rapid Risk Assessment of Acute Public Health Events*. Geneva, World Health Organization, 2012 (http://whqlibdoc.who.int/hq/2012/WHO_HSE_GAR_ARO_2012.1_eng.pdf, accessed 28 August 2012).
4. Field E, Kasai T. Western Pacific Surveillance and Response: a journal to reflect the needs of our Region. *Western Pacific Surveillance and Response Journal*, 2010, 1:1–2. doi:10.5365/wpsar.2010.1.1.007
5. Vandy S et al. *Vibrio parahaemolyticus* enteritis outbreak following a wedding banquet in a rural village – Kampong Speu, Cambodia, April 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):25–28. doi:10.5365/wpsar.2012.3.4.004
6. Parry A, Fearnley E, Denehy E. 'Surprise': Outbreak of *Campylobacter* infection associated with chicken liver pâté at a surprise birthday party, Adelaide, Australia, 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):16–19. doi:10.5365/wpsar.2012.3.4.011
7. Qian Z et al. A food-borne outbreak of *Aeromonas hydrophila* in a college, Xingyi City, Guizhou, China, 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4). doi:10.5365/2012.3.4.018
8. Xu YQ et al. An outbreak of viral hepatitis A associated with possible contaminated school well in one middle school, Guangxi, China. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):39–43. doi:10.5365/wpsar.2012.3.4.014
9. Wang R et al. An outbreak of acute gastroenteritis associated with contaminated bottled water in a university – Jiangxi, China, 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):44–47. doi:10.5365/wpsar.2012.3.4.009
10. Hope K et al. Measles transmission in health care waiting rooms: implications for public health response. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):33–38. doi:10.5365/wpsar.2012.3.3.009
11. Low C et al. Possible nosocomial transmission of measles in unvaccinated children in a Singapore public hospital. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):7–11. doi:10.5365/wpsar.2012.3.4.008
12. Wang M et al. Is single dose of routine mumps vaccine effective? A retrospective cohort study among children in a day-care center and a primary school in Guangdong province, China. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):29–32. doi:10.5365/wpsar.2012.3.4.012
13. Jargalsaikhan S et al. Mumps outbreak in Gurvantes soum, Omnogovi Province, Mongolia, January to April 2011. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):53–58. doi:10.5365/wpsar.2012.3.3.007
14. Datta S et al. Pertussis outbreak in Papua New Guinea: the challenges of response in a remote geo-topographical setting. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):3–6. doi:10.5365/wpsar.2012.3.3.008
15. Battsendiin M et al. An outbreak of syphilis in Darkhan-Uul Province, Mongolia, January to March 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):48–52. doi:10.5365/wpsar.2012.3.4.003
16. Zhang T et al. Investigation of an outbreak of cutaneous anthrax in Banlu village, Lianyungang, China, 2012. *Western Pacific Surveillance and Response Journal*, 2012, 3(4):12–15. doi:10.5365/wpsar.2012.3.4.005

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

Siddhartha Sankar Datta,[a] Steven Toikilik,[b] Berry Ropa,[b] Glenys Chidlow[c] and William Lagani[b]

Correspondence to Siddhartha Sankar Datta (e-mail: drsiddharthasdatta@gmail.com).

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

[a] World Health Organization, Port Moresby, Papua New Guinea.
[b] National Department of Health, Port Moresby, Papua New Guinea.
[c] PathWest Laboratory Medicine Western Australia, Australia.
Submitted: 13 September 2012; Published: 30 October 2012
doi: 10.5365/wpsar.2012.3.3.008

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.

Funding

None

References:

1. *Managing pertussis outbreaks during humanitarian emergencies: WHO Technical Note, February 2008*. Geneva, World Health Organization, 2008 (http://whqlibdoc.who.int/hq/2008/WHO_HSE_EPR_DCE_2008.2_eng.pdf, accessed 12 August 2012).
2. Pertussis vaccines: WHO position paper. *Weekly Epidemiological Record*, 2010, 85:385–400. pmid:20939150
3. *WHO Topics: Pertussis*. Geneva, World Health Organization (http://www.who.int/immunization/topics/pertussis/en/index.html, accessed 12 August 2012).

4. Department of Immunization, Vaccines and Biologicals. *WHO-recommended standards for surveillance of selected vaccine-preventable diseases.* Geneva, World Health Organization, 2003 (http://www.who.int/vaccines-documents/DocsPDF06/843.pdf, accessed 12 August 2012).

5. *Data on pertussis. Reported incidence time series: WHO Immunization surveillance, assessment and monitoring*. Geneva, World Health Organization, 2012 (http://www.who.int/immunization_monitoring/data/data_subject/en/index.html, accessed 12 August 2012).

6. *DTP3 Coverage Series. Official coverage estimates: WHO Immunization surveillance, assessment and monitoring*. Geneva, World Health Organization, 2012 (http://www.who.int/immunization_monitoring/data/data_subject/en/index.html, accessed 12 August 2012).

7. *Climate and Weather Goilala* (http://goilala.com/people-and-place/climate-weather, accessed on 12 August 2012).

8. *District Immunization Total 2011*. Papua New Guinea, National Health Information System, 2011 (data accessed from NHIS, 12 August 2012).

Possible nosocomial transmission of measles in unvaccinated children in a Singapore public hospital

Constance Low,[ab] Koh Cheng Thoon,[c] Raymond Lin,[a] Ariel Chua,[ab] Pengiran Hishamuddin,[ab] Joanne Tay[a] and Jeffery Cutter[a]

Correspondence to Constance Low (e-mail: Constance_LOW@moh.gov.sg).

Introduction: Measles is an acute, highly communicable viral disease, with measles outbreaks usually occurring in settings where there are unvaccinated populations. After being notified of a cluster of five measles cases in a Singapore public hospital in August 2011, the Ministry of Health Singapore conducted an outbreak investigation.

Methods: Active case detection was conducted, and all notified cases' movement history within the hospital were reviewed to determine any common exposures in place and time. Cases were classified as nosocomial if they had contact with other measles cases in the hospital seven to 21 days before onset dates. Laboratory testing included serological and molecular diagnostic methods.

Results: Of the 14 cases, seven cases were nosocomial cases. Investigations identified two wards where cases were epidemiologically linked. Two cases in Ward A were of D8 genotype and genotypically 100% identical, thus confirming a common source of infection. The six cases in Ward B (including one transferred from Ward A) had overlapping periods of admission and three cases were of the same D8 genotype, with a single nucleotide difference.

Discussion: The epidemiological linkages of the cases and laboratory findings suggest nosocomial transmission in Wards A and B. As a result of this investigation, the hospital implemented a new policy of isolating suspected measles cases instead of waiting until they had been laboratory confirmed. This investigation emphasizes the importance of early identification and isolation of suspected measles cases within health care institutions and reinforces the requirement for high measles vaccination coverage of health care workers.

Measles is an acute, highly communicable viral disease transmitted by droplet spread or direct contact with the nasal or throat secretions of an infected person. The average incubation period for measles is 14 days with a range of seven to 21 days.[1] Outbreaks of measles are known to occur in settings where unvaccinated susceptible populations congregate such as boarding schools, colleges, universities, factories, offices and institutions.

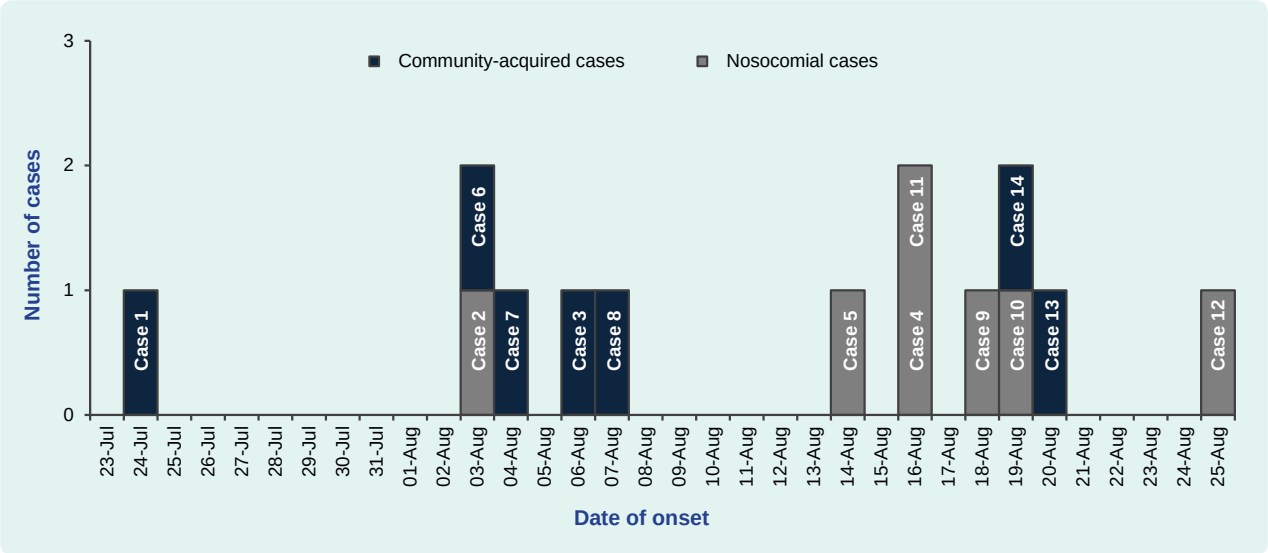
Measles is a notifiable disease under the Infectious Diseases Act in Singapore. All medical practitioners/laboratories are required to notify the Ministry of Health of any persons suspected or confirmed to have measles. Measles is endemic in Singapore with the majority of cases being sporadic and in unvaccinated persons. The D9 genotype has been endemic and detected in Singapore since 2010. Other genotypes seen in Singapore include G3 and H1 in 2010, and D4, D8 and G3 in 2011.[2,3]

Measles vaccination has been compulsory in Singapore since 1985. Under the National Childhood Immunization Programme, the first dose of the trivalent measles, mumps and rubella (MMR) vaccine is to be administered by the age of two years and the second dose at six to seven years of age. However, in view of the large proportion of reported cases of measles among unvaccinated infants and preschool children, the MMR immunization schedule was amended effective 1 December 2011, with the first dose to be given at 12 months of age and the second dose at 15 to 18 months of age. Over the past six years, the national vaccination coverage for the MMR vaccine has been consistently maintained at around 95% for the first dose and above 90% for the second dose.[4]

On 23 August 2011, the Ministry of Health was notified of a cluster of five measles cases in a public hospital. Of these cases, three had a previous admission

[a] Communicable Diseases Division, Ministry of Health, Singapore.
[b] Singapore Field Epidemiology Training Programme, Ministry of Health, Singpore.
[c] Kandang Kerbau Women and Children's Hospital, Singapore.
Submitted: 10 October 2012; Published: 30 October 2012
doi: 10.5365/wpsar.2012.3.4.008

Figure 1. **Onset of illness of 14 reported laboratory-confirmed cases of measles in a public hospital, 24 July to 25 August 2011**



to the institution within the past two weeks. We report herein the epidemiological investigations for the outbreak.

METHOD

A clinical case of measles was defined as a child presenting with rash, fever and one or more of the following symptoms: cough, coryza or conjunctivitis, who had been admitted to the hospital. A laboratory-confirmed case was defined as a clinical case with one or more of the following laboratory results: presence of measles immunoglobulin M or detection of measles virus either through immunofluorescence antigen testing or measles polymerase chain reaction (PCR). A nosocomial (intra-hospital) case was defined as a confirmed case who had contact with another confirmed case in the hospital seven to 21 days before the onset of symptoms with no other source identified. A community-acquired case was a confirmed case that had no prior history of being at the hospital during the 21 days before onset of symptoms or was known to have contact with another confirmed case (non-hospital).

As part of our investigations into the possibility of intra-hospital transmission of measles, we reviewed the movement history within the hospital for all 14 cases to determine any common exposures in place and time.

Genotyping was conducted from throat swabs collected from cases. These were sent to the laboratory at Kandang Kerbau Women's and Children's Hospital for testing by real-time PCR, and positive samples were forwarded to the National Public Health Laboratory for genotyping. Genotyping was conducted following the protocol provided by the WHO Western Pacific Regional Office at the training workshop in Hong Kong (China) in 2009. A 540-bp region of nucleoprotein (N) gene was amplified and sequenced. Sequences of N gene were submitted to Measles Nucleotide Surveillance[5] to determine the genotypes.

RESULTS

Active case detection revealed 14 laboratory-confirmed measles cases admitted to the same hospital between 2 August and 20 August 2011. Seven were female sand seven were males, with ages ranging from four months to three years. None of the cases has been vaccinated against measles; four had missed their vaccination and the other 10 were too young for vaccination. Two family clusters were detected: one involving a pair of siblings and the other, a pair of cousins. These cases were not in the nosocomial group as they were not linked to the hospital.

The epidemic curve for these 14 cases is shown in **Figure 1**. Seven cases had been previously admitted to the hospital for unrelated illnesses approximately two to three weeks before their admission for measles and were therefore considered nosocomial cases; the other seven were considered community-acquired cases.

Our investigations at the hospital identified two general wards, Ward A and Ward B, as two areas where the seven nosocomial cases could be epidemiologically linked to each other in time and place. All patients are free to interact with each other in these wards except for those in isolation who are discouraged from leaving their room. The maximum capacity for either ward is 38, comprising 30 beds and eight infant cots. Genotyping of the measles virus for Cases 2, 4, 5, 10, 12 and 13 was performed while the rest of the samples were unsuitable or unavailable for genotyping.

Ward A

Case 2 was hospitalized in Ward A from 4 to 7 August 2011 and was subsequently diagnosed with measles on 7 August. Case 10 was admitted for bronchiolitis from 7 to 9 August 2011. Both their beds were in the same cubicle. They shared a common period of exposure of approximately 16 hours (**Figure 2**). Case 10 was then readmitted on 21 August 2011 for measles – an onset date 10 days after the common exposure. The measles virus isolated from both cases was of D8 genotype and were genotypically 100% identical.

Ward B

Cases 2 (transferred from Ward A), 4, 5, 9, 11 and 12 were admitted to Ward B.

Cases 2, 4 and 12 had overlapping periods of hospitalization in Ward B, although their beds were situated in different cubicles and rooms. Case 2 was transferred to Bed 26 in the isolation room of Ward B on 7 August after being diagnosed with measles and was nursed in this room from 7 to 14 August 2011. Case 4 was hospitalized for bronchiolitis from 5 to 8 August 2011. Cases 2 and 4 shared an overlapping period in Ward B for approximately 21 hours (**Figure 2**). Case 12 was hospitalized for upper respiratory tract infection and bronchiolitis from 6 to 8 August 2011. Cases 2 and 12 shared an overlapping period of hospitalization in Ward B for approximately 1.5 days.

Case 4 was subsequently readmitted on 21 August 2011 for measles with an onset date eight days after the patient's overlapping period of hospitalization with Case 2. Case 12 was readmitted on 26 August 2011 for measles, 16 days after the patient's overlapping hospital period with Case 2. Cases 2, 4 and 12 were infected with measles of the same genotype D8, with a single nucleotide difference found in Case 2.

Cases 5, 9 and 11 had no exposure to Case 2 while they were in Ward B, but had common exposure with each other and with Cases 4 and 12 (**Figure 2**). The genotype for Case 5 was 100% identical to that of Cases 4 and 12. Cases 9 and 11 were unable to be genotyped.

One community-acquired case (Case 13) also had D8 genotype; however, there was no evidence of any contact with any of the nosocomial cases.

DISCUSSION

The epidemiological linkages of the reported cases and laboratory findings suggest nosocomial transmission of measles in Wards A and B. Case 2 could have infected Case 10 while they were both in Ward A as their measles virus genotypes were 100% identical. They had a relatively close physical proximity within the ward, and the onset of symptoms for Case 10 was 10 days after the overlapping period of hospitalization, which falls within the known incubation period of measles (seven to 21 days).

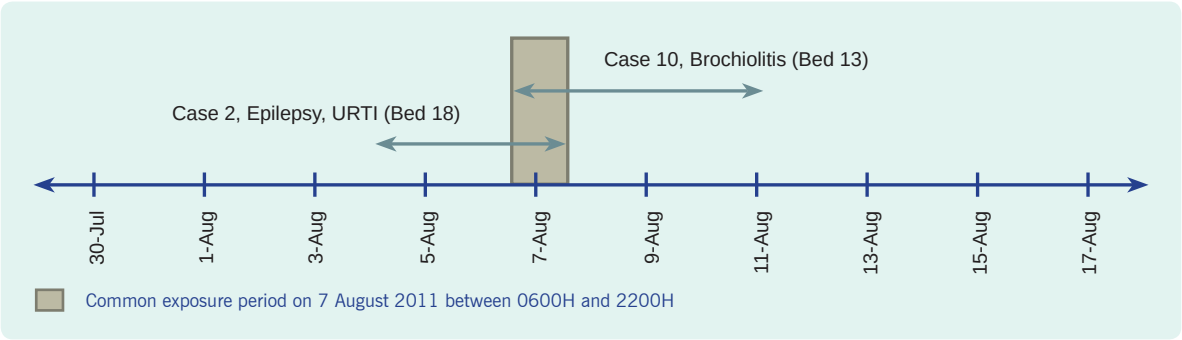
There are two possible hypotheses for transmission within Ward B.

(1) Case 2 was the index case infecting Cases 4 and 12 based on the assumption that Case 2 may not have been fully compliant with isolation while in the ward. As Cases 5, 9 and 11 did not have any exposure to Case 2 during the time they were in Ward B, they could have been community-acquired infections. Cases 2, 4 and 12 had similar genotype with only one nucleotide difference. Cases 4 and 12 also developed measles symptoms eight days and 15 days, respectively, after their overlapping period of hospitalization with Case 2, which is within the known incubation period for measles.

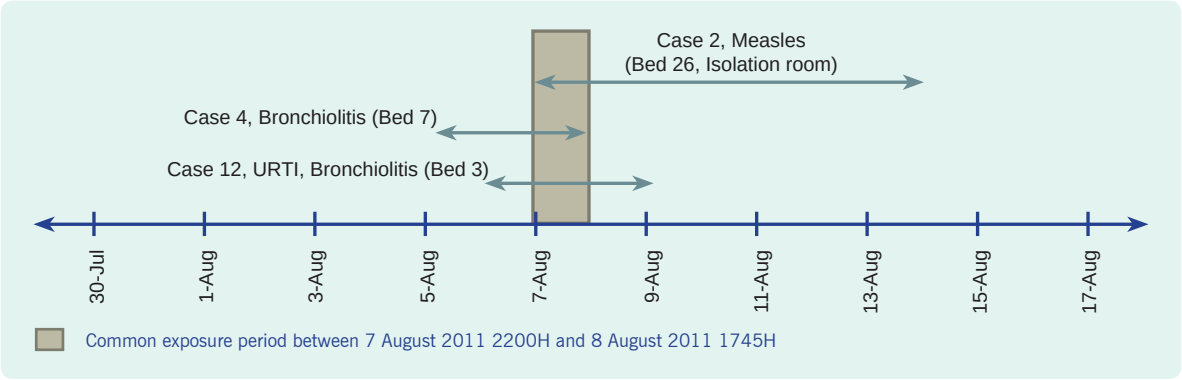
(2) The index case was an unknown patient or visitor with measles (before the onset of rash) who was present in Ward B from 5 to 7 August 2011. This person could have infected Cases 4, 5, 9, 11 and 12, as they were in two neighbouring

Figure 2. **Common exposure for nosocomial cases in Kandang Kerbau Women and Children's Hospital, Singapore, 2011**

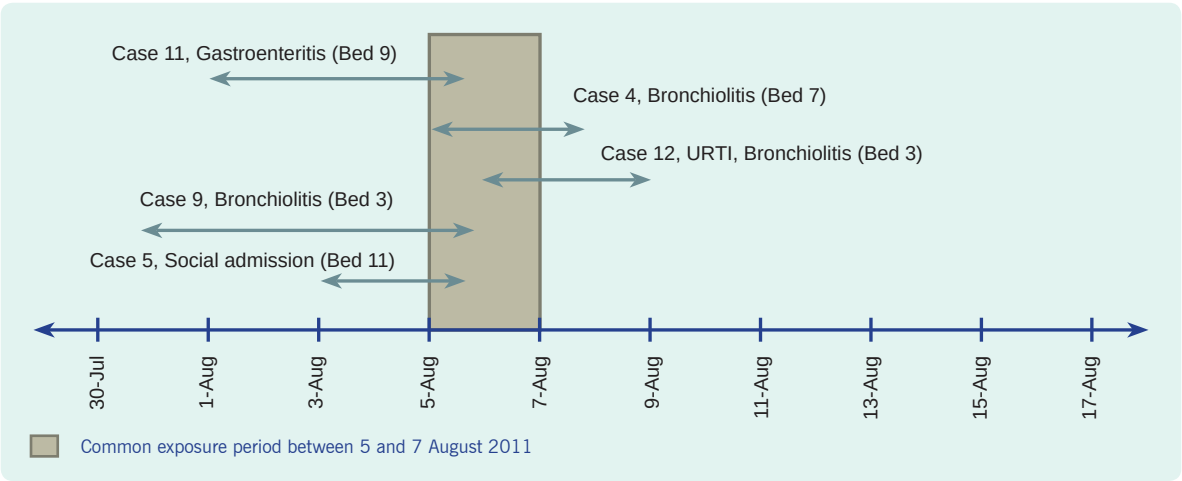
A. Common exposure period for Cases 2 and 10, Ward A



B. Common exposure period for Cases 2, 4 and 12, Ward B



C. Common exposure period for Cases 4, 5, 9, 11 and 12, Ward B



URTI – Upper respiratory tract infection

cubicles in the ward during the same period (5 to 7 August 2011) (**Figure 2**). These five cases also developed measles symptoms between nine and 16 days after 5 to 7 August 2011, which falls within the known incubation period for measles.

Not all 14 cases were able to have their samples genotyped as they were either unavailable or unsuitable, including samples from both the nosocomial and community-acquired group. The one sample that was genotyped from the community-acquired group was for Case 13 who had the same D8 genotype as the

nosocomial cases. As there was no epidemiological link between this case and any of the nosocomial cases, we consider this an incidental finding.

During the investigation we noted some cases were not immediately isolated at admission, even though they were suspected measles cases. Isolation occurred only after laboratory confirmation of measles, potentially exposing other susceptible children to the virus. As a result, the hospital implemented a new policy of isolating all suspected measles cases from admission and then de-isolating them once laboratory results were confirmed negative.

There were no reports of frontline health care workers from Wards A and B with measles in the months of July and August 2011. Therefore, health care workers as a source of infection for these cases were unlikely. All frontline health care workers in this hospital are required to prove their measles and rubella immunity by documentary evidence of vaccination or serology testing.

CONCLUSION

This report describes a possible nosocomial outbreak of measles occurring within a health care setting. Similar incidents have previously been reported in the Republic of Korea,[6] Australia[7] and in Pennsylvania[8] and Indiana[9] in the United States of America. The risk of measles transmission within health care settings emphasizes the importance of early identification and isolation of suspected measles cases and reinforces the requirement for high vaccination coverage of health care workers against measles. Other measures to prevent or reduce nosocomial transmission include maintaining high vaccination coverage and timely vaccination of children according to vaccination schedules.

Conflict of interest

None declared.

Funding

None.

Acknowledgements

Professor Goh Kee Tai, Ministry of Health Singapore

References:

1. *Manual for the surveillance of vaccine-preventable diseases (4th Edition, 2008).* Atlanta, Centers for Disease Control and Prevention (CDC), 2008 (http://www.cdc.gov/vaccines/pubs/surv-manual/chpt07-measles.html, accessed 7 February 2012).
2. World Health Organization Western Pacific Region. *Measles and Rubella Bulletin, 2012, 6(1)* (http://www.wpro.who.int/immunization/documents/measles_rubella_bulletin_vol6_issue1.pdf, accessed 10 October 2012).
3. World Health Organization Western Pacific Region. *Measles and Rubella Bulletin, 2012, 6(9)* (http://www.wpro.who.int/immunization/documents/MRBulletin_Vol6Issue9.pdf, accessed 10 October 2012).
4. *Communicable diseases surveillance in Singapore 2010*. Singapore, Ministry of Health, 2011.
5. *Measles Nucleotide Surveillance* (http://www.hpa-bioinformatics.org.uk/Measles/Public/Web_Front/main.php, accessed 10 October 2012).
6. Choi WS et al. Outbreak of measles in the Republic of Korea, 2007: importance of nosocomial transmission. *The Journal of Infectious Diseases*, 2011, 204 Suppl 1:S483–490. doi:10.1093/infdis/jir087 pmid:21666204
7. Kelly HA, Riddell MA, Andrews RM. Measles transmission in healthcare settings in Australia. *The Medical Journal of Australia*, 2002, 176:50–51. pmid:11936282
8. Centers for Disease Control and Prevention (CDC). Hospital-associated measles outbreak – Pennsylvania, March–April 2009. *MMWR, Morbidity and Mortality Weekly Report*, 2012, 61: 30–32. pmid:22258416
9. Centers for Disease Control and Prevention (CDC). Import-associated measles outbreak–Indiana, May–June 2005. *MMWR, Morbidity and Mortality Weekly Report*, 2005, 54:1073–1075. pmid:16251862

Investigation of an outbreak of cutaneous anthrax in Banlu village, Lianyungang, China, 2012

Zhang Ting-lu,[a] Cui Liang-liang,[bc] LI Li,[a] Zhang Ming-lei,[d] Qi Fang,[d] Ying Liang[a] and Bao Chang-jun[e]
Correspondence to Zhang Ting-lu (e-mail: tlzhang66@gmail.com).

Objective: After notification of a suspected case of anthrax following the slaughtering of a sick cow in Banlu village, an area that has not had any anthrax cases for decades, we aimed to confirm the outbreak, determine the transmission mechanism and implement control measures.

Methods: The outbreak response team interviewed all people that had contact with the sick cow. Three types of cases' specimens were collected and tested by blood smear, real-time polymerase chain reaction (PCR) and the gold colloid method. Traceback of potentially contaminated meat and cattle were conducted.

Results: There were five confirmed and three probable cases verified among 17 people who had contact with the sick cow – an attack rate of 47%. The incubation period ranged from one to eight days with a median of two days. All eight cases had lesions. All were native residents of Banlu village aged between 21 and 48 years. Five male cases were professional butchers; two females and one male were temporary assistants. The sick cow's meat and hide, as well as all cattle processed at the same time, were recalled. Hypochlorite was used to disinfect the contaminated environments, butchering facilities and the contacts' personal effects.

Conclusion: This outbreak was caused by anthrax bacillus transmitted to contacts from the tissues of the sick cow. Control of the outbreak was managed by recalling all potentially infected meat and disinfecting the slaughter house and the suspected cases' personal effects and environment.

Cutaneous anthrax often occurs among herdsmen or butchers in pasture areas in the northern or western parts of China each year[1,2] and in many developing countries like India and Bangladesh.[3,4] In Lianyungang, a coastal prefecture in the eastern part of China, the major crops are wheat and rice, although thousands of cattle are imported for slaughter from pastures in the northern part of China each year. Banlu village, located in the north of Lianyungang prefecture with a population of 1466 in 367 households, has a long history of slaughtering cattle. There has been no cutaneous anthrax cases reported in Lianyungang prefecture in past decades.

On 2 August 2012, the Lianyungang Centre for Disease Control (CDC) was notified from a hospital doctor of a case of anthrax with three lesions on both of his hands (two lesions on his left little finger and another one on the back of his right hand) after slaughtering a sick cow in Banlu village. This case worked at the largest of the three slaughter houses in the village. After confirming the information by telephone, several epidemiologists and laboratory staff from the CDC were sent to the village for further investigation the same day. Information about this suspected case of cutaneous anthrax was also sent to the veterinary officers. We describe the outbreak investigation that followed.

METHODS

According to national guidelines,[5] we conducted face-to-face interviews with all suspected cases defined as slaughter house workers who were exposed to the tissues of the sick cow. This included anyone involved in the slaughtering, skinning, cutting and/or washing of meat and viscera/organs and/or selling the meat of the sick cow. The outbreak case definitions were then defined as: a probable case had skin lesions involving vesicular eruption and/or black eschar; a confirmed case was a probable case with one of three laboratory-positive

[a] Lianyungang Municipal Center for Disease Control and Prevention, Lianyungang, Jiangsu Province, China.
[b] China Field Epidemiology Training Programme, Beijing, China.
[c] Jinan Municipal Center for Disease Control and Prevention, Jinan, Shandong Province, China.
[d] Ganyu County Center for Disease Control and Prevention, Ganyu, Jiangsu Province, China.
[e] Jiangsu Province Center for Disease Control and Prevention, Jiangsu Province, China.
Submitted: 10 October 2012; Published: 5 November 2012
doi: 10.5365/wpsar.2012.3.4.005

Table 1. **Characteristics of probable and confirmed cases of cutaneous anthrax in Banlu village, China, July to August 2012**

Patients	Sex	Age	Role in butchering process	Onset	Discharge	Case definition	Blood smear	Real-time PCR			Gold colloid method
								Serum	Eschar	Blister liquid	
Case 1	Male	48	Butchering	26 July	August 27	Confirmed	(–)	(–)	(+)	–	(–)
Case 2	Male	23	Butchering	26 July	August 31	Confirmed	(–)	(–)	(+)	–	(–)
Case 3	Female	27	Washing	26 July	August 16	Probable	–	–	–	–	(–)
Case 4	Male	21	Butchering	27 July	August 20	Confirmed	(–)	(–)	(+)	–	(–)
Case 5	Male	59	Washing	27 July	August 10	Probable	–	–	–	–	(–)
Case 6	Male	26	Butchering	29 July	August 20	Confirmed	–	–	(–)	–	(+)
Case 7	Male	28	Butchering	30 July	August 30	Confirmed	(+)	(–)	(+)	(+)	(+)
Case 8	Female	43	Washing	2 August	August 16	Probable	–	–	–	–	(–)

PCR – polymerase chain reaction; (+) – positive; and (–) – negative.

results: the anthrax bacillus was detected by blood smear; serum, liquid from blisters or eschars tested positive by real-time polymerase chain reaction (PCR); or the anthrax antigen tested positive by the gold colloid method.

Information involving name, age, occupation, work practices, disease onset, symptoms and treatments were recorded on questionnaires. We also collected information from the medical records from village clinics and hospitals. Excel 2003 was used for the database, and data were analysed with Epi Info 3.5.1. Three types of clinical specimens were collected: blood, eschar and blister fluid. The blood smear with Gram staining was done at the Lianyungang CDC Laboratory and the PCR and the gold colloid method were done at Jiangsu Province CDC Laboratory. On 2 August 2012, the veterinary officers arrived at Banlu village for the traceback investigation and the recall of potentially contaminated meat and cattle with the outcome reported to the outbreak investigation team. Ethics approval was not required as this was an outbreak investigation, although patient consent was obtained before taking specimens.

RESULTS

Epidemiological investigation

Among the 17 suspected cases (seven butchers, five temporary assistants who washed the meat and organs of the sick cow, four vendors and one person who purchased the hides), eight met the outbreak case definitions: five confirmed and three probable cases (**Table 1**). The attack rate was 47.1% (8/17). There were six male and two female cases aged between 21 and 48 years old, with a median age of 28 years. Five male cases were professional butchers; two female cases and one male case were temporary assistants. All eight cases were native residents of Banlu village; Case 1 was the father of Case 2; Case 8 was the mother of Case 4.

All eight cases had lesions, fever, dizziness, headache, cough, chest pain, fatigue and armpit lymphadenectasis or submaxillary lymph node intumescence; 50% had a fever over 39°C after onset of disease. The highest number of lesions in a single case was nine; the largest lesion was 3.5 cm in diameter, and the smallest was 0.2 cm in diameter (**Figure 1**). With regards to lesion location, 41% (9/22) were on arms, 27% (6/22) on legs, 23% (5/22) on hands and 9.1% (2/22) on faces.

The sick cow was slaughtered on 25 July 2012. Three cases had disease onset the next day, two cases on 27 July, one case on 29 July, one case on 30 July and the final case on 2 August. The incubation period ranged from one to eight days with a median of two days (**Figure 2**). On 4 August 2012, the eight cases were sent to a Lianyungang communicable disease hospital for isolation and treatment. Patients were discharge when the eschar responded to treatment and sloughed off. With penicillin treatment, three probable cases and five confirmed cases were cured and discharged before 1 September (**Table 1**).

Figure 1. **Lesions on the face, right arm and leg, Banlu village, China, July to August 2012**

Of the five confirmed cases, three were confirmed by PCR from eschar specimens (Case 1, Case 2 and Case 4), one by gold colloid method from a blood specimen (Case 6) and one (Case 7) by blood smear, PCR and gold colloid method (**Table 1**).

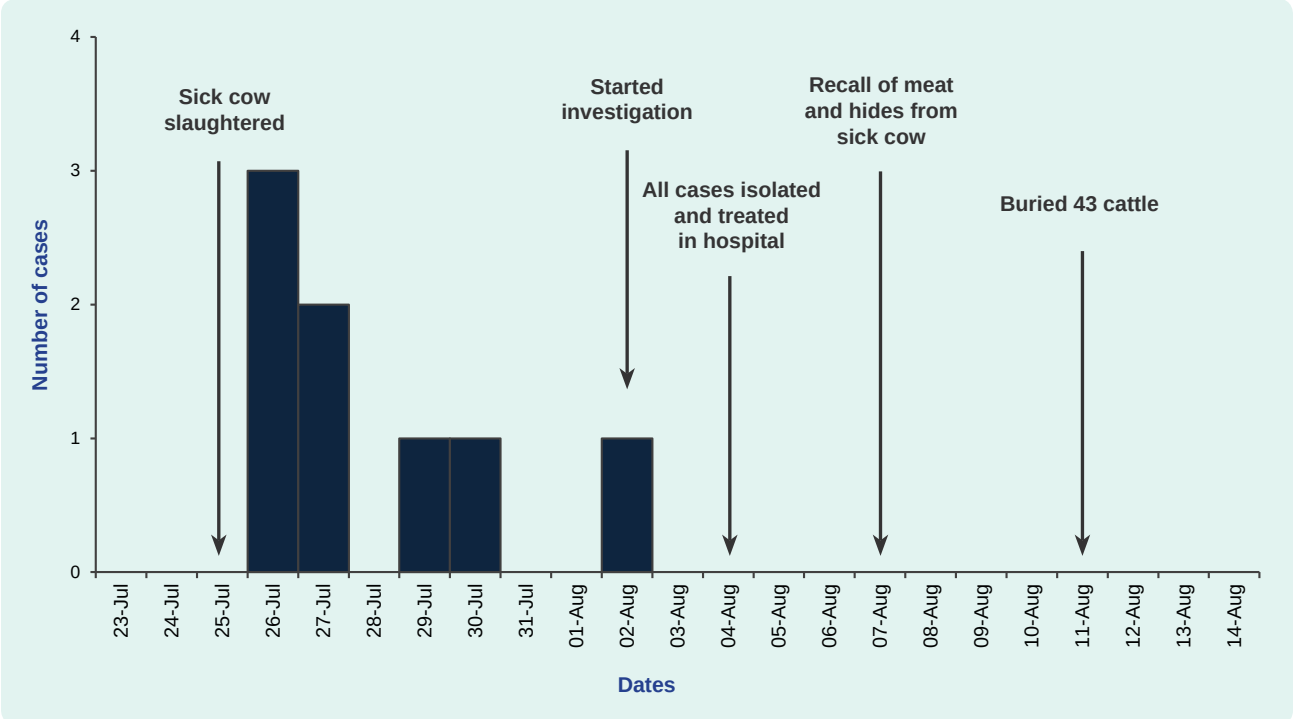
Traceback and environmental control measures

The sick cow was manually butchered on 25 July because one of its legs had broken during the travelling period. The traceback investigation found that 200 cattle were transported to the slaughter house from a pasture in the northern part of China on 25 July. On 7 August, hundreds of kilograms of meat and hide from the sick cow were recalled (**Figure 2**).

Twenty-six cattle were butchered by an automated process in the slaughter house; this meat was destroyed by police on the road to Shanghai. Thirty-four cattle were sold to Nanjing, and the meat was destroyed by the Nanjing local government. A further 43 cattle were still in Banlu village waiting for butchering and these were euthanized and buried in a deep pit by the Jiangsu Province Food and Drug Administration on 11 August. Another 90 cattle were sold to a neighbouring province, and no further intervention information by that local government was provided.

As the slaughter house sewerage and butchering site had been contaminated by the sick cow's blood, wastewater and excreta, the contaminated environments, butchering facilities and the contacts' personal effects were disinfected. Hypochlorite was used to disinfect the slaughtering site, butchering facilities and the suspected cases' personal effects every day from 2 to 18 August 2012. The medical trash and the wards in the clinic/hospital were disinfected every day until 31 August 2012.

Figure 2. **Epidemic curve of the cutaneous anthrax outbreak in Banlu village, China, July to August 2012**



DISCUSSION

We report on an outbreak of cutaneous anthrax that occurred in Banlu village, Lianyungang between 25 July and 14 August 2012. All cases had an incubation period of one to eight days, consistent with cutaneous anthrax,[6] and five cases tested positive were confirmed by laboratory testing. The mode of human transmission was through contact with the tissues of the sick cow thought to be infected by anthrax bacillus in its native pasture. The slaughter house had purchased 200 cattle with valid veterinary quarantine certificates from a pasture in the northern part of China in July 2012 where cutaenous anthrax has been reported before.[7] In an outbreak in 2005, all cases were involved in the butchering of sick or dead cows six days before onset of disease.[7]

Similar outbreaks have been recently reported in India[3] and Bangladesh.[4] In West Bengal in India an outbreak of cutaneous anthrax occurred following the slaughter of a dead bullock in a small tribal village. Most cases (81.8%) were exposed to the bacteria during butchering, although the attack rate of 7% was much lower than that in Banlu village.[3] In Bangladesh, 15 cutaneous anthrax cases were reported between April and August 2011, which also occurred after slaughtering with symptoms similar to those in this outbreak.[4]

The control measures used in this outbreak included the recall of all potentially infected meat and hides from the cattle at the slaughter house at the same time the ill cow was processed. Disinfection of both the slaughter house and the suspected cases' personal effects and environment was also done. As the investigation occurred nine days after exposure, and the slaughter house is routinely hosed out, we did not test any environmental samples for the presence of anthrax.

Our recommendations from this outbreak investigation include establishing surveillance in Banlu village for anthrax, educating butchers on the modes of anthrax transmission and care of skin abrasions, establishing prevention methods including personal cleanliness and refraining from purchasing or killing dead or dying cattle and other animals.

Conflicts of interest

None declared.

Funding

None.

References:

1. Dong-peng L et al. Epidemiological analysis of anthrax in Gansu Province from 2005 to 2011 [in Chinese]. *Chinese Journal of Health Education*, 2012, 28:544–550.
2. Guang-jiu S et al. Analysis on anthrax resource and epidemic in Liaoning Province [in Chinese]. *Chinese Journal of Zoonoses*, 2007, 23:416.
3. Chakraborty PP et al. Outbreak of cutaneous anthrax in a tribal village: a clinico-epidemiological study. *The Journal of the Association of Physicians of India*, 2012, 60:89–93. pmid:22715553
4. Siddiqui MA et al. Recent outbreak of cutaneous anthrax in Bangladesh: clinico-demographic profile and treatment outcome of cases attended at Rajshahi Medical College Hospital. *BMC Research Notes*, 2012, 5:464. doi:10.1186/1756-0500-5-464 pmid:22929128
5. *Diagnostic, treatment and tackling program for anthrax*. Beijing, Ministry of Health of the People's Republic of China, 2005, No. 497.
6. David L. Heymann. *Control of Communicable Diseases Manual. 18th Edition*. Washington, DC, American Public Health Association, 2004, p. 21–26.
7. Mu H, Ping W, Xiu-ju H. Report on an outbreak of cutaenous anthrax cases in Shengyang City. *Modern Preventive Medicine*, 2007, 1:159.

'Surprise': Outbreak of *Campylobacter* infection associated with chicken liver pâté at a surprise birthday party, Adelaide, Australia, 2012

Amy Parry,[ab] Emily Fearnley[ab] and Emma Denehy[a]

Correspondences to Amy Parry (e-mail: amy.parry@health.sa.gov.au).

Objective: In July 2012, an outbreak of *Campylobacter* infection was investigated by the South Australian Communicable Disease Control Branch and Food Policy and Programs Branch. The initial notification identified illness at a surprise birthday party held at a restaurant on 14 July 2012. The objective of the investigation was to identify the potential source of infection and institute appropriate intervention strategies to prevent further illness.

Methods: A guest list was obtained and a retrospective cohort study undertaken. A combination of paper-based and telephone questionnaires were used to collect exposure and outcome information. An environmental investigation was conducted by Food Policy and Programs Branch at the implicated premises.

Results: All 57 guests completed the questionnaire (100% response rate), and 15 met the case definition. Analysis showed a significant association between illness and consumption of chicken liver pâté (relative risk: 16.7, 95% confidence interval: 2.4–118.6). No other food or beverage served at the party was associated with illness. Three guests submitted stool samples; all were positive for *Campylobacter*. The environmental investigation identified that the cooking process used in the preparation of chicken liver pâté may have been inconsistent, resulting in some portions not cooked adequately to inactivate potential *Campylobacter* contamination.

Discussion: Chicken liver products are a known source of *Campylobacter* infection; therefore, education of food handlers remains a high priority. To better identify outbreaks among the large number of *Campylobacter* notifications, routine typing of *Campylobacter* isolates is recommended.

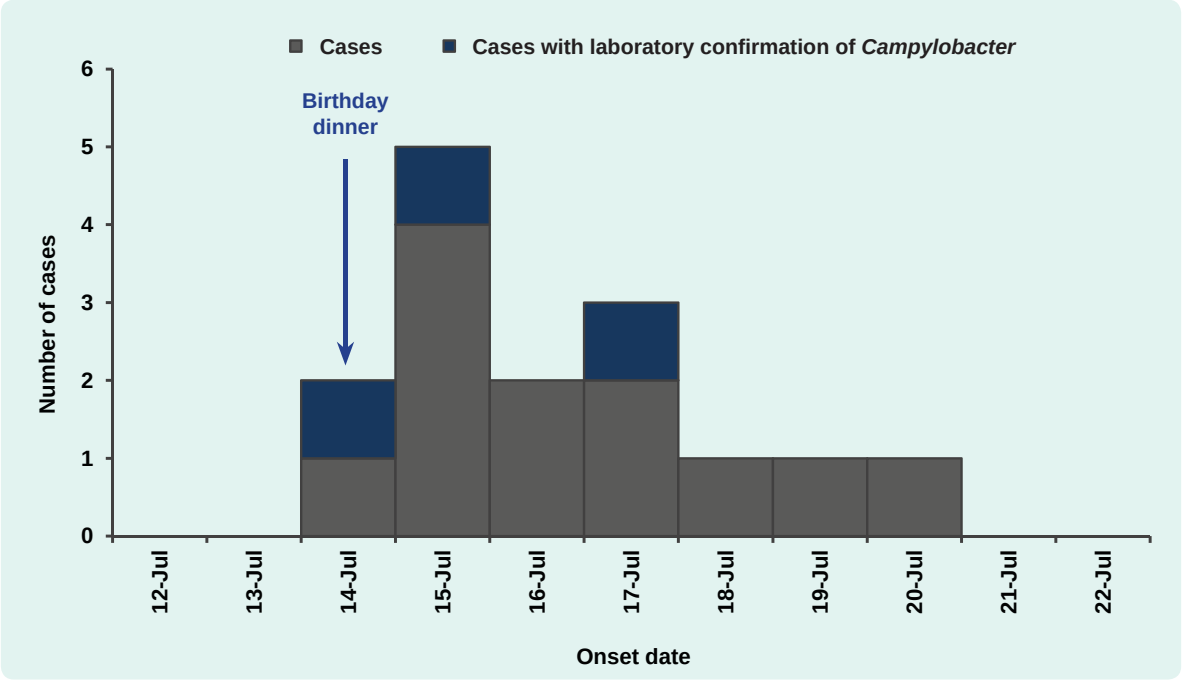
Campylobacteriosis is the most commonly reported notifiable infectious gastrointestinal disease in Australia, with annual national notification rates of between 104.8 and 117.3 per 100 000 during the period 2007–2011 (excluding New South Wales, the largest state in Australia).[1] Notification rates are similar in South Australia and other developed countries.[2,3] True case numbers are most likely higher due to an estimated 90% of campylobacteriosis cases not being reported.[4] Despite high case numbers, campylobacteriosis outbreaks are uncommon.[2,3,5–7] One key reason for this is the limited microbiological speciation and typing of specimens.

Campylobacter is a bacterium commonly found in raw poultry[8,9] and other sources, including contaminated water, unpasteurized milk and pets.[10] The incubation period of *Campylobacter* infection is usually between two and five days, but can range from one to 10 days.[11] Symptoms include diarrhoea, fever and abdominal pains.[11] The infective dose is reportedly low, with 500 organisms required to cause illness.[5,7]

On 27 July 2012, the South Australian Communicable Disease Control Branch was notified of a suspected campylobacteriosis outbreak linked to a surprise birthday party at a restaurant on 14 July 2012. The index case reported that other guests were also ill after the party. A retrospective cohort study was conducted among the 57 guests. The investigation objectives were to define the outbreak by person, time and place; identify the potential source of infection; and institute intervention strategies to prevent further illness.

[a] Communicable Disease Control Branch, South Australian Department of Health and Ageing, Adelaide, South Australia, Australia.
[b] OzFoodNet, South Australian Department of Health and Ageing, Adelaide, South Australia, Australia.
Submitted: 12 October 2012; Published: 13 November 2012
doi: 10.5365/wpsar.2012.3.4.011

Figure 1. **Reported illness by date of onset after attending a surprise birthday party, South Australia, July 2012 (n = 15)**



METHODS

A retrospective cohort study was conducted among the 57 guests at the surprise birthday party at a restaurant on 14 July 2012. The questionnaire collected demographic information, personal and household gastrointestinal illness before and after the event, food and beverage consumption at the party and other common events attended. Presentation to a medical practitioner and hospitalization information were also obtained. Guest contact details (a combination of telephone numbers and postal addresses) were provided by the event organizer. The questionnaire was completed by trained interviewers via telephone or through self-completion of paper-based questionnaires, with all interviews completed within 14 days. Guests contacted via post were invited to telephone the investigation team to complete their questionnaire.

A case was defined as any person who consumed food and/or beverages at the birthday party on 14 July 2012 and subsequently reported diarrhoea (three or more loose stools in a 24-hour period).

Data analysis was conducted with STATA 12. Univariate analysis included attack rates, *p*-values, relative risks and 95% confidence intervals (exact). A *p*-value of less than 0.05 was considered significant. chi-squared (exact) tests were used to test for significance between categorical variables. Additional analysis was conducted excluding the cases that reported illness within 24 hours to account for the possibility that their illness was not associated with this outbreak. As this did not affect the outcome, this analysis was excluded.

The Food Policy and Programs Branch conducted an environmental investigation at the implicated premises. As there was no left-over product, information on ingredients and cooking processes of foods served were obtained.

RESULTS

All 57 guests responded to the investigation questionnaire (100% response rate). Fifteen met the case definition. The epidemic curve (**Figure 1**) indicates illness onset was rapid, with two cases reporting illness later on the night of the party and five reporting illness early the next morning. Eight of the 15 cases sought medical care, three of whom provided faecal specimens. All three faecal specimens were confirmed via culture with *Campylobacter* infection; one was further speciated as *Campylobacter jejuni*. One case reported hospitalization.

After diarrhoea, the most commonly described symptom for all 15 cases was abdominal pains (85.7%).

Table 1. **Univariate food frequency analysis from surprise birthday party, South Australia, July 2012 (n = 57)**

Meal	Exposure	Exposed			Unexposed					
		No. ill	Total	AR%	No. ill	Total	AR%	RR	95% CI	*p*-value
Starter	Nuts	2	13	15.4	12	39	30.8	0.5	0.1–2.0	0.279
	Olives	3	12	33.3	11	43	25.6	1.3	0.5–3.34	0.594
Entrée	Chicken liver pâté	14	26	53.8	1	31	3.2	16.7	2.4–118.6	<0.001
	Mussels marinière	1	29	3.5	14	28	50.0	0.1	0.0–0.5	<0.001
Main course	Duck fillet with orange glaze	6	24	25.0	9	33	27.3	0.9	0.4–2.2	0.780
	Chateaubriand with béarnaise sauce	9	33	27.3	6	23	26.1	1.1	0.4–2.5	0.921
Dessert	Flourless chocolate cake	6	23	26.1	9	34	26.5	1.0	0.4–2.4	0.974
	Rhubarb crème brûlée	11	35	31.4	4	22	18.2	1.7	0.6–4.8	0.269
After dinner	Chocolate sponge birthday cake	1	13	7.7	14	43	32.6	0.2	0.0–1.6	0.076
	Chocolates	3	9	33.3	10	35	28. 6	1.2	0.4–3.4	0.780

AR – attack rate; RR – relative risk; CI – confidence interval.

No vomiting was reported. The median duration of illness for those recovered at the time of interview (n = 12) was eight days.

Two children under 18 years attended the party; remaining guests were adults (40% aged between 40 and 49 years). The sex distribution of people attending the party was even (females 51%). There was no statistical difference between illness and sex or age.

The menu served at the party consisted of two options each for entrée, main course and dessert. Consumption of the chicken liver pâté entrée was significantly associated with illness (relative risk [RR]: 16.7, 95% confidence interval [CI]: 2.4–118.6), whereas consumption of mussels for entrée was inversely associated with illness (RR: 0.1, 95% CI: 0.0–0.5). No other foods or beverages served at the party were associated with illness (**Table 1**). Nine males reported eating pâté compared to 17 females, of which five males and 10 females were cases (1:2).

The environmental investigation team identified that livers used in the pâté were sautéed during preparation; actual duration of cooking was not recorded.

DISCUSSION

Consumption of chicken liver pâté was associated with the illness at the surprise birthday party. The reduced risk of illness associated with consumption of the mussel marinière was likely due to the dichotomous nature of the menu choices rather than a true biological association.

Studies have reported that livers can be both internally and externally contaminated with *Campylobacter*.[8,9] The presence of *Campylobacter* in chicken livers can be reduced by cooking them for two to three minutes after they reach a core temperature of 70°C to 80°C.[8] The restaurant reported only sautéing the livers before making the pâté and that a large volume of pâté was made and stored in batches. It is plausible that multiple batches of pâté were served that evening, some contaminated and others not. Insufficient cooking of the chicken livers was most likely a significant causative factor in this outbreak.

Cases reported rapid onset of illness after the event, shorter than the usual incubation period for campylobacteriosis, perhaps due to a large concentration of bacteria in the pâté[12] or an increased virulence of the strain. Susceptibility to *Campylobacter* infection is influenced by host immunosuppression, stomach acidity and antibiotic and proton pump inhibitor use.[7,12,13]

Pâté as the vehicle for *Campylobacter* infection is not a new finding. Numerous *Campylobacter* outbreaks throughout Australia[9] and internationally[2,3,5] have also identified liver pâté as the possible vehicle. Outbreaks of this kind may be greatly underestimated due to inherent difficulties in detecting *Campylobacter* outbreaks in Australia.[6] *Campylobacter* isolates are not routinely subtyped despite molecular subtyping methods being

available to identify reasonable genetic diversity in human cases.[14] Without subtyping, the identification of clusters and outbreaks is largely restricted to temporal or geographical associations or reliance on medical notifications identifying common events.[15]

As all guests responded to the questionnaire, there was no potential for selection bias. The majority of interviews were conducted in the first five days of the investigation, reducing recall bias. A potential investigation limitation of the study design was the use of a mixed method approach of telephone and paper-based questionnaires.

In summary, *Campylobacter* infection linked to liver pâté has been identified numerous times despite the cooking procedures necessary to ensure safe preparation of liver pâté being clearly described. The current high standards of hygiene and food preparation in Australia have minimized the impact of foodborne illness linked to commercial settings. This outbreak has demonstrated the importance of continuing education of *Campylobacter* infection, and the appropriate handling and cooking of higher risk foods, including livers. Furthermore, to better identify outbreaks among the large number of *Campylobacter* notifications, routine typing of *Campylobacter* isolates is recommended.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

The OzFoodNet programme is an initiative of the Australian Government Department of Health and Ageing. The authors would like to acknowledge the work of the investigation team and other members of the Department who provided advice. Thank you to the South Australia Health Disease Surveillance and Investigation Section: Annika Wendland, Helen Livissianos, Remy Boyes, Hannah Vogt and Pip Rokkas; the Food Standards Surveillance Section of Food Policy and Programs Branch: Glen Martin, Garry Clarke, Jamie Woodward, Vanessa McEvoy and Alessia Centofanti; as well as Communicable Disease Control Branch doctors: Ann Koehler, Albert Lessing, Kushani Marshall and Jane Raupach.

References:

1. *National Notifiable Disease Surveillance System*. Canberra, Australian Government Department of Health and Ageing, 2012 (http://www9.health.gov.au/cda/Source/CDA-index.cfm, accessed 19 September 2012).
2. Little CL et al. A recipe for disaster: outbreaks of campylobacteriosis associated with poultry liver pâté in England and Wales. *Epidemiology and Infection*, 2010, 138:1691–1694. doi:10.1017/S0950268810001974 pmid:20727250
3. O'Leary MC et al. A continuous common-source outbreak of campylobacteriosis associated with changes to the preparation of chicken liver pâté. *Epidemiology and Infection*, 2009, 137:383–388. doi:10.1017/S0950268808001003 pmid:18647437
4. Hall G et al. Estimating community incidence of *Salmonella*, *Campylobacter*, and *Shiga* toxin-producing *Escherichia coli* infections, Australia. *Emerging Infectious Diseases*, 2008, 14:1601–1609. doi:10.3201/eid1410.071042 pmid:18826825
5. Inns T, Foster K, and Gorton R. Cohort study of a campylobacteriosis outbreak associated with chicken liver parfait, United Kingdom, June 2010. *Euro surveillance: European Communicable Disease Bulletin*, 2010, 15(44):pii=19704. pmid:21087588
6. Unicomb LE et al. Outbreaks of campylobacteriosis in Australia, 2001 to 2006. *Foodborne Pathogens and Disease*, 2009, 6:1241–1250. doi:10.1089/fpd.2009.0300 pmid:19895264
7. Janssen R et al. Host-pathogen interactions in *Campylobacter* infections: the host perspective. *Clinical Microbiology Reviews*, 2008, 21:505–518. doi:10.1128/CMR.00055-07 pmid:18625685
8. Whyte R, Hudson JA, Graham C. *Campylobacter* in chicken livers and their destruction by pan frying. *Letters in Applied Microbiology*, 2006, 43:591–595. doi:10.1111/j.1472-765X.2006.02020.x pmid:17083702
9. Merritt T, Combs B, Pingault N. *Campylobacter* outbreaks associated with poultry liver dishes. *Communicable Diseases Intelligence*, 2011, 35:299–300. pmid:22624491
10. Tenkate TD, Stafford RJ. Risk factors for *Campylobacter* infection in infants and young children: a matched case-control study. *Epidemiology and Infection*, 2001, 127:399–404. doi:10.1017/S0950268801006306 pmid:11811871
11. Heymann MD. *Control of Communicable Diseases Manual 19th Edition*. Washington, World Health Organization and American Public Health Association, 2008.
12. Allos BM. *Microbiology, pathogenesis, and epidemiology of Campylobacter infection*, 9 August 2011 (http://www.uptodate.com/contents/microbiology-pathogenesis-and-epidemiology-of-campylobacter-infection, accessed 24 September 2012).
13. Neal KR et al. Omeprazole as a risk factor for campylobacter gastroenteritis: case-control study. *BMJ (Clinical research ed.)*, 1996, 312:414–415. doi:10.1136/bmj.312.7028.414 pmid:8601113
14. Mickan L et al.; Australian *Campylobacter* Subtyping Study Group. Multilocus sequence typing of *Campylobacter jejuni* isolates from New South Wales, Australia. *Journal of Applied Microbiology*, 2007, 102:144–152. doi:10.1111/j.1365-2672.2006.03049.x pmid:17184329
15. Swaminathan B et al.; CDC PulseNet Task Force. PulseNet: the molecular subtyping network for foodborne bacterial disease surveillance, United States. *Emerging Infectious Diseases*, 2001, 7:382–389. pmid:11384513

An outbreak of acute gastroenteritis associated with contaminated bottled water in a university – Jiangxi, China, 2012

Ruiping Wang,[ab] Huijian Cheng,[c] Jun Zong,[c] Ping Yu,[c] Weijie Fu,[c] Fuqiang Yang,[c] Guoqing Shi[a] and Guang Zeng[a]

Correspondence to Huijian Cheng (e-mail: ejian2373@sina.com).

Background: On 23 May 2012, a university in Jiangxi, China reported a gastroenteritis outbreak. We investigated the outbreak to identify the agent, source and mode of transmission and to recommend control measures.

Methods: A case was defined as any person from the university with onset of diarrhoea (≥3 times/24h) from 1 to 31 May 2012. Active case finding was conducted by reviewing university hospital and drug-store records and interviewing students, workers and teachers. We then conducted a case-control study in which we compared food, water and environmental exposure history. Water samples were collected and tested.

Results: We identified 417 cases – an attack rate (AR) of 4.7% (417/8781) for the university. There were 416 student cases (AR = 5.7%) distributed across all 11 colleges, five of which were more heavily affected (AR range = 5.9%–14%). In the case-control study, cases had higher odds of having drunk bottled water (odds ratio [OR] = 4.1; 95% confidence interval [CI] = 1.7–9.9), and there was a dose–response relationship (χ^2trend = 4.6, $P < 0.05$). Drinking boiled bottled water was inversely associated with being a case (OR = 0.22, 95% CI = 0.07–0.71). Eating in any of the three university canteens or drinking water from the city water supply was not associated with being a case. Pathogenic *Escherichia coli* was isolated from two unopened bottled water specimens and from four student cases.

Conclusion: This gastroenteritis outbreak was most likely caused by contaminated bottled water. The company in question has been shut down and no further cases have been reported. Increased regulation of bottled water plants and better coordination between different investigators for future outbreaks is recommended.

In May 2012, a university in Jiangxi province, China notified the Jiangxi Provincial Center for Disease Control and Prevention (JXCDC) of a gastroenteritis outbreak with more than 70 students affected in the previous week. The university is located in the northwest of Nanchang City and comprises two teaching buildings, four laboratory buildings, 15 student dormitories, three canteens, one faculty residence and one kindergarten. The total number of students, teachers and canteen workers was 8871.

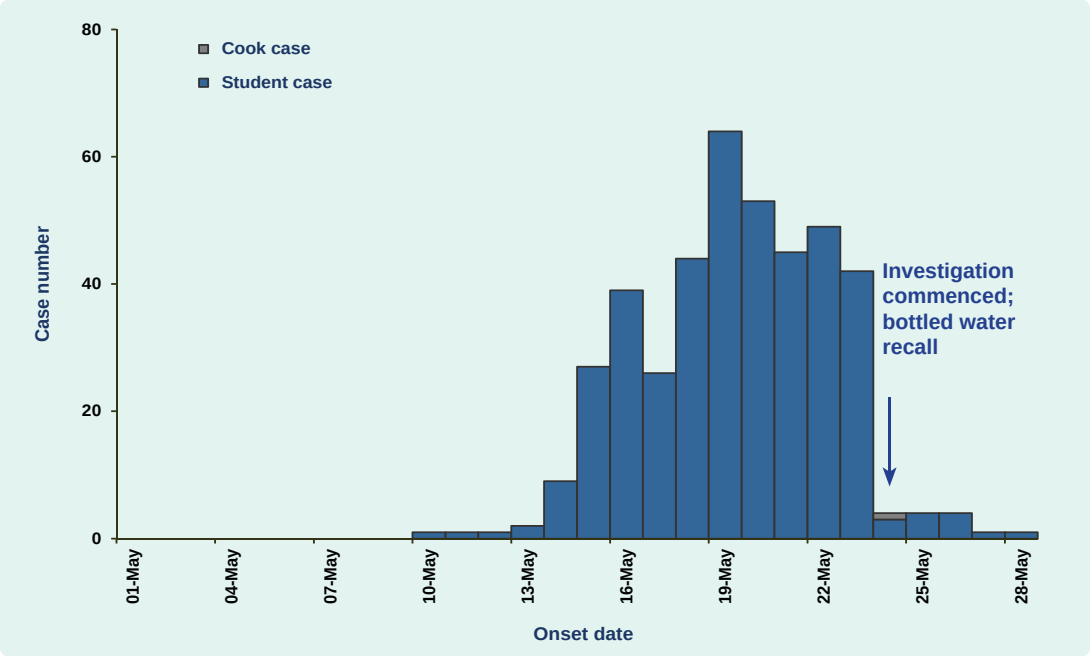
China Field Epidemiology Training Programme (CFETP) along with JXCDC investigated this outbreak to identify the agent, source and mode of transmission and to recommend control measures.

METHODS

A case was defined as any person in the university with onset of diarrhoea (≥3times/24h) from 1 to 31 May 2012. Active case finding was conducted by reviewing university hospital medical registration and drug-store-records and interviewing university canteen workers, students and teachers from each college. Attack rates were calculated using population numbers (teachers, students and canteen workers) in the university as the denominator. We used a structured questionnaire, which included questions on food and water exposures and other environmental factors. To determine attack rates for each of the three canteens in the university we reviewed the students' electronic dining records as

[a] China Field Epidemiology Training Programme (CFETP) Beijing, China.
[b] Songjiang Center for Disease Control and Prevention, Shanghai, China.
[c] Jiangxi Provincial Center for Disease Control and Prevention, Jiangxi, China.
Submitted: 12 October 2012; Published: 13 November 2012
doi: 10.5365/wpsar.2012.3.4.009

Figure 1. **Epidemic curve of acute gastroenteritis outbreak in a university, Jiangxi province, China, May 2012**



well as interviewing the students about their dining habits.

We then conducted a case-control study from 21 to 23 May and selected 106 new student cases during this period. One hundred and six students from the same dormitories as the cases were selected as controls; they were excluded if they reported any gastrointestinal symptoms. We used a more specific questionnaire that focused on drinking-water. These exposures were then compared, and analysis was conducted using SAS 9.1.3.

From 16 to 21 May, nine unopened bottled water specimens from six batches, 10 water specimens from drinking-water machines in cases' dormitories and six water specimens from the city water supply were collected for testing. The water from the drinking machines was from the same factory that provided the bottled water. The total bacteria count and the coliform bacteria count of water specimens were tested according to the Chinese national standard examination methods for drinking-water (GB/T5750.12–2006).[1]

Two faecal specimens and 25 anal swabs were collected from untreated student cases from 22 to 24 May. Faecal and anal swab specimens were cultured on sorbitol-MacConkey medium for *Escherichia coli* and classified by serum agglutination, and tested for *Escherichia coli* toxin gene by polymerase chain reaction (PCR). *Salmonella, Shigella* and *Staphylococcus* bacteria, vice haemolytic vibrio, cholera, haemolytic streptococcus, liszt's bacteria, gas single spore bacterium, pseudomonas bacteria, rotavirus, stellate virus, adenovirus, intestinal virus and goblet virus were also tested in the water, faecal and anal swab specimens.

RESULTS

Description of cases

We interviewed 8871 persons during active case finding, and 7360 of these were students. There were 417 cases of gastroenteritis in the university – a total attack rate (AR) of 4.7% (417/8781). After diarrhoea, clinical symptoms mainly included abdominal pain (64%), bloating (50%), vomiting (17%) and fever (8%). The median duration of illness was three days (range one to five days).

The onset date of the first case was 10 May with case numbers escalating from 14 May. This then levelled off from 16 to 23 May to about 50 cases each day. (**Figure 1**) The investigation commenced on 24 May and the bottled water was recalled later on the same day. This gastroenteritis outbreak lasted for 19 days.

There were 416 student cases (AR = 5.7% [416/7360]) with 223 males (AR = 5.2%) and 193 females (AR = 6.3%); females were more likely to be a case (relative risk [RR] = 0.82, 95% confidence interval [CI]: 0.68–0.99). The remaining case was a

Table 1. **Case-control analysis of the association between drinking-water and gastroenteritis, Jiangxi province, China, May 2012**

Drinking-water	Cases		Controls		OR	95%CI
	No.	%	No.	%		
What kind of water did you drink in the recent week?						
School-provided bottled water	97	92	73	77	4.10	1.70–9.90
Bottled mineral water	7	6.6	16	17	0.37	0.13–1.00
Boiled water	2	1.9	11	12	0.15	0.02–0.71
How did you drink the bottled water?						
Drank directly	77	79	68	52	1.90	0.88–3.90
Blended with boiled bottled water	15	15	13	10	1.20	0.48–3.20
Drank after boiling	5	5.2	19	15	0.22	0.07–0.71
How much bottled water do you drink on average each day?						
> 1500ml	21	22	12	9	3.00	1.10–8.20
1001–1500ml	25	26	23	18	1.80	0.68–4.80
501–1000ml	34	35	36	28	1.60	0.65–3.80
< 500ml	17	18	29	22	ref	–

OR – odds ratio; CI – confidence interval

cook. The 416 student cases were distributed across all 11 colleges. Five of these colleges were heavily affected (AR range = 6%–14%), with the ARs of the six other colleges ranging from 2% to 5%. The ARs of the 11 colleges were statistically different (χ^2 = 167, $P < 0.01$). The AR for canteen 1 was 14% (229/1667), canteen 2 was 12% (270/2333) and canteen 3 was 11% (189/1675); there was no statistical difference between them (χ^2 = 5.9, P = 0.05).

Case-control study

The case-control study found that 92% of student cases drank bottled water compared to 73% of control-students (odds ratio [OR] = 4.1; 95% CI = 1.7–9.9). Drinking boiled water was inversely associated with being a case, and there was no difference between cases and controls that reported drinking mainly bottled mineral water (**Table 1**).

Among the students who reported they drank mainly bottled water in the past week, drinking bottled water directly had a higher odds ratio, while drinking bottled water after boiling had a lower odds ratio (OR = 0.22, 95% CI = 0.07–0.71). Moreover, there was a dose response relationship for student cases who drank more bottled water (from <500 ml/day to >1500 ml/day) (χ^2trend = 4.6, $P < 0.05$) (**Table 1**).

Laboratory results

The total bacteria count and the coliform bacteria count of the nine unopened bottled water specimens and 10 water specimens from drinking-water machines exceeded national standards. Water specimens from the city water supply complied with the national drinking-water standard. *Escherichia coli O157* and *Enterotoxigenic Escherichia coli (ETEC) O55:K19* were isolated from two unopened bottled water specimens.

Enteropathogenic Escherichia coli (EPEC) O126:K71, EPEC O125:K70, EPEC O44:K74 and *ETEC O15:K17* were isolated from one faecal and three anal swabs, respectively. The ETEC O15:K17 from the faecal specimen was verified as heat labile toxin positive, with all other pathogenic bacteria testing negative for the toxin.

DISCUSSION

In this university gastroenteritis outbreak investigation, the most likely source of the outbreak was contaminated bottled water. The case-control study showed that the odds of cases reporting that they mostly drank bottled water in the week before the outbreak was four times higher than the controls; there was a dose response relationship as student cases who drank more bottled

water had higher ARs. The total bacteria count and the coliform bacteria count of bottled water specimens and water specimens from the drinking-water machines exceeded national standards, and the bottled water was also contaminated with pathogenic *Escherichia coli*. Also, after the implementation of comprehensive control measures such as recalling the contaminated bottled water, conducting safe-drinking education and rinsing dormitory drinking-water machines, the number of diarrhoea cases in the university reduced sharply.

It is unlikely that this outbreak was caused by food exposure in university canteens as the three canteens had different managers and served different food, and the student AR of each of the three canteens was not statistically different. Also, the epidemic curve suggested a continuing common source as the exposure mode; canteen food is therefore an unlikely source due to the turnover of meals at the canteens. It was also unlikely that the city water supply was the cause of the outbreak. City water is provided at student dormitories, canteens, the faculty residence and the kindergarten; there was no case from the teacher communities or the kindergarten so we assumed that the city water was not associated with the outbreak.

Until the middle of the 20th century, *Escherichia coli* had been regarded as a nonpathogenic bacteria to humans and part of the normal intestinal colony.[2] However, some serotypes of *Escherichia coli* are pathogenic both to human and animals, especially infants, resulting in serious diarrhoea and sepsis. In bad environmental conditions, *Escherichia coli* can be dispersed with faeces. The presence of *Escherichia coli* in water or food indicates faecal contamination and embodies the possible existence of intestinal pathogenic bacteria. Therefore, the coliform bacteria count is generally regarded as the hygiene standard for drinking-water and food. That the coliform count was higher than the standard in the bottled water in this outbreak investigation suggests faecal contamination at some part of the production cycle of the bottled water.

In recent years, bottled water has become more popular in China because of its lower price and because it can be drunk directly.[3] However, as the public health surveillance of bottled water lags behind in China, and as people will drink bottled water directly without boiling, exposure to contaminated bottled water can cause serious gastroenteritis outbreaks. Other gastroenteritis outbreaks related to *Escherichia coli*-contaminated bottled water have also been reported in field investigations in China.[4,5]

There are some limitations in this investigation. As the occurrence of this outbreak was hidden, since the symptoms of diarrhoea were light and most cases did not go to hospitals for treatment, there was a delay in the discovery and report of the outbreak. We collected only two faecal specimens, with only one heat labile toxin *ETEC O15:K17* isolated. Although *ETEC O15:K17* fits the clinical characteristics of the cases and the epidemiology of the outbreak, we cannot definitively state that *ETEC O15:K17* was the causative agent. For future outbreaks, we recommend that investigators increase the proportion of faecal specimens collected.

The large decline in cases after our investigation and the recall may be due to the fact that at this stage we conducted active case finding through university hospital doctors only, not by interviewing each students as we did during the investigation. Due to the light clinical symptoms, some student cases may not go to hospitals despite knowing about the outbreak. This probably was the reason why case numbers decreased quickly after 24 May. We were also unable to acquire incidence information from other schools in which bottled water was supplied by the same water company. This was because the water company manager refused to talk with our investigators and we were unable to inspect the company premises. We were therefore also unable to ascertain possible pollution sources and steps, or determine the source of the contamination.

As a result of this outbreak, we recommended that the water company stop producing bottled water and identify the contamination source. On 3 June, the water company was shut down by the Nanchang Bureau of Quality and Technical Supervision. To prevent future outbreaks, we also suggested that the long-term regulatory oversight and surveillance of bottled water

be enhanced to ensure the security of drinking-water. During future outbreaks, we also recommend that departments such as the Centre for Disease Control and Prevention, Food and Drug Administration, Bureau of Health Supervision and Bureau of Quality and Technical Supervision share results and findings and conduct investigations collaboratively.

Conflicts of interest

None declared.

Funding

None.

References:

1. *Standard examination methods for drinking water-Microbiological parameters (GB/T5750.12–2006) - National Standards of People's Republic of China, 1st edition* [in Chinese]. Hong Kong, China Standards Press, 2007.
2. Heymann DL, editor. *Control of Communicable Diseases Manual, 18th edition.* Washington, DC, American Public Health Association. 2004.
3. Xiaohong X, Shuozhu J. Acute gastroenteritis outbreak investigation caused by *Escherichia coli* polluted bottled water. *Medicina Infantil*, 2009, 22:2239.
4. Shen JC et al. A norovirus-borne outbreak caused by contaminated bottled spring water in a school, Zhejiang province [in Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi*, 2011, 32:800–803. pmid:22093472
5. Lin Z. A bacillary dysentery outbreak investigation associated with bottled spring water in Zhejiang province [in Chinese]. *Zhejiang Journal of Prevention Medicine*, 2006, 18:25–26.

Vibrio parahaemolyticus enteritis outbreak following a wedding banquet in a rural village – Kampong Speu, Cambodia, April 2012

Som Vandy,[a] Som Leakhann,[b] Has Phalmony,[c] Justin Denny,[d] and Maria Concepcion Roces[c]

Correspondence to Maria Concepcion Roces (e-mail: rocesm@wpro.who.int).

Introduction: Foodborne outbreaks are common in Cambodia, but only a few investigations documenting the etiology and source have been conducted. In April, we learnt of 49 acute diarrhoea cases in a village following a wedding banquet. We undertook an investigation to identify the pathogen, source and mode of transmission.

Methods: We interviewed banquet hosts and food handlers to obtain the menu and guest list. Guests were asked about signs and symptoms and onset of illness, time of meal and food or drinks consumed. Rectal swabs were taken from 13 cases for culture. A case-control study was undertaken; cases were guests who had acute diarrhoea within three days after the wedding and controls were guests who remained well during the same time period.

Results: There were 256 guests. Of 69 interviewees, 52 got sick (attack rate 75%). Aside from diarrhoea, cases had abdominal pain (94%), vomiting (48%), nausea (42%) and fever (25%). Incubation periods ranged from seven to 51 hours (median 16.5). Rectal swabs from three cases grew *Vibrio parahaemolyticus*. Among the food and drinks served, vegetable salad with raw octopus was the only one associated with illness (odds ratio: 6.6, 95% confidence interval: 1.3–36.1, $P = 0.01$).

Discussion: Vegetable salad with raw octopus was the suspected vehicle for transmission of this *Vibrio parahaemolyticus* enteritis outbreak. Messages regarding the risks from eating raw seafood were disseminated, and food handlers were advised to cook seafood to high temperatures. Efforts to improve foodborne disease surveillance and food safety are being undertaken.

Vibrio parahaemolyticus is a gram-negative bacteria that inhabits marine environments and is a well known cause of foodborne disease outbreaks in south-eastern Asia.[1] *Vibrio parahaemolyticus* infection is typically contracted by eating contaminated seafood such as raw or undercooked shellfish[1,2] and was first identified as a cause of foodborne outbreaks in 1950 following an incident in Japan when 20 out of 272 ill persons died after eating sardines.[3] In Taiwan, China it is believed that up to 71% of foodborne illness outbreaks from 1996 to 1999 were caused by *Vibrio parahaemolyticus*.[4]

In Cambodia, there is no routine reporting of food poisoning cases. However, an event-based surveillance system exists which captures reports from the media and includes a hotline number that health workers or the general public can call to report suspected outbreaks. These reports are then investigated by Rapid Response Teams (RRTs) as needed.

On 10 April 2012, the Kampong Speu Provincial RRT informed the Communicable Disease Control Department of 49 cases with acute diarrhoea seen at the Veal Angpopel Health Center during the past two days after most of the cases attended a wedding party on 8 April held in Tbaung Boeung village. Upon receipt of the report, a RRT travelled to the village, located about one and a half hours from Phnom Penh by car, to conduct an outbreak investigation. The objectives of the investigation were to identify the etiologic agent, source and mode of transmission and to recommend appropriate public health measures.

This paper details the clinical, laboratory and epidemiological findings from this outbreak investigation

[a] Communicable Disease Control Department, Ministry of Health, Cambodia.
[b] Kampong Speu Provincial Health Department, Ministry of Health, Cambodia.
[c] World Health Organization, Phnom Penh, Cambodia.
[d] South Asia Field Epidemiology and Technology Network, Inc.
Submitted: 10 October 2012; Published: 14 November 2012
doi: 10.5365/wpsar.2012.3.4.004

and is the first documented *Vibrio parahaemolyticus* enteritis outbreak from Cambodia in the English literature.

METHODS

We interviewed key informants (health centre staff, hosts of the wedding party, some persons involved in food preparation and a few patients). A list of party attendees and the menu were obtained. Wedding attendees came from eight provinces, and at the time of the field investigation many attendees had returned to their home provinces. We were therefore only able to interview attendees who lived in the village where the wedding was held and a nearby village. A team of eight persons interviewed these wedding party attendees in person using a standard foodborne illness questionnaire. Data on demographic information, signs and symptoms, onset of illness, time of meal and food items consumed during the party were obtained.

Since we were only able to interview 27% of the guests (69/256), we used a case-control study design. Cases were wedding party attendees who developed acute diarrhoea (≥ three loose bowel movements in a day) after the party anytime from 8 to 10 April. Controls were wedding party attendees who remained well during the three days after the party.

We obtained rectal swabs from 13 cases who agreed to have samples taken from them. The samples were sent to the laboratory at the National Institute for Public Health, Cambodia for bacterial culture.

Data were entered into a computer and analysed using Epi Info. We calculated odds ratios, confidence intervals and *P* values using the Fischer's exact test (2-tailed) and Yates corrected χ^2 test.

RESULTS

Wedding party

The wedding party was held on 8 April from morning until evening at the bride's family home and was attended by 256 guests. Food was served from 15:00 to 19:00. The menu consisted of the following: vegetable salad with raw octopus, chicken soup with coconut milk, pork salad, fried fish with sauce, chicken soup with lime and rice. Beverages served were beer, soft drinks and water. Guests could request to have ice with their drinks.

The various food items were prepared by a team of 20 people. Food preparation began early in the morning, and some dishes (soups and fish) were reheated during the day. The main ingredients for the vegetable salad (carrots, lettuce, various herbs, garlic, peanuts, bean sprouts and octopus) were chopped and kept in separate bowls on a long table. During meal time, a server would mix the various ingredients in a serving plate and place the plate on the guests' tables.

Since there were no left-over food samples, none was available for laboratory testing.

Cases

Of 69 guests interviewed, 52 got sick (attack rate 75%). The majority (46/52 or 88%) of the cases had watery diarrhoea, five (10%) had mucoid stools, while one (2%) had bloody diarrhoea. Other signs and symptoms of cases were abdominal pain (94%), vomiting (48%), nausea (42%) and fever (25%). Eighteen cases were hospitalized. All cases recovered (**Figure 1**).

Of the 13 rectal swabs collected, three were positive for *Vibrio parahaemolyticus*. All other specimens had no enteropathogenic organisms isolated. Subtyping of the *Vibrio parahaemolyticus* isolates was not done.

The incubation periods of the cases ranged from seven to 51 hours with a median of 16.5 hours.

Case-control study

Fifty-two cases and 17 controls were included in the study. The age and gender distribution of cases and controls were similar. Fifty-four per cent of cases and 53% of controls were male. The median age for cases was 40 years (range 10–75) and 37 years for controls (range 5–63).

Among the food items served, only the vegetable salad with raw octopus was found to have a statistically significant association with illness with an odds ratio of 6.6 (95% CI: 1.3–36.1) (**Table 1**). Several interviewers reported that non-wedding party attendees developed diarrhoea after eating vegetable salad taken home by wedding party guests and that rectal swabs from two non-guests were also positive for *Vibrio parahaemolyticus*.

Figure 1. **Number of outbreak cases by incubation period, Tbaung Boeung Village, Cambodia, April 2012 (n = 52)**

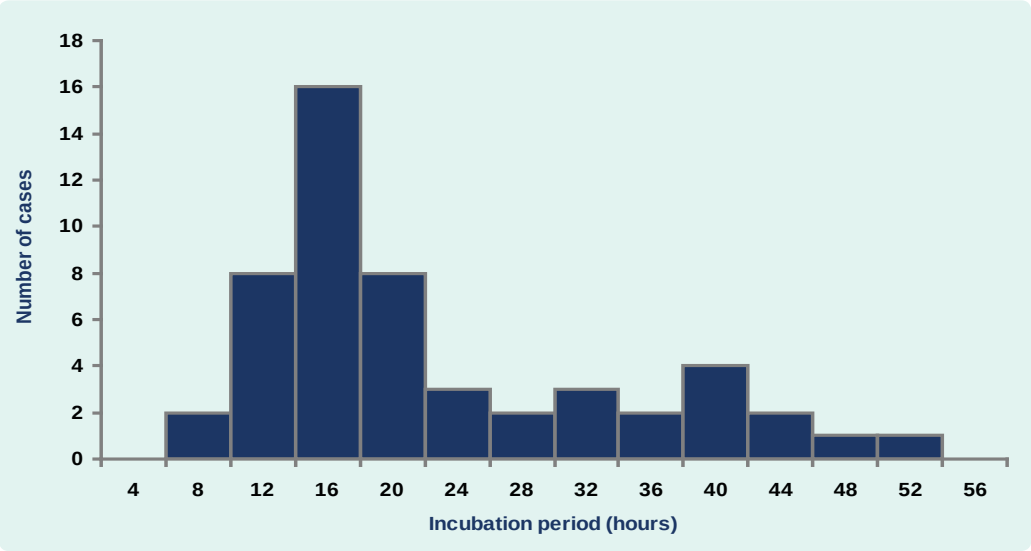


Table 1. **Results of case-control study, Tbaung Boeung Village, Cambodia, April 2012**

Food items	Cases (n = 52)		Controls (n = 17)		OR	95% CI	*P* value
	Ate	Did not eat	Ate	Did not eat			
Vegetables salad with raw octopus	48	4	11	6	6.6	1.3–36.1	0.01
Chicken soup with coconut milk	36	16	9	8	2.0	0.6–7.1	0.35
Pork salad	43	9	11	6	2.6	0.7–10.5	0.17
Fish with sauce	38	14	12	5	1.1	0.3–4.3	1.00
Chicken soup with lime	40	12	10	7	2.3	0.6–8.7	0.21
Rice	42	10	13	4	1.3	0.3–5.5	0.73
Ice	47	5	14	3	2.0	0.3–11.8	0.40
Water	38	14	11	6	1.5	0.4–5.5	0.55
Beer	20	32	7	10	0.9	0.3–3.1	0.93
Soft drink	24	28	6	11	1.6	0.5–5.7	0.62

OR – odds ratio; CI – confidence interval.

Environmental Investigation

Through interview with those involved in the food preparation, it was revealed that the octopus from the vegetable salad was bought from a market (30 minutes travel time). Seafood sold in this market comes from a southern coastal province. From source to market, the seafood is transported in ice boxes (2.5 hours travel time) and kept in ice at the market. However, when the octopus was bought from the market, it was packed in a plastic bag without ice.

The RRT educated the food handlers about proper food handling, preparation and hygiene. The following messages were provided to the food handlers in this outbreak:

- Cook seafood to high temperatures (≥70°C) and ensure all portions of the seafood are exposed to this high temperature, i.e. well-cooked.
- Refrigerate cooked seafood if it will not be ingested immediately after cooking because *Vibrio parahaemolyticus* can multiply rapidly to reach high counts in contaminated food held at room temperature for just a few hours.
- Avoid the use of untreated seawater for washing food items.

- Foods served to large groups of persons should be well-cooked.

DISCUSSION

This foodborne outbreak was most likely caused by *Vibrio parahaemolyticus* from contaminated raw octopus served at the wedding. Both the signs and symptoms and incubation periods of the cases were compatible with *Vibrio parahaemolyticus* enteritis,[2] and *Vibrio parahaemolyticus* was also isolated from rectal swabs of cases.

The epidemic curve was that of a common point source outbreak and the case-control study suggested that the vegetable salad with raw octopus was probably the vehicle for transmission in this food poisoning outbreak. Despite the limited sample size, particularly the small number of controls, there is convincing evidence that the vegetable salad with octopus was the vehicle for transmission. This includes the anecdotal finding of *Vibrio parahaemolyticus*-positive cases among family members that did not attend the wedding party but ate the vegetable salad brought home by household members who attended the party. Among the food items served during the wedding party, only the vegetable salad was brought home by the guests since this was a special dish and easy to pack.

Among the ingredients in the salad, the raw octopus most likely contained the bacteria. *Vibrio parahaemolyticus* infection from undercooked shellfish and bivalves, particularly oysters, is well described in the medical literature.[1,2,5] This study provides evidence for contamination of saltwater octopus with *Vibrio parahaemolyticus*. Saltwater octopus is a food item commonly consumed in Cambodia.

As this study emphasizes the dangers of consuming raw seafood in Cambodia, an important issue raised by this investigation is the need to improve food safety. Public health messages on the importance of cooking sea food well before consumption, especially during special occasions when large numbers of persons can become acutely infected, were one such measure employed by the RRT in this investigation.

Foodborne outbreak surveillance in Cambodia is conducted principally through an event-based surveillance system. Mechanisms for reporting and investigating large foodborne outbreaks with laboratory confirmation should be considered to better understand the most frequent causes of such outbreaks in the country. The existing indicator-based surveillance system could be used to detect clusters of diarrhoea disease, thereby triggering an outbreak investigation with sample collection.

Finally, this study demonstrates the importance of including questions about raw seafood in salads and vegetable dishes during investigations of foodborne outbreaks.

Conflict of interest

None declared.

Funding

None.

Acknowledgements

We are grateful for the cooperation and support of the local health staff and village residents during the field investigation. We also thank the laboratory staff of the National Institute of Public Health, Cambodia for testing the clinical samples obtained from some cases.

References:

1. Su YC, Liu C. *Vibrio parahaemolyticus*: a concern of seafood safety. *Food Microbiology*, 2007, 24:549–558. doi:10.1016/j.fm.2007.01.005 pmid:17418305
2. Heymann DL, editor. *Control of Communicable Diseases Manual*, *19th edition*. Washington, DC, American Public Health Association, 2008.
3. Fujino T et al. On the bacteriological examination of shirasu-food poisoning. *Medical Journal of Osaka University*, 1953, 4:299–304.
4. Chiou CS et al. *Vibrio parahaemolyticus* serovar O3:K6 as cause of unusually high incidence of food-borne disease outbreaks in Taiwan from 1996 to 1999. *Journal of Clinical Microbiology*, 2000, 38:4621–4625. pmid:11101606
5. Balter S et al.; Centers for Disease Control and Prevention (CDC). *Vibrio parahaemolyticus* infections associated with consumption of raw shellfish–three states, 2006. *MMWR, Morbidity and Mortality Weekly Report*, 2006, 55:854–856. pmid:16902397

Mumps-containing vaccine effectiveness during outbreaks in two schools in Guangdong, China, 2012

Wang Man,[ac] Zhao Jin-kou,[b] Wang Tao,[c] Hao Li-xin,[d] Ma Chao,[d] Su Qi-ru[d] and Luo Hui-ming[d]

Correspondence to: Huiming Luo (e-mail:Hmluo@vip.sina.com).

Introduction: Mumps-containing vaccine was licensed in the 1990s in China with a single dose administered routinely to children aged 18–24 months since 2008. However, an increase in reported mumps cases during the period 2009 to 2012 casts doubt on the effectiveness of a single-dose mumps vaccination. In March 2012, large numbers of mumps cases in a day-care centre and primary school in Guangdong Province were investigated to estimate the effectiveness of mumps-containing vaccine.

Methods: A mumps case was defined as a case with acute onset of unilateral or bilateral swelling of the parotid gland or other salivary glands. Clinical data were collected among students and staff members in the two schools from 6 February to 3 June 2012. Vaccination history was obtained from immunization certificates. Vaccine effectiveness (VE) was calculated among children in classes that had more than two mumps cases.

Results: The cohort included 369 children from seven classes, four from the day-care centre and three from the primary school. Vaccination certificates available for 347 children showed immunization coverage of 82% (285/347). The overall attack rate was 14.6% (54/369); the VE for a single dose of mumps vaccine was 65% (95% confidence interval [CI]: 19%–85%) when given within three years and 15% (95% CI: -2%–52%) when given three to six years before the outbreak. For two doses of vaccine the VE was 53% (95% CI: -15–80%).

Discussion: A single dose of mumps-containing vaccine was not effective to prevent these outbreaks among preschool and school children. A second dose of mumps-containing vaccine to four to five-year-old children should be considered in China.

Mumps, an acute viral illness characterized by unilateral or bilateral tenderness or swelling of the parotid or other salivary glands, is transmitted through person-to-person contact or by direct contact with respiratory droplets or saliva from an infected person.[1] Mumps-containing vaccines are now available globally for the prevention and control of mumps. Since 1990, live attenuated mumps vaccine has been licensed in China, and has been included in national routine immunization programmes since 2008. Children aged 18–24 months routinely receive one dose of measles-mumps-rubella vaccine (MMR) free of charge. However, data from the China Information System for Diseases Control and Prevention showed that the number of reported mumps cases continued to increase, with incidence rates of 22.5 per 100 000 in 2009 and 33.9 per 100 000 in 2011, with children aged five to six years having the highest incidence rate. From 2009 to 2011, the numbers of annually reported mumps outbreaks in China were 466, 265 and 440 respectively, and nearly 75% of the reported outbreaks occurred in preschool centres and primary schools.

In March 2012, two separate mumps outbreaks were reported in a day-care centre and a primary school in Guangdong Province, China. The Chinese Field Epidemiology Training Programme was requested to investigate the two outbreaks. The objectives of the investigation were to establish a retrospective cohort to examine mumps-containing vaccine effectiveness (VE) and to assess whether the length of time between vaccination and subsequent illness were related to vaccine failure.

METHODS

A mumps case was defined as a case of acute onset of unilateral or bilateral swelling of the parotid gland

[a] Chinese Field Epidemiology Training Programme, Beijing, China.
[b] The Global Fund to fight AIDS, Tuberculosis and Malaria, Geneva, Switzerland.
[c] Zhongshan Municipal Center for Disease Control and Prevention, Zhongshan, China.
[d] National Immunization Programme, Chinese Center for Disease Control and Prevention, Beijing, China.
Submitted: 29 October 2012; Published: 19 December 2012
doi: 10.5365/wpsar.2012.3.4.012

or other salivary gland in a student or staff member in the two schools from 6 February to 3 June 2012. An outbreak class was defined as a class with more than two mumps cases and was the study population for the data analysis. Mumps cases among vaccinated students were defined as having swelling of the parotid or other salivary glands and having a vaccination history with mumps-containing vaccine before the outbreak.

Case-finding was undertaken from reports from the school doctor and questionnaires completed by parents until the maximum incubation period (25 days) after the onset of the last case; the outbreak was then declared over. The questionnaire included information on any history of mumps before the current outbreak. Vaccination status and timing of vaccination for each student before the outbreak was obtained from immunization certificates. Mumps-containing vaccines included monovalent, bivalent (measles and mumps) and trivalent (measles, mumps and rubella) formulations.

Vaccination coverage before the outbreak was calculated as the proportion of vaccinated students, with students with unknown vaccination status excluded, using the equation: coverage rate = (one dose + two doses)/(no vaccine + one dose + two doses) * 100%. VE for mumps-containing vaccine was estimated using the equation: 1 − relative risk (RR) * 100%, where RR = attack rate of vaccinated students/attack rate of unvaccinated students, as described by Orenstein et al.[2] When estimating the effectiveness of one dose, people who had received two doses were excluded from the calculations of attack rates of vaccinated students. Similarly, people who had received one dose were excluded from calculations when estimating the effectiveness of two doses. We evaluated whether time between vaccination and current outbreak was a potential risk factor for vaccine failure among single-dose mumps-containing vaccine recipients by calculating VE for those vaccinated less than three years versus three years and older. Epi Info 3.5.1 was used for data analysis.

RESULTS

The outbreaks were detected and reported by the school doctors to the local center for disease control and prevention on 22 March 2012 for the day-care centre and on 16 April 2012 for the primary school. MMR was provided free of charge to students who did not develop mumps-like symptoms in the day-care centre on 24 March and in the primary school on 17 April 2012.

During the outbreak period, a total of 68 mumps cases were identified in the two schools. Four classes in the day-care centre and three Grade 1 classes in the primary school were identified as outbreak classes comprising 189 and 180 students, respectively. Mixing of students mainly occurred in the classroom.

Among the 33 mumps cases at the day-care centre, 30 (91%) were in the four outbreak classes with a mean age of five years (ranges four to six years) and 61% (20/33) were male. In the primary school, 33 students were identified as mumps cases with a mean age of eight years (range: seven to 11 years) and 70% (23/33) were male. Of the 33 student cases, 24 (73%) were from the three outbreak classes. There were two teacher cases. The epidemic curve of the seven outbreak classes (n = 54) shows the number of doses of mumps-containing vaccine that each case received (**Figure 1**).

Of the seven classes investigated, the vaccination status for 21 children in the primary school and one child in the pre-school centre were unknown since they could not supply vaccination immunization certificates. The coverage rate of the three outbreak classes in the primary school and four outbreak classes in the preschool centre were 90% (143/159) and 76% (142/188), respectively.

Of the seven classes investigated, none of students had a history of mumps before the outbreak. The combined attack rate was 22.6% (14/62) among unvaccinated students, 14.4% (33/229) among vaccinated students with single dose and 10.7% (6/56) among vaccinated students with two doses.

The estimate of VE for a single dose of the mumps-containing vaccine against clinical mumps was 36% (95% confidence interval [CI]: -12%–63%), and 53% (95% CI: -15%–80%) for two doses. Single dose of mumps VE was 65% (95% CI: 19%–85%) within three years after the vaccination, and declined to 15% (95% CI: -52%–52%) in three to six years after the vaccination (**Table 1**).

Figure 1. **Distribution of mumps cases in a day-care centre and a primary school, Guangdong, China, 2012 (n = 54)**

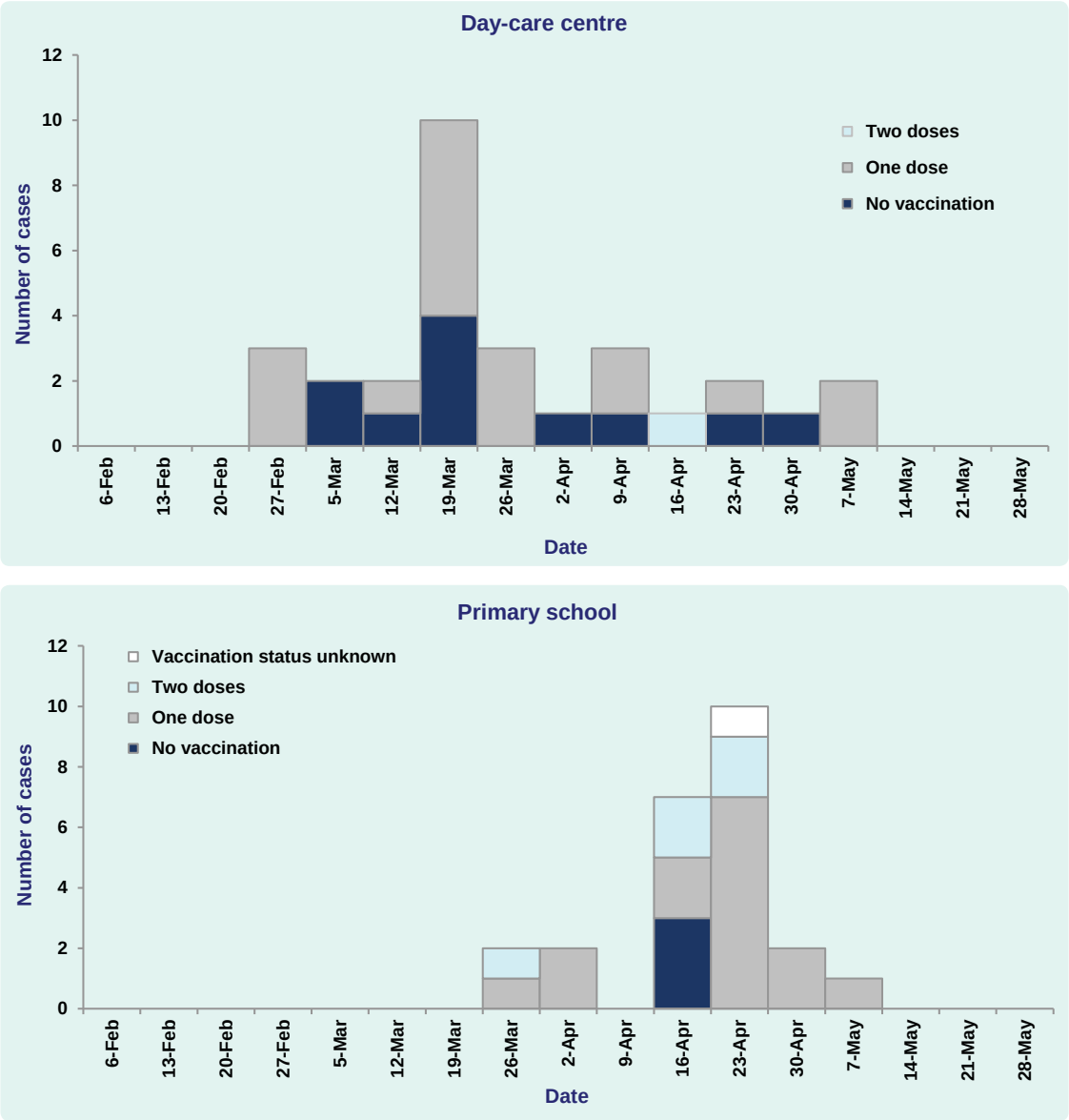


Table 1. **Estimates of vaccine effectiveness for a single dose of the mumps-containing vaccine by time since vaccination in two schools of Guangdong, China, 2012***

School	Number of years since vaccination	Cases	AR (%)	VE (%)	95% CI
Day-care centre	No vaccine	11	23.9	Ref	–
	< 3	5	7.6	66	8–87
	3–6	13	18.3	23	-56–62
Primary school	No vaccine	3	18.8	Ref	–
	< 3	2	7.1	62	5–97
	3–6	13	20.3	–	–
Total	No vaccine	14	22.6	Ref	–
	< 3	7	7.9	65	19–85
	3–6	26	19.3	15	-52–52

AR – attack rate; VE – vaccine effectiveness; CI – confidence interval.

* Students with unknown vaccination status or two doses of mumps vaccination before the outbreak were excluded.

DISCUSSION

These two outbreaks of mumps occurred in a day-care centre and primary school in Guangdong Province, China, which had mumps-containing vaccine coverage of 76% and 90%, respectively, before the outbreak. The results demonstrated that the VE of single-dose of mumps vaccine was 65% within three years, and 15% within three to six years. VE must be at least 79%–95% to interrupt mumps community transmission with a coverage rate of 95%.[3] Our study suggested that a single dose of mumps-containing vaccine was not effective enough to prevent outbreaks among preschool and schoolchildren.

Three mumps strains are used in China: Jeryl Lynn, RIT 4385 and S79. Both RIT4385 and S79 both were developed from the Jeryl Lynn vaccine strain. In post-license studies, the VE estimate of a single dose and two doses of the Jeryl Lynn mumps-containing vaccine was 79% (range: 62%–91%) and 88% (range: 79%–95%), respectively.[1] Two other studies reported a VE for the S79 strain at 86% (95% CI: 77%–92%)[4] and 80% (95% CI: 60–90%), respectively.[5] The VE estimates in our study were lower than these; however, it is difficult to identify the cause and may be multifaceted due to the case definition, exposure, attack rate, time since vaccination and age of vaccination. Six per cent (22/369) of the students were excluded from analysis since they could not provide immunization certificates, and the attack rate of students among them was 4.5% (1/22). If all of the students with unknown vaccination status had either one dose or two doses of mumps-containing vaccine history, the estimates of VE would be higher, 40% for one dose and 60% for two doses.

Since the clinical manifestation was specific for mumps, we relied on clinical diagnosis and did not ask for laboratory confirmation. The estimates of VE may be imprecise owing to the small number of cases, as reflected by the wide confidence interval. Despite the limitations, to our knowledge the current study was the first rigorous cohort study of outbreaks to estimate mumps VE in China.

Since 2009, reported mumps cases have increased in China, with a large number of mumps outbreaks occurring in preschool centres and primary schools. However, data from the China Information System for Diseases Control and Prevention showed that, in the three provinces (Beijing, Tianjin and Shanghai) that have a two-dose mumps vaccination policy, the reported number of mumps cases have declined sharply since 2009, as have the number of mumps outbreaks (J Liu, Department of National Immunization Programmen, Chinese Center for Disease Control and Prevention, Beijing, China). In our study, those students receiving two doses of mumps-containing vaccine had an estimated VE of 53%, which was higher than that of those receiving a single dose (36%), although this was not significantly different, possibly due to small sample size. This study also suggests that mumps VE may decline three years after vaccination, and previous studies also documented increased risk of developing mumps with increasing time after vaccination.[6–8] We recommended that a second dose of mumps-containing vaccine to four- to five-year-old children be considered in China, and this has been communicated to the Ministry of Health.

Conflicts of interest

None declared.

Funding

None.

References:

1. *The immunological basis for immunization series, module 16: mumps*. Geneva, World Health Organization, 2010 (http://whqlibdoc.who.int/publications/2010/9789241500661_eng.pdf, accessed 15 November 2011).
2. Orenstein WA, Bernier RH, Hinman AR. Assessing vaccine efficacy in the field. Further observations. *Epidemiologic Reviews*, 1988, 10:212–241. pmid:3066628
3. Anderson RM, May RM. Immunisation and herd immunity. *Lancet*, 1990, 335:641–645. doi:10.1016/0140-6736(90)90420-A pmid:1969023
4. Fu C, Liang J, Wang M. Matched case-control study of effectiveness of live, attenuated S79 mumps virus vaccine against clinical mumps. *Clinical and Vaccine Immunology*; CVI, 2008, 15:1425–1428. doi:10.1128/CVI.00122-08 pmid:18667635
5. Fu CX et al. Evaluation of live attenuated S79 mumps vaccine effectiveness in mumps outbreaks: a matched case-control study. *Chinese Medical Journal*, 2009, 122:307–310. pmid:19236809
6. Cortese MM et al. Mumps vaccine performance among university students during a mumps outbreak. *Clinical Infectious Diseases*, 2008, 46:1172–1180. doi:10.1086/529141 pmid:18444852
7. Cohen C et al. Vaccine effectiveness estimates, 2004–2005 mumps outbreak, England. *Emerging Infectious Diseases*, 2007, 13:12–17. pmid:17370510
8. Vandermeulen C et al. Outbreak of mumps in a vaccinated child population: a question of vaccine failure? *Vaccine*, 2004, 22:2713–2716. doi:10.1016/j.vaccine.2004.02.001 pmid:15246601

Measles transmission in health care waiting rooms: implications for public health response

Kirsty Hope,[a] Rowena Boyd,[a] Stephen Conaty[a] and Patrick Maywood[a]

Correspondence to Kirsty Hope (e-mail: Kirsty.hope@sswahs.nsw.gov.au).

Background: Seventeen cases of locally acquired measles occurred in South Western Sydney and Sydney local health districts between July and October 2011. Three of the cases were known to have at least one dose of measles-mumps-rubella (MMR) vaccine. Seven cases were infected within a health care setting waiting room by five index cases. Current national protocols require follow-up of all susceptible contacts in the same waiting room for any length of time for up to two hours after the index case has left.

Methods: Cases were interviewed using a standardized questionnaire. Information included: demographics, illness and activities during the exposure and infectious periods. Health care settings provided arrival and discharge times, maps of floor layouts and location of patients during stay.

Results: All health care setting transmission occurred in cases who were present at the same time as their index cases, with cross-over time ranging from 20 to 254 minutes. No index case was isolated. Index cases were between day four and six of illness when transmission occurred. None of the five index cases and one of seven secondary cases had received at least one dose of MMR vaccine. Of the seven secondary cases, two were one year of age, one was 17 years old and four were between 30 and 39 years old.

Conclusion: As Australia moves towards measles elimination, follow-up of cases is important; however, with limited public health resources a targeted response is vital. In this small but well-documented series of secondary cases acquired in a health care setting, all were infected following direct, proximate contact of at least 20 minutes. Changes to the national guidelines may be warranted, ensuring that limited resources are focused on following up contacts at greatest risk of disease.

In countries close to achieving measles elimination, the epidemiology of reported measles cases has changed, with implications for public health and outbreak control. These changes include a shift in incidence from preschool-aged children to older age groups who may have missed vaccination as a child, an increasing proportion of international importations and an increasing pool of susceptible people among groups whose members do not routinely accept vaccinations such as those opposed to vaccination for religious or philosophical reasons.[1,2] These changes in epidemiology and the infrequency of measles cases has allowed an increased focus on control of onward transmission settings where there is a high risk of measles transmission.[3]

Previous studies have shown that outside the home, measles is readily transmitted in educational facilities, sports halls, religious institutions, orphanages, refugee camps, aeroplanes and health facilities.[4–8] Health facilities are of particular concern because of the risk of exposure to measles for those who may already be seriously ill. Health care waiting rooms in particular are important in the transmission of measles as a large number of sick and healthy people congregate together in a confined space.[9]

In countries where measles incidence is low, transmission is facilitated by failures or delays in diagnosis due to physicians inexperienced with an increasingly rare disease.[10,11] This increases the likely number of presentations and time spent in waiting rooms. The importance of health care waiting rooms as a setting where measles transmission occurs is further enhanced by a failure to isolate the infectious patient or a lack of isolation facilities and low vaccination coverage of health care workers.[11–14]

Between July and October 2011, 17 cases of locally acquired measles occurred in South Western Sydney and Sydney local health districts. Seven secondary cases

[a] South Western Sydney and Sydney Local Health Districts Public Health Unit, New South Wales, Australia.
Submitted: 12 September 2012; Published: 20 December 2012
doi: 10.5365/wpsar.2012.3.3.009

were infected within a health care setting waiting room by five index cases. Current Australian national protocols require follow-up of all susceptible contacts in the same waiting room for any length of time for up to two hours after the index case has left. People born before 1966 are ordinarily considered to be immune through natural infection, however, they are followed up to determine if they were accompanied by a person who may be at risk.[3]

In a metropolitan health authority that includes high demand emergency departments (EDs) and large general practices (GPs), adhering to the national protocol during an outbreak quickly consumes available public health resources. This paper describes the outbreak, transmission in health care settings and raises questions about the application of the national guidelines for public health response when resources are limited.

METHODS

Analysis of a case series was conducted between July 2011 and January 2012. Cases were routinely notified by physicians or by laboratories as required by legislation.[15] Cases were interviewed by a public health nurse using a standardized questionnaire. Information collected included: demographic details, onset date, symptoms, potential exposures and activities during the infectious periods. Public health action implemented in response to a confirmed case followed the New South Wales measles response guidelines.[3] As part of the response to this outbreak GPs and EDs in the area were alerted and asked to report suspected measles to the Public Health Unit (PHU). For cases where transmission occurred in a healthcare setting waiting room (defined as either an ED or a GP waiting room), the facilities were contacted and asked to provide arrival and discharge times, maps of floor layouts and location of patients during their stay.

RESULTS

Description of outbreak

Seventeen cases of measles were notified to South Western Sydney (SW) PHU with an onset date between July and September 2011. Characteristics of the cases are outlined in **Table 1**. No case had travelled internationally in their exposure period or had contact with friends or family members who had recently travelled overseas. All cases were locally acquired, with seven acquiring their infection during a visit to a local ED or GP waiting room (**Figure 1**).

Table 1. **Characteristics of confirmed measles cases, Sydney,* Australia, July to October 2011 (*n* = 17)**

Characteristics	*n*	%
Age group		
0–12 months old	0	0
13 months–four years old	4	24
15–19 years old	2	12
20–29 years old	5	29
30–39 years old	6	35
Gender		
Male	7	41
Female	10	59
Country of birth		
Australia	11	65
New Zealand	2	12
Samoa	1	6
Brazil	1	6
Egypt	1	6
Italy	1	6
Vaccination status		
Yes (at least one dose MMR)	3	18
No	10	59
Unknown	4	24
Place of exposure		
Overseas	0	0
Locally acquired	17	100
Source of exposure		
Household member/sibling	4	24
Health care setting waiting room	7	41
Same locality (apartment complex)	2	12
Unknown	4	24

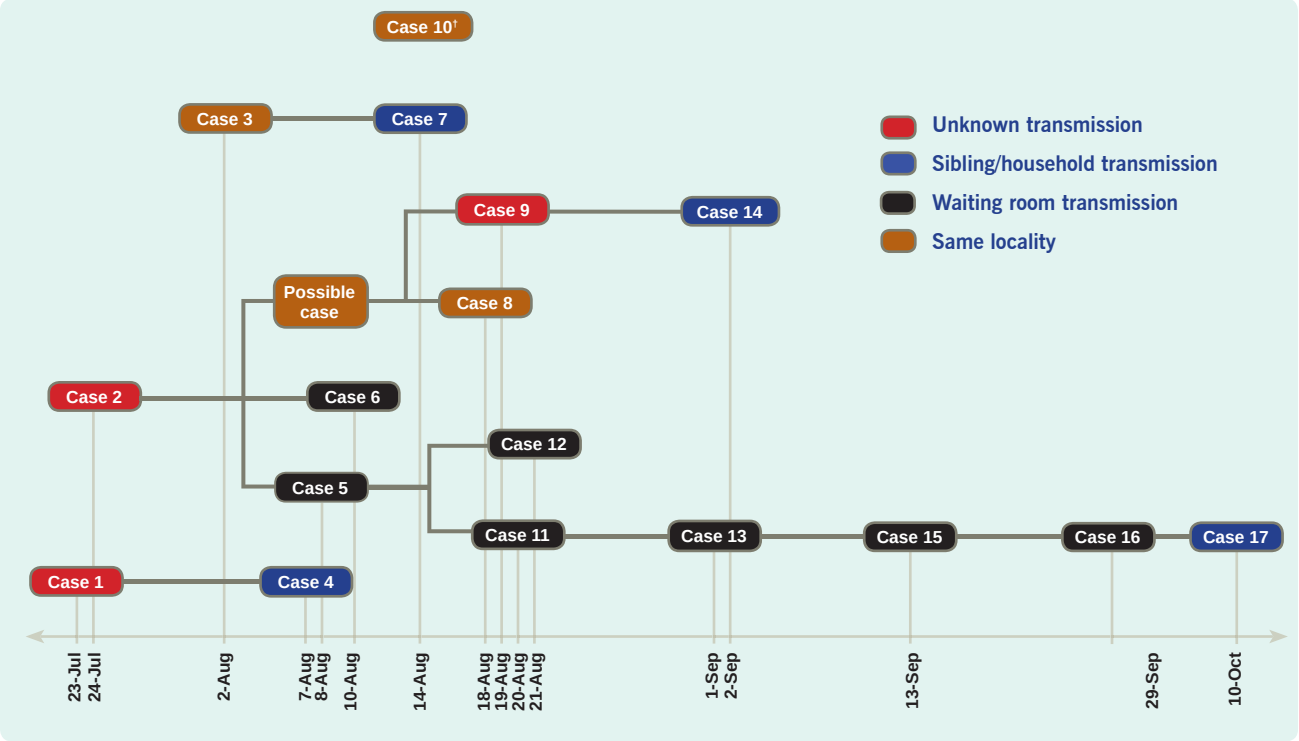
* In South Western Sydney and Sydney local health districts.

All cases were old enough to have received their 12-month vaccination. Four of the 17 cases were under four years old and therefore too young to have received their second scheduled measles-containing vaccine according to the National Immunization Programme schedule.

Delay in diagnosis

Only six of the 17 cases were diagnosed on their first contact with a health service (GP or ED). Three cases were diagnosed on their second visit; two cases on the third visit, one on the fourth, two on the fifth and one case on the sixth visit. The diagnosis of two cases was missed; they were diagnosed approximately five months later, during detailed assessment of ED triage notes to identify possible source cases. The median number of days from onset to notification was

Figure 1. **Onset date and transmission links of measles cases, Sydney,* Australia, July to October 2011**



* South Western Sydney and Sydney local health districts.

† Case 10 acquired infection from a case who lives in another health jurisdiction.

eight (range: three–178 days), the median number of days from rash developing to notification was four (range: zero–175 days).

Transmission in health care setting

The five index cases were between days four and six of illness when transmission occurred. None had been isolated within the health care facility. The seven secondary cases, established to have been infected in a health care setting, were present at the same time as their index case. Contact time ranged from 20 to 162 minutes. All secondary cases would have come within two metres of their index case while in the health setting. One secondary case was seen in the same treatment room as the index case and another case was standing near the index case in the registration line (**Table 2**). None of the five index cases and one of seven secondary cases had received at least one dose of measles-mumps-rubella (MMR) vaccine. Of the seven secondary cases, two were one year of age, one was 17 years old and four were between 30 and 39 years old.

DISCUSSION

Transmission of measles in healthcare settings may prove to be an important obstacle to the elimination of measles in developed countries like Australia. While Australia has high immunization coverage, there are a small proportion of those born between 1966 and 1981 (aged between 29 and 45 years) that may be susceptible because they were born after measles circulation began to decline but have not received two doses of measles vaccine. There are also occasional children who are susceptible because they are not vaccinated or vaccine has failed; fewer than 1% of people fail to develop immunity to measles following the second dose of vaccine.[16] Young adults are highly mobile, have many social contacts and often have several visits to health care facilities before they are diagnosed. Many ED and GP waiting areas are large, have high throughput and waits can be long. These factors increase the probability of an acutely unwell and infectious measles case making contact with another susceptible person.

Table 2. **Contact details of measles transmission in health care facilities, Sydney,* Australia, July to October 2011**

Case	Case age	Index case	Index case age	Overlap time (minutes)	Health care setting	Nature of contact
Case 5	35	Case 2	33	154	Emergency Department	Standing near each other in registration line (booked in three minutes apart).
Case 6	1	Case 2	33	157	Emergency Department	In same waiting room for a maximum of 2.3 hours, unsure of proximity. Waiting room is spacious with approximately three metres between rows of chairs. Most chairs situated close to registration desk and triage room. There is a separate kids' room but it is not frequently used.
Case 11	1	Case 5	35	254	Emergency Department	Index case was located in a treatment bed in the main access area for acute beds, paediatric ward, toilets and kitchenette for tea and coffee. Treatment bed opens to corridor with a curtain separating it from the beds on either side. Case would have walked past bed at least once, within two to three metres of the index case.
Case 10	31	Out of area case	33	176	Emergency Department	Registered eight minutes after index case, there was no other registration in between the two cases. Index case was placed on a chair in a narrow corridor next to triage, everyone entering the acute area had to walk through this corridor.
Case 12	36	Case 5	35	162	Emergency Department	Index case was located in a treatment bed in the main access area for acute beds, paediatric ward, toilets and kitchenette for tea and coffee. Treatment bed opens to corridor with a curtain separating it from the beds on either side. Case 12 would have walked past bed at least once, within two to three metres of the index case.
Case 13	38	Case 11	1	20	General Practice	Cases seen by different doctors in different rooms. However, both sat in waiting room for approximately 20 minutes. Waiting room very small, with 33 chairs organized around the wall and in rows. Rows were approximately one metre apart.
Case 15	17	Case 13	38	50	General Practice	Both seen by same doctor in same room. Cases arrived 15 minutes apart. Index case billed 27 minutes before Case 15. Possibly seen by same doctor directly after index case; however, length of consultation unknown.

* In South Western Sydney and Sydney local health districts.

With limited public health resources, refinements to the national guidelines may be warranted. It will be essential to balance the role of health care facilities in the transmissions of measles with the high workload required by large numbers of contacts, many of whom are immune. The Australian measles guidelines defines waiting room contacts as "people who stayed in a waiting area at the same time as the case and people who waited in the waiting area or who were seen in the same consultation room up to two hours after the case left."[3] Two previous cluster investigations in 1981 and 1982 of transmission from a single case to contacts in a health facility indicated that airborne spread of measles can occur up to an hour after the index case has left the premises.[17,18] However, even in the small outbreak reported here, non-isolated cases in health care waiting rooms often resulted in exposure to 100 or more individuals who needed to be traced to ascertain possible susceptibility to measles. Although our case series was small, all transmissions occurred to patients or relatives who were already in the health facility when the index case arrived or to patients or relatives who arrived while the index case was still in the facility. Hospitals and primary care facilities keep records of entry and exit times; in addition, some facilities keep records of the bed or treatment rooms occupied by the index case. Therefore, if resources are limited, focusing only on contacts who were present in a facility at the same time as the case may be warranted.

Delayed diagnosis has been indicated as a risk for transmission in many outbreaks in countries reaching measles elimination. The diagnosis of measles is difficult

with early symptoms resembling many conditions. However, many doctors have never seen a case of measles and are unfamiliar with the more typical later features of rash, fever, cough and conjunctivitis. Continuing communication with GP and ED staff is vital to ensure that measles is considered as a possible diagnosis in persons with fever and rash, that appropriate tests are ordered and that the appropriate notification process is followed.

A review of nosocomial measles transmission identified health care workers as important sources of transmissions in health care facilities.[9] In past outbreaks within Australia health care workers have been identified as secondary cases.[1,4,8] While no health care worker was identified as a case during this outbreak, high rates of vaccination should be maintained in this group.

Measles cases in Australia have been mainly due to overseas acquired infections; however, this outbreak has shown continued transmission can occur within Australia in a small group of susceptible people. Exposure information collected during an outbreak is vital to ensure the source of infection can be determined, to identify sources of threats and to assist in developing prevention strategies. Currently, investigations focus on where the person travelled during their infectious period, thus allowing follow-up of contacts to prevent further transmission. While this is important, detailed information during the case exposure period is also important; knowing how transmission occurred can help inform prevention strategies, which become increasingly important when a country is close to elimination.

Many outbreaks in countries reaching elimination occur in children whose parents do not want their children vaccinated. This outbreak occurred in young adults, who were not vaccinated as a child or who did not know their vaccination status; no case was a conscientious objector. A high number of contacts with unknown vaccination status affected the efficiency of the investigation and may have resulted in unnecessary prescribing of normal human immunoglobulin. Past outbreaks have also demonstrated that verbal history of prior doses of MMR vaccine is unreliable.[1]

The information collected through this investigation was affected by recall bias: patients self-reported onset dates, date of rash appearance and activities during exposure and infectious periods. While onset and rash dates should be fairly accurate, it is possible that activities during exposure or the infectious period could have been left out or not accurately reported. This outbreak investigation relied on passive surveillance (i.e. for cases to be notified to the public health unit); therefore, cases could have been missed if they were not ill enough to seek medical care and if a doctor failed to diagnose measles.

In addition it was not possible to measure exact distance between the health care waiting room transmission cases and their index case; therefore, information from the health provider about room or bed allocation and entry and exist times was used to approximate distance and exposure time. Previous studies have shown that airborne transmission of measles is possible;[17,18] however, no attempt was made to determine either the design and operation of air conditioning systems in these health care settings or their efficacy in limiting aerosol spread for this study.

CONCLUSION

As Australia moves towards measles elimination, follow-up of cases is important. In this small but well-documented series of secondary cases acquired in health care settings all were infected following direct, proximate contact of at least 20 minutes. A review of national guidelines should consider a more targeted follow-up to ensure a more efficient use of resources. Public health resources may be better spent on education of GP and ED staff to facilitate isolation on suspicion of measles and prompt diagnosis to reduce the possibility that infectious cases expose large numbers of people in these waiting room settings.

Conflicts of interest

None declared.

Funding

None.

References:

1. Hanna J et al. Measles in health care facilities: some salutary lessons. *Communicable Diseases Intelligence*, 2000, 24:211–212. pmid:10981353
2. Miranda AC et al. Measles transmission in health facilities during outbreaks. *International Journal of Epidemiology*, 1994, 23:843–848. doi:10.1093/ije/23.4.843 pmid:8002200

3. Communicable Diseases Network of Australia. *Measles: National Guidelines for Public Health Units*. Canberra, Department of Health and Ageing, 2009 (http://www.health.gov.au/internet/main/publishing.nsf/Content/55AD336B864C7203CA25755F000307B6/$File/measles-song.pdf, accessed 13 July 2012).

4. Weston KM et al. Nosocomial and community transmission of measles virus genotype D8 imported by a returning traveller from Nepal. *Communicable Diseases Intelligence*, 2006, 30:358–365. pmid:17120490

5. Andrews R; Surveillance and Response Team. Measles outbreak among young adults in Victoria. *Communicable Diseases Intelligence*, 2001, 25:12. pmid:11280193

6. Kelly HA, Riddell MA, Andrews RM. Measles transmission in healthcare settings in Australia [Editorial]. *Medical Journal of Australia*, 2002, 176:50–51. pmid:11936282

7. Istre GR et al. Measles spread in medical settings: an important focus of disease transmission? *Pediatrics*, 1987, 79:356–358. pmid:3822636

8. Beard F et al. Contact tracing of in-flight measles exposures: lessons from an outbreak investigation and case series, Australia, 2010. *Western Pacific Surveillance and Response Journal*, 2011, 2:25–33. doi:10.5365/wpsar.2011.2.2.010

9. Botelho-Nevers E et al. Nosocomial transmission of measles: an updated review. *Vaccine*, 2012, 30:3996–4001. doi:10.1016/j.vaccine.2012.04.023 pmid:22521843

10. Choi WS et al. Outbreak of measles in the Republic of Korea, 2007: importance of nosocomial transmission. *Journal of Infectious Diseases*, 2011, 204(Suppl 1):S483–490. doi:10.1093/infdis/jir087 pmid:21666204

11. Ehresmann KR et al. An outbreak of measles among unvaccinated young adults and measles seroprevalence study: implications for measles outbreak control in adult populations. *Journal of Infectious Diseases*, 2004, 189(Suppl 1):S104–107. doi:10.1086/377714 pmid:15106098

12. Muscat M. Who gets measles in Europe? *Journal of Infectious Diseases*, 2011, 204(Suppl 1):S353–365. doi:10.1093/infdis/jir067 pmid:21666185

13. Delaporte E et al. Measles in Geneva between 2003 and 2010: persistence of measles outbreaks despite high immunisation coverage. *Euro Surveillance: European Communicable Disease Bulletin*, 2011, 16(39):pii=19980. pmid:21968424

14. Mette A et al. Under-reporting of measles - an evaluation based on data from North Rhine_Westphalia. *Deutsches Ärzteblatt International*, 2011, 108:191–196. pmid:21505600

15. *Public Health Act 1991 No 10*. Sydney, New South Wales Government, 2012 (http://www.legislation.nsw.gov.au/viewtop/inforce/act+10+1991+FIRST+0+N/, accessed 13 July 2012).

16. National Health and Medical Research Council. *The Australian Immunisation Handbook, 9th edition*. Canberra, Department of Health and Ageing, 2008 (http://www.health.gov.au/internet/immunise/publishing.nsf/content/handbook-home, accessed 13 July 2012).

17. Remington PL et al. Airborne transmission of measles in a physician's office. *JAMA: Journal of the American Medical Association*, 1985, 253:1574–1577. doi:10.1001/jama.1985.03350350068022 pmid:3974036

18. Bloch AB et al. Measles outbreak in a pediatric practice: airborne transmission in an office setting. *Pediatrics*, 1985, 75:676–83. pmid:3982900

A foodborne outbreak of *Aeromonas hydrophila* in a college, Xingyi City, Guizhou, China, 2012

Qian Zhang,[a] Guo-Qing Shi,[b] Guang-Peng Tang,[c] Zhi-Tin Zou,[c] Guang-Hai Yao[c] and Guang Zeng[b]
Correspondence to Qian Zhang (e-mail: zhangqian527@126.com).

Background: On 12 May 2012, over 200 college students with acute diarrhoea were reported to the Guizhou Center for Disease Control and Prevention. We conducted an investigation to identify the agent and mode of transmission and to recommend control measures.

Methods: A suspected case was a person at the college with onset of ≥ two of the following symptoms: diarrhoea (more than three loose stools in 24 hours), abdominal pain, vomiting or fever (> 37.5C) between 6 and 15 May 2012. A confirmed case also had a positive *Aeromonas hydrophila* culture from a stool sample. A retrospective-cohort study of 902 students compared attack rates (AR) by dining place, meals and food history. We reviewed the implicated premise, its processes and preparation of implicated food.

Results: We identified 349 suspected cases (AR = 14%) and isolated *Aeromonas hydrophila* from three stools of 15 cases. Students who ate in cafeteria A were more likely to be ill compared to those eating in other places (relative risk [RR]: 3.1, 95% confidence interval [CI]: 2.0–4.8). The cohort study implicated cold cucumber (RR: 2.6, 95% CI: 2.0–3.3) and houttuynia dishes (RR: 1.8, 95% CI: 1.4–2.3). Environmental investigation showed that vegetables were washed in polluted water from a tank close to the sewage ditch, then left at 30°C for two hours before serving. The *Escherichia coli* count of the tank was well above the standard for drinking water.

Conclusion: This outbreak of *Aeromonas hydrophila* was most probably caused by salad ingredients washed in contaminated tank water. We recommended enhancing training of foodhandlers, ensuring tanks and sewerage systems comply with appropriate standards and adequate monitoring of drinking water sources.

On 12 May 2012, a college in Xingyi City, China notified the Guizhou Center for Disease Control and Prevention (CDC) of over 200 students sick with acute diarrhoea. The illness was reported as gastroenteritis-like with diarrhoea, abdominal pain, headache, vomiting and fever being common symptoms. An outbreak investigation was conducted to identify the agent, the mode of transmission and to recommend control measures. This paper describes the public health investigation.

METHODS

Cases

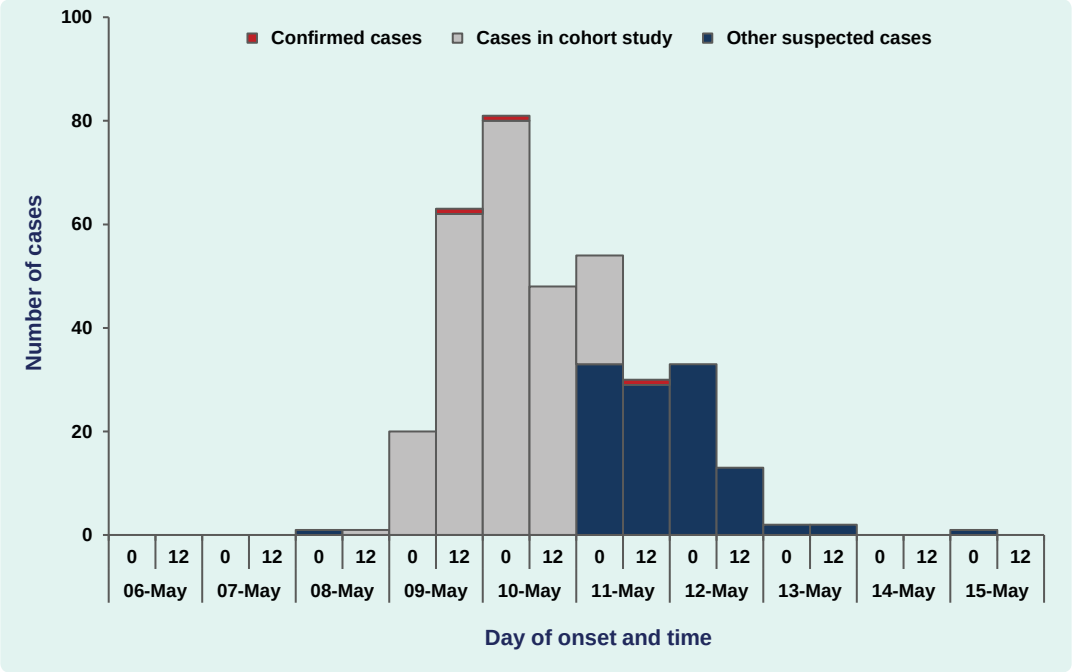
A suspected case was defined as any person in the college with two or more of the following symptoms: diarrhoea (more than three loose stools in 24 hours), abdominal pain, vomiting or fever (> 37.5°C) between 6 and 15 May 2012. A confirmed case was a suspected case with a positive *Aeromonas hydrophila* culture from a stool specimen.

Case-finding was conducted through outpatient and inpatient records from the school infirmary and county hospital. Student dormitories were visited and students interviewed to find further unreported cases. A structured questionnaire comprised questions about detailed food and water consumption for the three days preceding illness onset. Students, teachers and cafeteria staff were interviewed using the standardized questionnaire to identify illness and exposure details.

We were able to obtain computerized data that recorded meals served at college cafeterias by student name. Data were collected for all meals from 6 to 11 May.

[a] Key Laboratory of Surveillance and Early-warning on Infectious Disease, Division of Infectious Diseases, Chinese Center for Disease Control and Prevention, Beijing, China.
[b] Chinese Field Epidemiology Training Programme, Chinese Center for Disease Control and Prevention, Beijing, China.
[c] Guizhou Center for Disease Control and Prevention, Guizhou Province, China.
Submitted: 14 November 2012; Published: 19 December 2012
doi: 10.5365/wpsar.2012.3.4.018

Figure 1. **Epidemic curve by onset date and time, *Aeromonas hydrophila* outbreak, Guizhou Province, China, 2012 (n = 349)**



Cohort study

A retrospective cohort study was initiated to compare attack rates (AR) for dining place, meals and food history. We selected 40 dormitories by AR-stratified sampling. The cohort study population comprised the 989 students that had lunch at the college on 8 May. We calculated relative risks (RR) with 95% confidence intervals (CI), comparing all foods consumed at that meal. We also calculated a chi-squared test for trend for the dose–response data for the cucumber salad.

Laboratory investigation

Faecal specimens were cultured at laboratories at Guizhou CDC. Food and environmental samples were tested at Xingyi CDC. The World Health Organization (WHO) definition of safe drinking-water, *Escherichia coli* not detectable in 100 ml of water,[1] was used to assess the water.

Environmental investigation

Site visits were made to the suspected cafeteria and bottled-water factory to identify the possible sources and causes of contamination. The entire production process in the cafeteria, from the purchase of raw ingredients to preparation of implicated food, was thoroughly reviewed with management.

RESULTS

Cases

There was a total of 349 suspected cases (AR = 14%). After diarrhoea, the main symptoms were abdominal pain (80%), headache (55%), vomiting (29%) and fever (18%); 14% of cases reported acute diarrhoea with blood and mucus. Median duration of illness was seven days (range: two to 18 days) with 40% having self-limiting symptoms. The first case's onset date was 8 May and cases continued until 15 May (**Figure 1**).

The ARs for students (14%) and cafeteria staff (21%) were much higher than that of teachers (1%). Boarding students had a significantly higher risk than those who were on graduation field work and did not live at the school (relative risk [RR] = 6.9, 95% CI = 4.4–11). There were four dormitories (A, B, C and D) and ARs among dormitory A, B and C were higher than dormitory D. The AR among students who ate in cafeteria A was 64% compared to the 21% who ate in other places (RR: 3.1, 95% CI: 2.0–4.8). From analysis of the electronic cafeteria records, four meals were associated with illness: lunch on 8 May (RR: 1.8, 95% CI: 1.3–2.4); supper on 8 May (RR: 1.5, 95% CI: 1.1–2.1); supper on 9 May (RR: 1.5, 95% CI: 1.1–2.1); and supper on 10 May (RR: 1.5, 95% CI: 1.1–2.1).

Table 1. **Dose–response analysis of Chinese cucumber salad in an outbreak of *Aeromonas hydrophila*, Guizhou Province, China, May 2012**

Tablespoons	Sick	Not sick	AR (%)	RR	95% CI
2	73	105	41.0	1.8	1.1–2.0
1	59	94	38.6	1.6	1.1–1.9
½	39	102	27.7	Ref	–

AR – attack rate, RR – rate ratio; CI – confidence interval.

Cohort study

Questionnaire responses were returned for 902 (91%) students in the cohort study of all students who had lunch on 8 May at the college. We found that the cold cucumber dish made from Chinese cucumbers (RR: 2.6, 95% CI: 2.0–3.3) and the cold houttuynia dish (a wild heartleaf vegetable that grows in the south-west of China [RR: 1.8, 95% CI: 1.4–2.3]) were associated with illness. Illness was not statistically significantly different among those exposed and not exposed to the other 28 dishes (data not shown). The RR of the cucumber dish increased by 1.4 for each tablespoon consumed ($P = 0.016$, **Table 1**).

Laboratory findings

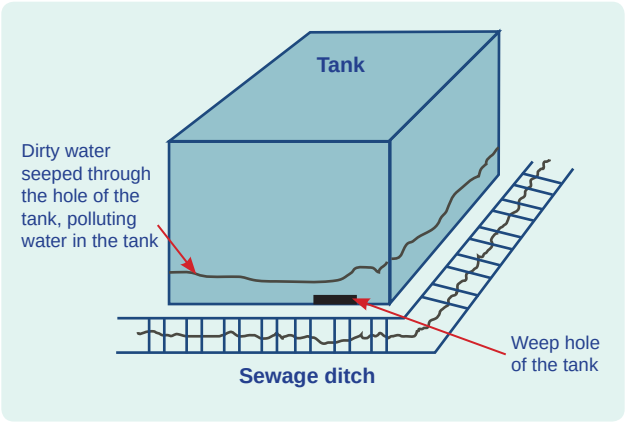
We collected 15 stool specimens from 15 cases, of which three were culture positive for *Aeromonas hydrophila* and negative for all other common gastroenteritis agents, such as *Salmonella*, *Shigella*, *Vibrio cholera*, *Vibrio parahemolyticus*, *Typhoid bacillus*, *Bacillus paratyphosus*, *Campylobacteria* and toxigenic *Escherichia coli*.

The testing of the tank water showed that the *Escherichia coli* count was > 1600MPN/100ml, higher than the WHO standard.

Environmental findings

Bottled water is the most common drink at the college. There were 300 bottles of water restocked between 4 and 8 May, and the same batches were also restocked in 56 nearby villages. This bottled water was not considered a source of the outbreak as there were no increases in notifications of acute diarrhoea in these villages and because interviews with the teachers found that although they drank bottled water at the college, they had a much lower morbidity (1%).

Figure 2. **The tank used to wash the vegetables in an outbreak of *Aeromonas hydrophila*, Guizhou Province, China, May 2012**



Environmental investigation of cafeteria A showed that when the supply of tap water in the kitchen stopped, a water tank was used for washing vegetables. The tank was located close to the sewage ditch of the cafeteria (< 10 cm) and there was a weep hole at the bottom of tank (**Figure 2**). Interviews with school staff identified that between 8 and 10 May the cafeteria stopped supplying tap water and that the sewage ditch was blocked on 8 May, resulting in the overflow of dirty water into the weep hole of the tank. Cafeteria staff then washed the vegetables for the cold dishes using water from the tank. The cold dishes were then left at 30°C for two hours before serving.

DISCUSSION

This serious outbreak of *Aeromonas hydrophila* was most likely caused by contaminated cold dishes. The possible source was contaminated water from the tank used for washing vegetables. The inappropriate food storage and display allowed for the reproduction of *Aeromonas hydrophila*.

Aeromonas hydrophila is a gram-negative facultatively anaerobic bacteria with an optimal growth temperature of 35%–37°C.[2–4] The incubation period of *Aeromonas hydrophila* is typically 24–48 hours,[2] and the main symptoms are diarrhoea, gastroenteritis, abdominal pain, vomiting and fever. Duration of illness can range from three days to six months but can be self-

limiting.[5–8] *Aeromonas* is ubiquitous to water, with the ability to form biofilms in and subsequently colonize water systems.[3] The heterotrophic plate count calculated that *Aeromonas* can make up 1%–27% of total bacteria in samples of drinking water, implicating drinking-water as a possible source of infection.[9,10]

The symptoms, duration and incubation of the illness in this outbreak conformed to that of *Aeromonas hydrophila*. Three stools were positive for *Aeromonas hydrophila* and all 15 stools tested were negative for other gastroenteritis pathogens. The epidemiological evidence implicating cold salads as the vehicle of transmission was supported by environmental findings. Cucumbers and houttuynia used in the implicated salads were washed in water from a tank that had an extremely high *Escherichia coli* count. It was likely that the water of the tank was contaminated by the sewage ditch located nearby (< 10 cm). There were also anecdotal reports from school staff that students were sick with diarrhoea the last time the sewage ditch was blocked.

The local temperature was rather high before and during the outbreak. This and the inappropriate operations in the cafeteria may have caused reproduction of *Aeromonas hydrophila*. The cold dishes sold well in the students' cafeteria, which may be why so many students were involved in this outbreak.

This was not the first large outbreak of *Aeromonas hydrophila*. An outbreak involving 381 children from two day-care centres were reported in 1992.[11] Another outbreak of *Aeromonas hydrophila* occurred in 1993 in China with 82 cases, and the source of infection was found to be drinking-water contaminated by sewage.[12] In recent years, the number of outbreaks caused by *Aeromonas hydrophila* has been significantly increasing, mostly due to contaminated drinking-water and food.

Our investigation had some limitations. Less than 10% of the reported cases had their stools examined for *Aeromonas hydrophila* because most cases either self-medicated or were treated as outpatients. Collecting specimens after antibiotic use may explain the low positive proportion of *Aeromonas hydrophila*. The investigation was unable to isolate *Aeromonas hydrophila* from the salads since there were no leftovers. There was also the potential for recall bias in the three-day food histories with some students not supplying detailed information because they could not remember.

Gastroenteritis occurs frequently in summer, and nonstandard cold salad preparation and storage could make pathogens easy to spread and breed. This outbreak highlighted the importance of enhancing the training of kitchen staff on correct operations such as using clean water to wash vegetables and keeping food in cold storage before serving. Moreover, tanks and sewage ditches should comply with the *Code for Design of Dietetic Buildings*.[13] The supervision department also should strengthen monitoring and sterilizing drinking-water to guarantee food safety.

Conflicts of interest

None declared.

Funding

None.

References:

1. *Guidelines for drinking-water quality, 4th edition*. Geneva, World Health Organization, 2011 (http://www.who.int/water_sanitation_health/publications/2011/dwq_chapters/en/index.html, accessed 20 May 2012).
2. *Aeromonas*. In: *Addendum to Guidelines for drinking-water quality, 2nd edition*. Geneva, World Health Organization, 1998 (http://www.who.int/water_sanitation_health/dwq/en/admicrob2.pdf, accessed 20 May 2012).
3. Parker JL, Shaw JG. *Aeromonas* spp. clinical microbiology and disease. *The Journal of Infection*, 2011, 62:109–118. doi:10.1016/j.jinf.2010.12.003 pmid:21163298
4. Igbinosa IH et al. Emerging *Aeromonas* species infections and their significance in public health. *The Scientific World Journal*, 2012, 2012:625023. doi:10.1100/2012/625023 pmid:22701365
5. Moyer NP. Clinical significance of *Aeromonas* species isolated from patients with diarrhea. *Journal of Clinical Microbiology*, 1987, 25:2044–2048. pmid:3693537
6. Yang SM, Wand MS. *Aeromonas hydrophila* and its pathogensis to humans. *Chinese Journal of Disease Control and Prevention*, 2006, 10:511–514.
7. Morinaga Y et al. Clinical characteristics of seven patients with *Aeromonas septicemia* in a Japanese hospital. *Tohoku Journal of Experimental Medicine*, 2011, 225:81–84. doi:10.1620/tjem.225.81 pmid:21892001
8. Llopis F et al. Epidemiological and clinical characteristics of bacteraemia caused by *Aeromonas* spp. as compared with *Escherichia coli* and *Pseudomonas aeruginosa*. *Scandinavian Journal of Infectious Diseases*, 2004, 36:335–341. doi:10.1080/00365540410020631 pmid:15287377
9. Rusin PA et al. Risk assessment of opportunistic bacterial pathogens in drinking water. *Reviews of Environmental Contamination and Toxicology*, 1997, 152:57–83. doi:10.1007/978-1-4612-1964-4_2 pmid:9297985
10. Egorov AI et al. Occurrence of *Aeromonas* spp. in a random sample of drinking water distribution systems in the USA. *Journal of Water*

and Health, 2011, 9:785–798. doi:10.2166/wh.2011.169 pmid:22048437

11. de la Morena ML et al. Diarrhea associated with *Aeromonas* species in children in day care centers. *The Journal of Infectious Diseases*, 1993, 168:215–218. doi:10.1093/infdis/168.1.215 pmid:8515113

12. Qing-wen J et al. An acute diarrhea outbreak associated with *E. Aeromonas* caused by contaminated drinking water. *Journal of Environmental Health*, 1993, 10:99–101.

13. Code for Design of Dietetic Buildings (JGJ 64-89). Professional Standard of People's Republic of China. Beijing, Ministry of Commerce and Ministry of Health, 1989.

An outbreak of hepatitis A associated with a contaminated well in a middle school, Guangxi, China

Xu Ye-qing,[ab] Cui Fu-qing,[c] Zhuo Jia-tong,[d] Zhang Guo-ming,[c] Du Jin-fa,[d] Den Qu-yun[c] and Luo Hui-min[c]
Correspondence to: Luo Hui-ming (e-mail:Hmluo@vip.sina.com).

Background: In May 2012, an outbreak of viral hepatitis A was reported to the Guangxi Center for Disease Control and Prevention from a middle school in Liujiang County. An investigation was conducted to identify the cause and mode of transmission and to recommend control and prevention measures.

Methods: A case was defined as any person from the middle school with onset of fatigue, anorexia, abdominal pain, diarrhoea or jaundice from 20 February to 20 May 2012. We compared attack rates (AR) between boys and girls, assuming that only boys used well water and girls used pipeline water. We then selected 133 students from three classes in each of the three grades to compare AR by reported water source and drinking history.

Results: There were 22 cases, an AR of 3.8% (21/553) for students and 1.5% for teachers (1/65). Those who used well water were 8.7 (95% confidence interval [CI] = 2.1–37.2) times more likely to be ill than those using pipeline water. The cohort study showed that students who reported using well water daily were 5.2 (95% CI = 0.7–41.8) times more likely to be ill than those that reported using the pipeline water daily. Eighteen cases were confirmed as hepatitis A.

Conclusion: This hepatitis A outbreak was potentially caused by a contaminated school well. We recommended that the school discontinue using the well and that the students should drink boiled water. As there is a vaccine for hepatitis A, we recommended that several doses of the vaccine be stored for controlling outbreaks and for immunizing susceptible populations in future outbreaks.

Hepatitis A infection is an acute, usually self-limiting disease of the liver caused by hepatitis A virus. Hepatitis A virus can be transmitted through food, water and from person to person, primarily by the faecal–oral route. Risk factors for hepatitis A virus infection are related to resistance of hepatitis A virus to the environment and include poor sanitation in large areas of the world and abundant hepatitis A virus shedding in faeces. Under these conditions epidemics can arise from water and food contamination.[1–3] The incidence of hepatitis A is closely related to socioeconomic development.[4] An estimated 1.5 million clinical cases of hepatitis A occur each year worldwide.[1] In areas where Hepatitis A virus is highly endemic, most hepatitis A virus infections occur during early childhood.[1]

Viral hepatitis A is a category B infectious disease in China; therefore, all cases of hepatitis A are reported by hospitals to the Chinese Center for Disease Control and Prevention (CDC). Though incidence is low, hepatitis A can cause large outbreaks resulting in huge economic loss and social panic[5] such as the large outbreak of about 310 000 people in Shanghai in 1988.[2] Hepatitis A vaccine was included in routine immunization in China in 2008, with children aged 18 months eligible for a free injection of hepatitis A vaccine.

In May 2012, an outbreak of viral hepatitis A was reported to the Guangxi CDC from a middle school in a rural location in Liujiang County. Fellows from the China Field Epidemiology Training Programme, along with Guangxi CDC staff, conducted an investigation to identify the cause and mode of transmission and to recommend control and prevention measures.

METHODS

We conducted an outbreak investigation including a retrospective cohort study. A case was defined as any

[a] Chinese Field Epidemiology Training Programme, Beijing, China.
[b] Xinjiang Uygur Autonomous Region Center for Disease Control and Prevention, Urumqi, China.
[c] National Immunization Programme, Chinese Center for Disease Control and Prevention, Beijing, China.
[d] Guangxi Zhuangzu Autonomous Region Center for Disease Control and Prevention, Guangxi, China.
Submitted: 28 October 2012; Published: 20 December 2012
doi: 10.5365/wpsar.2012.3.4.014

person from the school with onset of fatigue, anorexia, abdominal pain, diarrhoea or jaundice from 20 February to 20 May 2012, with all other diagnoses excluded. Active case finding was conducted by reviewing the county hospital's medical registrations and by interviewing students and teachers from the school. We used a structured questionnaire, which included questions on water exposures and other environmental factors. Attack rates (AR) were calculated using the number of teachers and students in the school as denominators. We found there were no vaccination records for the local area hepatitis A vaccination programme before 2007.

To verify the hypothesis that well water was the cause of this hepatitis A outbreak, we conducted a retrospective cohort study. We selected 133 students from three classes in the three grades. We used a more specific questionnaire that focused on drinking water. We also evaluated whether the students drank boiled water and the frequency. Those who answered "seldom" were scored 1, "sometimes" were scored 2, "often" were scored 3, and "always" were scored 4. The scores were analysed using logistic regression using Epi Info.

We conducted an environmental investigation at the school to determine food and water supply arrangements. The visit occurred after the implicated well was closed, so no water samples were able to be collected. Serum samples were collected from student and teacher cases between 20 February and 20 May 2012 and tested using the hepatitis A virus immunoglobulin test.

RESULTS

Environmental investigation

The environmental investigation found that all students lived on the school campus. The middle school comprised three grades of 12 classes with 553 students (288 boys and 265 girls) and 65 teachers.

There were two water sources at the school, one from the waterworks which was piped into the school buildings, the other from a well obtained from outside taps. The pipeline water was treated whereas the well water was not treated. The well was located close to potential environmental contamination sources, including a vegetable garden often fertilized with toilet faeces. There were no water facilities or toilets in the boys' dormitory, so the boys used the outside well water for bathing and mouth wash, with some even drinking the tap water directly. There were water facilities and toilets in the girls' dormitory, so they used the pipeline water for daily washing. The teachers' dormitory also used pipeline water. However, the teacher case lived in a domestic cottage next to the school well and used the well water for cooking and washing.

The school had one canteen that provided three meals each day. It used pipeline water for daily food preparation and for drinking water. As only one teacher and two female students were ill, compared with 19 male students, a foodborne outbreak of hepatitis was considered unlikely. Also, the number of cases declined after use of the well water was stopped.

There were no hepatitis A cases reported among other people in this county.

Cases

There were 22 cases whose clinical symptoms consisted of malaise (100%), anorexia (100%), nausea (72%), jaundice (41%), abdominal pain (41%), fever (32%) and vomiting (27%). There were 21 student cases giving an AR of 3.8% (21/553) and one teacher case giving an AR of 1.5% (1/65). There were no severe cases or deaths. Of the 22 cases, 18 were laboratory confirmed as hepatitis A virus.

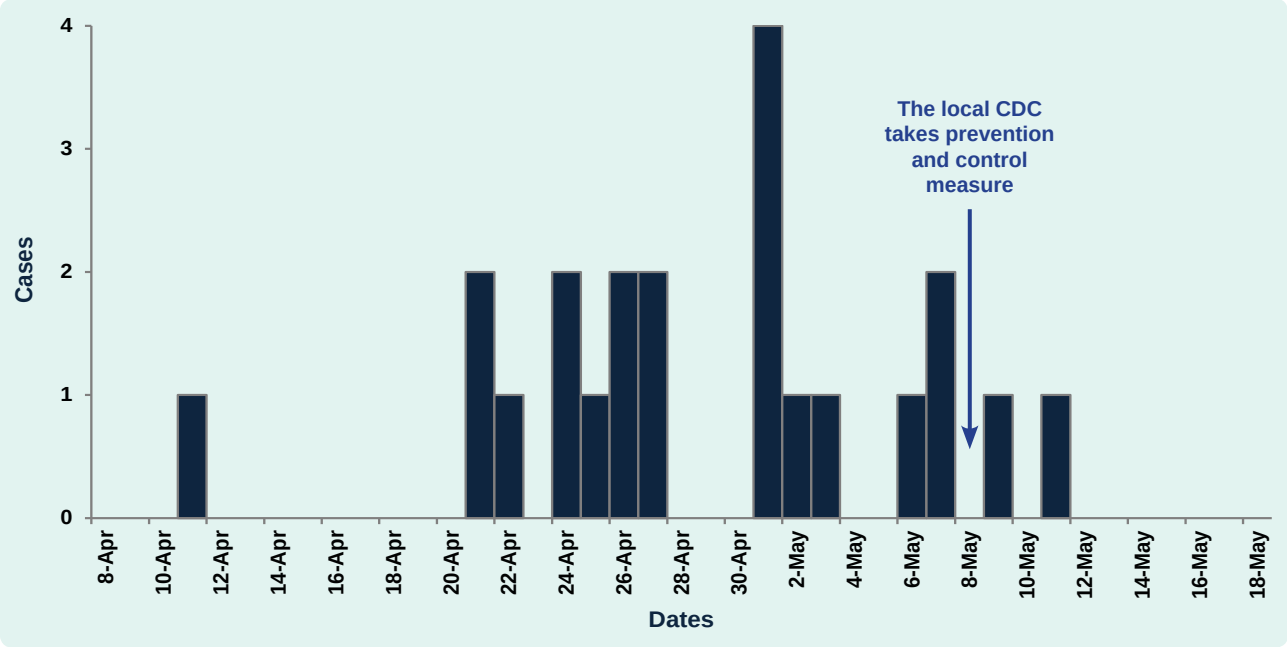
The epidemic curve showed the first case occurred on 11 April, and that cases continued for the next 30 days (**Figure 1**).

The teacher case was 54 years old; the student cases ranged in age from 13 to 16 years. Most of the cases were male students (n = 19) with an AR of 6.6% (19/288). The two female student cases corresponded to an AR of 0.8% (2/265). Assuming that all male students used the well water and all female students used pipeline water, those that used the well water were 8.7 (95% confidence interval [CI] = 2.1–37.2) times more likely to be ill.

Cohort study

In the cohort study of 133 students, the AR of those who reported using the school well water daily was 10.4% (7/67) compared to 1.8% (1/56) of those who reported using pipeline water (RR = 5.2, 95% CI = 0.7–41.8).

Figure 1. **The epidemic curve for outbreak cases in a middle school, Guangxi Province, China, 2012**



Logistic regression analysis of drinking boiled water showed that this increased, the risk for morbidity decreased by 15% (OR: 0.85, 95% CI = 0.48–1.5).

DISCUSSION

This hepatitis A outbreak in a middle school in Guangxi province, China, was most likely caused by contaminated well water. There were 22 cases with an AR of 3.6%; 19 cases were male students. Being a male student was associated with illness, because they used the well water, whereas the females at the school had access to and used treated pipeline water. The well water was delivered to boys for daily washing, and some students also drank the well water directly. The results of the cohort study also showed that students who reported using the well water were associated with illness. The well water was not treated and was located next to a vegetable field that was often fertilized by faeces, a possible source of contamination.

There was one teacher case and only two female student cases. As all students and teachers eat at the same cafeteria at the school, the likeliness of the outbreak being caused by food is very small. No additional hepatitis A cases were reported among people living near this school, discounting community transmission.

Hepatitis A is transmitted by contaminated water and food including seafood such as blood clams. It can cause both sporadic cases and outbreaks. Since 1990 in China, the reported number and morbidity of hepatitis A has been decreasing, although there is a significant difference among the provinces, with the less well-off regions having higher morbidity.[5] Outbreaks mainly happen in schools due to the concentration of susceptible population, intensive living, daily diet and drinking conditions.[6]

This outbreak of hepatitis A revealed the management issue of using wells in rural schools. Due to the economy, quite a few schools that cannot afford pipeline water fees use well water instead. Water drawn from wells located in low-lying places can become contaminated after rain. This can result in outbreaks of intestinal infectious diseases such as this hepatitis A outbreak. Although the well water in this outbreak was for domestic use, some students drank the water directly.

There are some limitations to our investigation. We were only able to administer the cohort study questionnaires to 133 students, which comprised only eight ill students. We were also unable to test the well water as the well had been closed before our arrival at the

school. However, despite these limitations, it is plausible that contaminated well water caused this outbreak.

As a result of this outbreak, we recommended that the school discontinue using the well and that the students drink boiled water. We also recommended that drinking water safety for rural school residents be investigated through close collaboration among the government, water conservancy and health and education bureaux. This could potentially prevent future outbreaks. We also recommended that hepatitis A vaccines be stored for use in controlling outbreak through immunizing susceptible populations.[7,8]

Conflicts of interest

None declared.

Funding

None.

References:

1. Fiore AE, Wasley A, Bell BP. Prevention of hepatitis A through active or passive immunization. *MMWR. Morbidity and Mortality Weekly Report*, 2006, 55 RR07:1–23. pmid:16708058
2. Wu J et al. Spring 1988 Shanghai hepatitis a outbreak indirect economic loss analysis. *Chinese Public Health Management*, 1990, 4:41–43.
3. Lemon SM. Type A viral hepatitis: epidemiology, diagnosis, and prevention. *Clinical Chemistry*, 1997, 43(8[B]):1494–1499.
4. Centers for Disease Control and Prevention (CDC). Prevention of hepatitis A through active or passive immunization: recommendations of the Advisory Committee on Immunization Practices. *MMWR. Morbidity and Mortality Weekly Report*, 1996, 45(RR15):1–30. pmid:9005304
5. Zheng H et al. Epidemiological analysis on hepatitis A in China during 2004–2006. *Chinese Journal of Vaccines and Immunization*, 2007, 13:336–341.
6. Li LI et al. Analysis and countermeasure for current situation of hepatitis A, B in China. *Disease Surveillance*, 2009, 24:307–312.
7. Hai-tian SUI et al. Epidemic characteristics on hepatitis A in China during 1990–2006. *Chinese Journal of Vaccines and Immunization*, 2007, 13:466–469.
8. Committee on Infectious Diseases. Hepatitis A vaccine recommendations. *Pediatric*, 2007, 12:189–199.

An outbreak of syphilis in Darkhan-Uul, Mongolia, January to March 2012

Battsendiin Munkhzul,[ab] Batjargaliin Batdorj[ac] and Jantsansengeegiin Baigalmaa[ab]

Correspondence to Battsendiin Munkhzul (e-mail: mzula_mgl@yahoo.com).

Background: Fifty-eight syphilis cases were notified from Darkhan-Uul Province in the first three months of 2012, which is double that of the same period in 2011. The objective of this investigation was to confirm the existence of the outbreak, examine the risk factors of cases and develop recommendations to prevent further spread.

Methods: We conducted a descriptive study of cases notified to the national surveillance system diagnosed with syphilis between 1 January and 20 March 2012 in Darkhan-Uul Province. Additional data were collected from doctors' record books and outpatient cards. We compared outbreak cases to non-outbreak cases notified in Darkhan-Uul Province in 2011.

Results: The total notification rate was 62.3 per 100 000. The notification rate was highest among 20–29 year olds, and 38 (65.5%) were females. More males than females were detected through contact tracing (45% compared with 10.5%). Only 10% of cases reported using condoms during their last sexual encounter, with 65.5% reporting having had casual sex or multiple sex partners. There were no homosexual cases. Compared to the non-outbreak cases, outbreak cases had a significantly higher proportion of detection through contact tracing (22.4% compared with 0.7%) but a lower proportion of detection through prevention (3.5% compared with 26.5%). There was also a higher proportion of primary syphilis in outbreak cases (62.1% compared with 41.7%).

Conclusion: The syphilis outbreak in Darkhan-Uul Province was confirmed. We recommended effective contact tracing followed by timely diagnosis and treatment. Health promotion activities targeted to high school, college and university students on syphilis infection and prevention as well as condom usage were recommended for future prevention.

Syphilis is a sexually transmitted infection caused by the spirochete bacterium *Treponema pallidum*. The primary route of transmission is through sexual contact; congenital syphilis can also be transmitted from mother to fetus during pregnancy or at birth.[1] Blood products can also transmit the infection.[1] Globally, there are about 448 million new infections of curable sexually transmitted infections (STI) (syphilis, gonorrhoea, chlamydia and trichomoniasis) annually.[2] In 2010 in Mongolia, there were 14 301 cases of STI, representing 34.6% of all registered infectious diseases.[3] The proportion of syphilis was 21% among all reported STI cases in 2010.[3]

Darkhan-Uul Province, located in the northern part of the country, has a population of 93 137. The syphilis notification rate in Darkhan-Uul Province has been higher than national and provincial averages since 2001 to 2009.[3] Darkhan Health Department reported a two-fold increase in syphilis cases in the first three months of 2012 compared to the same period in 2011. Therefore, the aim of this investigation was to confirm the existence of the outbreak, determine the characteristics of cases and develop recommendations to prevent further spread. We also compared cases reported during the outbreak to cases notified in a non-outbreak period in Darkhan-Uul Province.

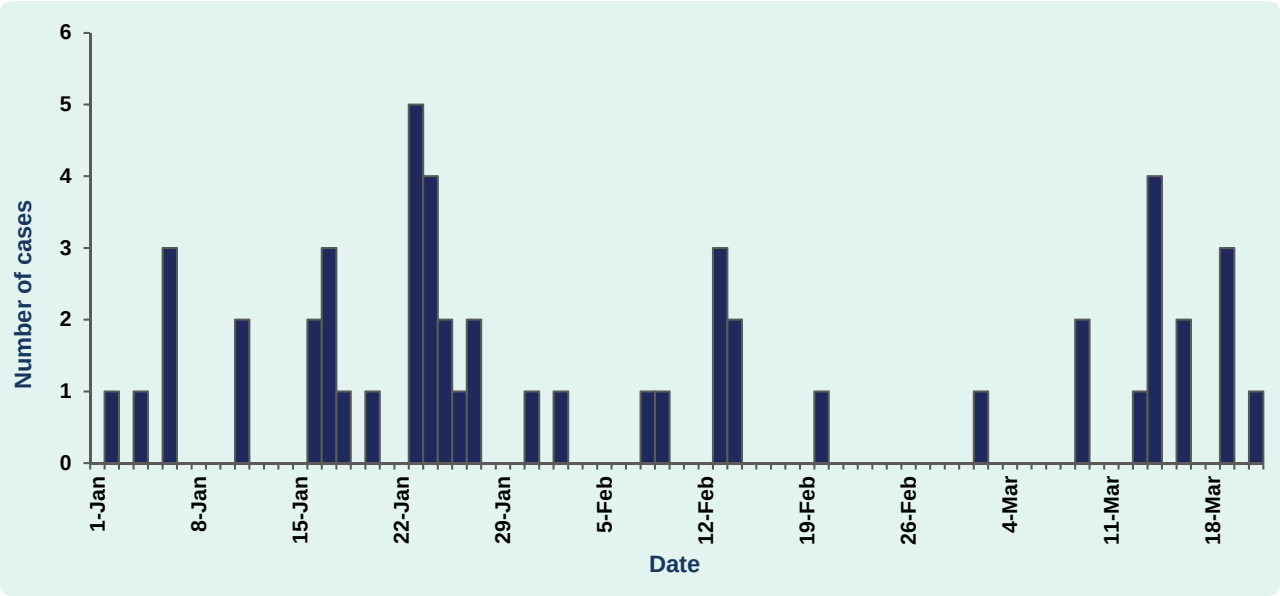
METHODS

We conducted a descriptive study of all syphilis cases notified to the national surveillance system from Darkhan-Uul Province between 1 January and 20 March 2012. We included cases diagnosed with any stage of syphilis as classified by STI physicians in accordance with the International Classification of Diseases–10 (ICD–10).[4] The diagnoses were confirmed using laboratory tests (Rapid Plasma Reagin and Treponema pallidum Hemaglutination Assay).

We collected information from STI outpatient cards and STI doctors' record books for each case. From the record books we collected age, sex, residence, social status, reported detection method and reported source of syphilis infection for a case. Additional information from STI outpatient cards were symptoms and risk

[a] Mongolian Field Epidemiology Training Programme, Ulaanbaatar, Mongolia.
[b] National Center for Communicable Diseases, Ulaanbaatar, Mongolia.
[c] Khuvsgul Province Health Department, Mongolia.
Submitted: 3 October 2012; Published: 20 December 2012
doi: 10.5365/wpsar.2012.3.4.003

Figure 1. **Epidemic curve of syphilis cases reported in Darkhan-Uul Province, Mongolia, January to March 2012 (*n* = 58)**



behaviours including: having casual sex (sex with a non-regular sex partner or spouse), condom use during last sexual encounter, having multiple or new sex partners in the last three months, previous STI history, last sexual encounter with whom and where, and condom usage. We compared the characteristics between male and female cases using the chi-squared test in Open–Epi. We compared outbreak cases with non-outbreak cases reported to the national surveillance system in 2011 from Darkhan-Uul Province. The age distribution, social status, source of infection, detection of infection and stage of syphilis of all outbreak cases to non-outbreak cases were compared using the chi-squared test.

We protected the confidentiality of the respondents through the use of codes. Since this work was conducted in the context of an emergency response to an outbreak, it was exempt from ethical clearance.

RESULTS

There were 58 cases diagnosed with syphilis from 1 January to 20 March 2012 in Darkhan-Uul Province, yielding a notification rate of 62.3 per 100 000. The notification rate for January 2012 was higher than the mean of the number of cases from the same time period in 2011, and it was higher than the threshold of the mean plus two standard deviations. Therefore, this was defined as an outbreak.

Cases were continuously reported between January and March with the highest number of cases reported on 23 January 2012. The number of cases then began to decrease during the early part of February 2012 (**Figure 1**). There were 38 female and 20 male cases; although the notification rate for females was almost double that for males, this difference was not statistically significant (102.3 per 100 000 compared with 54.2 per 100 000 respectively, $P = 0.4$). Median age was 24 years (range: 14–40 years) with the highest incidence among those aged 20–24 (327.5 per 100 000) and 25–29 (207.7 per 100 000) years (**Table 1**).

Addresses were available for 40 cases, and based on residency, there was no obvious geographic clustering of cases; all cases were spread throughout the city. The proportion of cases employed (41.4%) was higher than those unemployed (17.4%) and other social groups. There was a higher proportion of employed male cases (55.5%) than employed female cases (34.2%) but a higher proportion of female students (26.3%) compared with male students (15.0%). However, there was no significant difference in social status of female and male cases ($P = 0.2$) (**Table 1**).

Most male cases (80.0%) reported being infected from casual sex, compared with 57.9% for females. In contrast, 39.5% of female and 15.0% of male cases reported being infected by their spouse ($P = 0.15$). Sex workers comprised 15.8% ($n = 6$) of female cases.

Table 1. **Characteristics of outbreak cases by sex in January to March 2012 and non-outbreak cases in 2011, Darkhan-Uul Province, Mongolia**

Characteristics	Outbreak cases, 2012						Non-outbreak cases, 2011	
	Female		Male		Total		Total	
Section A. Reported syphilis incidence per 100 000 by age group and sex								
Age groups	**Cases**	**Rate**	**Cases**	**Rate**	**Cases**	**Rate**	**Cases**	**Rate**
14 and below	1	8.7	0	0.0	1	4.3	0	0.0
15–19	5	110.9	2	36.8	7	76.7	10	109.5
20–24	17	327.5	5	115.3	22	207.2	62	583.8
25–29	9	207.7	9	234.6	18	207.6	37	426.8
30–34	4	96.9	2	55.8	6	75.4	25	314.0
35–39	2	51.2	1	32.1	3	40.1	9	120.2
40–44	0	0.0	1	35.8	1	14.9	3	44.8
45 and above	0	0.0	0	0.0	0	0.0	5	26.2
P*-value	***P* = 0.4**						***P* = 0.3**	
Total	**38**	**102.3**	**20**	**54.2**	**58**	**62.3**	**151**	**162.1**
Section B. Information from STI record book								
Social status	**Cases**	**%**	**Cases**	**%**	**Cases**	**Rate**	**Cases**	**Rate**
Children under 15	1	2.6	0	0.0	1	1.7	0	0
Employed	13	34.2	11	55.0	24	41.4	58	38.4
Unemployed	7	18.4	4	20.0	11	19.0	45	29.8
Sex worker	6	15.8	0	0.0	6	10.3	5	3.3
Other	1	2.6	2	10.0	3	5.2	5	3.3
Student	10	26.3	3	15.0	11	22.4	38	25.2
P*-value	***P* = 0.2**						***P* = 0.1**	
Source of infection								
Spouse	15	39.5	3	15.0	18	31.0	69	45.7
Sex worker	1	2.6	1	5.0	2	3.4	1	0.7
Casual sex	22	57.9	16	80.0	38	65.5	81	53.6
P*-value	***P* = 0.1**						***P* = 0.06**	
Detection of infection								
Antenatal care	12	31.6	0	0.0	12	20.7	27	17.9
Due to symptoms	13	34.2	11	55.0	24	41.3	59	39.1
Voluntary visit	1	2.6	0	0.0	1	1.7	1	0.7
Prevention activities	2	5.3	0	0.0	2	3.5	40	26.5
Contact tracing	4	10.5	9	45.0	13	22.4	1	0.7
Second generation surveillance†	6	15.8	0	0.0	6	10.3	0	0
Active dispensary control‡							23	15.2
P*-value	***P* < 0.001**						***P* < 0.001**	
Stage of syphilis								
Primary syphilis	21	55.2	15	75.0	–	–	–	–
Secondary syphilis	12	31.6	3	15.0	–	–	–	–
Latent	5	13.1	2	10.0	–	–	–	–
P*-value	***P* = 0.3**						***P* = 0.01**	
Total	**38**	**100.0**	**20**	**100.0**	–	–	–	–
Section C. Information from outpatient cards§								
Sexual behaviour								
New sex partner in last 3 months	13	52.0	13	86.7	26	60.0	–	–
Multiple sex partners in last 3 months	9	36.0	10	66.7	19	47.5	–	–
Drank alcohol during or before sex	3	12.0	8	53.3	11	27.5	–	–
Received blood or blood product	1	4.0	0	0.0	1	2.5		
Location of sex								
Bar	0	0.0	1	6.7	1	2.5	–	–
Hotel	2	8.0	8	53.3	10	25.0	–	–
At sexual partner's home	7	28.0	1	6.7	8	20.0	–	–
At own home	15	60.0	3	20.0	18	45.0	–	–
Outside	1	4.0	0	0.0	1	2.5	–	–
Other	0	0.0	2	13.3	2	5.0	–	–
P*-value	***P* = 0.002**							
Previous STI history								
Yes	3	12.0	3	20.0	6	15.0	–	–
No	22	88.0	12	80.0	34	85.0	–	–
***P*-value**	***P* = 0.5**							
Condom usage during last sex								
Yes	2	8.0	2	13.3	4	10.0	–	–
No	23	92.0	13	86.7	36	90.0	–	–
P*-value	***P* = 0.6**							
Total	**25**	**100.0**	**15**	**100.0**	**40**	**100.0**	–	–

* The first *P*-value compares male and female outbreak cases; the second *P*-value compares total outbreak cases and total non-outbreak cases.

† The seventh round of second generation surveillance (SGS) among the most-at-risk population represented by female sex workers, mobile men, male STI clients and men who have sex with men was carried out in 2012.

‡ People who are under control of dispensary (mostly female sex workers).

§ In section C, data for 10 cases were not available.

One third of female cases were identified through antenatal care, another third because they were symptomatic and 10.5% through contact tracing. In contrast, just over half of male cases were detected because they were symptomatic (55%) and the rest through contact tracing (45%), and these differences were statistically significant ($P < 0.001$) (**Table 1**).

Among the 40 cases for which outpatient cards were available, 47.5% reported having had multiple sex partners in the last three months, and 65% reported having had a new sex partner in last three months. A statistically significant difference in the location of the last sexual encounter was observed between females and males ($P = 0.002$); more than half of male cases (53.3%) reported they last had sex at a hotel whereas 60% of female cases said they had it at home. Only 10% reported using condoms the last time they had sex. Six cases had a previous history of a STI diagnosis; there was no difference in previous STI diagnoses between females (12%) and males (20%) ($P = 0.5$) (**Table 1**).

There were no cases reported from homosexual contact or from injecting drug use.

When the outbreak cases were compared with non-outbreak cases, outbreak cases had a higher proportion of younger age groups (under 14 and 15–19 year olds) and more sex workers (10.3% compared with 3.3%) but a lower proportion of unemployed cases (19.0% compared to 29.8%). There was a higher proportion of reported casual sex in outbreak cases (65.5% compared with 53.6%) but a lower proportion of reported infection from spouses (31.0% compared with 45.7%). However, these differences were not significant (**Table 1**).

There was a significant difference between the two groups for detection ($P < 0.001$): a higher proportion through contact tracing in the outbreak cases (22.4% compared with 0.7%) but a lower proportion through prevention activities (3.5% compared with 26.5%). Similarly, there were significant differences for stages of syphilis ($P = 0.01$): a higher proportion of primary (62.1% compared with 41.8%) and a lower proportion of latent syphilis for outbreak cases (12% compared with 29.8%) but similar proportions of secondary syphilis (25.9% compared with 28.5%) (**Table 1**).

DISCUSSION

We confirmed the syphilis outbreak in Darkhan-Uul Province in early 2012. Females had higher notification rates than males, and most cases were 20–29 years old. This pattern of more female notifications,which has been observed over the last decade in Mongolia (with the exclusion of 2004 and 2008),[3,5] is the opposite of patterns reported in China,[6] Germany[7] and Sweden,[8] where male incidence was higher and the majority of male cases were men who have sex with men (MSM). Syphilis outbreaks have also been reported among MSM.[9–13] Not self-reporting as an MSM in our study may have been due to negative reactions to homosexual people.

In this study, detection of female cases through contact tracing was much lower than male cases. Moreover most male cases were reportedly infected through casual sex whereas the majority of female cases were reportedly infected by their spouse. Possible explanations for this might be that male cases are detected after their spouses' antenatal care visits or that female cases tend to notify their partners more than the male cases. During this outbreak, the proportion of cases detected through contact tracing (22.4%) was higher than the average proportion of cases detected through contact tracing from reported syphilis cases in Darkhan-Uul Province from 2006 to 2011 at 15.6%.

The lower percentage of unemployed people and the higher percentage of sex workers in the outbreak period could be due to more detection through the National Second Generation STI/HIV Surveillance survey (SGS) conducted in 2012.[14] More cases are identified through contact tracing in outbreak periods compared to non-outbreak periods. The much higher percentage of symptomatic syphilis identified in this outbreak might be attributable to active contact tracing during the outbreak period. In contrast, the much higher percentage of latent cases identified in the non-outbreak period could be related to identifying cases through prevention examinations that are conducted throughout the year in STI dispensaries.

There were some limitations in this investigation. As the cases were identified through routine surveillance,

based on ICD–10 case definitions[4] and *Guidelines for STI treatment and services*,[15] some undiagnosed syphilis cases may not have been detected, leading to an underestimation of cases. Also, as we could not link the cases, because the study was conducted from STI record books, we were unable to determine if the cases were related to each other. Our risk factor analysis was limited as the outpatient cards of 18 of 58 cases were not found.

The rate of cases of syphilis in this outbreak was highest in the 15–19 and 20–24 age groups, with 22.4% of cases being students. The main risk factors for infection in this study were having casual sex and low condom use. Based on these findings, we recommended that contact tracing be improved and guidelines on partner notification services be developed. We also recommended that education, information and communication materials and behavioural change communication activities be targeted to high school, college and university students about STI including syphilis, especially prevention through condom usage.

Conflict of interest

None declared.

Funding

This study was undertaken within the Mongolian Field Epidemiology Training Programme (MFETP).

Acknowledgements

We would like to thank G Surenkhand, vice-director of National Center for Communicable Diseases and director of the MFETP for providing guidance and support. We would like to thank S Uranchimeg, STI physician, and B Erdenetsetseg, epidemiologist, of Darkhan-Uul Health Department for their time and help to complete the analysis. We gratefully thank Luo Dapeng, WHO Mongolia Office; Takaaki Ohyama, Japan-FETP; staff from WHO Regional Office for the Western Pacific who conducted the scientific writing workshop and the MFETP team for their comments and assistance to improve the results of this paper.

References:

1. Heymann DL. *Control of Communicable Diseases Manual, 19th edition*, 2008. Washington DC, American Public Health Association, 2008.
2. *Sexually transmitted infections - Fact sheet No. 110, August 2011*. Geneva, World Health Organization, 2011 (http://www.who.int/mediacentre/factsheets/fs110/en/, accessed 20 April 2012).
3. Baigalmaa J et al. Situation of sexually transmitted infections in Mongolia, 2001–2010. Ulaanbaatar, Ministry of Health, 2011.
4. *The International Classification of Diseases 10th Edition*, Geneva, Word Health Organization, 2010 (http://apps.who.int/classifications/icd10/browse/2010/en, accessed 10 December 2012).
5. Jantsansengeegiin B et al. Increasing syphilis notifications in Mongolia: results from national surveillance for 2001–2011. *Western Pacific Surveillance and Response*, 2012, 3(4):86–93. doi:10.5365/wpsar.2012.3.2.008
6. Hesketh T, Ye XJ, Zhu WX. Syphilis in China: the great comeback. *Emerging Health Threats Journal*, 2008, 1:e6. doi:10.3134/ehtj.08.006 pmid:22460215
7. Bremer V, Marcus U, Hamouda O. Syphilis on the rise again in Germany – results from surveillance data for 2011, *Euro Surveillance: European Communicable Disease Bulletin*, 2012, 17(29):pii=20222. pmid:22835467
8. Velicko I, Unemo M. Recent trends in gonorrhea and syphilis epidemiology in Sweden: 2007 to 2011. *Euro Surveillance: European Communicable Disease Bulletin*, 2012, 17(29):pii=20223. pmid:22835468
9. Yarlagadda S et al. A syphilis outbreak: recent trends in infectious syphilis in Birmingham, UK, in 2005 and control strategies. *International Journal of STD & AIDS*, 2007, 18:410–412. doi:10.1258/095646207781024865 pmid:17609033
10. Hourihan M et al. Lessons from the syphilis outbreak in homosexual men in east London. *Sexually Transmitted Infections*, 2004, 80:509–511. doi:10.1136/sti.2004.011023 pmid:15572625
11. Emerson CR et al. The syphilis outbreak in Northern Ireland. *International Journal of STD & AIDS*, 2007, 18:413–417. doi:10.1258/095646207781024874 pmid:17609034
12. Cecere D, Senft S and Jones S. Syphilis Outbreak – Alaska, 2011–2012. *State of Alaska Epidemiology Bulletin No. 4*, 21 February 2012.
13. Cusini M et al. Syphilis outbreak in Milan, Italy. *Sexually Transmitted Infections*, 2004, 80:154. doi:10.1136/sti.2003.007526 pmid:15054187
14. *Second Generation HIV/STI Surveillance report – 2009*. Global Fund Supported Project on AIDS and TB. Ulaanbaatar, Ministry of Health, 2010.
15. *Guidelines for STI treatment and services – Order No. 429*, dated 10 December 2009. Ulaanbaatar, Ministry of Health, 2009.

Investigation of a mumps outbreak in Mongolia, January to April 2011

Igore Munkhjargal,[a] Jargalsaikhan Selenge,[a] Amarjargal Ambaselmaa,[b] Rentseng Tuul,[b] Purevsuren Delgermaa,[b] Sarankhuu Amarzaya,[b] Jantsansengee Baigalmaa,[b] Barhas Byambajav,[c] and Dapeng Luo[d]

Correspondence to Jargalsaikhan Selenge (e-mail:seke_8@yahoo.com).

Introduction: The Gurvantes district in Omnogovi Province reported a suspected mumps outbreak to the Mongolia Ministry of Health in March 2011. An outbreak investigation team was established to verify the diagnosis and to determine the magnitude of the outbreak.

Methods: The descriptive study comprised retrospective investigation of local hospital medical records and surveillance data, and interviews with school teachers, doctors, probable cases and their close contacts. The World Health Organization standard case definition was used to define mumps cases. Clinical specimens were collected for laboratory confirmation.

Results: There were 153 cases, none under two years of age, with the five- to 14-years-old age group having the highest rates. There was no difference by sex ($P = 0.12$). A single index case appeared to be the source of the outbreak, and there were four outbreak waves. Of the 129 cases with information on epidemiological links, 94 (72.3%) were linked to other cases at a kindergarten or school, 17 (13%) were from secondary spread of family members, two (1.5%) were from secondary spread of other relatives, and 16 had no established links. Eight cases (5.2%) were confirmed through laboratory investigation.

Conclusion: This was the first high-magnitude mumps outbreak since the introduction of the measles-mumps-rubella vaccine in Mongolia in September 2009. There were no cases among vaccinated children; cases were seen among older children and adults not eligible for the vaccine. This suggests that immunity to mumps is still low in Mongolia. Future outbreaks may occur among this unvaccinated population.

Mumps is an acute viral disease caused by a paramyxovirus and is usually spread by respiratory droplets.[1] Humans are the only natural hosts with one third of cases being asymptomatic. Infection typically begins with non-specific symptoms, such as myalgia, headache, malaise and low-grade fever, followed by unilateral or bilateral swelling of the parotid glands; unless complications occur the illness resolves completely.[1,2] Orchitis, most commonly unilateral, occurs in 20%–30% of post pubertal male cases.[1,2] Encephalitis and permanent neurological sequelae are rare complications. Pancreatitis is reported in approximately 4% of unvaccinated cases.[3]

Although mumps is most frequently reported in children aged five to nine years, both adolescents and adults may be affected. Children younger than 14 years comprise 90% of cases,[4] and in countries that have not introduced mumps vaccine, 80%–90% of adults older than 20 years are immune from natural infection.[2] One strategy to control mumps is to have the measles-mumps-rubella (MMR) vaccination as part of a national immunization programme.[3] However, in recent years in countries with mumps vaccination, many mumps outbreaks have been identified among both vaccinated and unvaccinated people. Large mumps outbreaks were reported from Sweden in 2004,[5] the United States of America in 2006,[6] the Netherlands in 2010[7] among vaccinated populations and Scotland in 2010[8] where half the cases were vaccinated.

An early warning and response surveillance system consisting of case- and event-based surveillance was established in Mongolia in 2008. Mumps is one of the notifiable diseases reported to this system on a monthly basis by epidemiologists and health care providers from primary to tertiary level. Usually, mumps is confirmed clinically at the provincial level due to lack of laboratory

[a] Mongolian Field Epidemiology Training Programme, Ulaanbaatar, Mongolia.
[b] National Center for Communicable Diseases, Ulaanbaatar, Mongolia.
[c] Health Department, Omnogovi Province, Mongolia.
[d] World Health Organization, Ulaanbaatar, Mongolia.
Submitted: 29 August 2012; Published: 21 December 2012
doi: 10.5365/wpsar.2012.3.3.007

capacity. Event-based surveillance is the organized and rapid capture of information about events that are a potential risk to public health such as a mumps outbreak. These outbreaks are required to be reported by the hospitals as soon as possible to the National Surveillance Unit of the National Centre for Communicable Diseases (NCCD).

Mumps vaccine was not available in Mongolia before 2009. Mumps epidemics occurred approximately every five years[9] with 5073 mumps cases registered in 2006 and 1990 cases in 2009. The inter-epidemic years of 2007, 2008 and 2010 reported fewer than 1000 cases per year.[9] Mumps vaccination was added to the routine vaccination schedule in September 2009 with two doses at nine and 24 months of age. The first dose is earlier than that recommended by the World Health Organization (WHO)[3] due to many cases of mumps and measles being reported in Mongolia in the under one-year-old age group. In 2010, MMR vaccination coverage rates were 97% both at the national level and for Omnogovi Province.[10] Therefore, in 2011, children aged between nine months to 3.5 years should have been protected by the vaccine with children older than 3.5 years old being susceptible.

An outbreak of suspected mumps was reported from the Gurvantes district to the NCCD, Ministry of Health in early March 2011. Fellows from the Mongolian Field Epidemiology Training Programme (MFETP) and staff from NCCD were invited by the Ministry of Health to investigate the outbreak.

METHODS

Study design

A descriptive epidemiological study was conducted from 15 to 22 March 2011. The outbreak investigation team consisted of MFETP fellows, epidemiologists, a physician and a virologist of NCCD and the health department of Omnogovi Province.

Survey site

Gurvantes district is located 300 km from the Omnogovi Province centre at the border with China and in 2011 had an official population of 4243. Trade across the border with China, as well as many mining and coal basin companies, are common in this district. There is frequent movement of the population between urban and rural areas.

Data collection

Active case finding was conducted by the local health authority by screening all households on 7 March 2011. All outpatients and inpatients diagnosed with mumps in the Gurvantes district hospital were included in our survey. The probable and confirmed cases were based on the WHO-recommended case definition.[11] A probable case was defined as any person who had "acute onset of unilateral or bilateral tender, self-limited swelling of the parotid or other salivary gland, lasting two or more days and without other apparent cause"[11] in the Gurvantes district from 11 January to 8 April 2011. Confirmed cases were probable cases positive for mumps virus immunoglobulin M (IgM) on acute serum sample.

Data collection included: (1) synthesis of local hospitals' medical records and surveillance data, (2) face-to-face interviews with cases and/or their relatives, and (3) interviews with school teachers and local doctors. The following data were collected: age, sex, social status, symptoms and complications, date of onset of illness and vaccination history. Population data were obtained from the local health government.

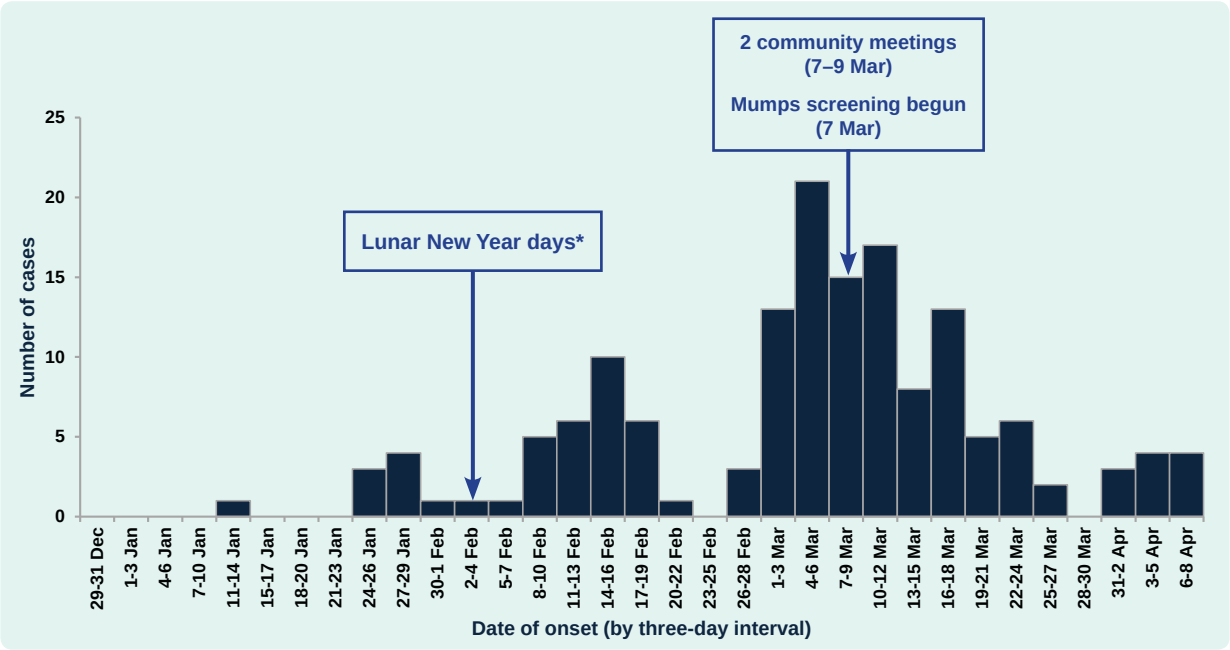
Analysis

Attack rates (overall, by age, by gender) and frequencies were calculated using Epi-info. Epidemiological linkages, defined as a case who had been in contact with a probable or confirmed case during their incubation period (range 12–25 days from onset of symptoms),[2] were also established among cases.

Laboratory analysis

Samples were collected from probable cases from 16 to 18 March 2011. All serum samples were tested for the presence of mumps-specific IgM antibody using commercial enzyme immunoassays (NovaTec Immundiagnostic, Dietzenbach, Germany). Nested polymerase chain reaction (PCR) amplification of a 639 bp fragment encompassing the entire small hydrophobic gene was conducted. Positive PCR products were purified and sequenced. The nucleotide sequences were analysed with reference sequences of different genotypes to determine the genotype of the specimens.

Figure 1. **Epidemic curve of mumps outbreak, Gurvantes district, Omnogovi Province, Mongolia, January to April 2011 (n = 153)**



* Lunar New Year, Mongolia national holiday, was from 2 to 5 February.

Ethics

Ethical clearance was not required as this outbreak investigation was considered to be a public health response.

RESULTS

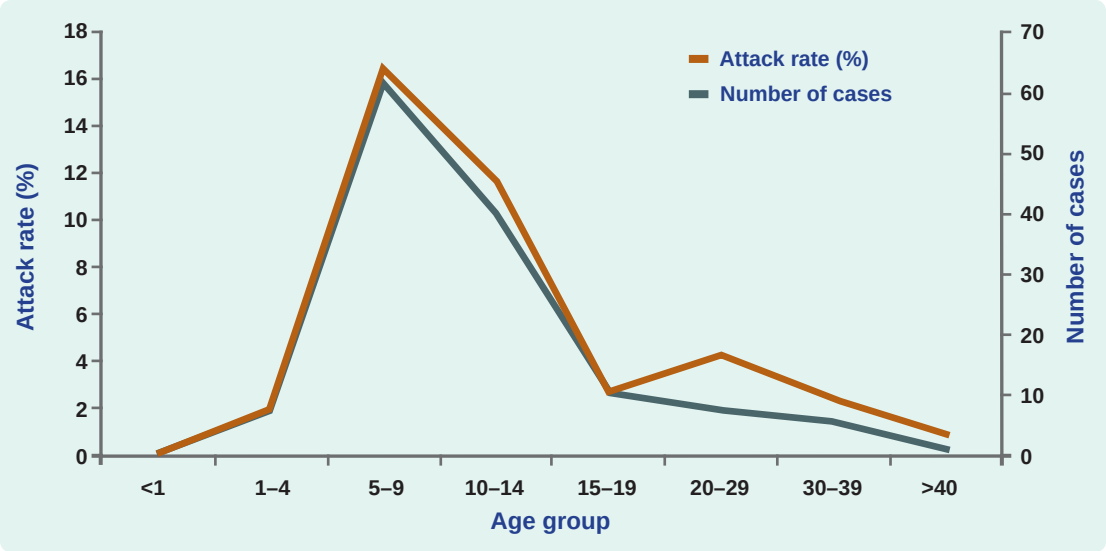
There were 153 probable cases of mumps in the Gurvantes district between 11 January and 8 April 2011; an overall attack rate of 3.6%. Three cases were identified from medical records, seven through active surveillance and the remaining from the surveillance system.

Most cases had mild symptoms: swelling of salivary glands 152 (99%), fever 29 (19%), vomiting 23 (15%) and diarrhoea five (3%). Among the post pubertal males (≥ 17 years), six (33.3%) reported testicular pain. Twenty-four cases (16%) were hospitalized while the remaining 129 cases (84.3%) either sought outpatient treatment or self-medicated. There were nine cases (6%) with complications: meningitis (two cases), meningitis with orchitis (one case), orchitis (five cases) and pancreatitis (one case). Seven of these complicated cases were male. Eight of 12 serum samples were confirmed mumps-specific IgM antibody positive. In July 2011, the outbreak mumps virus genotype was identified as F type.

The epidemic curve shows that the onset date of the index case was 11 January 2011, and there were four outbreak waves. The first wave occurred at the end of January. Lunar New Year was celebrated from 2 to 5 February before the second and third wave of the outbreak. Community meetings, attended by most of the adults, were held on 7 and 9 March. On 7 March, household screening was conducted. The number of cases peaked at the end of March and returned to lower levels in April with the last case onset date of 13 April (**Figure 1**). The index case was identified as a student of a secondary school who had no travel history and could not recall any contact with any suspected mumps cases the month before onset of symptoms.

There were no cases among children aged less than 2.5 years old. The median age of cases was 10 years old (range: two to 40 years old) with about 70% of cases being children aged between five and 14 years old. A major proportion of cases (119, 78%) were children at kindergarten (under five years of age), elementary (six–10 years of age) and secondary schools (11–17 years of age); six (4%) cases were children who stay at home. The remaining 28 cases were adults (**Figure 2**). There was no significant difference of the attack rate between males and females (4% compared with 3%, respectively). All cases were unvaccinated.

Figure 2. **Number of cases and attack rate by age group, Gurvantes district, Omnogovi Province, Mongolia, 11 January to 8 April 2011**



Of the cases, 129 provided information about epidemiological linkages to other cases. Ninety-four cases (72.3%) had contact with another case at kindergarten or school, 17 cases (13%) were from secondary spread within households, two cases (1.5%) were linked to relatives; 16 cases (12.3%) had no identified exposures (**Figure 3**).

DISCUSSION

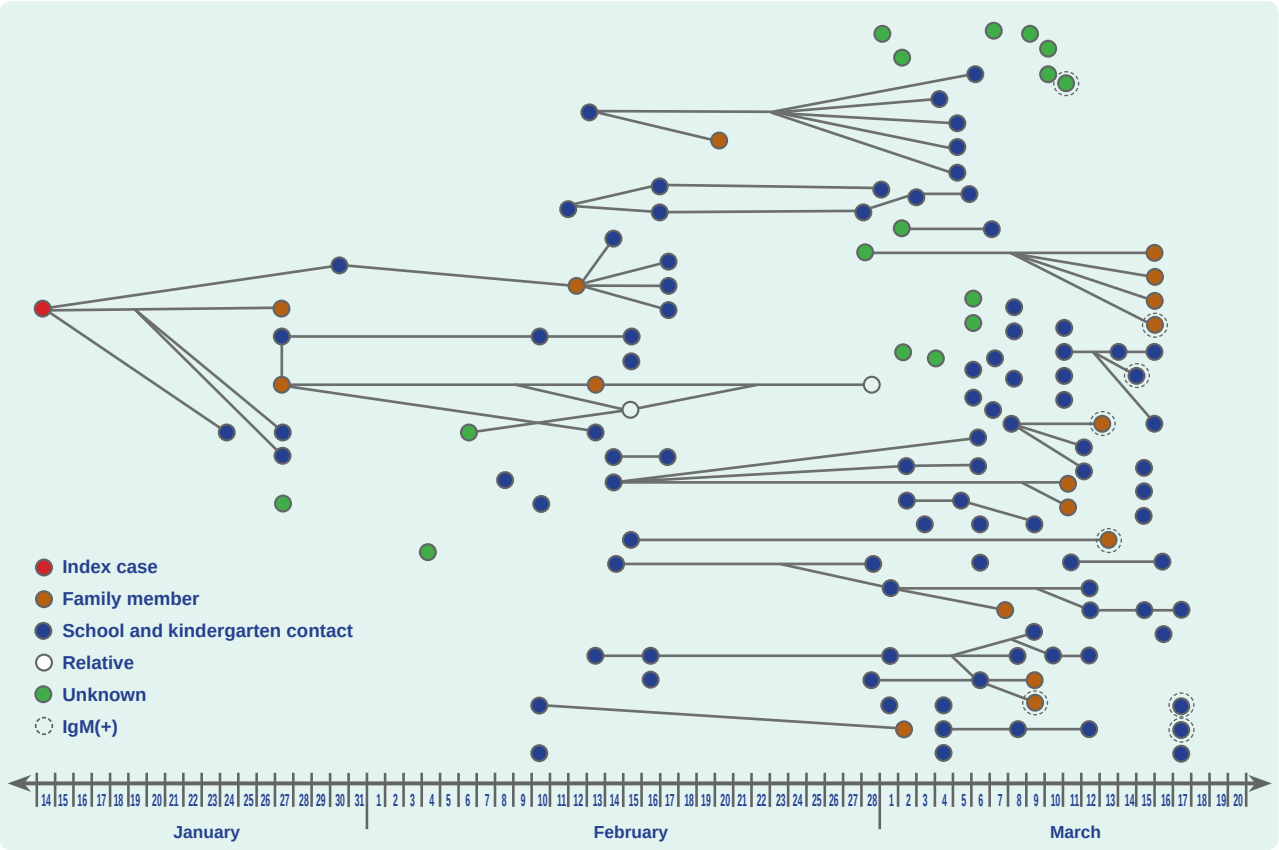
This outbreak of mumps in the Gurvantes district from January to April 2011 is the first outbreak of mumps with high case numbers since the introduction of the MMR vaccine into the national immunization schedule in September 2009. The overall attack rate was 3.6%, much higher than recent reports in many other countries.[12,13] This implies that the overall immunity level of the general population to mumps in Mongolia is low. There were no cases among children who were eligible for vaccination, and the attack rate was highest among the five- to 14-years-old age group, consistent with mumps cases reported in Mongolia from 2006 to 2010.[9] This age group is unvaccinated and would not have natural immunity to mumps yet. The primary transmission of mumps in this outbreak was through kindergarten and school contacts.

Following the index case there were four outbreak waves with a generation period of about 20 days within three months. Generally the incubation period for mumps is 16–18 days (range: 12–25).[2] Mongolian people celebrate Lunar New Year for three to five days. Relatives visit and are greeted with an arm-hold embrace. The community meetings would have been attended by most of the adult population. Those social activities could have facilitated the transmission of mumps and spread it to the community in the third and fourth generations of the outbreak. Another generation of the outbreak did not follow, possibly due to most adults having natural immunity to mumps. Testing identified mumps virus genotype F in this outbreak. Mumps virus genotype F circulated dominantly in China,[14–16] a neighbouring country of Mongolia; transmission of mumps was possible between the two countries

Six per cent of cases had a complication, consistent with published literature that reports mumps complications in 1.0%–10% of cases.[2–4,6] The five cases (28%) with orchitis were also similar to that reported previously at 20%–37% in adults.[2,4,17] Recent mumps outbreaks in the vaccinated population reported lower percentages of mumps cases with orchitis, for instance, 5% in the United States of America in 2006,[6] 12% in the Netherlands in 2010[7] and 0.03% in Sweden in 2004.[5]

Our investigation had several limitations. There was a low proportion of laboratory confirmation (eight cases, 5.2%). However, the clinical symptoms of probable cases were consistent with mumps.

Figure 3. **Epidemiological links of mumps outbreak, Gurvantes district, Omnogovi Province, Mongolia, 11 January to 8 April 2011**



Note: Family member defined as person who lives in same house with contact. Relative defined as person who had visited contact's house several times but does not live with contact.

The index case had no history of travel. It is likely that there were undetected cases in the district with mild symptoms or asymptomatic infections prior to the index case being detected. The number of cases could be underreported. Mass screening was conducted among the population during the investigation and so the possibility of missing cases would be minimal.

The investigation verified the outbreak and suggested that general immunity to mumps virus is still low among Mongolia's young population despite the MMR vaccine being introduced into the national routine immunization programme in 2009. Health care workers should be aware that mumps outbreaks with high attack rates can occur among unvaccinated populations. All children's institutions should report any child with mumps symptoms to the health organizations in a timely manner as an important action to control mumps. Since a single index case caused this outbreak, it is important to exclude people who have mumps symptoms from schools and workplaces. We also identified the need to conduct risk assessments on the probability of further spreading of mumps to other areas in the immediate future and for subsequent seasons.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

We would like to thank the patients, clinicians and other staff of the Gurvantes district hospital; health department of Omnogovi Province, Mongolia; Viral Laboratory and Surveillance Department of NCCD; Dr G Surenkhand, NCCD Deputy Director for Communicable Diseases, Mongolia; and staff from the WHO Regional Office for the Western Pacific who conducted the scientific writing workshop.

References:

1. Galazka AM, Robertson SE, Kraigher A. Mumps and mumps vaccine: a global review. *Bulletin of the World Health Organization*, 1999, 77:3–14. pmid:10063655
2. Heymann DL. Mumps. In: *Control of Communicable Diseases Manual, 19th edition*. Washington, DC, American Public Health Association, 2008, 431–434.
3. World Health Organization. Mumps virus vaccines - position paper. *Weekly Epidemiological Record*, 2007, 82:49–60 (http://www.who.int/immunization/wer8207mumps_Feb07_position_paper.pdf, accessed 15 August 2012).
4. Litman N, Baum SG. Mumps. In: Mandell GL, Bennett JE, Dolin R, eds. *Principles and practice of infectious diseases, 7th edition*. Philadelphia, Churchill Livingstone Elsevier, 2010, 2201–2206.
5. Sartorius B, et al. An outbreak of mumps in Sweden, February-April 2004. *Euro Surveillance: European Communicable Diseases Bulletin*, 2005, 10(9):pii=559. pmid:16280614
6. Dayan GH et al. Recent resurgence of mumps in the United States. *The New England Journal of Medicine*, 2008, 358:1580–1589. doi:10.1056/NEJMoa0706589 pmid:18403766
7. Whelan J, et al. Ongoing mumps outbreak in student population with high vaccination coverage, Netherlands, 2010. *Euro Surveillance: European Communicable Diseases Bulletin*, 2010, 15(17):pii=19554. pmid:20460086
8. Walker J, et al. Ongoing outbreak of mumps infection in Oban, Scotland, November 2010 to January 2011. *Euro Surveillance: European Communicable Diseases Bulletin*, 2011, 16(8):pii=19803. pmid:21371413
9. Kidokoro MH et al. Characterization of mumps viruses circulating in Mongolia: identification of a novel cluster of genotype. *Journal of Clinical Microbiology*, 2011, 49:1917–1925. doi:10.1128/JCM.02387-10 pmid:21411578
10. *National Immunization Coverage Report – 2010*. Ulaanbaatar, Immunization Department, National Center for Communicable Diseases, 2011.
11. *WHO-recommended standards for surveillance of selected vaccine-preventable diseases*. Geneva, World Health Organization, 2003 (http://www.who.int/vaccines-documents/DocsPDF06/843.pdf, accessed 14 August 2012).
12. Otto W et al. Ongoing outbreak of mumps affecting adolescents and young adults in Bavaria, Germany, August to October 2010. *Euro Surveillance*, 2010, 15(50):pii=19748. pmid:21172171
13. Kuzmanovska G et al. Mumps outbreak in the former Yugoslav Republic of Macedonia, January 2008–June 2009: Epidemiology and control measures. *Euro Surveillance: European Communicable Diseases Bulletin*, 2010, 15(23):pii=19586. pmid:20546692
14. Cui AL, Zhu Z, Wang CY. Genetic characteristics of mumps virus in China from 2006 to 2008 [in Chinese]. *Zhongguo Yi Miao He Mian Yi*, 2009, 15:8–13. pmid:20077668
15. Wang Y et al. Mumps virus genotype F Wild type mumps virus isolated in Liaoning Province, China, 2008: Genetic characterization of wild-type mumps virus isolated in Liaoning Province. *Journal of Bing Du Xue Bao*, 2011, 27:75–78.
16. Shi H et al. Molecular epidemiology of mumps virus strains circulating in south-west China from 2007 to 2009. *Journal of Medical Microbiology*, 2011, 60:1496–1501. doi:10.1099/jmm.0.021907-0 pmid:21680769
17. Fiebelkorn AP et al. Mumps. In: Roush SW, McIntyre L, Baldy LM, eds. *Vaccine Preventable Diseases Surveillance Manual, 4th edition*. Atlanta, Centers for Disease Control and Prevention, 2009.

Clostridium difficile infection outbreak in a male rehabilitation ward, Hong Kong (China), 2011

Tsz-sum Lam,[ab] Man-ting Yuk,[c] Ngai-chong Tsang,[c] Man-ha Wong[b] and Shuk-kwan Chuang[b]
Correspondence to Tsz-sum Lam (e-mail:mo_fetp1@dh.gov.hk).

Clostridium difficile is an anaerobic, gram-positive bacterium, capable of sporulation when environmental conditions no longer support its growth. The sporulation capacity enables the organism to persist in the environment for extended periods of time.[1] *Clostridium difficile* is the main pathogen accountable for antibiotic-associated colitis and for 15% to 25% of cases of nosocomial antibiotic-associated diarrhoea.[2] Major risk factors such as increased severity of underlying illness, increased age, prior antimicrobial use and gastric acid suppressors have been identified for *Clostridium difficile*.[3]

In 2009, a predominant clone of *Clostridium difficile* polymerase chain reaction (PCR) ribotype 002 with hyper-sporulation was identified in Hong Kong (China). This was temporally associated with a significant increase in both the incidence of toxigenic *Clostridium difficile* from 0.53 to 0.95 per 1000 admissions ($P < 0.001$) and the rate of positive detection from 4.2% to 6.3% ($P < 0.001$) between the periods of 2004 to 2008 and 2009.[4]

Hospital outbreaks of *Clostridium difficile* are uncommon in Hong Kong (China). The first outbreak was recorded by the Centre for Health Protection in May 2006 affecting 10 patients. In June 2011, a second outbreak of *Clostridium difficile* infection in a male rehabilitation ward of a public hospital was reported. We conducted a case-control study to identify potential risk factors for this outbreak. Both case and control patients were included from the same ward during the same period of hospitalization to allow for a genuine search for risk factors in an epidemic setting.[5] We defined cases as patients hospitalized for at least 48 hours with PCR-positive *Clostridium difficile* during the period of 3 June to 18 July 2011. Controls were patients with comparable length of hospitalization in the same ward with negative PCR.

We performed person, place and time analysis and collected stool samples from all patients in the affected ward for real-time PCR for *Clostridium difficile*. Stool samples were cultured for *Clostridium difficile* if the PCR was positive, and ribotyping was performed for successfully cultured strains. We collected information from all cases and controls of potential risk factors such as age; activities of daily living; rehabilitation service; and past medical, drug and hospitalization histories by medical record review using a standardized questionnaire.

We identified 15 case patients in June 2011 (median age: 78 years; range: 51–98) and 17 control patients (median age: 81 years; range: 54–93). Ten out of 15 PCR-positive case patients were also culture positive. Eight were *Clostridium difficile* ribotype 002 and two were ribotype non-002. The 15 case patients were distributed in all five areas of the ward. We could not identify any statistically significant risk factors in the case control analysis. The outbreak stopped 21 days with no additional cases after the implementation of environmental disinfection and increasing infection control measures such as using disposable wipes and hand washing with liquid soap.

Owing to the small sample size of 32, this study could not identify individual patient risk factors related to disease transmission in the outbreak. Increasing infection control measures was associated with interruption

[a] Field Epidemiology Training Programme, Hong Kong, People's Republic of China.
[b] Surveillance and Epidemiology Branch, Centre for Health Protection, Department of Health, Hong Kong, People's Republic of China.
[c] Hospital Authority, Hong Kong, People's Republic of China.
Submitted: 28 September 2012; Published: 3 December 2012
doi: 10.5365/wpsar.2012.3.4.001

in the disease transmission. The importance of strict compliance to infection control measures could not be overemphasized.

References:

1. Centers for Disease Control and Prevention (CDC). Guidelines for environmental infection control in healthcare facilities 2003. *MMWR. Morbidity and Mortality Weekly Report*, 2003, 52 RR10:1–42 (http://www.cdc.gov/HAI/organisms/cdiff/Cdiff_excerpt.html, accessed 8 Nov 2012).
2. Cohen SH et al.; Society for Healthcare Epidemiology of America; Infectious Diseases Society of America. Clinical practice guidelines for *Clostridium difficile* infection in adults: 2010 update by the society for healthcare epidemiology of America (SHEA) and the infectious diseases society of America (IDSA). *Infection Control and Hospital Epidemiology*, 2010, 31:431–455. doi:10.1086/651706 pmid:20307191
3. Dubberke ER et al. *Clostridium difficile*–associated disease in a setting of endemicity: identification of novel risk factors. *Clinical Infectious Diseases*, 2007, 45:1543–1549. doi:10.1086/523582 pmid:18190314
4. Cheng VC et al. *Clostridium difficile* isolates with increased sporulation: emergence of PCR ribotype 002 in Hong Kong. *European Journal of Clinical Microbiology & Infectious Diseases*, 2011, 30:1371–1381. doi:10.1007/s10096-011-1231-0 pmid:21468685
5. Goorhuis A, van Dissel JT, Kuijper EJ. Novel risk factors for *Clostridium difficile*-associated disease in a setting of endemicity? *Clinical Infectious Diseases*, 2008, 47:429–430, author reply 430–431. doi:10.1086/589928 pmid:18605911

Risk assessment of human infection with a novel bunyavirus in China

Wei-yi Xiong,[a] Zi-jian Feng,[a] Tamano Matsui[b] and Alice Ruth Foxwell[b]

Correspondence to: Wei-yi Xiong (e-mail: xiongwy@chinacdc.cn).

Objective: To assess the public health risk of human infection from a novel bunyavirus – severe fever with thrombocytopenia syndrome virus (SFTSV) – in China.

Methods: The likelihood of disease spread and the magnitude of public health impact were assessed to clarify overall risk. Literature about hazard, exposure and contextual factors associated with SFTSV infection was collected and reviewed. Information on SFTSV cases and the population in six provinces under surveillance was compared.

Results: SFTSV is a member of the Phlebovirus genus of the *Bunyaviridae* family. A widely distributed tick species, *Haemaphysalis longicornis*, can act as the vector; thus the disease is likely to spread in China. Symptoms of SFTSV infection are nonspecific, but have led to multiorgan dysfunction in severe cases. High-risk populations include farmers and older females. Evidence of human-to-human transmission within family and hospital has been reported. The capacity for treatment and diagnosis of SFTSV are adequate in rural communities in China, and community awareness of the disease should be high.

Discussion: There is a low to moderate public health risk related to SFTSV human infection in China. There is potential for an increase in the number of cases reported as awareness increases and when surveillance is expanded.

Severe fever with thrombocytopenia syndrome (SFTS) is a tick-borne haemorrhagic fever first reported in rural areas of central China between late spring and early summer in 2009.[1,2] At that time, an unusually high case fatality rate (CFR) of 30% was reported,[1] creating wide social concern. In June 2009, a novel Phlebovirus from the *Bunyaviridae* family, subsequently named SFTS virus (SFTSV), was isolated from a patient's blood sample.[1] A hospital-based active surveillance system aimed at the pathogenic and epidemiologic characteristics of SFTS was put in place in six provinces of central and north-eastern China. It found that among 241 hospitalized patients who met the case definition for SFTS, 171 were positive for SFTSV.[1] A tick species, *Haemaphysalis longicornis*, was found to carry the virus.[1,2]

Concerns about the potential spread of this novel disease and the possibility of a high number of deaths led to the undertaking of this risk assessment. The risk question addressed was "What is the public health risk related to human exposure to SFTSV in China?"

METHODS

The risk assessment process involved several components including gathering information through a literature review, a comparative analysis of demographic features between reported SFTSV cases and surveillance population and consensus through group discussion of data based on the likelihood of disease spread and the impact on public health. Estimates of likelihood and impact were then combined to decide on the overall level of risk with the assistance of a risk matrix to enhance the rigour of discussion. The estimates of likelihood of spread of disease, impact on public health, level of overall risk and risk matrix followed the World Health Organization guide for undertaking risk assessment for acute public health events.[3]

Expertise for group discussion included a core group of four people specializing in public health surveillance, epidemiology and infectious disease. Group discussions were held several times to reach consensus on the level of overall risk and the evidence that supported this level

[a] Chinese Center for Disease Control and Prevention, Beijing, China.
[b] World Health Organization Regional Office for the Western Pacific, Manila, Philippines.
Submitted: 30 September 2012; Published: 22 November 2012
doi: 10.5365/wpsar.2012.3.4.002

of risk. Presentation of outcomes following core team deliberation to a broader group with expertise in public health, laboratory, epidemiology, infectious disease, logistics and risk communication provided further refinement of the outcomes. Personal communication between the core team and experts from the Chinese Center for Disease Control and Prevention finalized the evidence.

Literature about hazard, exposure and contextual factors associated with SFTSV infection were searched using Google Scholar. Keywords used (both in English and in Chinese) included "severe fever with thrombocytopenia syndrome," "tick-borne disease," "SFTS," "SFTSV," "phlebovirus," "bunyavirus," "tick," "*Haemaphysalis longicornis,*" "health care-seeking" and "social panic." Full texts of the key articles that needed to be reviewed were collected from multiple sources such as PubMed, ProQuest, Wanfang and journals' web sites.

Based on the results of the literature review, only the capacity for diagnosis and treatment and public awareness were assessed for resilience under the section of contextual factors. The preparedness of local communities and their capacity to mitigate and/or adapt to disruptive consequences were not assessed because of the lack of available data and the difficulty of measuring the flexibility of community preparedness.

Demographic data of the population in the six provinces of central and north-eastern China where surveillance for SFTSV has been conducted were gathered from the China statistical yearbook 2010. The chi-squared test was used to compare the age and gender differences between SFTS cases and this population.

RESULTS

Hazard assessment

SFTSV is a member of the Phlebovirus genus of the *Bunyaviridae* family.[1,2] Prior to the discovery of SFTSV, the Phlebovirus genus consisted of 68 known serotypes divided into two major antigenic groups: the sandfly fever group (55 serotypes, including Rift Valley fever) transmitted by sandflies, and the Uukuniemi group (13 serotypes) transmitted by ticks.[4] Phylogenetic analyses shows that SFTSV variants isolated from humans and ticks are closely related to each other yet form a separate lineage distinct from Uukuniemi virus and other phleboviruses.[1] The *Bunyaviridae* family comprises single-stranded RNA viruses that cause a variety of human diseases including Rift Valley fever, SFTS, Crimean-Congo haemorrhagic fever and Hantavirus pulmonary syndrome. As single-stranded RNA, these viruses are highly prone to mutations that can enhance their capacity to adapt to new vectors and hosts.[5]

Complete information about the spectrum of infection in humans is not available. According to the prevention and treatment guideline published by the China Ministry of Health, the incubation period of SFTSV infection is one to two weeks.[6] Symptoms are nonspecific, including high fever (38°C or higher), anorexia, fatigue, gastrointestinal symptoms (abdominal pain or tenderness, nausea, vomiting and diarrhoea) and regional lymphadenopathy.[1,2,6] Laboratory test findings showed that 95% of patients had thrombocytopenia, 86% had leukocytopenia, 84% had proteinuria and 59% had hematuria.[1] Blood levels of serum alanine aminotransferase, aspartate aminotransferase, creatine kinase and lactate dehydrogenase were elevated in most patients, suggesting multiorgan dysfunction.[1] According to limited published data, the case fatality rate varied from 12% to 30%.[1,2] Other bunyavirus, such as Crimean-Congo haemorrhagic fever virus and hantavirus produce severe haemorrhagic fever and potentially fatal outcomes with mortality for hantavirus reaching 35%.[7]

Exposure assessment

Surveillance for SFTS among hospitalized patients was undertaken in six provinces in central and northeastern China: Liaoning, Shandong, Henan, Hubei, Anhui and Jiangsu.[1] Using the case definition defined by the China Ministry of Health,[6] the total number of cases between June 2009 and September 2010 was 241, and 96% (148/154) of the laboratory-confirmed cases in 2010 occurred from May to July.[1]

The age of SFTS cases ranged from 39 to 83 years. People aged over 50 years made up 75%[1] of the cases but constituted only 26% of the population under surviellance ($P < 0.001$). Fifty-six per cent of the cases were female[1] compared with 49% of the total population ($P = 0.029$). While 97% of the cases were farmers living in wooded and hilly areas and working in the fields,[1] precise information about occupation of the

total population in the surveillance provinces was not available.

No SFTSV was identified through real-time polymerase chain reaction (PCR) and no antibodies against SFTSV were identified from the patient-matched healthy control subjects in the endemic areas and healthy subjects from non-endemic areas.[1] Little population-based seroprevalance information was available; however, one study in Shandong Province in 2011 reported that 2% of 237 healthy humans and 83% of 134 goats tested had antibodies to SFTSV.[8]

Haemaphysalis longicornis is widely spread in China. The tick species has been found in 18 provinces (Hebei, Shandong, Henan, Anhui, Jiangsu, Taiwan, Hunan, Hubei, Shanxi, Shaanxi, Guizhou, Yunnan, Sichuan, Xizang, Gansu, Heilongjiang, Jilin and Liaoning), including all six surveillance provinces.[9]

In areas where SFTSV has been found, *Haemaphysalis longicornis* taken from domestic animals were found to carry SFTSV, suggesting it may be the vector for the virus.[1,2] Regular hosts of *Haemaphysalis longicornis* include goats, cattle, pigs, cats, rats, mice, birds and humans.[1] None of the animals from which ticks were collected showed signs of illness, and there were no reports of a similar disease occurring in animals in the same region.[2] Antibodies to SFTSV have been found in goats, cattle, dogs, pigs and chickens in Jiangsu Province.[10] There was no evidence of SFTSV being isolated from mosquitoes captured in the human-affected areas.[1]

A recent publication by Bao, et al[11] reported a family cluster of SFTSV where person-to-person transmission may have been plausible. Similarly Gai, et al.[12] reported a cluster of five cases suspected to have acquired the virus from blood or close nosocomial contact with a case that died from SFTSV. Personal protective equipment was not used by any of the people dealing with the index case in this nosocomial setting.

Context assessment (vulnerability and resilience)

Experts suggest that the capacity for treatment and diagnosis of SFTS is adequate in rural communities in China because of the continuous efforts by the China Ministry of Health in recent years to enhance the national public health system. Most of the provincial-level laboratories have the ability to confirm SFTSV infection, which includes isolation of SFTSV from the patient's serum, detection of SFTSV RNA in patient's serum during the acute phase of the illness, detection of seroconversion or an elevation by a factor of four in serum IgG antibodies against SFTSV on enzyme-linked inmmunofluorescence assay or neutralization testing in serum obtained during the convalescent.[6] It is unknown, however, whether tests for SFTSV are undertaken on a regular basis. There is no specific treatment other than supportive therapy;[6] thus most of the county-level hospitals have the ability to carry out the recommended therapy for SFTS patients.

Information about cost of diagnosis and treatment of SFTS was not available, although the majority of tests and drugs required for SFTS are on the reimbursement list of the New Rural Cooperative Medical Care System. This system covers more than 90% of the rural areas in China, including the areas in which SFTS cases have been found.[13]

Community awareness of the disease should be high. In September 2010, the China Ministry of Health held a special press conference about SFTS. Soon after, guidelines on SFTS control and prevention were issued by the Ministry of Health and distributed to the public. Health education information was published on the Internet, printed in newspapers and broadcast on radio and TV. Local Centers for Disease Control and Prevention distributed posters and leaflets to local residents. Therefore, people living in the affected area received information about SFTSV through multiple channels.

No formal studies have been published that provide a quantitative or qualitative estimation of interest in health matters, health care-seeking behaviour or the psychosocial impact caused by SFTS. However some understanding can be made through analysis from studies on other diseases.

In 2007, in a study linking hand, foot and mouth disease cases, media reports and a survey of hospital visitors showed that health care-seeking behaviour increased dramatically after initial cases were reported. The number of hospital visits for hand, foot and mouth disease was five times higher than that of the preceding year, and 85% of visitors reported that they felt "panic."[14]

Table 1. **Public health risk related to SFTSV human infection in China**

	Hazard	Exposure to agent	Vulnerability and resilience
Potential for spread	– A newly recognized member of Phlebovirus genus in *Bunyaviridae* family. – Bunyaviruses include many public health important viruses like Crimean-Congo haemorrhagic fever virus and hantavirus. – This family of viruses has demonstrated an ability to emerge and spread in human populations. The RNA virus has potential for mutation and ability to adapt to new hosts.	– Wide geographic distribution of vector. – Wide variety of domestic animals may act as a reservoir. – Virus only isolated from one specific tick species. – Human-to-human transmission possible following blood contact.	– Most of the local hospitals can make clinical diagnosis, but it is unknown if SFTSV is included in differential diagnoses.
Impact on public health	– May lead to multiorgan dysfunction in severe cases. – High CFR in hospitalized cases. – Has implications for the extended use of public health resources and high level infrastructure and health care training for patient care.	– Farmers, females and the elderly seem to be the high-risk population, a population who may present to health care at a later stage of the disease and, due to their age, may have co-morbidities.	– Most of the provincial CDCs can conduct laboratory confirmation. – Testing may not be done in all cases. – Residents living in rural areas usually have negative health care-seeking behaviour, which may translate to more severe presentation. – Mass media reports may lead to panic of the public and overloading of health care system during peak season. – Most of the necessary medicine and tests are covered in medical insurance systems.

CFR – case fatality rate; CDC – Chinese Center for Disease Control and Prevention.

Residents living in rural areas usually have negative health care-seeking behaviour. In a study conducted in Jiangsu Province, 64.8% of rural area residents reported they would not go to hospital until they become seriously ill, and self-treatment or visiting a private clinic was the first choice for 51.9% of the rural area patients.[15] If these delays in seeking qualified professional help also occur for SFTS cases, then there are likely to be more severe cases at presentation.

Risk characterization

The risk of SFTSV was characterized using the information collected, with key factors considered to assess the likelihood of spread of disease and its impact on public health (**Table 1**).

Discussion concluded that it is likely that the disease would spread due to the wide geographic distribution of the vector, ready contact with humans in rural settings and the capacity of this family of viruses to emerge and spread in human populations. Limited cases of nosocomial infection may also occur. Based on this, the overall public health impact was assessed as minor. Good diagnostics and treatment are available; however, the most-at-risk population, elderly females in rural farming communities, may present to health care late. This may increase the disease severity at presentation and thus the need for prolonged and sophisticated treatment in health care facilities. Overall the combination of the level of likelihood of spread of disease and the impact on public health results in a low to moderate public health risk of SFTSV human infection in China.

DISCUSSION

A low level of risk for a disease would indicate that it can be managed under existing protocols for surveillance systems, response and regulation.[3] As the level of risk increases, the focus and intensity of the guidance for SFTS prevention and treatment must also change so that the risk posed by the disease can be reduced to an acceptable level. This will allow the local health facilities to better handle the consequences of the changed level of risk. With a low to moderate level of risk for SFTS, there is an indication that current protocols are working well; however, some enhancement to current practice

may be appropriate for public health management of the disease. Recommendations made by this paper are summarized below.

This assessment had some limitations. Only published documents were used in this assessment as we were unable to access the primary data. SFTSV is novel and as such there have been few studies conducted. Therefore there were some key gaps in information including transmission mode, seroprevalence, full spectrum of infection, health care-seeking behaviour and suspicion of disease by clinicians. Hospital-based surveillance may bias the number of cases and spectrum of disease identified to date, community-based surveillance may have found more mild and asymptomatic cases and could provide a thorough knowledge of the status of this disease. Comprehensive national surveillance data and further research will be useful in understanding the risk to public health from this disease. There is potential for an increase in the number of cases reported as awareness increases and also from increased case reporting from other provinces when active surveillance is expanded. This will lead to a greater need for diagnosis and health care service during the peak season.

RECOMMENDATIONS

Based on this risk assessment, the main recommendations for decision-makers at the national level on SFTSV infection prevention and control in China are:

(1) expand the surveillance system to all the provinces where *Haemaphysalis longicornis* has been found;

(2) enhance the subsequent data analysis to provide a more comprehensive picture of SFTS distribution in China;

(3) implement further investigation on the epidemiology, seroprevalance, vector ecology and pathogenesis of the disease;

(4) examine local health care-seeking behaviour and its influence among SFTSV cases in selected areas to compensate for gaps in the understanding of SFTS;

(5) enhance training programmes based on the best available evidence for detection, differential diagnosis and personal protection from potential nosocomial infection for health workers;

(6) further enhance the multichannel public risk communication and health education on prevention of SFTS for the residents living in affected areas especially in the peak season; and

(7) update the risk assessment on a regular basis to support the adjustment of surveillance systems, control policies and intervention programmes.

Conflict of interest

None declared.

Funding

None.

Acknowledgements

The authors thank all the experts from Chinese Center for Disease Control and World Health Organization Regional Office for the Western Pacific who gave their generous and valuable opinions and supports.

References:

1. Yu XJ et al. Fever with thrombocytopenia associated with a novel bunyavirus in China. *The New England Journal of Medicine*, 2011, 364:1523–1532. doi:10.1056/NEJMoa1010095 pmid:21410387
2. Zhang YZ et al. Hemorrhagic fever caused by a novel tick-borne Bunyavirus in Huaiyangshan, China. *Zhonghua Liu Xing Bing Xue Za Zhi*, 2011, 32:209–220. pmid:21457654
3. *Rapid Risk Assessment of Acute Public Health Events*. Geneva, World Health Organization, 2012 (http://whqlibdoc.who.int/hq/2012/WHO_HSE_GAR_ARO_2012.1_eng.pdf, accessed 28 August 2012).
4. Elliot RM. Bunyaviruses and climate change. *Clinical microbial infection*, 2009,15(6): 510–517.
5. Qin XCH et al. Viruses of the family Bunyaviridae and their associated-diseases [in Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi*, 2010, 31:1111–1114. pmid:21162811
6. *Guideline for severe fever with thrombocytopenia prevention and treatment*. Beijing, China Ministry of Health, 2010.
7. MacNeil A, Ksiazek TG, Rollin PE. Hantavirus pulmonary syndrome, United States, 1993–2009. *Emerging Infectious Diseases*, 2011, 17:1195–1201. doi:10.3201/eid1707.101306 pmid:21762572

8. Zhao L et al. Severe fever with thrombocytopenia syndrome virus, Shandong Province, China. *Emerging Infectious Diseases*, 2012, 18:963–965. doi:10.3201/eid1806.111345 pmid:22608264

9. Chen Z et al. Geographic distribution and fauna of Chinese ticks [in Chinese]. *Sichuan Journal of Zoology*, 2008, 27:820–823.

10. Zhang WSH et al. Seroepidemiology of severe fever with thrombocytopenia syndrome bunyavirus in Jiangsu Province [in Chinese]. *Disease Surveillance*, 2011, 26:676–678.

11. Bao CJ et al. A family cluster of infections by a newly recognized bunyavirus in eastern China, 2007: further evidence of person-to-person transmission. *Clinical Infectious Diseases*, 2011, 53:1208–1214. doi:10.1093/cid/cir732 pmid:22028437

12. Gai ZHT et al. Person-to-person transmission of severe fever with thrombocytopenia syndrome bunyavirus through blood contact. *Clinical Infectious Diseases*, 2012, 54:249–252. doi:10.1093/cid/cir776 pmid:22095565

13. *China Network website* [in Chinese] (http://www.china.com.cn/policy/txt/2009-01/09/content_17079803.htm, accessed 1 May 2011).

14. Liu HB, Wang HM. Influence of mass media on the change of hospitalization behaviours of patients with hand, foot and mouth disease [in Chinese]. *Chinese Journal of Health Education*, 2010, 26:35–38.

15. Yao ZY, Zhang N. Analyzing medical care conducts of rural residents and their influence factor: A survey on town X in north Jiangsu Province [in Chinese] [Social Science Edition]. *Journal of Nanjing Agricultural University*, 2007, 7:12–17.

Tracking oseltamivir-resistance in New Zealand influenza viruses during a medicine reclassification in 2007, a resistant-virus importation in 2008 and the 2009 pandemic

Richard J Hall,[a] Matthew Peacey,[a] Jacqui C. Ralston,[a] Danielle J de Joux,[a] Judy Bocacao,[a] Mackenzie Nicol,[a] Molly Ziki,[a] Wendy Gunn,[a] Jing Wang[a] and Q Sue Huang[a]

Correspondence to Richard J Hall (e-mail: richard.hall@esr.cri.nz).

Introduction: Oseltamivir (Tamiflu®) is an important pharmaceutical intervention against the influenza virus. The importance of surveillance for resistance to oseltamivir has been highlighted by two global events: the emergence of an oseltamivir-resistant seasonal influenza A(H1N1) virus in 2008, and emergence of the influenza A(H1N1)pdm09 virus in 2009. Oseltamivir is a prescription medicine in New Zealand, but more timely access has been provided since 2007 by allowing pharmacies to directly dispense oseltamivir to patients with influenza-like illness.

Objective: To determine the frequency of oseltamivir-resistance in the context of a medicine reclassification in 2007, the importation of an oseltamivir-resistant seasonal influenza virus in 2008, and the emergence of a pandemic in 2009.

Methods: A total of 1795 influenza viruses were tested for oseltamivir-resistance using a fluorometric neuraminidase inhibition assay. Viruses were collected as part of a sentinel influenza surveillance programme between the years 2006 and 2010.

Results: All influenza B, influenza A(H3N2) and influenza A(H1N1)pdm09 viruses tested between 2006 and 2010 were shown to be sensitive to oseltamivir. Seasonal influenza A(H1N1) viruses from 2008 and 2009 were resistant to oseltamivir. Sequencing of the neuraminidase gene showed that the resistant viruses contained an H275Y mutation, and S247N was also identified in the neuraminidase gene of one seasonal influenza A(H1N1) virus that exhibited enhanced resistance.

Discussion: No evidence was found to suggest that increased access to oseltamivir has promoted resistance. A probable importation event was documented for the global 2008 oseltamivir-resistant seasonal A(H1N1) virus nine months after it was first reported in Europe in January 2008.

Over the last decade there has been an extensive amount of research into the development and occurrence of antiviral drug resistance in human influenza viruses.[1] An effective class of anti-influenza drugs known as neuraminidase inhibitors have been developed which include the drug oseltamivir phosphate (Tamiflu®). Neuraminidase inhibitors block the release of progeny virions from a host cell by selectively binding to the active site of the neuraminidase enzyme. This inhibits cleavage of the sialyl-acid bond to the host receptor, thus the virus is unable to be released from infected host cells and spread to new cells.[2] Clinical trials of oseltamivir have shown reduced symptom severity and a reduction in the duration of the illness.[3–5] Oseltamivir is reported to be widely used, with 65 million treatment courses prescribed worldwide.[6] Oseltamivir-resistance in influenza should be closely monitored to determine if the continued efficacy of oseltamivir warrants its use for influenza.[7] Such work not only determines the present efficacy of the drug but also reveals important information on the genesis of anti-viral drug resistance in influenza viruses.

In New Zealand, oseltamivir is a prescription medicine that is most effective if administered within the first 48 hours of infection. In 2007, to increase availability of oseltamivir and reduce delays in obtaining a prescription of oseltamivir from a medical doctor,

[a] WHO National Influenza Centre, Institute of Environmental Science & Research, National Centre for Biosecurity & Infectious Disease, New Zealand.
Submitted: 9 August 2012; Published: 10 December 2012
doi: 10.5365/wpsar.2012.3.3.002

pharmacists were allowed to directly provide oseltamivir during the winter influenza season (April to November inclusive). The pharmacist had to be satisfied that the oseltamivir was for a resident of New Zealand, aged 12 years or more and presenting with the symptoms of influenza.[8] This allowance was made with an expectation that influenza viruses from the community would be monitored for the potential development of oseltamivir-resistance.[9]

Preceding the 2007/2008 northern hemisphere season, instances of oseltamivir-resistance occurred at low levels in seasonal human influenza viruses.[10] Increased occurrence of resistance in influenza A(H1N1)pdm09 viruses has been detected in community samples in the United Kingdom,[11] and sustained community transmission has been reported in Australia.[12] Resistance has been shown to be caused by a number of mutations, particularly the His275Tyr (N1 numbering; herein referred to as H275Y) of the neuraminidase (NA) gene in influenza A(H1N1) viruses.[13] In the winter of 2007/2008, a relatively high incidence of resistant seasonal A(H1N1) influenza viruses was detected in Europe (average ~20%).[14,15] These resistant viruses, which were shown to carry an H275Y mutation, were subsequently reported in many other regions of the world.[16–18]

In this study we monitored the frequency of oseltamivir-resistance in influenza viruses circulating in New Zealand between 2006 and 2010. This surveillance was performed during a series of events that had the potential to alter the resistance profiles of circulating influenza viruses, including a change in the availability of oseltamivir at pharmacies in 2007, the importation of oseltamivir-resistant seasonal influenza viruses in 2008, and the emergence of influenza A(H1N1)pdm09. We discuss these findings in relation to the genesis of antiviral drug resistance in New Zealand, the importance of surveillance and in relation to findings overseas.

METHODS

Clinical material

Clinical samples were collected in New Zealand as part of the national influenza sentinel surveillance programme, which has been previously described.[19,20] Briefly, samples were collected weekly from general medical practice patients presenting with influenza-like illness, defined as an acute respiratory tract infection characterized by the abrupt onset of at least two of the following: fever, chills, headache and myalgia. Nasopharyngeal swabs or throat swabs were taken from patients and transported to the laboratory in viral transport media. Samples from 2006 to 2008 were obtained during the winter influenza season from May to September. Samples from 2009 and 2010 were obtained over the entire year as influenza surveillance was extended due to the pandemic.[21] Additional clinical samples were obtained from hospital diagnostic laboratories in New Zealand throughout the course of each year as part of a reference testing service. These hospitals were located in Auckland, Waikato, Christchurch and Dunedin.

Diagnosis of influenza virus was made either by real-time reverse transcriptase polymerase chain reaction (RT–PCR) (method developed by Centers of Disease Control and Prevention, Atlanta, Georgia; World Health Organization [WHO] recommended), or viral culture followed by a haemagglutination/haemagglutination-inhibition assay using WHO reference antisera.

Viral culture

Influenza viruses from 2006 to 2008 were grown in cultured Madin-Darby Canine Kidney (MDCK) cells in serum-free M199 media in the presence of TPCK-trypsin. Influenza viruses from 2009 were also grown in the cultured MDCK-SIAT1 cell line in DMEM:F12 media in the presence of TPCK-trypsin.[22]

Fluorometric neuraminidase-inhibition assay

Sensitivity of influenza viruses to oseltamivir was determined by fluorometric neuraminidase-inhibition assay, as described previously.[23,24] Briefly, neuraminidase was solubilised from influenza virus culture in a buffer containing 1% NP-40 at a ratio of 1:10 for seasonal influenza viruses or 1:20 for influenza A(H1N1) pdm09 viruses. The activity of neuraminidase was measured over a range of concentrations of oseltamivir carboxylate (obtained from Roche, Switzerland) with the fluorogenic substrate MUNANA at 37°C for one hour and then fluorescence was measured (emission 360 nm; excitation 448 nm). The 50% inhibitory concentration (IC_{50}) was determined using a log-

dose–response curve-fit in GraphPad PRISM (v5.04). The IC_{50} value represented the concentration at which oseltamivir inhibits neuraminidase activity by 50%. For any outliers that were initially identified as having IC_{50} values greater than two standard deviations above the mean, a titration of the virus was performed to ensure viral dilution was at the mid-point of the linear range of neuraminidase activity. Adjusted IC_{50} values for these initial outliers were recalculated as required and included in the final analysis. A greater than 10-fold increase from the mean IC_{50} value within a subtype was taken to be indicative of oseltamivir-resistance.[25]

Sequencing of the neuraminidase gene

The viral RNA was extracted directly from the clinical specimen using the Zymo viral RNA extraction kit (Zymo Research, Irvine California, United States of America; cat# R1034). The entire NA gene was amplified using universal NA influenza primers[26] and the same primers were used for direct sequencing by the Sanger method (Big Dye Terminator v.3.1 cycle sequencing kit, Applied Biosystems, Nieuwerkerk, NL) on a capillary sequencer (Model 3100 Avant, Applied Biosystems, Foster City, California, United States of America).

Sales data for oseltamivir

Sales data for oseltamivir in 2004 and 2007 was provided courtesy of Roche Pharmaceuticals. Data include both prescription and pharmacy-exemption sales.

Ethical statement

Samples were obtained as part of public health surveillance. Clinical conduct was consistent with the *New Zealand Code of Health and Disability Services Consumers' Rights*.

RESULTS

A total of 1795 influenza samples collected in New Zealand between 2006 and 2010 were tested for sensitivity to oseltamivir by fluorometric neuraminidase inhibition assay (**Figure 1, Table 1**).

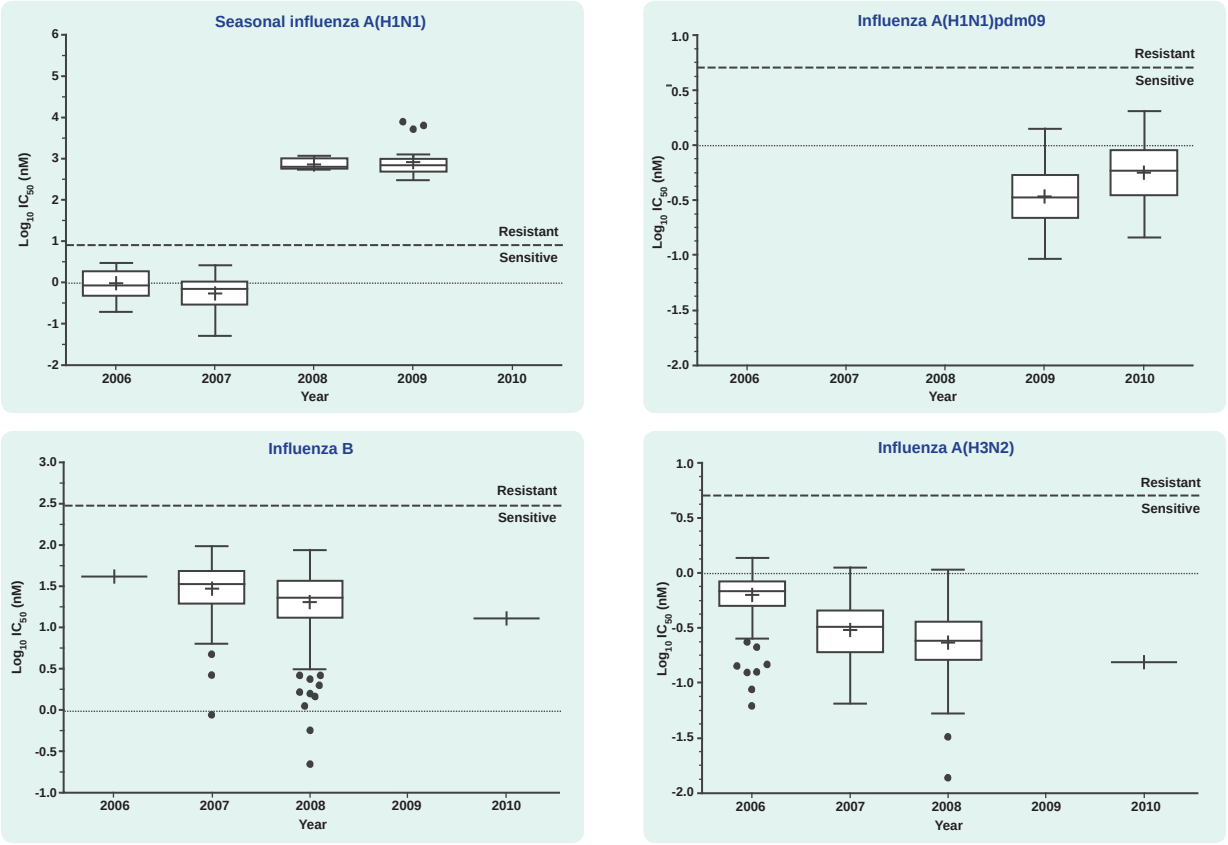
All 521 influenza A viruses and all 133 influenza B viruses from 2006 and 2007 were shown to be sensitive to oseltamivir. In 2008, 306 influenza B and 120 influenza A(H3N2) viruses were found to be sensitive to oseltamivir. However, all four seasonal influenza A(H1N1) viruses isolated in this year were

Table 1. **Comparison of IC_{50} values* for influenza viruses from New Zealand isolated from 2006 to 2010**

Influenza type/subtype		Year				
		2006	2007	2008	2009	2010
B	Number of isolates tested	1	132	306	-	1
	Mean IC_{50} (nM)	-	37.5	26.5	-	-
	Standard deviation (nM)	-	22.5	16.9	-	-
	Minimum IC_{50} (nM)	-	0.9	0.2	-	-
	Maximum IC_{50} (nM)	-	97.4	87.8	-	-
	Oseltamivir-resistance detected	-	No	No	-	No
A(H3N2)	Number of isolates tested	189	45	120	-	1
	Mean IC_{50} (nM)	0.7	0.4	0.3	-	-
	Standard deviation (nM)	0.3	0.3	0.2	-	-
	Minimum IC_{50} (nM)	0.1	0.1	0.1	-	-
	Maximum IC_{50} (nM)	1.4	1.1	1.1	-	-
	Oseltamivir-resistance detected	No	No	No	-	No
A(H1N1)	Number of isolates tested	18	136	4	25	-
	Mean IC_{50} (nM)	1.3	0.8	768	1385	-
	Standard deviation (nM)	0.9	0.6	287	1996	-
	Minimum IC_{50} (nM)	0.2	0.1	573	305	-
	Maximum IC_{50} (nM)	3.0	2.7	1184	7912	-
	Oseltamivir-resistance detected	No	No	Yes	Yes	-
A(H1N1)pdm09	Number of isolates tested	-	-	-	483	334
	Mean IC_{50} (nM)	-	-	-	0.4	0.7
	Standard deviation (nM)	-	-	-	0.2	0.4
	Minimum IC_{50} (nM)	-	-	-	0.1	0.1
	Maximum IC_{50} (nM)	-	-	-	1.4	2.1
	Oseltamivir-resistance detected	-	-	-	No	No

* IC_{50} – inhibitory concentration of the drug at which a 50% reduction in enzymatic activity is observed.

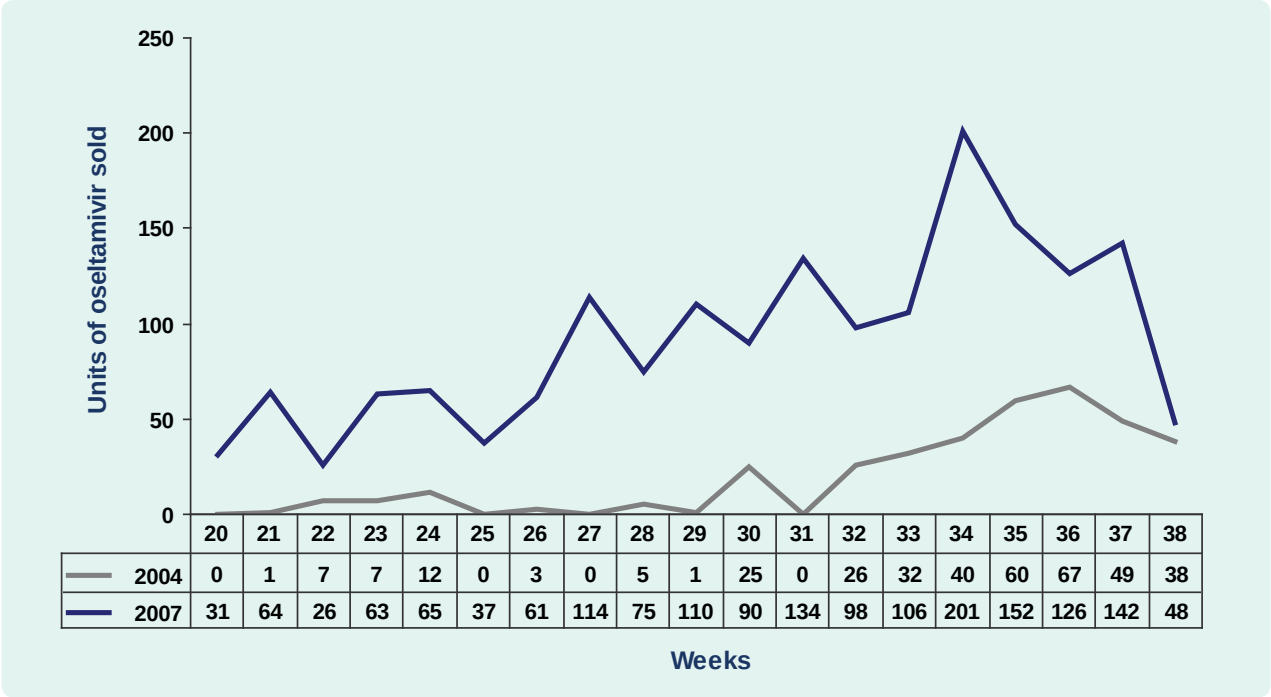
Figure 1. **Box plots of Log10 IC_{50} values* for each influenza virus type, New Zealand, 2006 to 2010†**



* IC_{50} – inhibitory concentration of the drug at which a 50% reduction in enzymatic activity is observed.

† Boxes indicate the first, second and third quartiles and the whiskers are calculated as 1.5 times the interquartile distance. Outliers beyond this distance are plotted individually as (•), and the mean for each data set is indicated by the symbol (+). The thick dashed line represents the threshold at which viruses are determined to be resistant to oseltamivir. This threshold is 10-fold higher than the mean IC_{50} value for all years, calculated for each subtype. The calculation of the mean IC_{50} value threshold does not include 2008 and 2009 seasonal influenza A(H1N1) viruses, as all viruses in these years were resistant to oseltamivir. The thin dashed line shows the log10 IC_{50} zero axis.

Figure 2. **Sales data for oseltamivir, New Zealand, 2004 and 2007**



	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
2004	0	1	7	7	12	0	3	0	5	1	25	0	26	32	40	60	67	49	38
2007	31	64	26	63	65	37	61	114	75	110	90	134	98	106	201	152	126	142	48

resistant to oseltamivir with IC_{50} values between 573 nM and 1184 nM (**Figure 1, Table 1**). Full-length sequencing of the NA gene for two of these viruses (sequence coverage of nucleotides 21–1413 and 22–940) revealed the presence of the H275Y mutation, with the sequenced region having almost complete identity (99% and 100% respectively) to the 2008 resistant-type viruses that had been reported from Europe earlier in the year [GenBank Accession: EU566977; A/Pennsylvania/02/2008(H1N1)]. Only a single nucleotide difference was observed (substitution E268D; G/T nucleotide 804; N1 subtype numbering).

As we have previously reported,[27] all 2009 seasonal A(H1N1) viruses tested for sensitivity to oseltamivir were resistant (n = 25; **Figure 1**; **Table 1**), with IC_{50} values between 305 nM and 7912 nM.[27] All were also shown to contain the H275Y mutation by RFLP analysis or by sequencing. Further sequencing of the NA gene of the 7912 nM virus (A/Wellington/31/2009), one of the three seasonal influenza A(H1N1) viruses with extremely high IC_{50} values of 5334 nM, 6370 nM and 7912 nM in this study (**Figure 1**), identified an additional significant mutation S247N (N1 numbering), as well as H275Y (GenBank accession KC117387).

All influenza A(H1N1)pdm09 viruses tested in this study from 2009 and 2010 were shown to be sensitive to oseltamivir (**Figure 1, Table 1**) and sequencing of the NA gene for 11 of these viruses found that none carried the H275Y mutation.

Oseltamivir sales data in New Zealand for 2004 and 2007 showed a 4.5-fold increase in usage with 373 doses sold in 2004 compared to 1678 doses sold in 2007 (**Figure 2**). The greatest difference between 2004 and 2007 was in week 34 with 161 more units of oseltamivir sold in 2007 compared to 2004. As the population of New Zealand is 4.5 million, this increase in usage represents only an extremely small proportion of the total population.

DISCUSSION

This study shows that antiviral drug resistance to oseltamivir between 2006 and 2010 occurred at a very low level for most human influenza viruses in New Zealand. The exceptions to this observation were the seasonal A(H1N1) viruses from January 2008 onward, which showed high levels of resistance. This virus appears to have arrived in New Zealand (a southern hemisphere country) during the winter influenza season, nine months after its emergence was first reported in Europe.[14,15] Other southern hemisphere countries such as Australia, South Africa and South America also reported the emergence of oseltamivir-resistant seasonal influenza viruses late in 2008.[17,28] The resistant-type seasonal A(H1N1) became the predominant influenza virus in the first half of the New Zealand 2009 influenza season, showing that this virus is capable of both sustained transmission in the community and maintaining resistance to oseltamivir.[29] Interestingly, we also note the occurrence of three of these seasonal A(H1N1) viruses with extremely high resistance to oseltamivir, brought about by the dual mutations S247N+H275Y. The S247N mutation reportedly reduces sensitivity to oseltamivir in seasonal A(H1N1) viruses[30] and influenza A(H5N1) viruses[31] and is known to cause extreme resistance to oseltamivir in influenza A(H1N1)pdm09 viruses in combination with H275Y.[32] Our results indicate that the presence of the dual S247N+H275Y mutation is likely to have a similar effect in seasonal A(H1N1) viruses.

Before 2008, we observed no oseltamivir-resistance for any influenza type/subtype in New Zealand. This is despite the regulatory change for oseltamivir in New Zealand in 2007, where it could be prescribed by pharmacists to patients presenting with influenza-like illness during the winter influenza season.[8] A similar system was established in the United Kingdom where accredited pharmacists were able to supply oseltamivir to at-risk individuals during influenza outbreaks.[33] Increased public access to the drug raises the potential for drug resistance due to selective pressure on the virus in individual patients undergoing treatment.[34] However, since no substantial increase in usage in New Zealand was observed between 2004 and 2007, we cannot speculate what impact the medicine reclassification had on oseltamivir resistance. A comparative study in Japan, where oseltamivir is more widely used, reported no significant effect on the occurrence of resistance.[35]

Oseltamivir is important for controlling the transmission and dissemination of pandemic viruses before a vaccine becomes widely available. No vaccine was available in New Zealand until one year after the first cases of influenza A(H1N1)pdm09 arose. This study shows that 100% of 817 influenza A(H1N1)

pdm09 viruses from 2009 and 2010 were sensitive to oseltamivir. During the early phases of the pandemic, New Zealand health authorities deployed a percentage of the pandemic stockpile of oseltamivir (<50 000 doses; Ministry of Health, New Zealand Government), which likely assisted in the initial containment of the pandemic. It took approximately six to seven weeks from the first reported New Zealand cases on 26 April 2010 to the declaration of management phase in June 2010 when the virus had established community transmission. Previous epidemiological modelling studies have suggested that increased usage of oseltamivir during a pandemic may trigger the development of resistant viruses with no reduction in fitness to the virus.[36,37] The levels of oseltamivir used in New Zealand are unlikely to have approached thresholds developed in these modelling studies, but our data show that oseltamivir-resistance in influenza A(H1N1)pdm09 viruses remained low despite the issuance of pandemic stockpiles of oseltamivir.

Continued surveillance for anti-viral drug resistance in influenza viruses is still required to ensure that stockpiled neuraminidase-inhibitors are effective and that clinicians can be kept informed of the efficacy of neuraminidase inhibitors when treating patients for influenza.

Conflicts of interest

None declared.

Funding

This work was funded in part by the New Zealand Ministry of Health and New Zealand Ministry of Science and Innovation.

Acknowledgements

New Zealand national influenza surveillance is funded by the Ministry of Health who kindly permitted the use of relevant data for publication. We also thank Darren Hunt for his review of the manuscript. Our special thanks to the GPs and nurses, the public health unit coordinators and the participating virology laboratories in Auckland, Christchurch, Waikato and National Influenza Centre at ESR. We also wish to acknowledge the kind support, advice and guidance from Aeron Hurt and Ian Barr at the WHO Collaborating Centre for Reference and Research on Influenza, Melbourne, Australia. We acknowledge Roche Pharamceuticals for providing sales data on oseltamivir which is presented in this study. We also thank the CDC for sharing the influenza virus RT-PCR protocol through a material transfer agreement. The MDCK-SIAT1 cells were a gift from M Matrosovich, Philipps University, Marburg.

References:

1. Hurt AC, Ho HT, Barr I. Resistance to anti-influenza drugs: adamantanes and neuraminidase inhibitors. *Expert Review of Anti-Infective Therapy*, 2006, 4:795–805. doi:10.1586/14787210.4.5.795 pmid:17140356
2. Matrosovich MN et al. Neuraminidase is important for the initiation of influenza virus infection in human airway epithelium. *Journal of Virology*, 2004, 78:12665–12667. doi:10.1128/JVI.78.22.12665-12667.2004 pmid:15507653
3. Aoki FY et al.; IMPACT Study Group. Early administration of oral oseltamivir increases the benefits of influenza treatment. *Journal of Antimicrobial Chemotherapy*, 2003, 51:123–129. doi:10.1093/jac/dkg007 pmid:12493796
4. Nicholson KG et al.; Neuraminidase Inhibitor Flu Treatment Investigator Group. Efficacy and safety of oseltamivir in treatment of acute influenza: a randomised controlled trial. *The Lancet*, 2000, 355: 1845–1850. doi:10.1016/S0140-6736(00)02288-1 pmid:10866439
5. Treanor JJ et al.; US Oral Neuraminidase Study Group. Efficacy and safety of the oral neuraminidase inhibitor oseltamivir in treating acute influenza: a randomized controlled trial. *JAMA: The Journal of the American Medical Association*, 2000, 283:1016–1024. doi:10.1001/jama.283.8.1016 pmid:10697061
6. Dutkowski R. Oseltamivir in seasonal influenza: cumulative experience in low- and high-risk patients. *Journal of Antimicrobial Chemotherapy*, 2010, 65 Suppl 2:ii11–24. doi:10.1093/jac/dkq012 pmid:20215131
7. Hurt AC et al.; WHO Consultation on Pandemic Influenza A(H1N1) 2009 Virus Resistance to Antivirals. Antiviral resistance during the 2009 influenza A H1N1 pandemic: public health, laboratory, and clinical perspectives. *The Lancet Infectious Diseases*, 2012, 12:240–248. doi:10.1016/S1473-3099(11)70318-8 pmid:22186145
8. *Minutes of the 34th meeting of the Medicines Classification Committee*. Auckland, New Zealand Medicines Classification Committee, 2006 (http://www.medsafe.govt.nz/profs/class/mccMin9June06.htm, accessed 28 November 2012).
9. *Oseltamivir Report 2006*. Wellington, New Zealand Medicines and Medical Safety Devices Authority, 2007.
10. Monto AS et al. Detection of influenza viruses resistant to neuraminidase inhibitors in global surveillance during the first 3 years of their use. *Antimicrobial Agents and Chemotherapy*, 2006, 50:2395–2402. doi:10.1128/AAC.01339-05 pmid:16801417
11. Lackenby A et al. Continued emergence and changing epidemiology of oseltamivir-resistant influenza A(H1N1)2009 virus, United Kingdom, winter 2010/11. *Euro Surveillance: European Communicable Disease Bulletin*, 2011, 16(6):19789. pmid:21315056
12. Hurt AC et al. Community transmission of oseltamivir-resistant A(H1N1)pdm09 influenza. *The New England Journal of*

Medicine, 2011, 365:2541–2542. doi:10.1056/NEJMc1111078 pmid:22204735

13. Yen HL et al. Importance of neuraminidase active-site residues to the neuraminidase inhibitor resistance of influenza viruses. *Journal of Virology*, 2006, 80:8787–8795. doi:10.1128/JVI.00477-06 pmid:16912325
14. Lackenby A et al. Emergence of resistance to oseltamivir among influenza A(H1N1) viruses in Europe. *Euro Surveillance: European Communicable Disease Bulletin*, 2008, 13:8026. pmid:18445375
15. Meijer A et al.; European Influenza Surveillance Scheme. Oseltamivir-resistant influenza virus A(H1N1), Europe, 2007–08 season. *Emerging Infectious Diseases*, 2009, 15:552–560. doi:10.3201/eid1504.081280 pmid:19331731
16. Dharan NJ et al.; Oseltamivir-Resistance Working Group. Infections with oseltamivir-resistant influenza A(H1N1) virus in the United States. *JAMA: The Journal of the American Medical Association*, 2009, 301:1034–1041. doi:10.1001/jama.2009.294 pmid:19255110
17. Hurt AC et al. Emergence and spread of oseltamivir-resistant A(H1N1) influenza viruses in Oceania, South East Asia and South Africa. *Antiviral Research*, 2009, 83:90–93. doi:10.1016/j.antiviral.2009.03.003 pmid:19501261
18. Influenza A virus resistance to oseltamivir - 13 June 2008. Geneva, World Health Organization, 2008 (http://www.who.int/influenza/patient_care/antivirals/oseltamivir_summary/en/index.html, accessed 28 November 2012).
19. Huang QS et al. Influenza surveillance and immunisation in New Zealand, 1997–2006. *Influenza and Other Respiratory Viruses*, 2008, 2:139–145. doi:10.1111/j.1750-2659.2008.00050.x pmid:19453466
20. Huang QS, Lopez L, Adlam B. Influenza surveillance in New Zealand in 2005. *New Zealand Medical Journal*, 2007, 120:U2581. pmid:17589549
21. Huang Q et al. Surveillance for the 2009 pandemic influenza A(H1N1) virus and seasonal influenza viruses - New Zealand, 2009. *MMWR, Morbidity and Mortality Weekly Report*, 2009, 58:918–921.
22. Matrosovich M et al. Overexpression of the alpha-2, 6-sialyltransferase in MDCK cells increases influenza virus sensitivity to neuraminidase inhibitors. *Journal of Virology*, 2003, 77:8418–8425. doi:10.1128/JVI.77.15.8418-8425.2003 pmid:12857911
23. Ives JA et al. The H274Y mutation in the influenza A/H1N1 neuraminidase active site following oseltamivir phosphate treatment leave virus severely compromised both in vitro and in vivo. *Antiviral Research*, 2002, 55:307–317. doi:10.1016/S0166-3542(02)00053-0 pmid:12103431
24. Wetherall NT et al. Evaluation of neuraminidase enzyme assays using different substrates to measure susceptibility of influenza virus clinical isolates to neuraminidase inhibitors: report of the neuraminidase inhibitor susceptibility network. *Journal of Clinical Microbiology*, 2003, 41:742–750. doi:10.1128/JCM.41.2.742-750.2003 pmid:12574276
25. Zambon M, Hayden FG, Global Neuraminidase Inhibitor Susceptibility N. Position statement: global neuraminidase inhibitor susceptibility network. *Antiviral Research*, 2001, 49:147–156. doi:10.1016/S0166-3542(01)00124-3 pmid:11428241
26. Hoffmann E et al. Universal primer set for the full-length amplification of all influenza A viruses. *Archives of Virology*, 2001, 146:2275–2289. doi:10.1007/s007050170002 pmid:11811679
27. Hall RJ et al. Pandemic influenza A(H1N1) viruses currently circulating in New Zealand are sensitive to oseltamivir. *Euro Surveillance: European Communicable Disease Bulletin*, 2009, 14:19282. pmid:19643060
28. García J et al. Antiviral resistance in influenza viruses circulating in Central and South America based on the detection of established genetic markers. *Influenza and Other Respiratory Viruses*, 2009, 3:69–74. doi:10.1111/j.1750-2659.2009.00072.x pmid:19496844
29. Hauge SH et al. Oseltamivir-resistant influenza viruses A (H1N1), Norway, 2007–08. *Emerging Infectious Diseases*, 2009, 15:155–162. doi:10.3201/eid1502.081031 pmid:19193257
30. Sheu TG et al. Surveillance for neuraminidase inhibitor resistance among human influenza A and B viruses circulating worldwide from 2004 to 2008. *Antimicrobial Agents and Chemotherapy*, 2008, 52:3284–3292. doi:10.1128/AAC.00555-08 pmid:18625765
31. Boltz DA et al. Emergence of H5N1 avian influenza viruses with reduced sensitivity to neuraminidase inhibitors and novel reassortants in Lao People's Democratic Republic. *Journal of General Virology*, 2010, 91:949–959. doi:10.1099/vir.0.017459-0 pmid:20016036
32. Hurt AC et al. Increased detection in Australia and Singapore of a novel influenza A(H1N1)2009 variant with reduced oseltamivir and zanamivir sensitivity due to a S247N neuraminidase mutation. *Euro Surveillance: European Communicable Disease Bulletin*, 2011, 16(23):19909. pmid: 21679678
33. Submission to the Medicines Classification Committee for: oseltamivir (Tamiflu® powder filled capsules, 75mg). *Review of the exemption to allow Pharmacy Prescribing of oseltamivir for treatment of influenza in adults and adolescents during the influenza season in New Zealand*. Roche Products (New Zealand) Limited, 2008 (http://www.medsafe.govt.nz/profs/class/agen39Tamiflu.doc, accessed 28 November 2012).
34. Calatayud L et al. Oseltamivir-resistant pandemic (H1N1) 2009 virus infection in England and Scotland, 2009–2010. *Emerging Infectious Diseases*, 2011, 17:1807–1815. doi:10.3201/eid1710.110117 pmid:22000349
35. Tashiro M et al.; Neuraminidase Inhibitor Susceptibility Network. Surveillance for neuraminidase-inhibitor-resistant influenza viruses in Japan, 1996–2007. *Antiviral Therapy*, 2009, 14:751–761. doi:10.3851/IMP1194 pmid:19812437
36. Eichner M et al. Antiviral prophylaxis during pandemic influenza may increase drug resistance. *BMC Infectious Diseases*, 2009, 9:4. doi:10.1186/1471-2334-9-4 pmid:19154598
37. Lipsitch M et al. Antiviral resistance and the control of pandemic influenza. *PLoS Medicine*, 2007, 4:e15. doi:10.1371/journal.pmed.0040015 pmid:17253900

Two cases of severe pneumonia after the 2011 Great East Japan Earthquake

Toshihide Nakadate,[a] Yutaka Nakamura,[a] Kohei Yamauchii[a] and Shigeatu Endo[a]

Correspondences to Toshihide Nakadate (e-mail: tnakadat@iwate-med.ac.jp).

In 2011, during the Great East Japan Earthquake and tsunami, 90% of victims died from drowning. We report on two tsunami survivors with severe pneumonia potentially caused by *Legionella pneumophila*. Both victims aspirated a large quantity of contaminated water; sand, mud and a variety of microbes were thought to have entered into their lower respiratory tracts. One patient had a mycotic intracranial aneurysm; the other patient had co-infections with several organisms, including *Scedosporium* species. Although scedosporiosis is a relatively rare infectious disease, symptoms are progressive and prognosis is poor. These pathogens are not specific for tsunami lung, but are reported causative agents for pneumonia after near-drowning.

Natural disasters can result in excess morbidity and mortality due to infectious diseases. Diseases that cause dramatic epidemics, such as measles, cholera, dysentery and malaria, are usually considered the main threats during humanitarian relief operations. Acute respiratory infections (ARI) have received far less attention in humanitarian relief and preparedness programmes despite recent evidence suggesting high excess morbidity and mortality and case fatality rates due to ARI occur during such events.[1] After the initial rush of patients with injury after the Great Hanshin-Awaji earthquake in 1995, the number of respiratory diseases, largely pneumonia, increased about 4.5-fold.[2]

Tsunamis, which result from sudden changes in the seafloor, can occur after an earthquake and can result in large quantities of earth and sand being swept up and deposited, leaving behind sediment called tsunami deposit. This tsunami deposit, found at various places that the tsunami passes and near to shoreline, can infect the soil. After the Indian Ocean earthquake and tsunami in 2004, multidrug-resistant bacterial infections were often found in the survivors, and a tsunami-related tetanus epidemic was reported.[3] Necrotizing pneumonia and pulmonary abscesses seen by the survivors of tsunamis were named tsunami lung.[4,5]

Tsunami lung occurs when people being swept by tsunami waves inhale salt-water contaminated with mud and bacteria. In some patients with tsunami lung, sand and plant fragments are collected from bronchoalveolar lavage fluid; therefore, the patients aspirate not only industrial materials but also various microbes that live in seawater, freshwater and soil. The resulting pneumonia-like infections are normally treated with antibiotics. However, when medical infrastructure is destroyed in such events and antibiotics are not available to treat infections in the early stages, pulmonary infections can fester, enter the bloodstream and spread to the brain, producing abscesses.

On 11 March 2011, a major 9.0-magnitude earthquake was generated near Japan, and the tsunami that resulted engulfed the Pacific coast of the Tohoku district of Japan, causing serious damage. The Japanese National Police Agency reported that of the 15 467 deaths, 13 135 (92.4%) were due to drowning.

We report on two cases of Legionnaires' disease that developed after near-drowning caused by this tsunami.

CASE PRESENTATION

Case 1: 33-year-old women

The patient was engulfed by the tsunami in Rikuzen-takada city, Iwate prefecture, Japan on 11 March 2011 and was rescued. Heavy oil covered her body. She was transported to the emergency centre with suspicion of chemical pneumonitis. Both lungs showed diffuse infiltrative shadows on a chest X-ray. Chemical pneumonitis from aspiration of heavy oil was diagnosed. Treatment included

[a] Department of Critical Care Medicine, Department of Respiratory Medicine, Iwate Medical University, Uchimar 19-1, Morioka, Iwate, Japan.
Submitted: 11 April 2012; Published: 30 October 2012
doi: 10.5365/wpsar.2012.3.2.002

Figure 1. **33-year-old woman's chest X-ray showed alveolar infiltrate with air bronchogram in left upper lobe, and showed multifocal, bilateral nodular opacities**

Figure 2. **Two-year-old girl's chest X-ray showed right upper lobe consolidation and infiltrative shadow in left upper lobe**

meropenem, administration of Sivelestat sodium and steroid pulse therapy.

In spite of administration of antibiotics, her respiratory state and oxygenation worsened. The chest X-ray showed alveolar infiltrates in the left upper lobe; it also showed multifocal, bilateral nodular opacities (**Figure 1**).

On day 17, massive haemoptysis occurred and because of airway occlusion and hypotension, the patient died. In the bronchoalveolar lavage fluid, *Legionella pneumophila* serogroup-1, *Pseudomonas aeruginosa*, *Stenotrophomonas maltophilia*, *Burkholderia cepacia* and filamentous fungi *Scedosporium apiospermum* and *Scedosporium prolificans* were detected. As a cause of massive haemoptyisis, necrotizing pneumonia and haemorrhagic infarct by these filamentous fungi were suspected.

Case 2: two-year-old girl

This patient was also engulfed in the tsunami in Rikuzen-takada city, Iwate prefecture, Japan on 11 March 2011 and was transported to our hospital on the following day, 12 March. We initially suspected aspiration pneumonia and started administration of ceftaxim. Because *Pseudomonas aeruginosa* was detected by sputum culture, we switched to piperacillin, but the chest shadow worsened (**Figure 2**). We then suspected Legionnaires' disease. Results of a urinary antigen test was positive and her antibody titre for *Legionella pneumophila* rose to 1024-fold. After Legionnaires' disease was diagnosed, and levofloxacin administered, the shadow of the right superior lobe was improved according to a chest film.

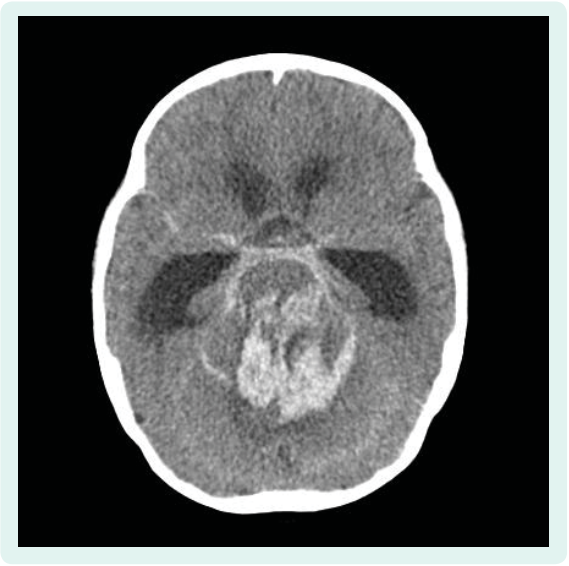
Her symptoms improved gradually, but sudden conjugate deviation and tonic convulsions of both lower extremities developed on day 23. A computed tomography scan of her brain showed bleeding around the brainstem associated with subarachnoid haemorrhage and hydrocephalus (**Figure 3**). A mycotic aneurysm was considered as the cause of the brainstem haemorrhage. The patient died on the 36th day of illness.

DISCUSSION

This report documents the development of two cases of Legionnaires' disease after the Great East Japan Earthquake disaster. This is not the first report of this diagnosis after this event.[6]

Legionella species inhabit fresh water environments and have been detected in rivers and brackish water areas. Both patients with Legionnaires' disease were rescued in a neighbourhood near a river that was destroyed by the tsunami, and so it is possible that

Figure 3. **Computed tomography scan of the brain after convulsion shows bleeding around brainstem associated with subarachnoid haemorrhage and hydrocephalus**



Legionella pneumophila may have been in the river and became part of the tsunami deposit.

Community-acquired pneumonia by *Legionella pneumophila* is extremely rare in Thailand, and in New Zealand and Australia, where *Legionella longbeachae* accounts for about half of Legionnaires' disease cases.[7] This may be due to differences in the living environment as *Legionella* bacteria multiply in man-made environmental waters and often cause human infection. The identification of the source of infection is important when we consider the high mortality rate of Legionnaires' disease and the widespread man-made water environments. Blood-streaked phlegm or haemoptysis occurs in about one-third of Legionnaires' disease patients, but massive haemoptysis is not common.[8] In contrast, cases of *Legionella pneumophila* pneumonia followed by invasive aspergillosis have been reported.[9] Neurologic symptoms and neurologic manifestations are known to be often found in Legionnaires' disease. However, brain abscess or cerebral haemorrhage has not been reported until now, so it difficult to conclude that the cerebral haemorrhage of Case 2 was due to Legionnaires' disease.

As for the cause of the massive haemoptysis of Case 1, superinfection of filamentous fungi is suspected. The filamentous fungi *Scedosporium apiospermum,* as well as the gram-negative bacilli *Pseudomonas aeruginosa, Stenotrophomonas maltophilia* and *Burkholderia cepacia* were all detected in Case 1. These bacteria have the ability to produce β-lactamase and form biofilm and are therefore resistant to antibiotics such as carbapenem or penicillin. These bacteria and filamentous fungi are widespread in soil and fresh water.

Scedosporium apiospermum is particularly known to cause systemic invasive mycosis after near-drowning. *Apiospermum* is resistant to many antifungal agents, and only voriconazole shows susceptibility in the available antifungal agents. In a review of 22 *Scedosporium apiospermum* infections that occurred after near-drowning, dissemination to the central nervous system was confirmed at high frequency (91%), with the most common lesion being multiple brain abscesses (65%).[10] The same study reported that the onset of symptoms can be slow with a delayed time to diagnosis of up to 28 days.[10] A patient who developed an infectious cerebral aneurysm due to scedosporiosis after near-drowning has also been reported,[11] and the mycotic contribution of *Scedosporium* spp. was suspected. In the East Japan tsunami, multiple brain abscesses by *Scedosporium apiospermum* also developed and were cured by anti-fungal treatment.[12]

General mycological staining does not discriminate *Scedosporium* and other filamentous fungi such as *Aspergillus* and *Fusarium*. Cultures of cerebrospinal fluid from infected patients may be negative or delayed up to three weeks.[13] Other diagnostic tests previously reported are polymerase chain reaction and immuno-chromatographic lateral-flow device.[14] During disasters, complicated instruments may not work due to power failure or shortage of reagents and materials. In New Orleans, after Hurricane Katrina in 2005, United States sea, land and airborne rescue teams were equipped with point-of-care tests (POCT), demonstrating the value of POCT in disaster response.[15]

CONCLUSION

The bacteria and filamentous fungi detected after the East Japan tsunami were widespread in the environment, suggesting the possibility of tsunami lung diagnoses in survivors. That multiple pathogens were detected, as in Case 1, is also suggestive of tsunami lung. These bacteria and fungi are resistant to antimicrobial agents and antifungal agents; therefore, these pathogens are resistant to treatment.

Because *Scedosporium* species often attack the central nervous system, and the progression of symptoms is slow, as are respiratory symptoms, careful observation of the central nerve symptom is necessary in such cases. However, both *Scedosporium* and *Legionella* pathogens are not specific for tsunami lung, but reported causative agents for pneumonia after near-drowning.

Conflicts of interest

None declared.

Funding

None.

References:

1. Bellos A et al. The burden of acute respiratory infections in crisis-affected populations: a systematic review. *Conflict and Health*, 2010, 4:3. doi:10.1186/1752-1505-4-3 pmid:20181220
2. Takakura R et al. Follow-up after the Hanshin-Awaji earthquake: diverse influences on pneumonia, bronchial asthma, peptic ulcer and diabetes mellitus. *Internal Medicine (Tokyo, Japan),* 1997, 36:87–91. doi:10.2169/internalmedicine.36.87 pmid:9099588
3. Jeremijenko A, McLaws ML, Kosasih H. A tsunami related tetanus epidemic in Aceh, Indonesia. *Asia-Pacific Journal of Public Health*, 2007, 19 Spec No:40–44. pmid:18277527
4. Allworth A. Tsunami lung a necrotizing pneumonia in survivors after the Asian Tsunami. *Medical Journal of Australia*, 2005, 182 (7):364. pmid:15080423
5. Kao AY et al. Case records of the Massachusetts General Hospital. Case 19–2005. A 17-year-old girl with respiratory distress and hemiparesis after surviving a tsunami. *The New England Journal of Medicine*, 2005, 352:2628–2636. doi:10.1056/NEJMcpc059015 pmid:15972870
6. Ebisawa K et al. Combined *Legionella* and *Escherichia coli* lung infection after a tsunami disaster. *Internal Medicine (Tokyo, Japan),* 2011, 50:2233–2236. doi:10.2169/internalmedicine.50.5800 pmid:21963747
7. Phares CR et al. Epidemiology of severe pneumonia caused by *Legionella longbeachae*, *Mycoplasma pneumoniae*, and *Chlamydia pneumoniae*: 1-year, population-based surveillance for severe pneumonia in Thailand. *Clinical Infectious Diseases*, 2007, 45:e147–55. doi:10.1086/523003 pmid:18190309
8. Jiva TM et al. Simultaneous legionellosis and invasive aspergillosis in an immunocompetent patient newly treated with corticosteroids. *Chest*, 1993, 104:1929–1931. doi:10.1378/chest.104.6.1929 pmid:8252995
9. Edelstein PH, Meyer RD. Legionnaires' disease. A review. *Chest*, 1984, 85:114–120. doi:10.1378/chest.85.1.114 pmid:6360569
10. Katragkou A et al. *Scedosporium apiospermum* infection after near-drowning. *Mycoses*, 2007, 50:412–421. doi:10.1111/j.1439-0507.2007.01388.x pmid:17714363
11. Messori A et al. Mycotic aneurysms as lethal complication of brain pseudallescheriasis in a near-drowned child: a CT demonstration. *AJNR, American Journal of Neuroradiology*, 2002, 23:1697–1699. pmid:12427626
12. Nakamura Y et al. Multiple *Scedosporium apiospermum* brain abscesses in a woman survivor of a tsunami in northeastern Japan: a case report. *Journal of Medical Case Reports*, 2011, 5:526. doi:10.1186/1752-1947-5-526
13. Guarro J et al. *Scedosporium apiospermum*: changing clinical spectrum of a therapy-refractory opportunist. *Medical Mycology*, 2006, 44:295–327. doi:10.1080/13693780600752507 pmid:16772225
14. Thornton CR. Development of an immunochromatographic lateral-flow device for rapid serodiagnosis of invasive aspergillosis. *Clinical and Vaccine Immunology (CVI)*, 2008, 15:1095–1105. doi:10.1128/CVI.00068-08 pmid:18463222
15. Kost GJ et al. Katrina, the tsunami, and point-of-care testing: optimizing rapid response diagnosis in disasters. *American Journal of Clinical Pathology*, 2006, 126:513–520. doi:10.1309/NWU5E6T0L4PFCBD9 pmid:16938656

Is the HIV sentinel surveillance system adequate in China? Findings from an evaluation of the national HIV sentinel surveillance system

Wen Lin,[a] Sanny Chen,[b] Nicole Seguy,[c] Zhongdan Chen,[d] Keith Sabin,[e] Jesus García Calleja[f] and Marc Bulterys[a]
Correspondence to Marc Bulterys (e-mail: zbe2@cdc.gov).

Background: An external evaluation was conducted to assess the performance of the national HIV sentinel surveillance system (HSS), identify operational challenges at national and local levels and provide recommendations for improvement.

Methods: The United States Centers for Disease Control and Prevention's (CDC) *Updated Guidelines for Evaluating Public Health Surveillance Systems* were followed to assess the key attributes of HSS. Comprehensive assessment activities were conducted, including: using a detailed checklist to review surveillance guidelines, protocols and relevant documents; conducting self-administered, anonymous surveys with 286 local China CDC staff; and carrying out field observations in 32 sentinel sites in four provinces.

Results: China has built an extensive HSS with 1888 sentinel sites to monitor HIV epidemic trends by population groups over time. The strengths of HSS lie in its flexibility, simplicity, usefulness and increase in coverage in locations and populations. With its rapid expansion in 2010, HSS faces challenges in maintaining acceptability, timeliness, data quality, representativeness and sustainability.

Recommendations: Implementation of the national guidelines should be standardized by strengthening training, monitoring and supervision of all staff involved, including community-based organizations. National surveillance guidelines need to be revised to strengthen data quality and representativeness, particularly to include specific instructions on HIV testing result provision, collection of identifying information, sample size and sampling methods particularly for men who have sex with men (MSM), collection of refusal information, and data interpretation. Sustainability of China's HSS could be strengthened by applying locally tailored surveillance strategies, strengthening coordination and cooperation among government agencies and ensuring financial and human resources.

China's first AIDS case was diagnosed in 1985.[1] In 2011, the estimated number of people living with HIV/AIDS was 780 000 (620 000–940 000), of whom 48 000 (41 000–54 000) were newly infected.[2] Although the overall national HIV prevalence remained low at 0.058% in 2011, the epidemic was highly concentrated in Southwestern China and Xinjiang autonomous region among key populations including injecting drug users (IDU), female sex workers (FSW) and their clients and more recently, men who have sex with men (MSM).[2,3] Sexual contact was the primary transmission mode, accounting for 68% of newly reported HIV/AIDS cases in 2010.[3] A dramatic increase in the epidemic was seen among MSM, which represented 29% of estimated new infections in 2011 compared to 12% in 2007.[2,4] In contrast, the proportion of new infections among IDU decreased from 42% in 2007 to 18% in 2011.[2,4]

In response to the HIV epidemic, the Chinese government built a comprehensive surveillance system, which included the national HIV sentinel surveillance system (HSS), HIV/AIDS case reporting system, and special epidemiologic surveys.[5–8]

[a] US Centers for Disease Control and Prevention, Global AIDS Program - China office, Beijing, China.
[b] Division of Global HIV and AIDS, Centers for Disease Control and Prevention, Atlanta, United States of America.
[c] HIV Department, World Health Organization, Beijing, China.
[d] The Joint United Nations Programme on HIV/AIDS, Beijing, China.
[e] Representative Office, World Health Organization, Viet Nam.
[f] Division of Strategic Information and Planning, HIV Department, World Health Organization, Geneva, Switzerland.
Submitted: 21 August 2012; Published: 8 November 2012
doi: 10.5365/wpsar.2012.3.3.004

Table 1. **Number of national HIV sentinel surveillance sites by population group, China, 1995–2011**

Surveillance	Population	Year																
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HSS	DU	8	8	13	19	19	25	25	37	49	62	77	97	97	94	124	303	303
	MSM	–	–	–	–	–	–	–	1	1	1	3	4	4	4	18	108	108
	FSW	13	13	17	22	21	25	25	35	43	52	66	82	82	74	161	520	520
	STD*	17	17	22	37	36	39	39	63	72	91	120	145	145	138	145	370	370
	ANC	–		1	1	1	4	4	13	18	26	37	34	34	36	82	376	376
	LDD	4	4	7	7	7	8	8	9	11	21	25	25	25	23	34	58	58
	Mobile population	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	87	87
	Young students	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	66	66
	FPD				12	12	–	–	–	–	–	–	–	–	–	–	–	–
	Clients of FSW	–	–	–	–	–	–	–	–	–	–	1	3	3	2	8	–	–
	TB patients	–	–	–	–	–	–	–	–	–	–	–	3	3	4	4	–	–
	Premarital exam	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–
	Subtotal	**42**	**42**	**60**	**98**	**96**	**101**	**101**	**158**	**194**	**253**	**329**	**393**	**393**	**375**	**600**	**1888**	**1888**
BSS	DU	–	–	–	–	–	–	–	–	–	9	22	27	27	30	–	–	–
	FSW	–	–	–	–	–	–	–	–	–	21	48	88	87	87	–	–	–
	STD	–	–	–	–	–	–	–	–	–	5	18	18	18	4	–	–	–
	LDD	–	–	–	–	–	–	–	–	–	2	5	8	9	10	–	–	–
	MSM	–	–	–	–	–	–	–	–	–	2	6	6	6	14	–	–	–
	Young students	–	–	–	–	–	–	–	–	–	3	6	12	12	10	–	–	–
	Subtotal	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**42**	**105**	**159**	**159**	**155**	**–**	**–**	**–**
	Total	**42**	**42**	**60**	**98**	**96**	**101**	**101**	**158**	**194**	**295**	**434**	**552**	**552**	**530**	**600**	**1888**	**1888**

BSS – behavioural sentinel surveillance; HSS – HIV sentinel surveillance; DU – drug users; FSW – female sex workers; STI – sexually transmitted infections clinic attendees; LDD – long-distance truck drivers; ANC – antenatal care clinic attendees; FPD – former plasma donors; MSM – men who have sex with men.

* Female outpatients recruited before 2009, male outpatients recruited from 1995 to 2011.

Before 1995, the national HIV surveillance was primarily based on a passive HIV/AIDS case reporting system in which doctors were obligated to report all diagnosed HIV/AIDS cases, with more detailed information on disease burden and high risk behaviours among specific subgroups obtained from local epidemiologic investigations and provincial HIV sentinel surveillance sites.[5–8] In 1995, HSS was established at 42 sites. This system comprised routine cross-sectional surveys on risk behaviours and sero-testing of participants targeted in four population groups – drug users (DU) of which about 60% were IDU, FSW, sexually transmitted infections (STI) clinic attendees and long-distance truck drivers (LDD). More national sites were added based on need.

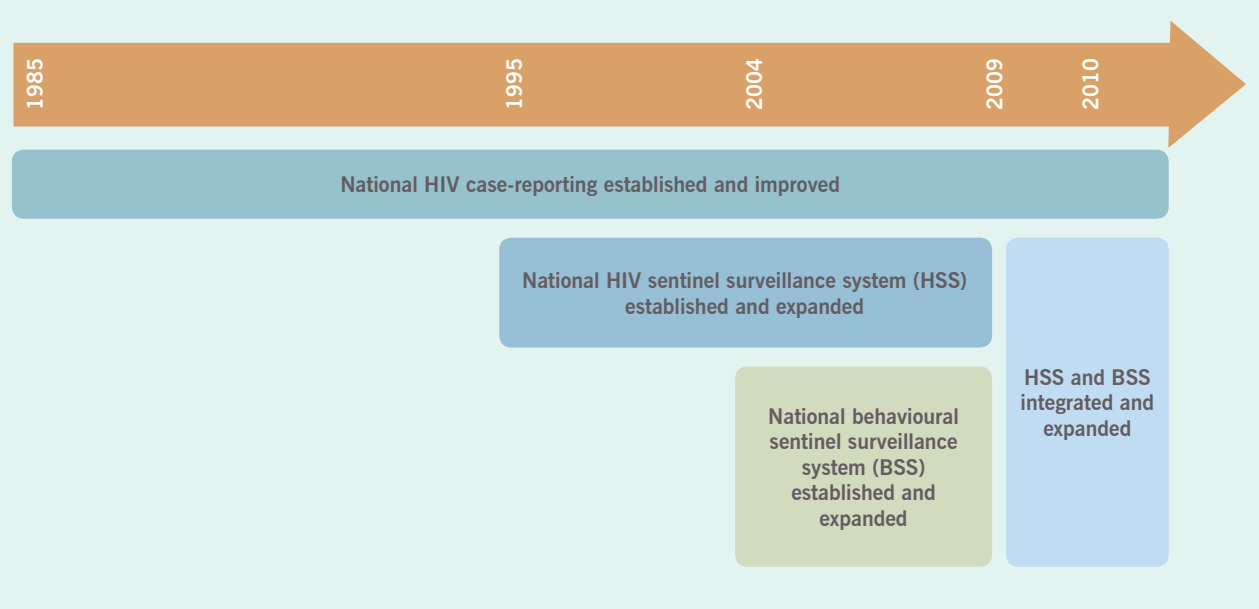
In 2004, an independent national behavioural sentinel surveillance system (BSS), which included a more detailed behavioural questionnaire was established. In 2009, both systems were integrated under a national standardized protocol. Most of the provincial sentinel surveillance sites were also incorporated into the national HSS. In 2010, the number of national sentinel sites expanded from 600 to 1888, targeting eight groups (DU, FSW, MSM, male STI clinic attendees, LDD, antenatal care [ANC] clinic attendees, young college students and male migrant workers) (**Table 1**, **Figure 1**).

Although several evaluations of China's surveillance system have been conducted,[9,10] the national HSS has not been evaluated since BSS started in 2004. We therefore conducted an external evaluation of HSS to assess its performance, identify operational challenges and provide recommendations to improve its performance.

METHODS

The evaluation followed the United States Centers for Disease Control and Prevention's (CDC) *Updated*

Figure 1. **Evolution of the national HIV sentinel surveillance system**



Guidelines for Evaluating Public Health Surveillance Systems,[11] focusing on assessing the attributes of the system, including usefulness, simplicity, flexibility, data quality, acceptability, representativeness, timeliness and stability.

From May to June 2011, we reviewed HSS guidelines and protocols using a detailed checklist to assess site selection criteria, sampling methods, survey contents, data collection and reporting and data analysis and use.

We conducted a self-administered and anonymous survey with 286 staff from 263 local Chinese Centers for Disease Control and Prevention (C-CDC) in 23 provinces on financial and human resources used for HSS, establishment of provincial sentinel surveillance, staffing and HSS supervision.

We conducted 32 site visits in Shandong, Jiangxi and Guizhou Provinces and Chongqing City which covered all but the male migrant worker sentinel group. We made direct observations of data collection and laboratory specimen handling; held focus group discussions; and conducted semi-structured interviews with over 100 key stakeholders including public health officials, C-CDC and laboratory staff at national and subnational levels who were involved in HSS and responsible for generating and receiving reports. Verbal informed consent was obtained and participation was voluntary. We assessed data quality by cross-checking 5% of the 2010 surveillance questionnaires against the electronic database during the field visits. Institutional Review Board review was waived.

RESULTS

Description of the national HIV sentinel surveillance system

The national HSS aims to monitor HIV prevalence and risk behaviours among targeted populations, to provide data for HIV/AIDS estimation and projection and to guide the development and impact assessment of HIV prevention and control strategies. The surveillance system comprises routine surveys of targeted populations covering demographics, detailed risk behaviours and sero-testing for HIV, syphilis and hepatitis C virus.

Site selection is based on the cumulative reported number of HIV/AIDS cases in the region, associated risk factors, local needs for HIV/AIDS prevention and intervention and local surveillance capacity. If HIV prevalence is over 5% for a high-risk population (DU, MSM, FSW and STI clinic attendees), local C-CDCs are required to establish sentinel sites targeting the general population (young students and pregnant women). If the HIV epidemic is low or uncharacterized, C-CDCs are required to establish sentinel sites targeting

high-risk populations and focus populations (LDD and male migrant workers). In 2010, a total of 1888 national sites were established in 31 provinces (**Table 1**).

Surveillance period, sample size and sampling method

From 1995 to 2004, the HSS survey was carried out semi-annually (April to June and October to December) and from 2005, annually from April to June. In 2009, sample size requirements changed from 400 to 800 for young students and from 250 to 400 for all other populations. However, if the HIV prevalence of one target population was over 10% in the previous year, the sample size was reduced to 250.

DU are sampled in communities (snowball sampling) or detention/detoxification centres. FSW are sampled at venues (stratified sampling) or detention centres. The minimum number of low-fee and medium-fee FSW surveyed is set at 10% and 40% of the total sample size, respectively. MSM are sampled at venues (stratified snowball sampling) or through the Internet or social networks. ANC and STI clinic attendees, male migrant workers and LDD are enrolled using consecutive sampling. Young students are sampled from colleges using multistage clustered sampling method.

HIV testing and reporting

For the sero-testing component of HSS, provinces choose either unlinked anonymous testing (UAT)[12] or linked confidential testing (LCT).[12] Pre- and post-test counselling are administered and HIV testing using enzyme-linked immunosorbent assay (ELISA) and HSS-specific HIV sero-testing kits for quality control are performed at certified local C-CDC or hospital laboratories according to national HIV testing guidelines. If LCT is employed, the individual's national identification number is collected when blood is drawn for confirmatory testing.

Data collection and reporting

Local C-CDC offices are responsible for uploading data into the web-based HSS. Each provincial C-CDC conducts the surveys, submits a report to the provincial health bureau and the National Center for AIDS/STD Control and Prevention (NCAIDS) and also provides feedback to lower-level C-CDCs and facilities that carried out the surveys. NCAIDS provides feedback to provinces at the annual national HSS conference.

Training and supervision

NCAIDS trains staff at all C-CDC levels annually and conducts annual field supervision in approximately 10% of surveillance sites in 10 provinces.

Performance of the national HIV sentinel surveillance system

Flexibility and simplicity

HSS has shown flexibility in adapting to changing needs over time, such as adding new population groups and questions, incorporating behavioural surveillance and changing the frequency of surveillance rounds from semi-annual to annual.

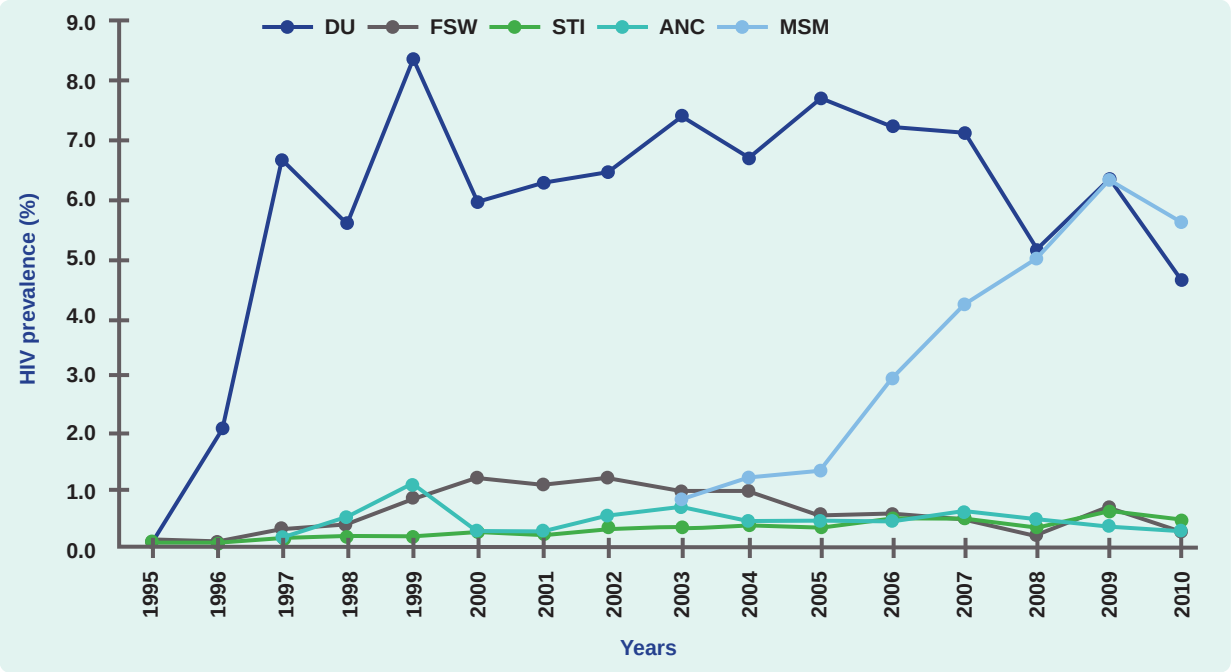
Data collection, analysis and reporting are standardized. Data entry uses an electronic online system,[13] making national-level analysis and subnational comparisons easier.

Usefulness

Since 2002, HSS data have been used for assessing national and provincial HIV prevalence trends over time[2,14–16] (**Figure 2**), generating national biennial HIV estimates,[2,4] and monitoring and evaluating the national HIV/AIDS action plans (2006–2010 and 2011–2015) and programme planning at national and provincial levels.[14,15] HSS has been a major source of data for China's Universal Access and the United Nations General Assembly Special Session (UNGASS) country progress report.[16] From this perspective, HSS is useful.

However, there are some issues with HSS that reduce its usefulness. Young student sites provide very limited information. There were no HIV infections detected and low reporting of risk behaviours at three sites that were visited. Also, although data analysis and use at the national and provincial levels are generally good, there are gaps in comprehensive analysis using multiple data sources, including surveillance, prevention and treatment programmatic data. Staff at prefecture and county levels have limited competence to analyse and use data.

Figure 2. **HIV prevalence from HIV sentinel surveillance data on selected populations, China, 1995–2010[2]**



DU – drug users; FSW – female sex workers; STI – sexually transmitted infections clinic attendees; ANC – antenatal care clinic attendees; MSM – men who have sex with men.

Stability

The number of staff dedicated to HSS was very limited at provincial and lower levels, and the staff turnover rate was high in provinces with low HIV epidemics. Of 263 C-CDCs surveyed, 218 (83%) received supervision visits from national and/or provincial C-CDCs in 2010 compared to 162 (62%) in 2008, suggesting that oversight of HSS by national and provincial staff has been strengthened since 2008.

In 2011, 12 000 Renminbi (US $1850) was allocated per sentinel site. However this amount was insufficient for sites surveying MSM and FSW as it did not include costs for mobilization, advocacy, training and supervision.

Timeliness

A basic standardized data analysis and reporting plan is used uniformly nationwide, enabling timely reporting to provincial and national levels. However, mandatory reporting of HIV test results using LCT is not as timely. In 10 sites visited, specimens were held for batch testing until late in the surveillance period and results were reported to implementing facilities and individuals as much as three months after blood draw, delaying prompt care and treatment, especially for HIV-infected pregnant women.

Acceptability

Collaboration within C-CDC agencies is high; however, there is lack of support from stakeholders. Hospitals and clinics with large patient flow are often reluctant to conduct surveys. At some school sites, HSS surveys are conducted among student volunteers, which may underestimate risk behaviours of this group. Acceptability of HSS among FSW is variable, waning during and soon after police crackdowns of FSW activity.

Data quality

Overall, 99.6% (1881/1888) of HSS sites collected data in 2010 and over 80% (1520/1881) of the sites achieved sufficient sample size. Data were accurately reported with mistakes (data missing or discrepancies between questionnaires and database) found in only six (1%) electronic entries compared with the questionnaires.

However, compliance with the national protocol at local levels needs to be promoted. Collection of personal identifying information was observed, which could have a significant impact on the acceptability

of HSS and the accuracy of information reported by participants, particularly for populations involved in illicit activities or subject to stigma, such as DU, FSW and MSM.

In clinical settings, laboratory technicians had limited knowledge of national HSS testing guidelines. Use of non-surveillance specific sero-testing kits was noted at two sites and inappropriate storage of test kits were reported at a provincial C-CDC where the kits were distributed.

Representativeness

Lack of information reported on refusal logs hindered our assessment of overall representativeness. However, we observed that convenience sampling of MSM through the Internet or social networks was frequently used, leading to oversampling of those who were younger, interested in HIV testing, with large social networks or access to the internet. IDU were frequently surveyed in detention or detoxification centres due to easier implementation, even though they did not necessarily represent drug users in the community. At some sites, STI clinic attendees were selected based on the physician's judgment of their likelihood to be at risk and the physician's patient load. Patients seen during peak hours were less likely to be surveyed than those seen at other times. Some pregnant women were selected at the time of delivery, allowing duplication and exclusion of known HIV-positive pregnant women who might have terminated their pregnancies.

DISCUSSION

China has built an extensive sentinel surveillance system to monitor HIV epidemic trends by population group over time. The strengths of China's HSS lie in its flexibility and relative simplicity. With its rapid expansion in 2010, however, HSS faces challenges in maintaining data quality, representativeness and sustainability. Addressing these challenges will allow HSS to provide accurate information for monitoring HIV transmission in the country.

This evaluation is subject to several limitations. We did not evaluate the HIV/AIDS case reporting system or special epidemiologic survey components of the HIV/AIDS surveillance system. Given the large variation in HIV epidemic patterns and local capacities, data from the 32 sites visited may not accurately reflect the performance of HSS as a whole. Staff interviewed were selected for convenience and all information was self-reported. We did not interview HSS participants to determine the acceptance of surveillance activities and representativeness of HSS.

HSS in China can be further strengthened to improve its sustainability, acceptability, data quality and representativeness. To strengthen sustainability, NCAIDS could consider estimating financial and human resources on real needs and prioritizing high HIV epidemic provinces. Strengthened coordination and cooperation among government agencies should also be considered to improve recruitment and facilitate information sharing. Different surveillance strategies should be used for high and low HIV epidemic areas. For example, in low HIV epidemic areas, NCAIDS may consider focusing on high-risk populations, conducting surveillance rounds every two years for population groups with stable HIV prevalence and dropping young students as they are not a good sentinel population for early warning of HIV epidemics. Data from voluntary blood banks may be considered for monitoring HIV infections among low-risk populations. In high HIV epidemic areas, in addition to sentinel surveillance among high-risk populations, routine HIV testing data at ANC, STI and methadone maintenance treatment clinics could also be used for surveillance purposes. This will require scaling up provider-initiated HIV testing and counselling, and improving HIV testing, data quality and collaboration between C-CDCs and clinical facilities. These improvements will lessen the burden of sentinel surveillance on C-CDC staff who are already overloaded, and hence strengthen the acceptability, sustainability and quality of such a huge surveillance system.

To strengthen data quality and representativeness, we recommend NCAIDS consider revising national surveillance guidelines to include specific instructions on HIV testing and timely test result provision (using LCT[12] instead of UAT so that the participants are able to receive their test results), collection of identifying information, sample size and sampling methods particularly for MSM, collection of refusal information and data interpretation in the surveillance report. Strengthening training, monitoring and supervision of all staff involved in HSS should also be considered. Trainings for laboratory technicians should cover specific requirements for HSS testing, which are different from HIV diagnosis requirements. Continuing to strengthen

data analysis and utilization is equally important. In addition to refresher trainings on sentinel surveillance for C-CDC staff, basic epidemiology and statistical analysis training should be offered at local levels to strengthen the use of surveillance data. Finally, evaluation of the HIV/AIDS case reporting system and special surveys should be considered to improve the understanding of the performance of the overall HIV surveillance system in China.

Conflicts of interest

None declared.

Funding

United States CDC Global AIDS Program (3 U2G PS001188) and World Health Organization (PO200334675, PO200431207).

Acknowledgments

We would like to express our most sincere acknowledgement to the staff at NCAIDS, local C-CDCs and implementing partners for their dedication and hard work in conducting the national HIV sentinel surveillance surveys and their efforts to improve the system. We are grateful to our Chinese colleagues at NCAIDS, Drs Zunyou Wu, Ning Wang and Jiangping Sun, for their strong support for this evaluation activity. Appreciation particularly goes to Dr Lu Wang and her fellows at the Epidemiology Division of NCAIDS, including Drs Shuquan Qu, Wei Guo, Lin Ge, Dongming Li, Liyan Wang, Lan Wang, Faxin Hei, Fangfang Chen, Qianqian Qing and Zhengwei Ding, for their coordination effort and comments on the evaluation report. We would also like to thank the provincial and local C-CDC staff in Jiangxi province, Guizhou province, Shandong province and Chongqing municipality.

Members of the evaluation team were: US CDC Global AIDS Program – China office: Wen Lin, Mingshan Qi, Ling Hao; United States CDC (Atlanta): Sanny Chen; World Health Organization (China): Nicole Seguy; World Health Organization (Viet Nam): Keith Sabin; United Nations Joint Programme on HIV/AIDS (UNAIDS) (China): Zhongdan Chen.

Note: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the United States CDC. Use of trade names and commercial sources are for identification purposes only and does not imply endorsement by the Public Health Service or the United States Department of Health and Human Services.

References:

1. Settle E. *AIDS in China: an annotated chronology: 1985–2003*. Monterey, China AIDS Survey, 2003 (http://portal.unesco.org/pv_obj_cache/pv_obj_id_6892BABDE8F4FD4B51ED7D6E8240F7BC76990E00/filename/82b973698fcdf215528d63d2b6796087AIDSchron_111603.pdf, accessed 27 February 2012).
2. National Center for AIDS/STD Control and Prevention, China; Joint United Nations Programme on HIV/AIDS; World Health Organization. *2011 estimates for the HIV/AIDS epidemic in China*. Beijing, Ministry of Health, 2011 (http://www.chinaids.org.cn/n1971/n2151/n777994.files/n777993.pdf, accessed 27 February 2012).
3. Wang L et al. Current case reporting of HIV/AIDS in China. *China Journal of AIDS and STD*, 2011, 17:275–278.
4. Wang N et al.; National Expert Group on HIV/AIDS Estimation. Estimating the number of people living with HIV/AIDS in China: 2003–2009. *International Journal of Epidemiology*, 2010, 39(Suppl 2):ii21–28. doi:10.1093/ije/dyq209 pmid:21113033
5. Wang L, Wang N. HIV/AIDS epidemic and the development of comprehensive surveillance system in China with challenges. [English]. *Chinese Medical Journal*, 2010, 123:3495–3500. pmid:22166538
6. Wu Z et al. Evolution of China's response to HIV/AIDS. *Lancet*, 2007, 369:679–690. doi:10.1016/S0140-6736(07)60315-8 pmid:17321313
7. Sun X et al. The development of HIV/AIDS surveillance in China. *AIDS (London, England)*, 2007, 21 Suppl 8:S33–38. doi:10.1097/01.aids.0000304694.54884.06 pmid:18172389
8. Jia Y et al. Sources of data for improved surveillance of HIV/AIDS in China. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 2007, 38:1041–1052. pmid:18613545
9. *Joint HIV surveillance and laboratory assessment*. Beijing, US CDC, Global AIDS Program and National Center for AIDS/STD Control and Prevention, 2003.
10. Global AIDS Program; National Center for AIDS/STD Control and Prevention. *Evaluation of the Guangdong HIV/AIDS Surveillance System, China*. Guangdong Provincial Center for Disease Control and Prevention, 2007.
11. German RR et al.; Guidelines Working Group of the Centers for Disease Control and Prevention (CDC). Updated guidelines for evaluating public health surveillance systems: recommendations from the Guidelines Working Group. *MMWR Recommendations and Reports: Morbidity and Mortality Weekly Reports*, 2001, 50 (RR-13):1–35, quiz CE1–7. pmid:18634202
12. *Guidelines for Using HIV Testing Technologies in Surveillance: Selection, Evaluation and Implementation 2009 update*. Geneva, World Health Organization and Joint United Nations Programme on HIV/AIDS, 2009 (http://www.who.int/hiv/pub/surveillance/hiv_testing_technologies_surveillance_.pdf, accessed 27 February 2012).
13. Mao Y et al. Development of a unified web-based national HIV/AIDS information system in China. *International Journal of Epidemiology,* 2010, 39(Suppl 2):ii79–89. doi:10.1093/ije/dyq213 pmid:21113041
14. Han M et al. Design and implementation of a China comprehensive AIDS response programme (China CARES), 2003–2008.

International Journal of Epidemiology, 2010, 39(Suppl 2):ii47–55. doi:10.1093/ije/dyq212 pmid:21113037

15. Sun X et al. Evolution of information-driven HIV/AIDS policies in China. *International Journal of Epidemiology*, 2010, 39 (Suppl 2):ii4–13. doi:10.1093/ije/dyq217 pmid:21113036

16. *UNGASS Country Progress Report (2008–2009)*. Beijing, Ministry of Health, 2010 (http://www.aidsdatahub.org/en/tools-guides/item/15769-ungass-country-progress-report-chinastate-council-aids-working-committee-office-china-2010, accessed 27 February 2012).

Increasing syphilis notifications in Mongolia: results from national surveillance for 2001–2011

Jantsansengeegiin Baigalmaa,[ab] Choijiljaviin Erdenechimeg,[a] Jadambaagiin Narantuya,[c] Aumakhanii Bulbul,[a] Jamsranjaviin Tugsjargal,[a] Erdenebatiin Dolgion,[a] Erdenebaatariin Soyolmaa,[a] Minjuuriin Enkhtuya,[a] Badrakhiin Jugderjav[a] and Sodnomyn Otgonsukh[a]

Correspondence to Jantsansengeegiin Baigalmaa (e-mail: j_baigalmaa@yahoo.com).

Background: In Western Pacific Region countries, sexually transmitted infections (STI) rates vary but are considered high. In Mongolia, syphilis incidence has increased between 2001 and 2011; therefore, the objective of this study was to describe the epidemiology of syphilis in Mongolia to provide evidence for prevention and control activities.

Methods: A retrospective analysis of syphilis was conducted using STI data from the passive surveillance system. This included demographic and clinical information and laboratory test results. In addition, a test for the trend of syphilis notification rates over time was conducted.

Results: Syphilis notification rates increased by twofold from 71 per 100 000 in 2001 to 152 per 100 000 in 2011 ($P < 0.006$), and there were significant differences observed between the capital city and the province rates over time ($P = 0.011$). Generally, notification rates among females were significantly higher than males ($P < 0.001$) except that male rates increased to 185 per 100 000, higher than female rates of 179 per 100 000 in 2009. The increase of notifications of latent syphilis for males ($P < 0.009$) and females ($P < 0.006$) was significant.

Discussion: This is the first analysis of the overall situation of syphilis in Mongolia, and although the years with the largest number of cases corresponded to large-scale screening programmes, we observed a significant increase in syphilis notification rates over time. These results will be useful for evidence-based prevention and control activities such as awareness campaigns for young adults.

Sexually transmitted infections (STI) are a major public health concern. The World Health Organization (WHO) estimates that annually more than 448 million new episodes of curable STI, which include syphilis, chlamydia, gonorrhea and trichomoniasis, occur throughout the world.[1] The majority of infections occur in south and south-eastern Asia, followed by sub-Saharan Africa, Latin America and the Caribbean.[2]

In WHO Western Pacific Region countries, STI rates vary but are generally considered high. The latest data from China showed that syphilis, which was considered controlled, has resurged in the last decade.[3] In addition, a fourfold rise in gonorrhoea, chlamydia, genital herpes and genital warts was observed in China between 1990 and 2000. Similar trends have been observed in Malaysia.[4] Surveys in Pacific island countries show a prevalence of syphilis of 0.3%.[5] A nationwide cross-sectional study conducted in 2008 showed that among 2000 antenatal care attendees in Mongolia, 25.5% had at least one STI.[6]

According to the AIDS and STI surveillance department of the National Center for Communicable Diseases (NCCD), STI represented about one third of all infectious diseases reported in Mongolia between 2001 and 2010. Syphilis, gonorrhea and trichomoniasis are the most frequently reported STI, and the syphilis rate has increased between 2001 and 2011.

[a] National Center for Communicable Diseases, Ulaanbaatar, Mongolia.
[b] Mongolian Field Epidemiology Training Programme, Ministry of Health, Ulaanbaatar, Mongolia.
[c] World Health Organization Representative Office in Mongolia, Ulaanbaatar, Mongolia.
Submitted: 30 April 2012; Published: 21 December 2012
doi: 10.5365/wpsar.2012.3.2.008

Therefore, for the first time in Mongolia, we aimed to describe the epidemiology of syphilis cases reported to the national STI surveillance system.

METHOD

This paper is a retrospective analysis of syphilis cases reported to the national STI surveillance department in Mongolia for the period 2001 to 2011.

In Mongolia, STI care and services are provided at three levels of health care nationwide. Primary level STI care is provided through 580 family group practices and primary health care clinics, secondary level care is provided through 29 provincial and capital city district hospitals and specialized or tertiary care is provided at the NCCD.[7] Due to the lack of laboratory capacity to diagnose STI at the primary health care level, syndromic diagnosis and treatment of STI was introduced in 2001.[7] In 2008, in response to the high rate of congenital syphilis in the country, all clinics in eight provinces and six districts of the capital city established testing capacity for STI, including syphilis, at all programme sites (personal communication with Dr Ch Erdenechimeg, STI and AIDS Department, NCCD).

Detection and confirmatory syphilis serologic testing (rapid plasma reagen [RPR] test, Treponema pallidum haemagglutination assay [TPHA], enzyme-linked immunosorbent assay [ELISA]) are conducted at the secondary level[8] and at the STI diagnostic laboratory of the NCCD.[7] The latter is the national reference laboratory, and 10% of all tests from secondary laboratories are sent on a quarterly basis to the reference laboratory for confirmation and quality assurance. Quality assurance of the STI laboratory of the NCCD is conducted at the Australian serologic reference laboratory in Sydney, Australia. Syphilis test quality assurance was 100% in 2011.

According to the International Classification of Diseases–10,[9] syphilis comprises two disease phases: early and late. Early syphilis is then categorized into primary, secondary and early latent syphilis; late syphilis is grouped into tertiary and late latent syphilis. Primary and secondary syphilis manifest with clinical symptoms after approximately four months of infection and are considered as new infection. Latent syphilis is an asymptomatic infection identified through serological testing and is diagnosed within or after two years of infection.

In Mongolia, at the primary STI care level, syndromic cases of primary syphilis with an obvious clinical symptom (classic chancre) are reported to the surveillance system; at the secondary and tertiary STI care levels, all cases require laboratory confirmation by RPR, TPHA or ELISA.

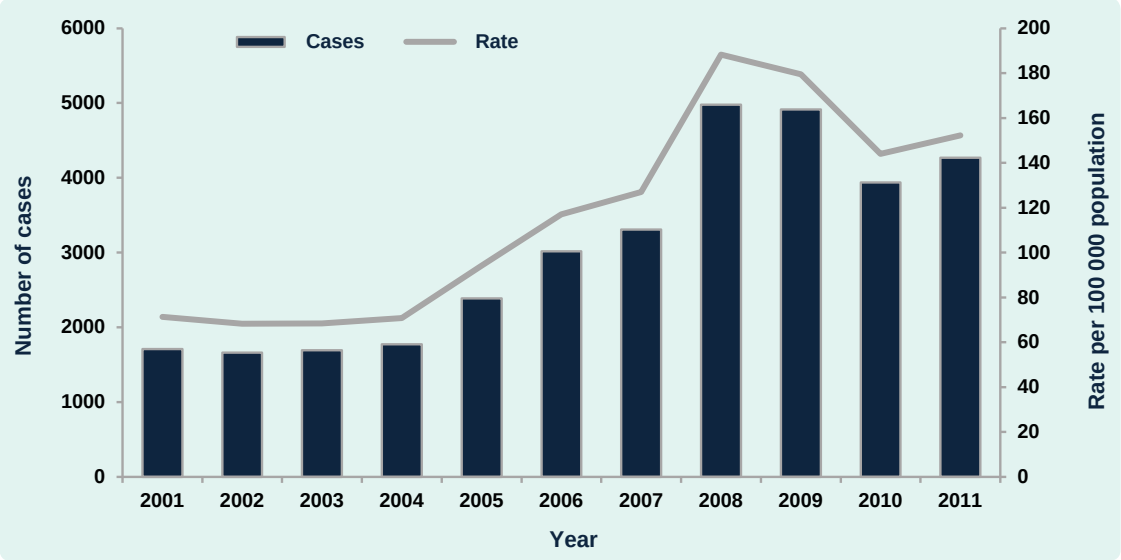
STI surveillance in Mongolia is a passive surveillance system. National STI surveillance and statistical data are collected from all levels of STI care and services and reported to the AIDS and STI surveillance department of the NCCD. STI care providers fill out STI outpatient cards and then send the reports to the next level of STI care. At the secondary level, the reports are summarized for the number of STI client visits, number of patients diagnosed with STI, laboratory confirmation and some contact tracing information. It is compulsory that the 21 provincial health departments and eight districts (except one, where they do not provide STI care and services) of the capital city send the reports to the AIDS and STI department of the NCCD on a monthly basis. STI surveillance and statistical data are kept and managed at the NCCD, and basic analysis is conducted on an annual basis for national statistical reporting. Case data collected include identification, social and geographic information, laboratory test results and contact tracing information.

We analysed all syphilis cases reported to the STI surveillance system from 2001 to 2011. The denominator for calculating syphilis rates was based on the 2001 to 2011 population data and estimated per 100 000 population. We conducted nonparametric trend tests across calendar-years to test for secular trends in syphilis notification rates over time.[10] Trend analyses were performed using STATA. The difference between sex and geographic distribution was tested using the chi-squared test in OpenEpi.

RESULTS

The syphilis notification rate increased twofold from 71 per 100 000 to 152 per 100 000 between 2001 and 2011. The rate was stable between 2001 and 2004; however, it began to increase after 2005, peaking in 2008 with a rate of 188 per 100 000. In 2010,

Figure 1. **Number of syphilis cases and notification rate per 100 000 population by year, Mongolia, 2001 to 2011**



a decrease in syphilis notifications was observed at 144 per 100 000 population, but the rate increased again to 152 per 100 000 in 2011 (**Figure 1**). Trend tests by year showed that this increase was statistically significant ($P = 0.006$).

Syphilis by stage of infection

Similar to the total syphilis notification rate, the notification rate of latent syphilis increased from 2005, peaking in 2008 at 134 cases per 100 000; this increase was statistically significant ($P = 0.009$). Primary and secondary syphilis rates remained at relatively constant levels until they peaked in 2009 with a notification rate of 27 and 49 cases per 100 000, respectively (**Figure 2**).

Syphilis testing

The number of serologic tests conducted for syphilis increased from 2001 and peaked in 2008 and 2009. As the number of tests performed increased, syphilis

Figure 2. **Notification rate of syphilis per 100 000 population by stage of infection and year, Mongolia, 2001 to 2011**

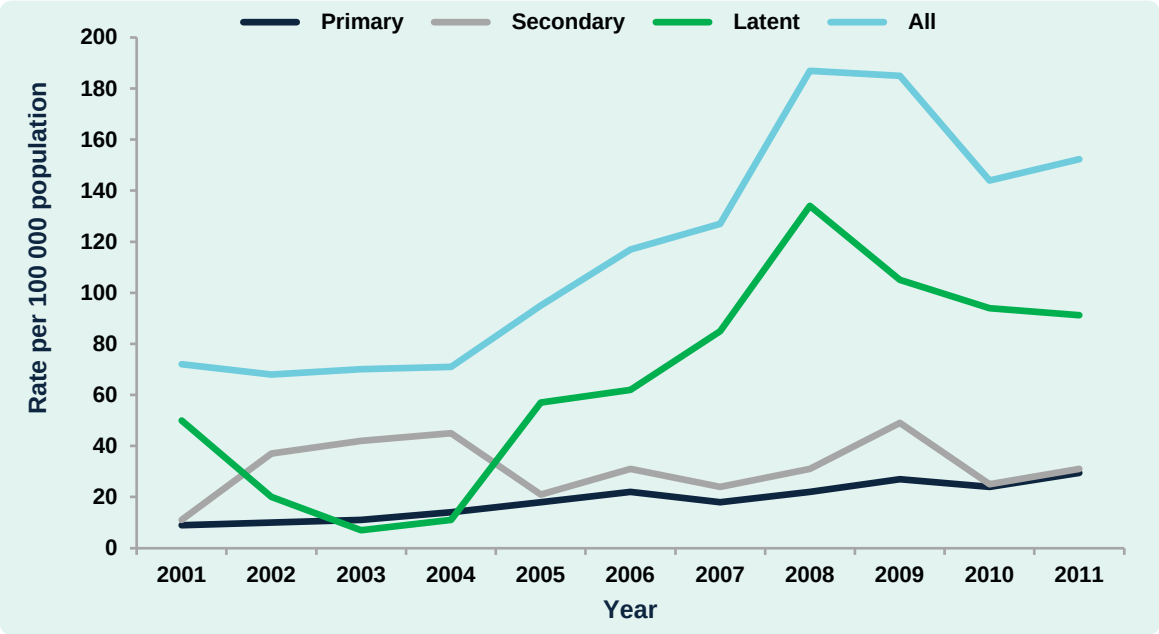
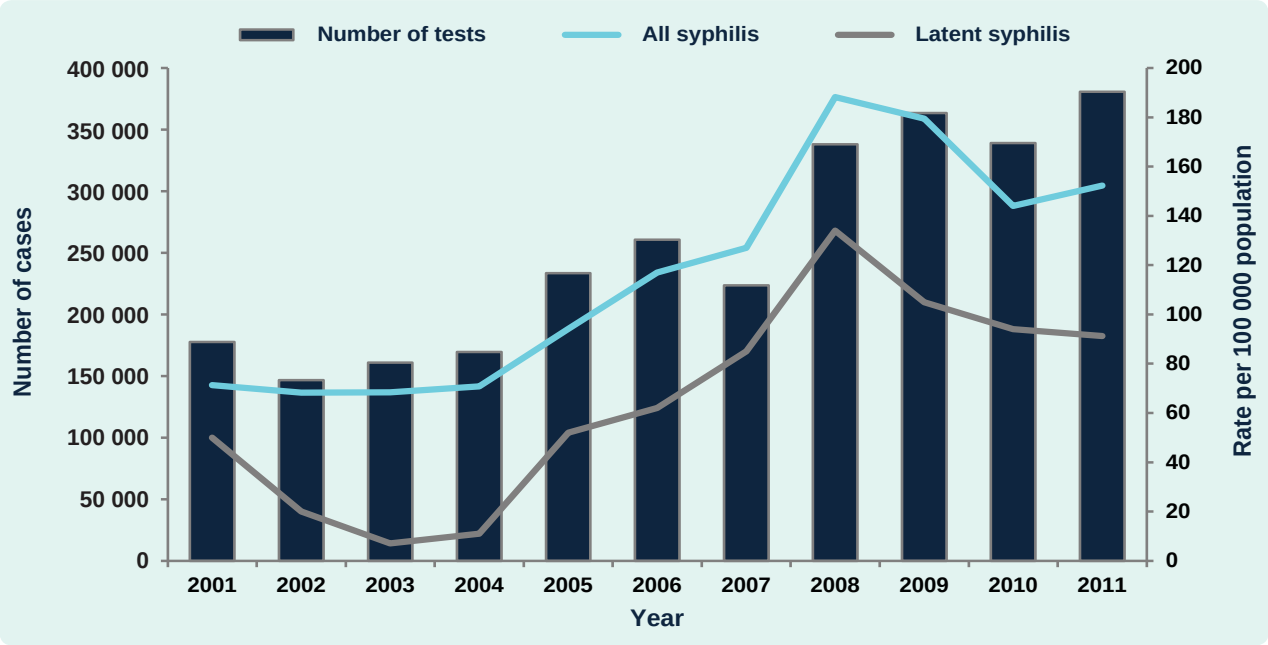


Figure 3. **Number of syphilis serologic tests performed and notification rate of total and latent syphilis per 100 000 population by year, Mongolia, 2001 to 2011**



notifications, including latent syphilis notifications, also increased (**Figure 3**).The proportion of positive tests ranged from 1–1.5 per 100 tests between 2001 to 2011 with no statistically significant difference overall ($P = 0.05$). The highest proportion of positive tests (1.5%) was observed in 2007, a year in which relatively few tests were performed. The greatest number of tests were performed in 2009 and 2011 during which the proportion of positive tests was lower than 2007 and 2008 (**Figure 4**).

Syphilis notifications by capital city and province average

Syphilis notification rates in the capital city (Ulaanbaatar) were continuously higher than province averages over the

Figure 4. **Number of syphilis tests performed and proportion of positive tests by year, Mongolia, 2001 to 2011**

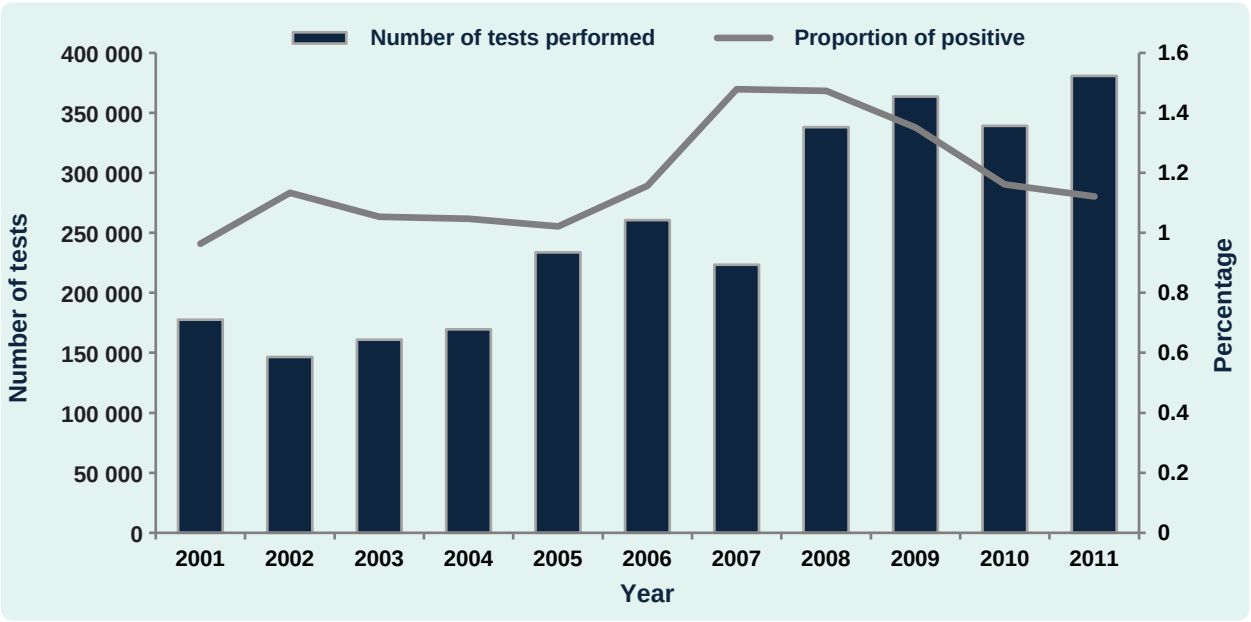
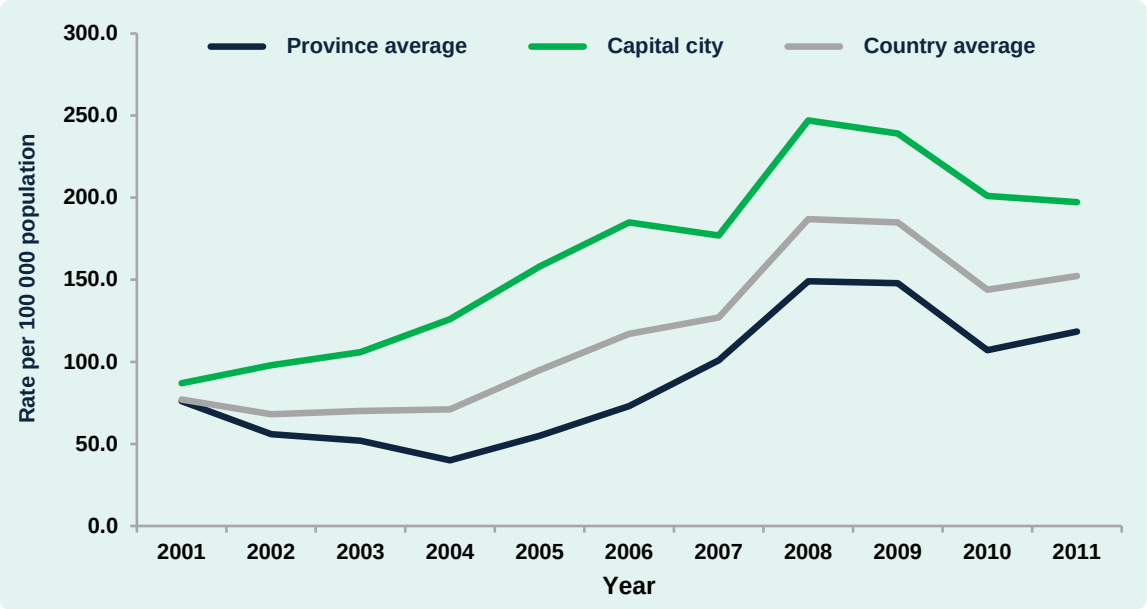


Figure 5. **Notification rate of syphilis per 100 000 population by province average, capital city and national average and year, Mongolia, 2001 to 2011**



study period, although both showed the same pattern as the total notification rates (**Figure 5**). There was a significant increase over time for both the capital city ($P = 0.004$) and province average ($P = 0.023$). The difference between provinces and the capital city was also statistically significant ($P = 0.011$).

Syphilis notifications by age and sex

Notification rates were higher among females than males in the period 2001 to 2008; in 2009, the male notification rate was slightly higher (185 per 100 000 compared with 179 per 100 000). In 2010, the female notification rate was more than twice as high as the male rate, increasing slightly from 2009. Overall, there was a significant difference between male and female syphilis notification rates ($P < 0.001$) (**Figure 6**).

Syphilis notification rates were highest among the sexually active and reproductive age group of 20 to 39 years. In addition, notification rates of syphilis consistently increased for young people aged 15 to 19 years and 20 to 24 years over the study period (**Table 1**).

Overall, pregnant women comprised approximately one third of reported syphilis cases. The year 2005 had the highest proportion of syphilis notifications in pregnant women at 80% of all female syphilis cases. In 2008, the year with the highest number of syphilis notifications, pregnant women comprised 40% of female cases.

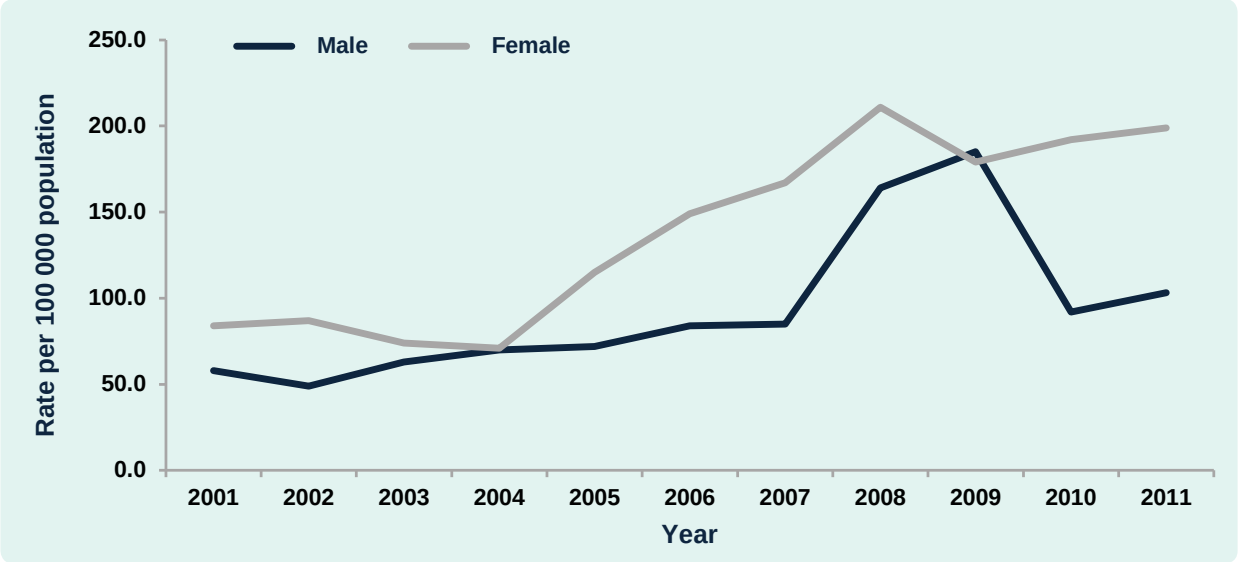
Notification rates of primary and secondary syphilis combined for females were generally higher than the rates for males between 2001 and 2009. In 2010, the notification rates decreased by half for males from 79 per 100 000 in 2009 to 35 cases per 100 000. Female rates remained the same. Tests for trends for primary and secondary syphilis combined in males ($P < 0.3$) and females ($P < 0.1$) demonstrated no significant change (**Figure 7**).

Latent syphilis notification rates in females were typically higher between 2001 and 2011 compared with males, except for 2009 when where the rates were similar (104 per 100 000 and 106 per 100 000, respectively). In 2010 and 2011, latent syphilis notification rates were more than twice as high for females (129 per 100 000 and 123 per 100 000) than for males (56 per 100 000 and 57 per 100 000). Latent syphilis both in males ($P < 0.009$) and females ($P < 0.006$) demonstrated a significant increase over time (**Figure 7**).

DISCUSSION

We observed a consistent increase in syphilis notifications in Mongolia from 2001, peaking in 2008 and 2009. The "Healthy Mongolian" health screening campaign organized in 2008 and 2009 provided free medical examinations including testing for syphilis (personal communication with Dr Ch Erdenechimeg, STI and AIDS Department, NCCD). Detection of cases during this

Figure 6. **Notification rate of syphilis per 100 000 population by sex and year, Mongolia, 2001 to 2011**



screening may have contributed to the observed peak of syphilis notification rates in 2008 and 2009. There were higher female syphilis notification rates overall and difference in notifications between the capital city and the provinces. Latent syphilis in both males and females also significantly increased during the observation period, similar to the increase observed for all syphilis notifications.

The significantly higher notification rates of females compared to males could be due to detection during medical examinations required for antenatal care. As latent syphilis is only detected through diagnostic tests after two years or more of infection,[8,9] there was a higher detection rate of latent male and female syphilis in the screening years, and the increase in proportions of non-pregnant women with syphilis in screening years suggest that there could be many undiagnosed syphilis cases among the population.

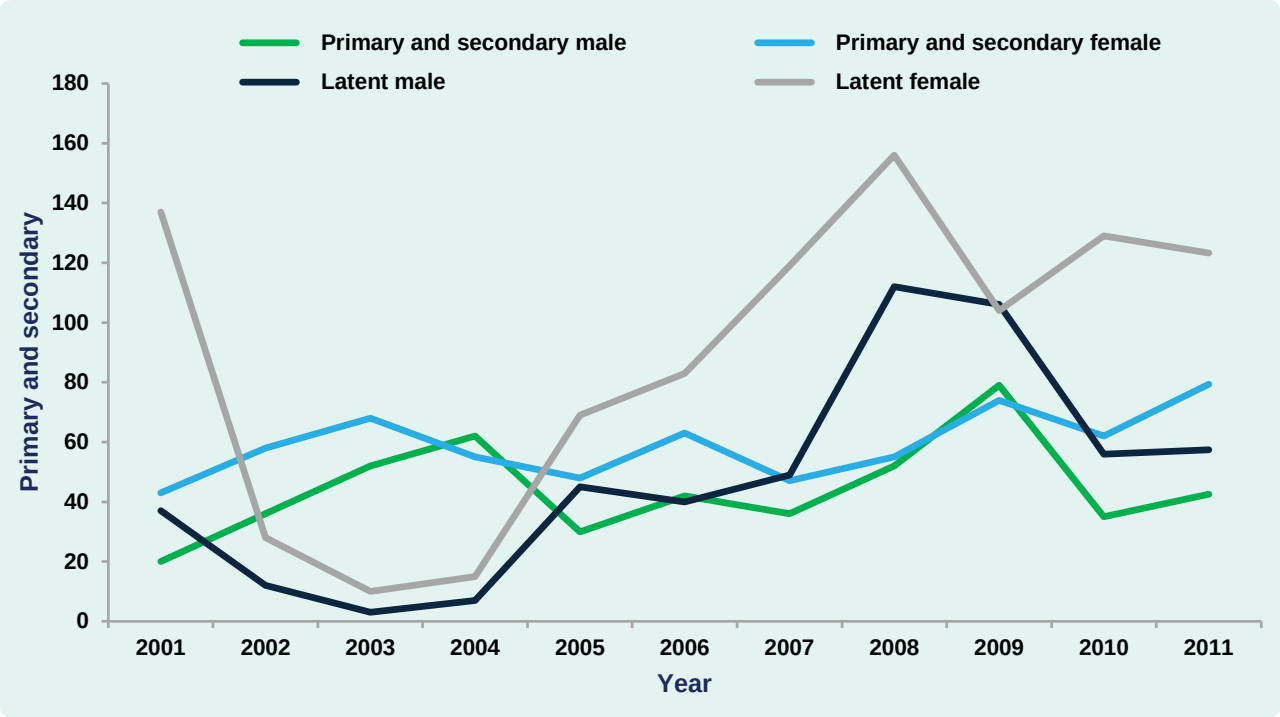
Syphilis notification rates were higher in Ulaanbaatar city compared to the provincial average. This may be related to the high population density,[11] a large sexually active population (including students and

Table 1. **Notification rate of syphilis per 100 000 by age group and year, Mongolia, 2001–2011**

Age groups	2001	2002*	2003*	2004*	2005	2006	2007	2008	2009	2010	2011
0–4	16	8	15	14	17	24	5	7	13	4	5.1
5–14	2	0	0	5	2	3	1	8	40	1	1.7
15–19	60	109	81	89	59	108	98	114	166	121	141.5
20–24	187				271	334	384	376	326	414	405.0
25–29	197	151	164	212	269	321	379	477	390	345	385.9
30–34	152				169	213	242	432	551	297	371.2
35–39	94	62	108	75	149	149	154	309	203	158	158.0
40–44	63				76	88	87	228	134	120	84.7
45–49	48	18	68	24	49	68	53	156	100	63	68.0
50–59	20				24	27	33	96	57	34	32.8
60 and above	4	3	1	1	8	6	4	21	22	6	12.5

* Data of some age groups were combined in the surveillance during the period 2002 to 2004.

Figure 7. **Notification rate of syphilis per 100 000 population by syphilis stage and sex, Mongolia, 2001 to 2011**



people of working age[12]) and a high concentration of risk groups including sex workers. It could also be due to the differences in use and access of health services including testing.

This analysis used secondary data collected from all levels of STI care and services in the surveillance system. The accuracy of secondary data is often not known. There can be overlap in the number of cases reported or missing data in some age groups. In this study, some cases of syphilis may have been reported more than once due to the complexity of differentiating between new and previous infections. There may also have been underreporting or misreporting of syphilis cases by some provinces, differences in laboratory testing and the quality of reports from health facilities. Also, STI cases receiving health care services in private clinics are not reported to the national surveillance system and potentially could lead to an underestimation in this analysis.

Despite of these limitations, this is the first analysis of syphilis notifications in Mongolia between 2001 and 2011, and these results will be used for future comparisons. Identifying the target population for screening programmes could offer an effective public health intervention for prevention and control among the population. Knowledge and awareness-raising campaigns targeted to those aged 15–24 years of age is recommended.

Conflicts of interest

None declared.

Funding

None.

References:

1. *Emergence of multi-drug resistant Nesseria gonorrhoeae – Threat of global rise in untreatable sexually transmitted infections*. Fact sheet. Geneva, World Health Organization, 2011 (http://whqlibdoc.who.int/hq/2011/WHO_RHR_11.14_eng.pdf,accessed 15 March 2012).
2. *Global prevalence and incidence of curable sexually transmitted infections*. Geneva, World Health Organization, 2001 (http://www.who.int/hiv/pub/sti/who_hiv_aids_2001.02.pdf, accessed 15 March 2012).
3. Chen ZQ et al. Syphilis in China: results of a national surveillance programme. *Lancet*, 2007, 369:132–138. doi:10.1016/S0140-6736(07)60074-9 pmid:17223476
4. *HIV and STI in Western Pacific Region 2000–2010.* Geneva, World Health Organization, 2012 (http://www.wpro.who.int/publications/2012/document_hiv_and_sti_2000-2010.pdf, accessed 21 December 2012).
5. *Regional Strategic Action Plan for the Prevention and Control of Sexually Transmitted Infections, 2008–2012*. Manila, World Health Organization Regional Office for the Western Pacific,

2008 (http://www.wpro.who.int/publications/docs/STIStrategy_FINAL30May2008.pdf, accessed 15 March 2012).

6. *Sexually transmitted infections prevalence survey among antenatal attendees*. Ulaanbaatar, Ministry of Health Mongolia, 2008.
7. *Strategic evaluation on improving quality of diagnosis and treatment of STIs*. Ulaanbaatar, STI and AIDS Department, National Center for Communicable Diseases, 2008.
8. *National Guideline on STIs and HIV/AIDS care and services.* Ulaanbaatar, Ministry of Health, Mongolia, 2010.
9. *The International Classification of Diseases 10th edition.* Geneva, World Health Organization, 2010 (http://www.who.int/classifications/icd/en/, accessed 10 December 2012).
10. Cuzick JA. A Wilcoxon-type test for trend. *Statistics in Medicine*, 1985, 4:87–90. doi:10.1002/sim.4780040112 pmid:3992076
11. *Mongolian Statistical Yearbook – 2011*. Ulaanbaatar, National Statistical Office of Mongolia, 2012.
12. *Statistical Indicators – 2011*. Ulaanbaatar, Ministry of Education Mongolia, 2012 (http://www.mecs.gov.mn/data/statistik/Books/2012/2012_Leaflet.pdf, accessed 17 December 2012).

Western Pacific Surveillance and Response Instructions to Authors

ABOUT WPSAR

The aims of WPSAR are:

1. to provide an open access journal to publish articles on the surveillance of and response to public health events and emergencies in the WHO Western Pacific Region and in areas with relevance to the Western Pacific Region; and
2. to build capacity in communicating epidemiological and operational research within the WHO Western Pacific Region.

Our objectives are:

1. to provide a platform for people working in surveillance and response in the Western Pacific Region to share their scientific and operational findings;
2. to publish a broad range of articles not limited to conventional research articles:
   - to disseminate short reports on outbreak investigations;
   - to publish analyses of surveillance data on communicable diseases;
   - to encourage the publication of evaluations of new and existing surveillance systems;
   - to promote the use of risk assessment for public health by facilitating risk assessment articles;
   - to support preparedness and response to public health events and emergencies through the dissemination of lessons learnt from such events; and
3. to build capacity in communicating epidemiological and operational findings in the Western Pacific Region through pre-submission assistance.

Scope

WPSAR covers all activities related to the surveillance of and response to public health events and emergencies, with a focus on topics that are relevant to the Western Pacific Region. Public health events may be acute or ongoing and can fall under any of the following areas: communicable diseases, natural disasters, bioterrorism, and chemical and radiological events. Other events and topics may also be considered. Response activities include those for acute events, e.g. responding to natural disasters, or for response to cases or epidemics of disease.

Why publish in WPSAR?

WPSAR is not limited to conventional research. It publishes a broad range of articles, including short outbreak investigation reports, lessons from the field, analyses of surveillance data, evaluations of surveillance systems and risk assessments for public health events. There are limited opportunities to publish these types of articles in other journals. We also accept the more traditional original research, perspectives and case reports/case series articles.

WPSAR is an open access journal, meaning it is free of charge for both readers and authors. It is also a continuous publication, which means articles are published as soon as they have completed the review and editing process.

WPSAR accepts all articles that fit the scope of the journal and that meet the minimum publication standards. We are especially interested in field epidemiology and operational research.

WPSAR also aims to build capacity in scientific writing and encourages submissions from authors with little or no experience in publishing in peer-reviewed journals. The Coordinating Editor often works with new authors on their submissions to ensure that articles fit the scope of WPSAR and meet the minimum standards for publication.

INSTRUCTIONS TO AUTHORS FOR ARTICLE WRITING AND SUBMISSION

WPSAR follows the guidelines of the *Uniform Requirements for Articles Submitted to Biomedical Journals by the International Committee for Medical Journal Editors* (ICMJE).

Formatting guidelines

Please submit your article in a Microsoft® Office Word file or a compatible file in English. Double-spaced, 12-point Arial font should be used to format your article. Please remove all automatic formatting including automatic numbering and referencing before submitting.

The format of the article will depend on the article type. Please see below for specific instructions per article type.

Outbreak Investigation Report

A short article describing a field or outbreak investigation including how it was detected, investigated and controlled. Rapid risk assessments undertaken during these investigations are also encouraged. These articles may be considered for rapid publication.

- Structured article with an abstract of ≤ 250 words and sections for introduction, methods, results and discussion
- Structured abstract with sections for objective, methods, results and discussion
- Word limit: ≤ 1500 words
- ≤ 15 references
- ≤ 2 figures/graphs/pictures

More comprehensive investigations can be submitted as Original Research.

Surveillance Report

A summary and interpretation of surveillance data over a given period of time. A description of the surveillance system and the limitations of the data collected must be included.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 10 figures/graphs/pictures

Surveillance System Implementation/Evaluation

An article describing the implementation of a new surveillance system or an evaluation of an existing surveillance system used to detect public health events.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Risk Assessments

An article detailing a risk assessment of a public health threat or event.

- Structured article with an abstract ≤ 250 words and sections for introduction (including risk question/s), risk assessment methodology, results, discussion and recommendations
- Structured abstract with objectives, method, results and discussion
- The results should include an assessment and/or characterization of the hazard, exposure and context, as well as the level of risk or risk characterization. The limitations must also be included. Risk management may be included in the discussion.
- Word limit: ≤ 3000 words
- ≤ 30 references
- ≤ 3 figures/graphs/pictures

Original Research

Original research articles may include epidemiological studies including outbreak investigations.

- Structured article with an abstract of ≤ 250 words and sections for introduction, methods, results and discussion
- Structured abstract with objective, methods, results and discussion
- Word limit: ≤ 3000 words
- ≤ 40 references
- ≤ 5 figures/graphs/pictures

Lessons from the Field

An article describing a problem faced in field epidemiology or during a public health event and the experience in trying to overcome the problem.

- Structured article with an abstract ≤ 250 words and sections for problem, context, action, lesson(s) learnt or outcome and discussion
- Structured abstract with the headings of problem, context, action, lesson(s) learnt and discussion
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Perspectives

An unstructured article discussing an issue regarding the surveillance of and response to public health events. The scope of the discussion must be clearly defined.

- Word limit: ≤ 1000 words
- ≤ 10 references
- ≤ 1 illustration

Case Report or Case Series

An unstructured article describing an unusual case or series of cases of public health significance. Subheadings may be used to increase the readability of the article.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Regional Analysis

An article providing an analysis of a topic for the Western Pacific Region, typically authored by WHO staff as part of their routine work on behalf of Member States. Regional Analyses do not undergo peer review.

Letter to the Editor

A letter commenting on a previously published article OR a letter commenting on the theme of the issue. Letters do not undergo peer review.

- Word limit: ≤ 500 words
- ≤ 5 references
- ≤ 1 illustration

News, Meeting and Conference Reports

News items and meeting and conference reports do not undergo peer review. Please contact the Coordinating Editor at WPSAR@wpro.who.int if you intend on submitting such an article.

Illustrations

Refer to the article type for the limit on illustrations (figures/graphs/pictures). Please insert all illustrations at the end of the article with titles. Each illustration must be referred to in the text and must be understood on its own. Use Microsoft® Office Excel for graphs and Microsoft® Office Word for tables and diagrams. Additionally, please provide a Microsoft® Office Excel spreadsheet of the data used to create a graph. Footnotes should be placed under the illustration and should use the following symbols in superscript format: *, †, ‡, §, ‖, **, ††, etc.

References

Reference the most recent and relevant publications. Please use the Vancouver referencing style with in-text citations and a bibliography at the end of the text. Sample references can be viewed on the National Institutes of Health website.

Place the bibliography at the end of the article text and not as footnotes. Write journal names in full. Use superscript sequential numbering for citing references in the text. Place the number after any punctuation. For example:

> These results are consistent with the original study.[11]

Reference personal communication in the text only and include the person's full name and institution.

Caution should be used in referencing websites; it should be done only when their content has been substantially described in the article.

Peer review process

Every article is initially screened by the Editorial Team to ensure it fits the scope of the journal. All articles, with the exception of regional analyses, letters to the editor, news items and meeting and conference reports, then undergo external peer review by two reviewers. This blind peer review process ensures that the reviewer does not know the identity of the author(s) and the author(s) do not know the identity of the reviewer. Significant effort is made to make this process timely, but since it relies on the availability and cooperation of persons external to the journal, it can take considerable time.

Upon receipt of the reviews, the Coordinating Editor assesses the comments and recommendations made by the reviewers, and then decides on the outcome of the peer review process. One of four options will be chosen: accept submission, accept with revisions, submit for review, or decline submission. The corresponding author will be advised of this outcome.

If the article has been accepted or accepted with revisions are required, you will be invited to revise your article according to the reviewer comments. A separate MS Word document outlining how you addressed each of the reviewer comments is also required. You must indicate the page and paragraph numbers where the changes were made and should provide reasons for not making a suggested change. Both the changes and reasons will be assessed

against the reviewer comments by the Coordinating Editor and may require further clarification from the authors. Once all comments have been adequately addressed, the article will commence the publication process.

If the outcome of the review process is "submit for review", then the same process is followed. However, the resubmitted article and responses to the reviewer comments are sent back to the original reviewers for another round of peer review. You will be asked to respond to a second round of reviewer comments, which will again be assessed by the Coordinating Editor. Once both sets of reviewer comments have been adequately addressed, the article will commence the publication process.

The publication process comprises rigorous editing for content and style by an external technical editor, followed by layout and proofreading. Authors may be asked to provide further information or clarifications during these stages. An article is not formally accepted for publication until these stages have been completed and approval has been granted by the Editorial Team. The authors will also have an opportunity to approve the final proof prior to publication on the WPSAR website. The article will be batched with others in the next quarterly issue.

Authorship

As per the International Committee of Medical Journal Editors (ICMJE), all authors should have contributed significantly to the article through one or more of the following in each category A, B and C:

A

- Study design
- Data collection
- Data analysis
- Data interpretation

B

- Drafting the article
- Critically revising the article

C

- Final approval of the article for submission

Any other contributors may be listed in the Acknowledgements section.

Acknowledgements

Contributors who do not fulfil the authorship requirements may be acknowledged. Permission from all contributors in the acknowledgement section should be sought. We assume that permission has been granted and will not follow up with the authors to confirm.

Ethics and permissions

It is the responsibility of authors to gain appropriate ethics approval for their work. A statement of ethics approval obtained or an explanation of why ethics approval was not required should be included for all articles during the submission process.

License for publication

Prior to publication, all authors are asked to sign a licence to publish that grants exclusive copyright license to the World Health Organization.

Conflicts of interest

A conflict of interest is defined by ICMJE as "when an author or author's institution, reviewer, or editor has financial or personal relationships that inappropriately influence (bias) his or her actions". Conflicts of interest may be financial, institutional, research or personal. A relationship does not always represent a conflict of interest and does not necessarily preclude publication in WPSAR. All authors and reviewers will be required to state any potential conflicts of interest, which will be assessed by the Editorial Team.

Funding

Authors will be required to state the sources of funding for their work.

Photographs for cover

If authors have taken photographs that are relevant to their article, they may be submitted for consideration for publication on the cover of the issue. Submission of a photograph does not guarantee its publication.

Language

Articles should be written in English. Authors who require assistance with preparing their articles in English should contact WPSAR at WPSAR@wpro.who.int. Once published, all abstracts and most articles are translated into Chinese.

Article submission process

Submit articles to the Coordinating Editor through the online journal management system on the WPSAR website. When submitting the article, you will be requested to provide the following:

- a cover letter describing the article and why it should be published;
- a title page with:
  - the article title,
  - a short title,
  - a brief description of the article of ≤ 50 words,
  - ≤ 7 keywords,
  - full names of all authors and institutions,
  - full contact details of the corresponding author,
  - data in an MS Excel spreadsheet for any graphs
  - names and e-mail addresses of two suggested reviewers (optional but recommended);
- acknowledgements, conflicts of interest, ethics statement and funding information (attached as a separate file to ensure a blind review);
- an MS Word file or equivalent of the article; and
- a scanned copy of the WPSAR licence for publication signed by all authors.

With the online journal management system, you will be able to track the progress of your article through the editorial process. If you encounter any difficulties with this system, please refer to our *WPSAR online journal system – User guide for authors*.

Corrections

If authors of a published article become aware of any errors with the article, they should contact the Coordinating Editor at WPSAR@wpro.who.int. Corrections will be published online.

Acknowledgement to WPSAR reviewers 2010-2012

The WPSAR Editorial Team is grateful to all reviewers that have contributed their time and expertise to peer-review our articles. We thank them for their support. Our apologies to those reviewers we may have inadvertently missed.

Our reviewers for articles published in 2012 were:

Bernadette Abela-Ridder; Bijay Adhikari; Phamh Anh; Martha Anker; Jantsansengeegiin Baigalmaa; Arindam Basu; Frank Beard; Steve Bice; Saraswathi Bina Rai; Marc Bulterys; Grazia Caleo; Scott Cameron; Deon Canyon; Junshi Chen; Maria Concepcion Roces; Tim Dallman; Emma Denehy; Georgina Dove; Paul Dunstead; David Durrhiem; Carol El Hayak; Dan Ewald; Emily Fearnley; James Fielding; Simon Firestone; Greg Flaherty; Ruth Foxwell; Pascale Frison; Katherine Gibney; Sally Gilbert; Nina Gloriani-Barzaga; Katy Harker; John Harris; Jason Harris; Aeron Hurt; Yuan Hutin; Pauline Kaye; Heath Kelly; Angela Kelly; Lillian Kent; Martyn Kirk; Shalomie Kiruba Shadrach; Kamal Kishore; Paul Kutsutani; Karin Lalor; Irwin Law; Jo Lawrence; Peter Leggat; Raymond Lin; Mary Louise McLaws; Chris Lowbridge; Ye Ma; Peter Massey; Amaya Maw-Naing; Patrick Maywood; Lisa McCallum; Marie McGrath; Michelle McPherson; Eric Mintz; Lertworapreecha Monthon; Rodney Moran; Maria Nerissa Dominguez; Sha'ari Ngadiman; Daxin Ni; Nao Nukiwa; Pagbajabyn Nymadawa; Makoto Ohnishi; S Okado; Amy Parker; Minal Patel; Mahomed Patel; Hai Phung; Z Qiaoli; Wiwat Rojanapithayakorn; James Rudge; Edward Ryan; Gina Samaan; Genesis Samonte; Micheal Samuel; Rossi Sanusi; Surakaw Aokaew; Connie Schmalijohn; Nicole Seguy; Craig Shadbolt; Varatharajan Shanthi; Liu Shusen; Greg Simmons; Tim Sly; Chris Sturrock; Anita Sulieman; Satowa Suzuki; Motoi Suzuki; Kenichiro Taneda; Jeanette Teo; Betsy Todd; Kuramansamy Verasingam; Mary Volcanis; Xiong Weiyi; HK Wong; Weigong Zhang; Pengfei Zhao

Our reviewers for articles published in 2010-2011 were:

John Aaskov; Peter Aitken; Ranil Appuhamy; Steve Bice; Frances Birrell; Julia Brotherton; Philippe Buchy; Scott Cameron; Lee Ching Ng; Stephanie Davis; Marcel Dubouloz; Rodger Duran; David Durrheim; Keith Eastwood; Andrea Forde; Ruth Foxwell; Sally Gilbert; Yvan Hutin; Andrew Jardine; BK Kapella; Heath Kelly; Chee Khoeng Chong; A Kimball; Sabra Klein; Sabra Klein; Karin Lalor; Stephen Lambert; Peter Leggat; Chris Lowbridge; Danielle Luliano; Ann Marie Kimball; Peter Massey; Lisa McCallum; Mike Nunn; Shinji Okada; Mahomed Patel; Minal Patel; Bev Paterson; Hai Phung; Scott Ritchie; Andy Robertson; Christina Rundi; Sharon Salmon; Vicki Slinko; Matt Thomas; Angela Wakefield; Andy Way; Peter Whelan; Wenwu Yin; Khalija Yusof; Weigong Zhang; Weigong Zhou

World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

wpsar@wpro.who.int | www.wpro.who.int/wpsar