World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

Volume 6, Number 2, 2015, Pages 1–93
p-ISSN: 2094-7321 e-ISSN: 2094-7313

(continued on the next page)

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/en

Western Pacific Surveillance and Response

Open access journal with continuous publication

Western Pacific Surveillance and Response (WPSAR) is an open access journal dedicated to the surveillance of and response to public health events. The goal of the journal is to create a platform for timely information sharing both within our region and globally to enhance surveillance and response activities. WPSAR is a continuous publication which means articles will be published online as soon as they have completed the review and editing process. Every three months articles will be batched for a print issue. It is a publication managed by the World Health Organization Regional Office for the Western Pacific.

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

A readership survey of *Western Pacific Surveillance and Response Journal*

Michelle McPherson,[a] Elizabeth Mangali,[a] James Fielding,[b] Joy Gregory[a] and Ailan Li[c]

Correspondence to the Coordinating Editor (email: WPSAR@wpro.who.int).

We established the *Western Pacific Surveillance and Response Journal* (WPSAR) in 2010 to increase the dissemination of data from surveillance systems in the Asia Pacific region as part of the Asia Pacific Strategy for Emerging Diseases.[1] WPSAR was to provide a platform for people working in surveillance and response in the Western Pacific Region to share scientific and operational findings and publish a broad range of articles not limited to conventional research articles.

In mid-2014, four years after the first issue of WPSAR, an online survey of WPSAR subscribers was conducted to assess the impact, network and visibility of WPSAR in the region to determine if these objectives had been met. Based on a similar survey undertaken by Eurosurveillance in 2011,[2] we sought to understand the WPSAR audience more comprehensively, how the journal is used and readers' expectations. The WPSAR readership survey link was emailed to the 514 registered subscribers, and 25% responded.

The readership survey indicated that the profile, visibility and readership of WPSAR is growing; nearly half of the responders reported reading their first WPSAR article in the previous 12 months. The journal also has considerable reach to 28 countries around the world, with more readers from Australia and the Philippines. Respondents worked in 16 countries from the World Health Organization's Western Pacific Region with others in Africa, Europe, South-East Asia and North America. Most of our readers work in public health practice and/or field epidemiology as epidemiologists, disease surveillance officers and public health specialists primarily for government, academic institutions or for public health organizations – our targeted audience.

Responses generally indicated satisfaction with the content, delivery, operation and expectations of WPSAR, and the journal is regarded as useful. Originality of content and timeliness were not rated as high; the latter is surprising as we take an average of only three months to publish our articles from their submission. We were pleased that our articles were rated as easy to read with clear figures, tables and illustrations; that there is an ease of access; and that expectations of the journal rated high.

That the journal is indexed in PubMed and has a regional scope were important for attracting manuscripts and readership, but further improvement by having an impact factor was a common theme. We are currently being evaluated for an impact factor and look forward to the result. That two thirds of respondents were aware that WPSAR is indexed on PubMed is encouraging, as is the 2000 times a month WPSAR articles are accessed through PubMed.[3]

A wide range of article types is included in WPSAR such as outbreak investigations, surveillance reports and evaluations and lessons from the field. This is in addition to the more standard original research articles. Although there has been an even distribution of these different article types in WPSAR, more than half of survey responders reported they read outbreak investigation and surveillance reports the most, suggesting that our second objective is being met.

At the time of the survey, 14 issues of WPSAR had been published comprising 101 non-editorial articles with 43 different subjects addressed. The most common of these were influenza, dengue, emergency response and tuberculosis; these topics are most likely linked

[a] WPSAR Editorial Team, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

[b] Emerging Disease Surveillance and Response Unit, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

[c] WPSAR Executive Editor, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

Published: 18 June 2015
doi: 10.5365/wpsar.2015.6.2.008

to our original policy of assigning themes to issues prospectively. All four topics were an assigned theme – for example, the emergency response articles refer to a themed issue on the Great Japan Earthquake. Since 2014, the number of non-themed submissions has increased, and we now publish a broader range of topics.

It was also noted that most of the WPSAR articles were on infectious diseases (with the exception of the 'Great East Japan Earthquake' issue), even though the scope of WPSAR is all activities related to the surveillance of and response to public health events and emergencies. As WPSAR represents a Region with an alarming number of disasters, including regular typhoons in the Philippines and the recent earthquake in Vanuatu, we encourage submissions on responding to these events. In fact we will be publishing a special issue on responding to Typhoon Haiyan later this year.

There were two suggestions from the survey that corroborate our long-term strategy for WPSAR. That very few respondents – even among the relatively few Chinese speakers who participated in the survey – knew that WPSAR is published in Mandarin suggests that we can greatly increase our visibility in China. Also, several respondents suggested broadening the scope of WPSAR to include noncommunicable diseases which is part of our existing long-term future.

Although we are pleased with the results of the survey that suggest that WPSAR is meeting its objectives, we recognize that the sample size may not be representative of all our subscribers or all those who read our articles either on PubMed or from our own website. However, our response rate of 25% does favourably compare to that of others journals which ranged from 7% to 43%.[3–8]

Therefore, in the relatively short time since its inception, WPSAR has established itself as a good quality regional journal that is well regarded by its readership. That two thirds of readers think it is fulfilling its role for timely sharing of information and that there is a wide range of article types and topics being published suggest that we are meeting our objectives of providing a platform for information sharing in surveillance and response in the Western Pacific Region.

We thank the survey responders and all of our subscribers, authors and reviewers: without you there would be no WPSAR. We look forward to WPSAR continuing to be the platform for publishing your surveillance and response work.

References:

1. *Asia Pacific Strategy for Emerging Diseases. (2005).* Manila, World Health Organization Regional Office for the Western Pacific, 2005 (http://www.wpro.who.int/emerging_diseases/documents/APSED_final_endorsed_and_edited_by_EDT-map_removed_FORMAT-20/en/, accessed 5 June 2015).
2. Steffens I. The Eurosurveillance reader survey – what's next? *Euro Surveillance: European Communicable Disease Bulletin*, 2011; 16: pii= 20014 (http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20014, accessed 15 May 2015).
3. *PubMed Central Publisher Services*. Maryland, National Institutes of Health, 2015.
4. Stein KF. Readership survey results. *Journal of the American Psychiatric Nurses Association*, 2008, 14:33–35. doi:10.1177/1078390307313916 pmid:21672878
5. Haines GR, Hillman BJ. The 2012 JACR readership survey. *Journal of the American College of Radiology: JACR*, 2013, 10:234–236. doi:10.1016/j.jacr.2013.01.010 pmid:23545080
6. Joshua E. Readership survey 2011. *Journal of Oral and Maxillofacial Pathology*, 2012, 16:1–3. doi:10.4103/0973-029X.92964 pmid:22438636
7. Starr S. Journal of the Medical Library Association readership survey. *Journal of the Medical Library Association: JMLA*, 2013, 101:167. doi:10.3163/1536-5050.101.3.001 pmid:23930083
8. Day PC. Readership survey 2013: what you think about our journal. *Aviation, Space, and Environmental Medicine*, 2013, 84:639–641. doi:10.3357/ASEM.3720.2013 pmid:23745295

The use of social media in public health surveillance

Isaac Chun-Hai Fung,[a] Zion Tsz Ho Tse[b] and King-Wa Fu[c]
Correspondence to Isaac Chun-Hai Fung (email: cfung@georgiasouthern.edu).

Social media are broadly understood as a set of online activities that facilitate interpersonal communication, information sharing, collaboration or crowdsourcing among online users. They have become a global phenomenon with over two thirds of worldwide adult Internet users being active on social networking sites in 2014.[1]

Social media are increasingly harnessed for public health and can be used as communication tools to disseminate disease risks and interventions and to promote healthy lifestyles and health policies. There is also the potential use of social media as data sources for public health surveillance. While social media will likely never replace traditional data sources for disease surveillance, they can provide complementary information. However, social media data are, in essence, observational data of online communications and were not designed for public health purposes. Analyses of social media data are subject to limitations that are generally associated with observational studies, i.e. possible confounding factors and no causal conclusion.

Following is a brief overview of some of the uses of social media data for public health surveillance and some of the data's strengths and limitations.

USING SOCIAL MEDIA FOR PUBLIC HEALTH SURVEILLANCE

There are three major applications for social media in public health surveillance: epidemiologic monitoring and surveillance, situational awareness during emergency response and communication surveillance (**Table 1**).

Epidemiologic monitoring and surveillance

For epidemiologic monitoring and surveillance, social media can be used to perform three specific functions:

Monitoring and retrieving official information

Public health officials use social media to monitor official information released by foreign authorities and to monitor domestic official accounts as these can be more timely, which is important in emergency responses (**Table 1**).[2,3]

Disease detection

Social media and other population-based digital platforms provide additional data sources for public health surveillance to detect disease outbreaks and estimate disease incidence. Syndromic surveillance can be undertaken by detecting symptoms disclosed by individuals on social media for non-public health purposes by either human readers or computer algorithm,[4] or through participatory epidemiology where applications allow participants to self-report their symptoms to disease-specific digital surveillance systems.[5,6] Diseases may also be detected via event-based surveillance as unofficial information or rumours about a new disease may circulate on social media, as in the case of a medical record of an H7N9 patient uploaded to Weibo in 2013.[7] Print media, radio and television may pick these up and generate news stories that are also circulated on social media and may be detected by event-based surveillance systems that monitor digital news feeds for disease news (e.g. HealthMap).[8] Digital data sources also provide epidemiologists with additional means to detect, investigate and verify outbreaks.

[a] Department of Epidemiology, Jiann-Ping Hsu College of Public Health, Georgia Southern University, Statesboro, Georgia 30460-8015, United States of America.
[b] College of Engineering, The University of Georgia, Athens, Georgia 30602, United States of America.
[c] Journalism and Media Studies Centre, The University of Hong Kong, Hong Kong Special Administrative Region, China.
Submitted: 3 March 2015; Published: 26 June 2015
doi: 10.5365/wpsar.2015.6.1.019

Table 1. **Summary of the uses of social media in public health surveillance**

Application	Purpose and scenario	Public health information to retrieve, detect or predict	Data targeted	Function of social media	Examples
1. Epidemiologic monitoring and surveillance					
(a) Monitoring official information	To monitor official information	Disease incidence and other case details	Links to original sources of official data	News feed	Retrieval of official information via Weibo during the 2013 H7N9 outbreak[2,3]
(b) Disease detection – syndromic surveillance	To detect outbreaks and to estimate disease incidence	Disease incidence and other case details	Self-reported symptoms	Syndromic surveillance	Twitter tweets of self-disclosed symptoms of influenza infection;[4] self-reports of symptoms via specialized apps[5,6]
(c) Disease detection – event-based surveillance	To detect outbreaks and to estimate disease incidence	Disease incidence and other case details	Media reports, unofficial information or rumours used as proxy measurable outcomes	Event-based surveillance (epidemic intelligence)	Unofficial information released on Weibo about an H7N9 patient;[7] systems that pick up news related to health events (e.g. HealthMap)[8]
(d) Timely estimates and forecasting of disease incidence	To provide timely estimates of current disease incidence or forecast future disease incidence	Disease incidence: start, peak and intensity	Social media text with keywords (diseases or symptoms) that correlate with disease incidence	As data sources for timely estimates or forecasts of disease incidence	US seasonal influenza estimates using Twitter data;[4] disease estimation and forecasts using Wikipedia access log;[9] US seasonal influenza forecast using Google Flu Trends[11]
2. Situational awareness					
(a) Surveillance for situational awareness	Humanitarian crises, usually natural disasters, e.g. typhoons and earthquakes	Reported needs (e.g. water supply and shelter)	Self-reported humanitarian needs	Information feed on humanitarian needs	Earthquake and tsunami in East Japan[10] and earthquake in Haiti[11]
3. Communication surveillance					
(a) Global awareness	To measure social media users' reactions to an outbreak situation	Media news reports, rumours, sentiments, awareness	User-generated data that reflect their knowledge, attitudes and perception of public health events	Monitoring of the general public's awareness and perception	Awareness of Ebola;[14] sentiment towards influenza vaccine[15]
(b) Specific reactions	To measure social media users' reactions to health promotion messages or events	Reception of particular public health messages	User generated data that are reactions to particular public health messages	Monitoring of the general public's reaction to specific public health messages	Breast cancer awareness month[16]

Timely estimates and forecasting of disease incidence

Epidemiologists are exploring ways to use social media and other digital data to provide timely estimates and forecasts of disease incidence. For example, Twitter data pertaining to influenza could facilitate timely incidence estimates as they were found to correlate with seasonal influenza data in the United States of America (USA).[4] Wikipedia access log data were also found to have potential for forecasting certain infectious diseases in some countries.[9] However, Google Flu Trends underperformed in comparison with the USA sentinel influenza-like illness surveillance system (ILI-Net) and a New York City syndromic surveillance system.[10] Advanced forecasting methods are also under development, with some using digital data as experimental inputs.[11]

Situational awareness during emergency response

Social media can be used following natural or man-made disasters to increase situational awareness of humanitarian crises. Individuals in distress can use social media to seek help and to connect with family, friends and emergency responders. The authorities can use social media to identify individuals in distress and to respond accordingly. Nongovernmental organizations can also use social media to track and map the needs of

displaced people, as seen with the 2011 earthquake and tsunami in Japan,[12] and the 2010 Haitian earthquake.[13]

Communication surveillance

Global awareness

Social media data can also provide measures of global awareness of disease outbreaks. Complementary to more traditional methods, social media trends can help to quantify changes in disease awareness,[14] and sentiments towards treatments and preventive interventions.[15]

Reaction to public health campaigns and messages

Analyses of social media data pertaining to specific health-promotion events can provide useful insights to public health professionals as they evaluate their campaigns.[16]

STRENGTHS AND LIMITATIONS OF SOCIAL MEDIA DATA

In societies where penetration of social media is high, analyses of social media data can be compared to large-scale observational population-based epidemiologic studies. Public health researchers can have access to user-generated content from millions of users worldwide. However, given the inherent observational nature of social media data, their analyses are subject to many limitations. For example, selection bias may exist as social media users and non-users may differ. Privacy settings on social media may restrict data access to some individuals. Personal information of social media users is often self-disclosed and difficult to verify. There could also be observer effects, as the awareness of Internet surveillance and the fear of retribution may render social media users unwilling to share epidemiologic information, especially in countries where real-name registration of social media is required.[17]

The balance between sharing public health information and protecting citizens' privacy remains an ethical challenge for public health agencies. Given these concerns, many public health-related social media studies have been conducted using only publicly accessible data. However, their generalizability remains a question because often people prefer to communicate health-related issues privately.

CONCLUSIONS

Social media offer both opportunities and challenges to public health professionals. Social media data can allow public health officials to monitor information, detect potential outbreaks, forecast disease trends, monitor emergency situations and gauge disease awareness and reactions to official health communications. Questions remain as to how to best analyse social media data for public health surveillance. Public health agencies need to clearly define the purposes of the surveillance systems, the scope of social media data to be used and how the data should be analysed.

Conflicts of interest

None declared.

Funding

None.

Acknowledgement

We thank Dr Scott Santibañez for his comments on the early versions of this manuscript.

References

1. Mander J. *GWI Social: GlobalWebIndex's quarterly report on the latest trends in social networking (Q4 2014)*. London, GlobalWebIndex, 2015.
2. Fung IC-H, Wong KK. Efficient use of social media during the avian influenza A(H7N9) emergency response. *Western Pacific Surveillance and Response Journal*, 2013, 4(4):1–3. doi:10.5365/wpsar.2013.4.3.005 pmid:24478916
3. Zhang EX et al. Leveraging social networking sites for disease surveillance and public sensing: the case of the 2013 avian influenza A(H7N9) outbreak in China. *Western Pacific Surveillance and Response Journal*, 2015, 6(2). doi:10.5365/wpsar.2015.6.1.013
4. Broniatowski DA, Paul MJ, Dredze M. National and local influenza surveillance through Twitter: an analysis of the 2012–2013 influenza epidemic. *PLoS ONE*, 2013, 8:e83672. doi:10.1371/journal.pone.0083672 pmid:24349542
5. Freifeld CC et al. Participatory epidemiology: use of mobile phones for community-based health reporting. *PLoS Medicine*, 2010, 7:e1000376. doi:10.1371/journal.pmed.1000376 pmid:21151888
6. Chunara R et al. Estimating influenza attack rates in the United States using a participatory cohort. *Scientific Reports*, 2015, 5:9540. doi:10.1038/srep09540 pmid:25835538
7. Salathé M et al. Influenza A (H7N9) and the importance of digital epidemiology. *The New England Journal of Medicine*, 2013, 369:401–404. doi:10.1056/NEJMp1307752 pmid:23822655

8. Brownstein JS, Freifeld CC. HealthMap: the development of automated real-time internet surveillance for epidemic intelligence. *Euro Surveillance: European Communicable Disease Bulletin*, 2007, 12(11):E071129.5. pmid:18053570

9. Generous N et al. Global disease monitoring and forecasting with Wikipedia. *PLoS Computational Biology*, 2014, 10:e1003892. doi:10.1371/journal.pcbi.1003892 pmid:25392913

10. Olson DR et al. Reassessing Google Flu Trends data for detection of seasonal and pandemic influenza: a comparative epidemiological study at three geographic scales. *PLoS Computational Biology*, 2013, 9:e1003256. doi:10.1371/journal.pcbi.1003256 pmid:24146603

11. Shaman J et al. Real-time influenza forecasts during the 2012–2013 season. *Nature Communications*, 2013, 4:2387. doi:10.1038/ncomms3837 pmid:23982432

12. Peary BDM, Shaw R, Takeuchi Y. Utilization of social media in the east Japan earthquake and tsunami and its effectiveness. *Journal of Natural Disaster Science*, 2012, 34:3–18. doi:10.2328/jnds.34.3

13. Zook M et al. Volunteered geographic information and crowdsourcing disaster relief: a case study of the Haitian earthquake. *World Medical & Health Policy*, 2010, 2:7–33. doi:10.2202/1948-4682.1069

14. Fung IC-H et al. Ebola and the social media. *Lancet*, 2014, 384:2207. doi:10.1016/S0140-6736(14)62418-1 pmid:25625391

15. Salathé M, Khandelwal S. Assessing vaccination sentiments with online social media: implications for infectious disease dynamics and control. *PLoS Computational Biology*, 2011, 7:e1002199. doi:10.1371/journal.pcbi.1002199 pmid:22022249

16. Thackeray R et al. Using Twitter for breast cancer prevention: an analysis of breast cancer awareness month. *BMC Cancer*, 2013, 13:508. doi:10.1186/1471-2407-13-508 pmid:24168075

17. Fu K-W, Chan CH, Chau M. Assessing censorship on microblogs in China: discriminatory keyword analysis and the real-name registration policy. *Internet Computing, IEEE*, 2013, 17:42–50. doi:10.1109/MIC.2013.28

A large outbreak of enterohaemorrhagic *Escherichia coli* O157, caused by low-salt pickled Napa cabbage in nursing homes, Japan, 2012

Ayako Tabuchi,[a] Taku Wakui,[a] Yuichiro Yahata,[b] Koichi Yano,[c] Kotaro Azuma,[c] Takuya Yamagishi,[b] Kazutoshi Nakashima,[b] Tomimasa Sunagawa,[b] Tamano Matsui[b] and Kazunori Oishi[b]

Correspondence to Yuichiro Yahata (e-mail: yahata@nih.go.jp).

Objective: In August 2012, an outbreak of enterohaemorrhagic *Escherichia coli* (EHEC) O157 infection was investigated by the City of Sapporo and Hokkaido Prefectural Government. The initial notification reported an illness affecting 94 residents of 10 private nursing homes distributed across multiple areas of Hokkaido, the northernmost island of Japan; at this time three cases were confirmed as EHEC O157 infection. The objectives of the investigation were to identify the source of infection and recommend control measures to prevent further illness.

Methods: A suspected case was defined as a resident of one of the private nursing homes in Hokkaido who had at least one of the following gastrointestinal symptoms: diarrhoea, bloody stool, abdominal pain or vomiting between 10 July and 10 September 2012. Cases were confirmed by the presence of Shiga toxin 1- and 2-producing EHEC O157 in stool samples of suspected cases. We conducted an epidemiological analysis and an environmental investigation.

Results: We identified 54 confirmed and 53 suspected cases in 12 private nursing homes including five fatalities. Of the 107 cases, 102 (95%) had consumed pickles, all of which had been manufactured at the same facility. EHEC O157 isolates from two pickle samples, 11 cases and two staff members of the processing company were indistinguishable. The company that produced the pickles used inadequate techniques to wash and sanitize the vegetables.

Discussion: Contaminated pickles were the likely source of this outbreak. We recommended that the processing company improve their methods of washing and sanitizing raw vegetables. As a result of this outbreak, the sanitation requirements for processing pickles were revised.

Enterohaemorrhagic *Escherichia coli* (EHEC) causes gastrointestinal illnesses, resulting in symptoms such as watery diarrhoea, bloody stool, vomiting and abdominal cramps/pain.[1] Among all reported EHEC cases, approximately 4% develop haemolytic uraemic syndrome (HUS) and around 0.5% are fatal.[2–4] The main route of EHEC transmission is via the ingestion of food contaminated with ruminant faeces.[5] In Japan, EHEC infection has been a notifiable disease since April 1999, with 3500–4500 cases reported annually between 2012 and 2014 of which 2600 were symptomatic cases.[2–4]

On 11 August 2012, a possible EHEC O157 outbreak affecting the residents of 10 private nursing homes was reported to the Public Health Office (PHO) of the City of Sapporo and Hokkaido Prefectural Government. These nursing homes provide daily support with household tasks such as cleaning, laundry and meals but not medical care. They are distributed across a wide area of Hokkaido, the northernmost island of Japan. By law, staff at all facilities record details of all meals consumed by residents.

The initial report stated that 94 residents were affected, including three confirmed EHEC O157 cases and one fatal case. The PHO requested that the investigation be supported by the National Institute of Infectious Diseases. The objectives of this investigation were to identify the source of infection and recommend control measures to prevent further illness.

[a] Field Epidemiology Training Programme of Japan, National Institute of Infectious Diseases, Tokyo, Japan.
[b] Infectious Diseases Surveillance Center, National Institute of Infectious Diseases, Tokyo, Japan.
[c] Public Health Office, City of Sapporo, Japan.
Submitted: 21 February 2014; Published: 16 April 2015
doi: 10.5365/wpsar.2014.5.1.012

METHODS

Case definition

A suspected case was defined as a resident of a nursing home in Hokkaido with at least one of the following gastrointestinal symptoms: diarrhoea, bloody stool, abdominal pain or vomiting between 10 July and 10 September 2012. A confirmed case was a suspected case in which Shiga toxin 1 and 2 (*stx*1 and *stx*2)-producing EHEC O157 was detected in stool sample.

Data collection and descriptive epidemiology

Public health nurses or food hygiene inspectors reviewed residents' food records and conducted interviews with each of the 588 nursing home residents and 417 staff members. Information was collected using a standardized questionnaire which included demographics (sex, age), symptoms, date of onset and exposure history (e.g. food consumption and contact with ill patients) within 14 days before the date of onset. Food items in the questionnaires were adjusted to the specific menu at each nursing home.

Environmental study

All nursing homes had their own kitchen for the preparation and cooking of three meals a day for residents. Staff from local public health centres conducted a trace-back investigation of uncooked food items served during the two weeks before the outbreak to determine common food suppliers.

On 28 August, an inspection of one of the food suppliers was conducted by the PHO in accordance with the Food Sanitation Act,[6] and the process of preparing the suspected food was replicated on-site on 7–8 September 2012. The concentration of sodium hypochlorite was monitored digitally.

Laboratory investigations

From each of the 12 nursing homes, faecal samples from all residents and mandatory stored food samples served from 24 July to 5 August 2012 were collected. Frozen food, environmental samples and stool samples from 12 staff members were also collected from the food supplier during the initial inspection as required by law.[6]

All samples were tested at Sapporo City Institute of Public Health and Hokkaido Prefectural Institute of Public Health. EHEC O157 isolation and Pulse-Field Gel Electrophoresis (PFGE) analysis were performed by Sapporo City Institute of Public Health, as previously described by Terajima et al.[7]

RESULTS

Descriptive epidemiology

There were 588 residents in the 12 nursing homes and 54 confirmed and 53 suspected cases (**Table 1**); the overall attack rate among residents was 18% (107/588). The median number of cases per nursing home was eight (range: 1–19 residents).

Of the 107 cases, 94 were women (88%) and the median age was 87 years (range: 72–102 years of age; **Table 1**). Among them, 106 (99%) reported diarrhoea and 74 (69%) had bloody stool. Two cases (2%) developed HUS and two (2%) developed acute encephalopathy. Five cases were fatal (case fatality rate: 5%); the median age was 95 years (range: 80–99 years of age). The onset of symptoms occurred during 3–17 August 2012, peaking on 7 August (**Figure 1**). No cases were reported after 17 August 2012. The median incubation period was six days (range: 2–16 days) from the time of exposure to the onset of gastrointestinal symptoms.

One particular brand of pickles, made by Company A, was the only uncooked food item served that was eaten at all 12 facilities. The pickles were packaged on 30 July by Company A and served on 1 or 2 August at each nursing home and had been consumed by 102 cases (95%). No other food items were commonly served in all facilities. None of the care staff at any of the nursing homes consumed foods served to residents.

Laboratory tests

Of the 338 residents of 12 nursing homes that had stool specimens collected, the *stx*1- and *stx*2-producing EHEC O157 strains (*eae* positive and *aggR* negative) were isolated in 81 residents. The clinical case definition was met by 54 of the 81 residents.

Stored pickles were collected from two of the affected nursing homes and *stx*1- and *stx*2-producing

Table 1. **Characteristics of subjects (*n* = 107)**

Characteristics	Median	Range
Age (years)	87	72–102
Incubation period (days)	6	2–16
	n	**%**
Cases (n = 107)		
Suspected cases	53	50
Confirmed cases	54	50
Sex		
Female	94	88
Male	13	12
Symptoms		
Diarrhoea	106	99
Abdominal pain	48	45
Bloody stool	74	69
Vomiting	9	8
Nausea	10	9
Fever	46	43
Seizure	1	1
Complications		
Haemolytic uraemic syndrome (HUS)	2	2
Acute encephalopathy	2	2
Deaths (case fatality rate)	5	5
Medical institution		
Admitted to hospital	87	81
Food consumption		
Pickles*	102	95

* Pickles, low-salt pickled Napa cabbage.

EHEC O157 were isolated from both samples. The samples had been packaged on the same day (30 July) by the same food processing company according to the delivery records.

Twelve staff members of Company A also had stool samples collected; three were positive for EHEC O157. These three staff members reported eating the pickles, after which they developed diarrhoea, soft faeces or abdominal cramps between 4 and 5 August.

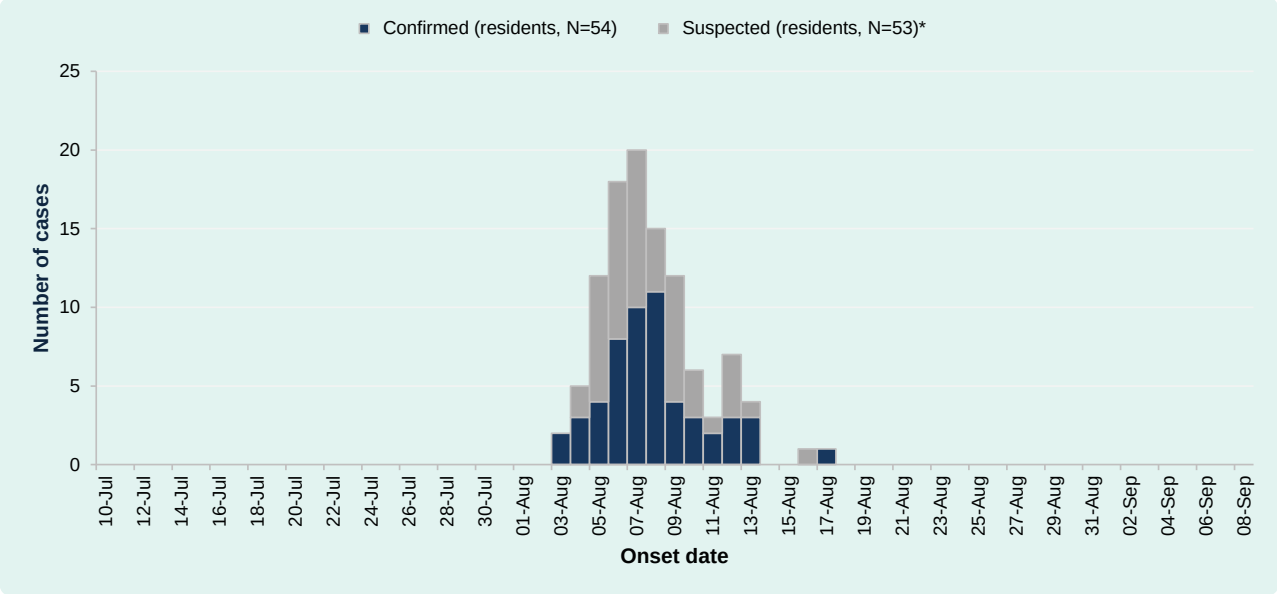
PFGE patterns from 11 stool samples from cases from six of the nursing homes, stool samples from two staff members of Company A and two pickle samples were indistinguishable.

Environmental study

The main ingredients of the pickles were Napa cabbage and salt with some cucumber and carrot. It took two days to prepare without a fermentation agent or vinegar. The product's salt content is low (2%) and is served without washing.

During the replication process at the processing plant several issues were identified with the processing of the pickles: (1) during washing, running water could not circulate effectively around the leafy vegetables in

Figure 1. **Epidemic curve of enterohemorrhagic *E. coli* O157 cases (*n* = 107*) at 12 nursing homes in Sapporo City and Hokkaido Prefecture, Japan, July to September 2012**



* Onset date of one case unknown.

the tank, and (2) the same sodium hypochlorite solution was used repeatedly about 10 times to sanitize the vegetables after washing; hence, the concentration of sodium hypochlorite gradually dropped (tank 1: from 250 mg/L to 100 mg/L; tank 2: 210 mg/L to 95 mg/L) during replication. The concentration of sodium hypochlorite was not checked or recorded at Company A during commercial production. Staff performed adequate hand hygiene procedures during production, including wearing gloves. Company A did not keep records on the source of the leafy vegetables or any other ingredients used in the manufacturing process, thus limiting the trace-back investigation.

Public health outcome

On 11 August 2012, Company A suspended production and performed a recall. On 12 October 2012, the Ministry of Health, Labour and Welfare (MHLW) revised the sanitation requirements for the processing of pickles.

DISCUSSION

This large common-source outbreak of *stx*1- and *stx*2-producing EHEC O157 was likely caused by the consumption of contaminated pickles at nursing homes. The pickles had been consumed by most cases, and most compelling, the same PFGE pattern was observed from nursing home cases, Company A cases and samples of the pickles.

That the onset dates of the cases from Company A occurred after the nursing home index cases were reported suggested that the staff members were not the source of infection or contamination. This is further confirmed by the adequate hygiene practice observed during the environmental investigation.

There have been similar outbreaks caused by low-salt pickles in Japan.[8] Tsukemono, a traditional Japanese food, has a high salt content (around 10%) and is a naturally fermented pickle. Low-salt pickles,[9] however, are very similar to tsukemono, but are not fermented. Low-salt pickles are becoming more common due to development of the cold chain during shipping and a general tendency of consumers to limit salt intake; however, they are similar to raw vegetables and therefore have a similar risk of cross contamination.[10,11] In Japan, national guidelines recommend not serving raw vegetables in school meals due to the risk of contamination of micro agents such as EHEC and salmonellosis.[12] However, nursing homes did not have such guidelines or regulations. As a result of this outbreak, we recommended that low-salt pickles should not be served in nursing home settings.

After this outbreak, the MHLW investigated the processing of low-salt pickles and found that only 6% of processing companies washed raw vegetable materials.[13] As a result, on 12 October 2012, the MHLW revised the guidelines for the preparation for low-salt pickles and added the importance of sufficient washing and sanitization.

This investigation collected retrospective data and so there could have been some susceptibility to recall bias. As there was only one food common to all facilities, which was consumed by 95% of cases, an analytical study of food items was not warranted, especially as the laboratory evidence pointed to the pickles.

In conclusion, this outbreak was most likely caused by EHEC O157-contaminated pickles served at nursing homes. We recommend that raw foods not be served to vulnerable members of the population such as elderly people.

Ethics statement

The investigation was conducted in accordance with the Food Sanitation Act.

Conflicts of interest

None declared.

Funding

This investigation was supported by a grant from the Ministry of Health, Labour and Welfare, Japan.

Acknowledgements

We thank the Public Health Office of the City of Sapporo, Sapporo City Institute of Public Health, Hokkaido Prefectural Government, and Hokkaido Prefectural

Institute of Public Health for their assistance in the epidemiological investigation and laboratory tests. We also thank Sunao Iyodad, Jun Terajima, and Makoto Ohnishi of the Department of Bacteriology I, National Institute of Infectious Diseases, Japan for advice and technical assistance.

References:

1. Fontain O et al. Diarrhea caused by enterohemorrhagic strains. In Heymann DL, editor. *Control of communicable diseases manual*. 19th ed. Washington DC, American Public Health Association, 2008, pp 181–186.
2. National Institute of Infectious Diseases. Enterohemorrhagic *Escherichia coli* infection in Japan as of April 2012. *Infectious Agents Surveillance Report*, 2012, 33:115–116 (http://www.nih.go.jp/niid/en/iasr-vol33-e/865-iasr/2134-tpc387.html, accessed 11 March 2015).
3. National Institute of Infectious Diseases. Enterohemorrhagic *Escherichia coli* infection in Japan as of April 2013. *Infectious Agents Surveillance Report*, 2013, 34:123–124 (http://www.nih.go.jp/niid/en/iasr-vol34-e/865-iasr/3570-tpc399.html, accessed 12 March 2015).
4. National Institute of Infectious Diseases. Enterohemorrhagic *Escherichia coli* infection in Japan as of April 2014. *Infectious Agents Surveillance Report*, 2014, 35:117–118 (http://www.nih.go.jp/niid/en/iasr-vol35-e/865-iasr/4674-tpc411.html, accessed 12 March 2015).
5. Muto T et al. Outbreaks of enterohemorrhagic *Escherichia coli* O157 infections among children with animal contact at a dairy farm in Yokohama City, Japan. *Japanese Journal of Infectious Diseases*, 2008, 61:161–162. pmid:18362413
6. The First Special Diet Session. Katayama Cabinet. *The Food Sanitation Act.* Japan, 1947 (http://www.japaneselawtranslation.go.jp/law/detail_main?vm=&id=12, accessed 12 March 2015).
7. Terajima J et al. High genomic diversity of enterohemorrhagic *Escherichia coli* isolates in Japan and its applicability for the detection of diffuse outbreak. *Japanese Journal of Infectious Diseases*, 2002, 55:19–22. pmid:11971157
8. Ozeki Y et al. [A diffuse outbreak of enterohemorrhagic *Escherichia coli* O157:H7 related to the Japanese-style pickles in Saitama, Japan] (In Japanese) [The Journal of the Japanese Association for Infectious Diseases]. *Kansenshogaku Zasshi*, 2003, 77:493–498. doi:10.11150/kansenshogakuzasshi1970.77.493 pmid:12931575
9. Wendel AM et al. Multistate outbreak of *Escherichia coli* O157:H7 infection associated with consumption of packaged spinach, August-September 2006: the Wisconsin investigation. *Clinical Infectious Diseases*, 2009, 48:1079–1086. doi:10.1086/597399 pmid:19265476
10. Saitou T et al. Reported cases of hemolytic uremic syndrome associated with EHEC infection in 2010—NESID. (In Japanese). *Infectious Agents Surveillance Report*, 2011, 33:141–143 (http://idsc.nih.go.jp/iasr/32/375/dj375e.html, accessed 12 March 2015).
11. Food and Agriculture Organization, World Health Organization. *Joint FAO/WHO Food Standards Programme Codex Alimentarius Commission Twenty-seventh Session*. Rotterdam, Codex Committee on Food Additives and Contaminants, 2004 (ftp://ftp.fao.org/docrep/ fao/meeting/008/j2262e.pdf, accessed 12 March 2015).
12. VIII Food processing. In: *Standards for school lunch health administration.* Tokyo, Ministry of Education, Culture, Sports, Science and Technology, 2014 (http://www.mext.go.jp/b_menu/houdou/20/07/08071616/001/008.htm, accessed 12 March 2015).
13. *Result for inspection of premises for low-salt pickles of processing company*. Tokyo, Inspection and Safety Division, Pharmaceutical and Food Safety Bureau, Ministry of Health, Labour and Welfare, 2012 (http://www.mhlw.go.jp/stf/houdou/2r9852000002owtc-att/2r9852000002owwz.pdf, accessed 12 March 2015).

Chelonitoxism outbreak caused from consuming turtle, Eastern Samar, Philippines, August 2013

Ray Justin Ventura,[ab] Paola Katrina Ching,[ab] Vikki Carr de los Reyes,[b] Ma Nemia Sucaldito[b] and Enrique Tayag[b]

Correspondence to Ray Justin Ventura (e-mail: rayjustinventura@gmail.com).

Background: On 21 August 2013, the Event-based Surveillance and Response system of the Department of Health, Philippines captured a foodborne illness event among residents of a coastal village in Eastern Samar, Philippines. The suspected cause was the consumption of a sea turtle found near the village. A team from the Department of Health was sent to conduct an outbreak investigation.

Methods: A case was defined as any person in Arteche, Eastern Samar, who developed dry mouth and burning sensation in the throat from 15 August to 27 August, 2013. Severity of the disease was classified as mild, moderate or severe. We conducted records review, environmental investigation, interviews of key informants and a retrospective cohort study.

Results: Sixty-eight cases were identified; four died (case fatality rate = 6%). All cases had a history of turtle meat consumption. Dose-dependent relationship was noted between amount of turtle meat consumed and the risk of illness. In the cohort study, consumption of turtle meat and turtle meat soup were associated with illness.

Conclusion: This study identified turtle meat as the source of this foodborne outbreak and emphasized the dangers of consuming turtle meat. Other reported cases of turtle meat poisoning in the Philippines suggest that turtle consumption is an ongoing practice in the country. By publishing information about sea turtle poisoning outbreaks in the Philippines, we hope to raise awareness of the potential severe health effects from ingesting these endangered sea creatures.

Chelonitoxism (sea turtle meat poisoning) is a rare and sometimes fatal type of food poisoning caused by eating marine turtles. It has been reported in subtropical Atlantic, Pacific and Indian Ocean countries.[1] Green sea turtles (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*) are the species most commonly implicated. Studies show that all parts of the sea turtle are potentially toxic. Symptoms can be as mild as nausea and vomiting to more severe forms of neurologic manifestations, coma and ultimately death.[2]

Although legally protected in the Philippines,[3] sea turtles are considered a local delicacy, especially in the coastal areas. As a result, reports of chelonitoxism have persisted in the Philippines, the earliest from 1917, when 33 cases of chelonitoxism were reported in Cebu with 14 deaths (case fatality rate [CFR] = 42%).[4] In 1954, 14 cases were reported in Mindanao with 11 deaths (CFR = 79%).[5] More recently in Sorsogon, six of 33 villagers (attack rate [AR] = 18%) manifested symptoms consistent with chelonitoxism after eating turtle meat.[6]

On 21 August 2013, the Event-based Surveillance and Response (ESR) system of the Department of Health, Philippines captured a foodborne illness event among residents of Rawis, a small village situated in the coastal area of Arteche, Eastern Samar. The suspected cause was the consumption of a sea turtle found near the village. On 27 August 2013, a team from the Department of Health was sent to conduct an outbreak investigation to verify the outbreak and identify risk factors.

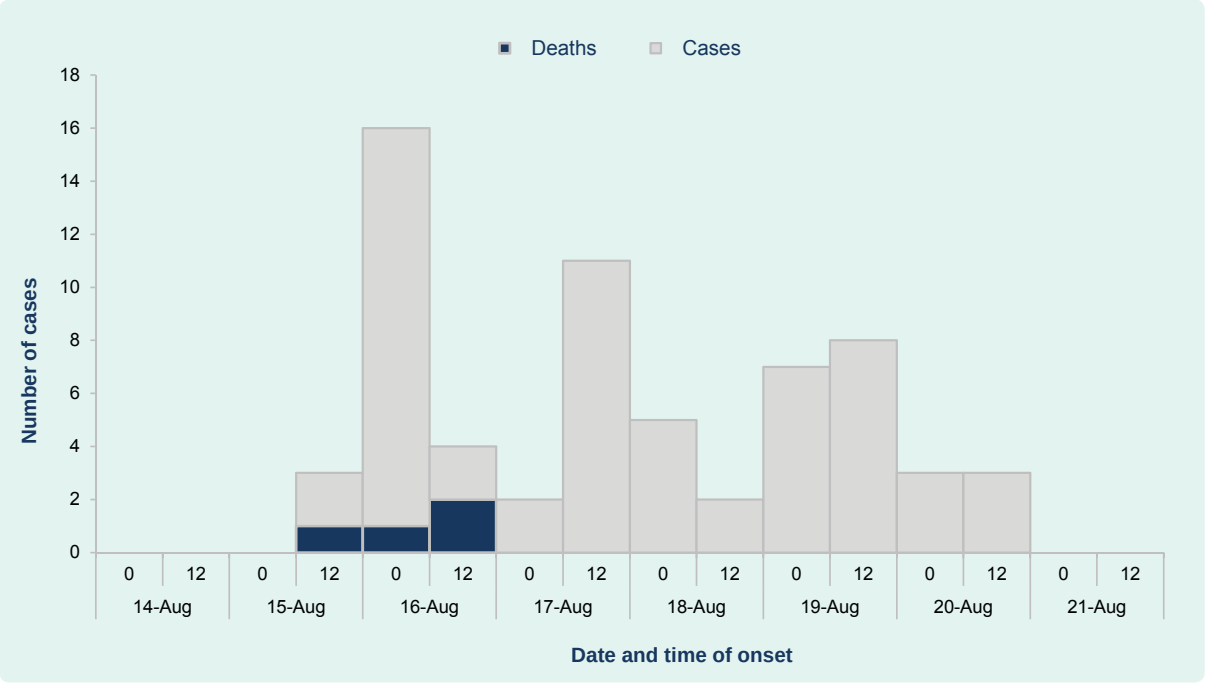
METHODS

Epidemiological investigation

A case was defined as any person in Arteche, Eastern Samar, who developed dry mouth and burning sensation in the throat from 15 to 27 August 2013.

[a] Field Epidemiology Training Program, National Epidemiology Center, Department of Health, Sta Cruz, Manila, Philippines.
[b] Department of Health, Sta Cruz, Manila, Philippines.
Submitted: 15 January 2015; Published: 20 April 2015
doi: 10.5365/wpsar.2015.6.1.003

Figure 1. **Number of cases by date and time of onset, turtle meat poisoning outbreak, Eastern Samar, Philippines, 2013 (*n* = 68)**



Active case finding was conducted by reviewing medical records from the Arteche Rural Health Unit and the Eastern Samar Provincial Hospital. The initial 10 cases were interviewed using a structured questionnaire with data on demographics, food and water exposures and environmental risk factors.

Severity of disease was classified as mild, moderate or severe as per standard case categorization.[2] A mild case was defined as having throat pain and dryness of mouth with or without diarrhoea, dizziness, malaise and sweating. A moderate case was someone who developed any of the following: mouth ulcerations, white coated tongue or tongue fissures. A severe case was someone who developed neurological manifestations including alternating periods of lethargy and agitation or decrease in sensorium.

We conducted a retrospective cohort study among residents of Sub-village 4. A more specific questionnaire was used for the cohort study comprising questions on the amount of turtle meat consumed and consumption of turtle meat soup to obtain data on the amount of turtle meat consumed, the types of body parts consumed, consumption of turtle meat soup and participant's sex. Analysis was done using EpiInfo version 3.5.4. We calculated relative risks (RR), 95% confidence intervals (CI), *P* values and food-specific AR and attack rate ratios (ARR). Risk factors approaching significance ($P < 0.2$) in univariate analysis were retained for multivariate logistic regression using a forward stepwise procedure.

Environmental investigation

A site visit was conducted in Sub-village 4 to identify the circumstances surrounding the event. We interviewed the Municipal Environment and Natural Resources Officer to gather data on turtle sightings, resident awareness of laws prohibiting the selling and butchering of sea turtles and to identify the implicated turtle. The fisherman who butchered and sold the implicated turtle meat was interviewed about the capture, processing and selling of the turtle meat.

RESULTS

Cases

A total of 68 cases were identified. Onset of symptoms ranged from four hours to five days (median = 1.5 days) (**Figure 1**). Signs and symptoms included light-headedness (68%), epigastric pain (41%) and vomiting (32%). Cases appeared on the evening of 15 August 2013 and peaked in the morning of 16 August. Fifty-two people (76%) received outpatient

Table 1. **Factors associated with turtle meat poisoning, Eastern Samar, Philippines, 2013**

Characteristics*	Sick n (%)	Not sick n (%)	Crude RR (95% CI)	Adjusted RR (95% CI)
Sex				
Male	48 (71)	35 (52)	1.53 (1.03–2.27)	2.02 (0.88–4.63)
Female	20 (29)	33 (49)		
Consumed turtle soup				
≥ ½ cup	12 (18)	3 (4)	1.62 (1.19–2.23)	4.26 (1.01–18.00)
< ½ cup	56 (82)	58 (85)		
Body part consumed†				
Meat	49 (63)	29 (37)	1.92 (1.28–2.88)	6.93 (2.82–17.02)
Internal organs	13 (77)	4 (23)	1.65 (1.19–2.30)	8.06 (0.90–71.72)
Blood	12 (75)	4 (25)	1.60 (1.14–2.26)	1.03 (0.12–8.54)
Head	5 (71)	2 (29)	1.46 (0.8–2.41)	–
Egg	5 (83)	1 (17)	1.72 (1.15–2.56)	–

95% CI, 95% confidence interval; RR, relative risk.

* Totals may not add up due to missing responses

† May have more than one response

medical care, six (9%) were hospitalized and four died (CFR = 6%).

Age of cases ranged from 2 to 80 years (median = 34 years); 74% were male. The most affected age group was 11- to 20-year-olds. All cases came from Sub-village 4. All of the cases ate turtle meat before the onset of illness. Thirty-five (51%) experienced mild symptoms, 27 (40%) were classified as moderate cases and 6 (9%) had severe manifestations.

Profile of deaths

Ages of the four deaths ranged from 23 to 80 years (median = 57 years). The onset of symptoms ranged from 24 to 46 hours (median = 34.5 hours). All fatal cases experienced severe manifestations before death. Three (75%) came from the one family. All consumed more than 10 tablespoons of turtle meat. Lethal cases also consumed turtle soup (100%), internal organs (100%), turtle eggs (75%) and the head (25%) of the turtle.

Cohort study

We interviewed 136 of 170 (80%) residents of Sub-village 4. Of study participants, 100 (74%) ate turtle meat. We found that being male (RR = 1.53, 95% CI: 1.03–2.27) and consuming ≥ 1/2 cup of turtle meat soup (RR = 1.62, 95% CI: 1.19–2.23) were associated with illness along with consumption of turtle meat (RR = 1.92, 95% CI: 1.28–2.88), internal organs (RR = 1.65, 95% CI: 1.19–2.30) and blood (RR = 1.60, 95% CI: 1.14–2.26). In multivariate analysis, consumption of turtle meat (RR = 4.26, 95% CI: 1.01–18.00) and consumption of ≥ 1/2 cup of turtle meat soup (RR = 6.93, 95% CI: 2.82–17.02) were the only risk factors associated with illness (**Table 1**).

We found a dose–response relationship with consumption of increasing quantities of turtle meat. The AR of those who ate more than 2 tablespoons of turtle meat was 87.3% (48/55) compared to 35.2% (12/36) for those who ate 1 tablespoon of turtle meat (RR = 2.47, 95% CI: 1.5–3.94) (**Table 2**).

Environmental investigation

The village people depend on fishing as their primary source of livelihood. They knew that catching, killing and selling sea turtles is prohibited and punishable by law, but they continue to do so because of the demand for this local delicacy. Most common sea turtle species seen in the area are the green sea turtle (*Chelonia mydas*) and the hawksbill sea turtle (*Eretmochelys imbricata*).

A fisherman captured a sea turtle on 15 August 2013 at 07:00 in shallow water. He positively

Table 2. **Dose–response analysis of turtle meat, Eastern Samar, Philippines, 2013**

Tablespoons of turtle meat	Sick	Not sick	AR (%)	ARR	95% CI
> 2	48	7	87.3	2.47	1.55–3.94
2	8	3	72.7	2.06	1.15–3.69
1	12	22	35.2	Ref	–
0	0	36	0	–	–

AR, attack rate; ARR, attack rate ratio; CI, confidence interval.

identified the species as *Chelonia mydas*. The live sea turtle was found trapped in the corals. The fisherman butchered the trapped sea turtle and sold a total of 12 kg of raw meat to the villagers within hours. No special preparation was done on the meat. The raw meat was individually prepared and cooked by several families. There was no banquet or community meal before the start of the outbreak.

Public health measures

After the incident, a community assembly was organized by the Municipal Health Office and the Department of Health to educate the villagers on the law prohibiting the killing of sea turtles and the dangers of consuming its meat.

DISCUSSION

This foodborne outbreak was most likely caused by consumption of turtle meat. The study revealed that 100% of cases had a history of turtle meat ingestion; none of those who did not eat turtle meat presented with symptoms. The signs and symptoms of the cases and incubation period were similar to those of other chelonitoxism outbreaks.[2] The dose–response relationship provides strong evidence as to the source of the outbreak. Other studies have also demonstrated a dose–response relationship with turtle meat or turtle soup poisoning.[2,7]

Investigators from the Federated States of Micronesia recently reported a similar outbreak with 191 cases of chelonitoxism after consuming sea turtle stew,[7] showing that the consumption of turtles is also common elsewhere. They reported a low CFR of 6%, possibly due to aggressive case ascertainment efforts. This is consistent with our CFR, although some studies have reported it as high as 100%.[2]

One of the limitations of this study was incomplete capture of the study population. As uncaptured residents may have been less likely to have the disease, we may have overestimated the occurrence of disease. Also, laboratory testing of specimens collected from human and animal samples was not done due to the lack of availability of testing centres. However, in this region, most sea turtle poisoning outbreaks are not usually laboratory confirmed.[4–7]

In conclusion, this study was able to identify the turtle meat as the source of this foodborne outbreak, emphasizing the dangers of consuming turtle meat. The persistence of chelonitoxism outbreaks in the Philippines proves that consumption of this animal is an ongoing practice in the country[6] despite it being illegal. Strict implementation of the law could prevent future incidents, but the feasibility of such implementation is unclear as it is difficult to keep coastal people from consuming a traditional food source. By publishing information about sea turtle poisoning outbreaks in the Philippines, we hope to raise awareness of the potential severe health effects from ingesting these endangered animals.

Conflicts of interest

None declared

Funding

This foodborne outbreak investigation was funded by the Department of Health, Philippines.

Acknowledgements

We are grateful for the cooperation and support of the Centre for Health and Development-Eastern Visayas, Eastern Samar Provincial Health Office, Eastern Samar Provincial Hospital, Local Government Unit of Arteche and town residents during the field investigation.

References:

1. Silas EG, Fernando AB. Turtle poisoning. Bulletin. *Sea Turtle Research and Conservation*, 1984, 35:62–75.
2. Fussy A et al. Chelonitoxism: new case reports in French Polynesia and review of the literature. *Toxicon*, 2007, 49:827–832. doi:10.1016/j.toxicon.2006.12.002 pmid:17250862
3. *Republic Act 9147: an act providing for the conservation and protection of wildlife resources and their habitats, appropriating funds therefor and for other purposes*. Manila, Congress of the Philippines, 2001.
4. Taylor EH. *Amphibians and turtles of the Philippines Islands*. Manila, Bureau of Printing Ed, 1921.
5. Ronquillo IA, Caces Borja P. Notes on a rare case of turtle poisoning (*Eretmochelys imbricata*). *Philippines Journal of Fish*, 1968, 8:119–124.
6. Deveraturda I et al. *Turtle meat poisoning outbreak in Barangay Liang, Irosin, Sorsogon, Philippines*. Manila, Epidemiology Bureau Library, Department of Health, 2014.
7. Pavlin BI et al. Mass poisoning after consumption of a hawksbill turtle, Federated States of Micronesia, 2010. *Western Pacific Surveillance and Response Journal*, 2015, 6(1). doi: 10.5365/wpsar.2014.5.3.006 pmid:26045970

Investigating an outbreak of staphylococcal food poisoning among travellers across two Australian states

Stephanie Fletcher,[a] Leng Boonwaat,[a] Terry Moore,[b] Ruchir Chavada[c] and Stephen Conaty[a]

Correspondence to Stephanie Fletcher (e-mail: stephanie.fletcher@sswahs.nsw.gov.au).

Introduction: *Staphylococcus aureus* is a common cause of staphylococcal food poisoning in Australia with several outbreaks associated with foods prepared by commercial caterers. Laboratory testing on cases of gastrointestinal illness caused by enterotoxin-producing *S. aureus* is not routinely done as this condition is self-limiting. Hence outbreaks of such illness may go undetected.

Methods: A retrospective cohort study was conducted among a group of tourists who were hospitalized in Sydney shortly after flying from Queensland. The group had consumed food prepared by a restaurant on the Gold Coast before transit. Laboratory analyses on stool specimens were conducted in Sydney. An environmental assessment of the restaurant in the Gold Coast was conducted, and environmental specimens were assessed for contamination.

Results: Epidemiological investigations linked the outbreak to a restaurant in the Gold Coast where the suspected food was produced. Stool samples from two of the hospitalized cases were confirmed to have enterotoxin-producing *S. aureus,* and several environmental samples were found to be contaminated with *S. aureus* as well. Investigations suggested that absence of hand washing and other unhygienic food handling at the implicated restaurant was the likely cause of this outbreak.

Conclusion: Food poisoning due to toxin-mediated *S. aureus* is frequently undetected and underreported. Public health units should consider toxin-producing pathogens such as *S. aureus* when investigating outbreaks where vomiting is the predominant symptom and occurs rapidly after consuming food.

Enterotoxin-producing *Staphylococcus aureus* causes toxin-mediated food poisoning with an estimated 1300 cases reported annually in Australia.[1] Intoxication or staphylococcal food poisoning (SFP) occurs following ingestion of food products contaminated with heat-resistant *S. aureus* enterotoxins.[2] Food handlers carrying enterotoxin-producing *S. aureus* in their noses or on their hands are the main source of food contamination via direct contact or through respiratory secretions. Foods high in starch and protein are believed to favour staphylococcal enterotoxin (SE) production. Staphylococcal food poisoning (SFP) symptoms generally have a rapid onset, appearing within three hours after ingestion (range: 30 minutes to 6 hours). Common symptoms include nausea, vomiting, abdominal cramps and diarrhoea. Fever is absent. Recovery usually occurs between 1 and 3 days.

On 28 October 2014, the local Public Health Unit in South Western Sydney Local Health District was notified by a hospital emergency department (ED) of an outbreak. A group of Japanese tourists travelling from Brisbane on an organized tour experienced sudden onset of vomiting and diarrhoea shortly after landing in Sydney. Twelve of the 27 passengers experienced multiple episodes of vomiting with onsets occurring progressively within 10–30 minutes of each other. All cases were assessed in the ED, and four were hospitalized overnight for observation.

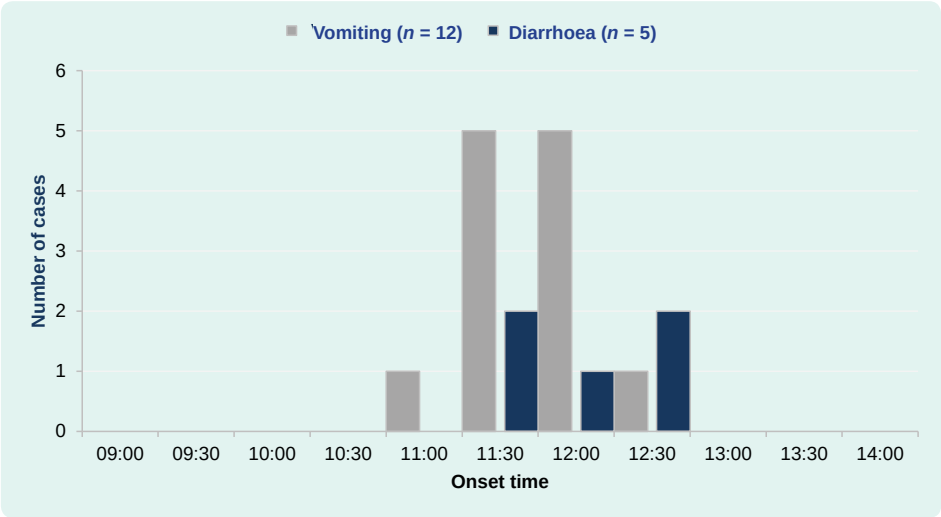
METHODS

Case finding

A case was defined as any member of the tour who travelled from the Gold Coast and experienced vomiting and/or diarrhoea between 11:00 and 16:00 on 28 October 2014. A cohort investigation was conducted to identify risk factors. A line listing including demographic details and clinical and food histories was prepared by Public Health Unit and/or ED staff with the assistance of an interpreter. Based on the three-day tour schedule,

[a] Public Health Unit, South Western Sydney Local Health District, New South Wales, Australia.
[b] Environmental Health Services, Public Health Unit, Gold Coast, Queensland, Australia.
[c] Sydney South West Pathology Service, Liverpool Hospital, New South Wales, Australia.
Submitted: 9 February 2015; Published: 4 May 2015
doi: 10.5365/wpsar.2015.6.1.011

Figure 1. **Number of cases by symptom onset, New South Wales, Australia, 2014**



the group's team leader believed that it was unlikely that anyone had consumed food outside of scheduled meals. Food-specific attack rates and risk ratios were calculated for each food item. Analysis was conducted using Microsoft Excel.

Laboratory investigations

Stool samples were collected from three hospitalized patients and tested using the routine direct molecular (triplex) test for detection of *Salmonella*, *Shigella* and *Campylobacter*.[3–5] Norovirus antigen testing (using enzyme immunoassays) and cultures for Staphylococcus were also performed on the stool specimens using Columbia colistin nalidixic agar with sheep blood (Thermo Fischer Scientific, Scoresby, Victoria, Australia). A multiplex polymerase chain reaction (PCR) for staphylococcal enterotoxin A to E based on published primers was then performed on the *S. aureus* isolates.[6] This multiplex PCR has only been validated on cultured bacterial isolates rather than direct detection from stool specimen. Blood cultures were done on all admitted patients for the detection of sepsis.

Environmental investigations

Environmental investigations were conducted by the Environmental Health Services at Gold Coast Public Health Unit in Queensland and also by the City of Gold Coast at the restaurant in question on 30 October 2014, two days after the food was consumed. A range of food samples and environmental swabs were collected including samples of boiled rice remaining from the tour group's breakfast. Food samples were assessed in accordance with the *Food Standards Australia New Zealand Ready to Eat Guidelines*.[7] Environmental swabs were collected and cultured for the presence of *Escherichia coli*, *S. aureus*, *Bacillus cereus* and *Salmonella* spp.

RESULTS

Clinical and epidemiological results

Twelve (44%) members of the group met the case definition; 10 were females. All 12 (100%) cases experienced vomiting and five (42%) experienced both diarrhoea and vomiting. No case of fever or headache was reported. The onset of illness was acute with all cases having onsets within two hours of the index case (**Figure 1**). Incubation periods ranged from 3 to 4.5 hours (mean 3.5 hours). The first case had an onset approximately 30 minutes after arrival at the airport in Sydney, characterized by profuse projectile vomiting. The second case's onset occurred approximately 15 minutes later followed by a period of concurrent vomiting and diarrhoea. Four elderly patients who had dehydration were admitted to hospital for intravenous hydration. Symptoms lasted for approximately 12 hours, and all cases were asymptomatic by the next morning. No clinical history was available for four group members.

Food histories were available for 23 of the 27 persons. All meals were catered and provided as part

Table 1. **Attack rates, risk differences and relative risks for food items consumed by cohort, New South Wales, Australia, 2014**

Food	Number of persons who						Difference (%)	Risk ratio	Lower 95% CI	Upper 95% CI
	Ate specified food			Did not eat specified food						
	Sick	Total	% sick	Sick	Total	% sick				
Sushi/rice ball	12	22	54.5	0	1	0.0	54.5	0	–	–
Fried chicken	11	21	52.4	1	2	50.0	2.4	1.0	0.2	4.4
Pickled grilled salmon	12	22	54.5	0	1	0.0	54.5	0	–	–
Bottled water	3	7	42.8	9	16	56.2	-13.4	0.8	0.3	1.9
Yogurt	11	21	52.4	1	2	50.0	2.38	1.0	0.2	4.4
Dried fruit	6	10	60.0	6	13	46.1	13.8	1.3	0.6	2.8
Muesli	4	8	50.0	8	15	53.3	-3.3	0.9	0.4	2.2
Coffee with milk	9	14	64.3	3	9	33.3	30.9	1.9	0.7	5.3
Tea with milk	2	7	28.6	10	16	62.5	-33.9	0.5	0.1	1.5
Water - plain	4	9	44.4	8	14	57.1	-12.7	0.8	0.3	1.8
Orange juice	1	1	100.0	11	22	50.0	50.0	2.0	1.3	3.0

CI, confidence interval.

of the tour. On 28 October, on departure from the Gold Coast, the group was provided with packaged meals that were consumed at the airport before the 08:25 flight to Sydney. The meal included sushi (also described as rice ball) with pickled grilled salmon, fried chicken and bottled water. All 27 persons consumed the packaged food at the airport. During the flight at approximately 10:00, group members had a light breakfast which included yogurt, drief fruit, muesli, assorted juices and tea/coffee. All but one of the 23 persons consumed the breakfast items (**Table 1**).

Slightly more cases consumed both sushi/rice ball, chicken and pickled salmon with attack rates and rate differences of 55% for sushi and pickled grilled salmon and 52% for fried chicken. The risk ratios for the sushi and pickled grilled salmon were undefined (infinite) because all ill people ate these food items (no one who did not eat these items fell ill).

Microbiological and environmental results

All stool samples obtained from cases were negative for norovirus and all other microorganisms. *S. aureus* was detected in two of three specimens. Enterotoxin PCR detected presence of *S. aureus* enterotoxin A and D in both specimens. Blood cultures were negative.

The boiled rice was of unsatisfactory bacteriological quality based on a high standard plate count, and *Salmonella* species were detected at potentially hazardous levels. Seven of 10 swabs were positive for an enteric pathogen. *S. aureus* was detected in swabs taken from the sink, refrigerator door and dish cloth at the restaurant. *B. cereus* was found on the bench top, chopping board and refrigerator door.

Environmental investigation revealed inadequate hand-washing facilities for food handlers at the premise; food handlers only used hand sanitizer to cleanse their hands. None of the food handlers had symptoms of skin/soft tissue infection or any open wounds. Potentially hazardous food was transported without adequate temperature control. Enforcement action was taken at the restaurant as per current Public Health response to inadequate hygiene measures.[8]

DISCUSSION

A foodborne illness outbreak among tourists travelling through Sydney was epidemiologically linked to the consumption of contaminated food from a restaurant in Gold Coast, Queensland. The rapid and synchronous onset of severe vomiting and short incubation period was consistent with a toxin-mediated food poisoning. This

is caused by bacterial toxins produced by *S. aureus* or *B. cereus* and associated with consumption of ready-to-eat foods such as cold meats or sushi often contaminated by food handlers who have been colonized by these pathogens. Based on the clinical presentation, testing for SFP was undertaken in addition to routine cultures and antigen testing. However, protocols to detect toxin-producing *B. cereus* from clinical samples (stool or blood) are not routine and hence laboratory testing for *B. cereus* was not undertaken. Vomitus sample would have been the most suitable for testing; however, patients had stopped vomiting on hospital presentation. Detection of SE in stools of two patients combined with isolation of a similar organism from the food handling environment was suggestive epidemiological evidence of SFP.

Staphylococcal food poisoning occurs when food contaminated by colonized food handlers carrying SE in their noses or on their hands that contain enterotoxins produced by *S. aureus* is consumed.[9] SEs are produced in food stored at elevated temperature (30–37°C) following contamination with *S. aureus*.[2,10] Even after the bacteria are destroyed by heat, the potent gastrointestinal exotoxins which are resistant to heat and proteolytic enzymes (particularly SEA) remain active in the digestive tract producing intoxication even at very low inoculums.[2,11] Investigators were only able to test the rice consumed by the group; however, environmental sampling conducted at the restaurant revealed that 7 of 10 swabs were positive for an enteric pathogen, including three with *S. aureus*. Due to the time lapse of the investigation, food specimens from the majority of foods consumed were not obtained for testing and toxin typing was not possible for environmental samples to make a molecular comparison. That there were also *B. cereus* detected in four environmental samples, suggests inadequate sanitizing of food-handling surfaces, indicative of poor food hygiene practices at the restaurant and potential environmental sources of food contamination. The detection of *Salmonella* in food also suggested poor food-handling practices at the restaurant.

A limitation of this investigation is the potential for recall bias, although the group had a clearly defined meal schedule with no reported deviation from this schedule. Therefore, recall bias would have been limited. The clinical specimens (stool and blood) were not tested for toxin-producing *B. cereus* which could have also caused the outbreak. The failure to isolate *S. aureus* from one of the stool samples could be due to pre-analytical factors like delay in receipt of the specimen, delay in plating to media, organism burden in the sample, presence of inhibitors of *S. aureus* in stool sample as well as analytical factors like sensitivity of detection of organism by the culture method. Additionally, due to the two-day delay in conducting the environmental investigation, investigators were unable to obtain and test the majority of foods consumed by the group.

Although diagnosis of SFP is mainly clinical, toxin detection aids with epidemiological investigations especially in large and multijurisdictional outbreaks.[12] Public health officials should consider including SFP in laboratory testing for outbreaks characterized by predominance of vomiting, absence of fever and simultaneous onsets. Where preliminary laboratory tests are negative for bacterial and viral pathogens, consideration should be given to further testing based on the preceding factors. Increased availability of improved diagnostic methods could help with the detection of toxin-mediated foodborne diseases.

Conflicts of interest

None declared.

Funding

This outbreak investigation was conducted as part of routine public health work. All authors are employed by the Public Health Service under their respective state governments.

Acknowledgements

The authors would like to acknowledge all the clinical, laboratory and environmental health staff who conducted the field investigations.

References

1. Kirk M et al. Foodborne illness, Australia, circa 2000 and circa 2010. *Emerging Infectious Diseases*, 2014, 20:1857–1864. doi:10.3201/eid2011.131315 pmid:25340705
2. Argudín MÁ, Mendoza MC, Rodicio MR. Food poisoning and *Staphylococcus aureus* enterotoxins. *Toxins*, 2010, 2:1751–1773. doi:10.3390/toxins2071751 pmid:22069659

3. Lund M et al. Detection of *Campylobacter* spp. in chicken fecal samples by real-time PCR. *Journal of Clinical Microbiology*, 2004, 42:5125–5132. doi:10.1128/JCM.42.11.5125-5132.2004 pmid:15528705

4. Malorny B et al. Diagnostic real-time PCR for detection of Salmonella in food. *Applied and Environmental Microbiology*, 2004, 70:7046–7052. doi:10.1128/AEM.70.12.7046-7052.2004 pmid:15574899

5. Vu DT et al. Detection of Shigella by a PCR assay targeting the ipaH gene suggests increased prevalence of shigellosis in Nha Trang, Vietnam. *Journal of Clinical Microbiology*, 2004, 42:2031–2035. doi:10.1128/JCM.42.5.2031-2035.2004 pmid:15131166

6. Becker K, Roth R, Peters G. Rapid and specific detection of toxigenic *Staphylococcus aureus*: use of two multiplex PCR enzyme immunoassays for amplification and hybridization of staphylococcal enterotoxin genes, exfoliative toxin genes, and toxic shock syndrome toxin 1 gene. *Journal of Clinical Microbiology*, 1998, 36:2548–2553. pmid:9705390

7. FSANZ. *Guidelines for microbiological examination of ready-to-eat foods*. Canberra, Food Standards Australia New Zealand (FSANZ), 2001.

8. Foodborne Illness Outbreak Management Guideline [press release]. *Queensland Health*, 2013, 15:2006.

9. El-Shenawy M et al. Cross sectional study of skin carriage and enterotoxigenicity of *Staphylococcus aureus* among food handlers. *Open Journal of Medical Microbiology*, 2014.

10. Pillsbury A et al. An outbreak of staphylococcal food poisoning in a commercially catered buffet. *Communicable Diseases Intelligence Quarterly Report*, 2013, 37:E144–148. pmid:24168088

11. Bergdoll MS. Enterotoxins. *Staphylococci and Staphylococcal Infections*, 1983, 2:559–598.

12. Asao T et al. An extensive outbreak of staphylococcal food poisoning due to low-fat milk in Japan: estimation of enterotoxin A in the incriminated milk and powdered skim milk. *Epidemiology and Infection*, 2003, 130:33–40. doi:10.1017/S0950268802007951 pmid:12613743

Lethal paralytic shellfish poisoning from consumption of green mussel broth, Western Samar, Philippines, August 2013

Paola Katrina Ching,[ab] Ruth Alma Ramos,[ab] Vikki Carr de los Reyes,[b] Ma Nemia Sucaldito[b] and Enrique Tayag[b]

Correspondence to Paola Katrina Ching (e-mail: paolaching@gmail.com).

Background: In July 2013, the Philippines' Event-Based Surveillance & Response Unit received a paralytic shellfish poisoning (PSP) report from Tarangnan, Western Samar. A team from the Department of Health conducted an outbreak investigation to identify the implicated source and risk factors in coastal villages known for green mussel production and exportation.

Methods: A case was defined as a previously well individual from Tarangan, Western Samar who developed gastrointestinal symptoms and any motor and/or sensory symptoms after consumption of shellfish from 29 June to 4 July 2013 in the absence of any known cause. The team reviewed medical records, conducted active case finding and a case-control study. Relatives of cases who died were interviewed. Sera and urine specimens, green mussel and seawater samples were tested for saxitoxin levels using high performance liquid chromatography.

Results: Thirty-one cases and two deaths were identified. Consumption of >1 cup of green mussel broth was associated with being a case. Seawater sample was positive for *Pyrodinium bahamense* var. *compressum* and green mussel samples were positive for saxitoxin. Inspection revealed villagers practice open defecation and improper garbage disposal.

Conclusion: This PSP outbreak was caused by the consumption of the green mussel broth contaminated by saxitoxin. As a result of this outbreak, dinoflagellate and saxitoxin surveillance was established, and since the outbreak, there have been no harmful algal blooms event or PSP case reported since. A "*Save Cambatutay Bay*" movement, focusing on proper waste disposal practice and clean-up drives has been mobilized.

Harmful algal blooms (HAB), commonly referred to as "red tides", can be caused by many microalgae such as the proliferation of *Pyrodinium bahamense* var. *compressum* (Pbc) dinoflagellate. HAB is predominant in tropical regions including the Philippines, with Pbc dinoflagellate-producing saxitoxin causing paralytic shellfish poisoning (PSP). This neurotoxin is water-soluble, acid stable and relatively heat stable even in high temperature.[1] Toxin levels of 120 to 180ug can produce moderate symptoms while levels of 400 to 1060ug can cause human death.[2] Within 5–30 minutes, perioral tingling and numbness extending to face and neck can occur. Uncoordination, respiratory difficulty and sensorium alteration are evident in severe cases.[3] Death can occur 1–12 hours after ingestion.[4] Gastrointestinal symptoms include vomiting, diarrhoea and abdominal cramps.

The Philippines has the highest number of PSP cases reported in Asia[5] with 2124 PSP cases and 120 deaths reported from 1983 to 2002. Green mussels (Pernavirides) and other bivalves were implicated for most cases. The first PSP outbreak was reported in the Western Samar region in 1983, the same region as this outbreak. The health hazards and socioeconomic impact of this outbreak prompted the Philippine Government to create the Toxic Red Tide Monitoring Programme in 1984.

Eutrophication, or excessive enrichment of nutrients in the water, can stimulate algal blooms. Increased phosphorous and nitrogen from sewage and agricultural run-off are conducive for phytoplankton production. Many Filipinos residing in coastal areas are dependent on bodies of water for their income and survival.

[a] Field Epidemiology Training Program, National Epidemiology Center, Department of Health, Sta Cruz, Manila, Philippines.
[b] Department of Health, Sta Cruz, Manila, Philippines.
Submitted: 15 January 2015; Published: 8 May 2015
doi: 10.5365/wpsar.2015.6.1.004

Cambatutay Bay, which surrounds Bahay and Gallego coastal villages in Tarangnan, is the primary source of the community's livelihood. It is well known for its green mussel farms and products like mussel chips, crackers and cookies. Tarangnan comprises 41 villages with a population of 25 703.

In July 2013, the Event-Based Surveillance & Response Unit of the National Epidemiology Center received a report of paralytic shellfish poisoning (PSP) with two deaths in Gallego village in Tarangnan, Western Samar. A team from the Department of Health was sent to conduct an outbreak investigation to identify the implicated source and to evaluate risk factors.

METHODS

Epidemiological investigation

A suspected case was defined as a previously well individual from Tarangan, Western Samar who developed gastrointestinal symptoms and any motor and/or sensory and gastrointestinal symptoms from 29 June to 4 July 2013 after consumption of shellfish in the absence of any known cause. A confirmed case had blood or urine positive for saxitoxin. The outbreak response team reviewed medical records of outpatients and admitted patients at the local health centre and district hospital. Active case finding of communities from the two villages with reported cases was conducted. Relatives of recently deceased community members were interviewed.

An unmatched case–control (1:3) study was conducted. Controls were well individuals randomly selected in the same or nearby households of the two villages. They were excluded if they reported any motor, sensory or gastrointestinal symptoms or tested positive for saxitoxin. We used a standardized questionnaire to collect data for cases and controls on demographics, symptoms (except for controls), hygiene practices and history of food consumption for the past three days. We used EPI Info version 3.5.4 software for statistical analysis and calculated odds ratios (OR) and confidence intervals. Significant risk factors from bivariate analysis were then tested in multivariate analysis.

Laboratory investigation

Twenty-five urine and 100 blood specimens from cases and controls were collected one week after onset of illness and were tested by the Marine Science Institute, University of the Philippines, Diliman, Quezon City for paralytic shellfish toxins (PSTs) by precolumn oxidation high performance liquid chromatography.

Environmental investigation

The team collected 500 ml of seawater and 30–40 green mussel and oyster samples from three coastal areas – Cambatutay Bay, Bahay village and Gallego village. Green mussel samples were tested by the regional Bureau of Fisheries and Aquatic Resources using mouse bioassay. Marine Science Institute tested seawater and shellfish samples for saxitoxin and dinoflagellates using pre-chromatographic oxidation reversed phase high performance liquid chromatography equipped with fluorescence detection.[10]

Investigators observed sanitation and food consumption practices in the two villages with the highest attack rates. Residents of the coastal areas were asked if algal blooms had been observed.

RESULTS

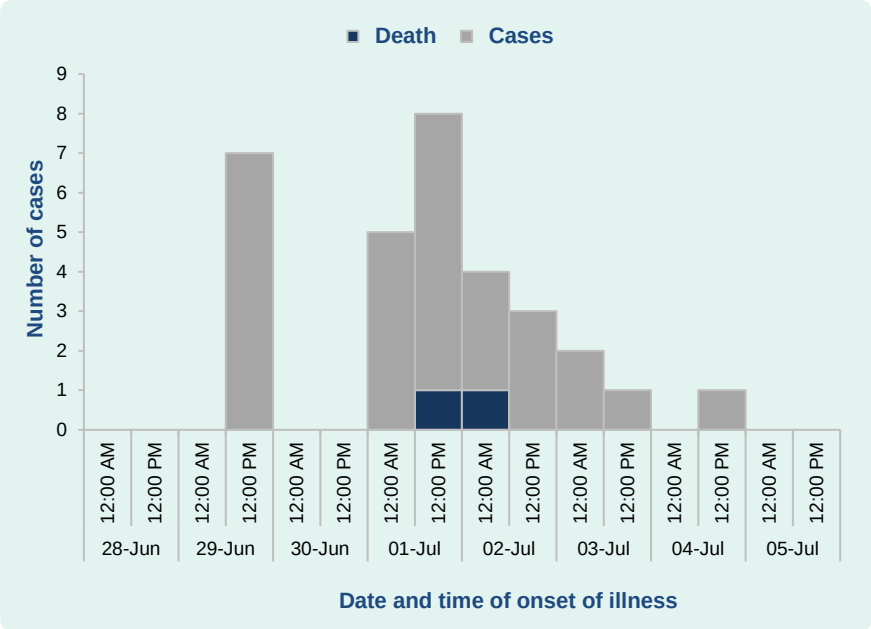
Case characteristics

A total of 31 cases were identified. The incubation period ranged from 1 hour to 23 hours (median 11 hours) with the first date of occurrence on 29 June 2013 and a peak on 1 July 2013 (**Figure 1**).Twenty-eight cases (90%) reported circumoral and extremity numbness, 20 (65%) reported dizziness and 17 (55%) light headedness. Eight cases (26%) were hospitalized; two died (case fatality proportion = 6%). There were 18 (58%) male cases; ages ranged from 3 to 59 years (median = 26 years). The most affected age groups were 21–30 years and 51–60 years (23% each).

All cases reported consuming green mussels, either raw, boiled or steamed; the total quantity ranged from three to 50 (median = 15). Consumption of less than one cup up to six cups of broth were reported.

The two deaths were males, aged 3 and 50 years, both from the same household. The older male died due to cardiorespiratory arrest 15 hours after onset of illness. He had eaten 50 green mussels, both raw and cooked. The child was pronounced dead on arrival 10 hours after

Figure. 1. **PSP cases by date and time of onset, Tarangnan, Western Samar, Philippines, June to July 2013 (*n* = 31)**



PSP, Paralytic shellfish poisoning.

illness onset. He had consumed more than two cups of mussel broth. Previous medical histories for both cases were unremarkable.

Case–control study

The case–control study comprised the 31 cases and 93 controls. Bivariate analysis revealed several significant risk factors: being male, harvesting their own food, eating raw foods, consuming at least one cup of mussel broth and consuming at least 15 green mussels. Interestingly, carbonated beverages were inversely associated with being a case (**Table 1**). However, only a small number of study participants (four cases and two controls) drank carbonated beverages. After multivariate analysis, consumption of at least one cup of green mussel broth emerged as the only significant association (OR: 12.0; 95% confidence interval: 2.1–63.2).

Laboratory examination

Saxitoxins and Pbc dinoflagellates were detected in the three water samples. The green mussel and oysters specimens had PSTs at levels higher than the international regulatory limit. The 100 human serum and 25 urine samples were negative for PSTs.

Environmental investigation

We observed families practicing open defecation in the hills, river and coastal areas. There was no organized garbage collection system; garbage was dumped haphazardly in backyards and near coastal areas. The village captain reported that discoloration of the seawater surface was noticed by one of his constituents in early June.

We did not observe discoloration of surface waters in Cambatutay Bay during sample collection. However, seawater samples collected four metres below the surface had a reddish discoloration.

DISCUSSION

This PSP outbreak was caused by consumption of green mussels, specifically as a mussel broth, harvested in Cambatutay Bay in Tarangnan, Western Samar. High toxicity of saxitoxin was found in both green mussel and seawater samples and cases primarily presented with neurological symptoms consistent with other PSP outbreaks.[6]

Consuming at least one cup of broth was identified as a risk factor for illness. Saxitoxins are known to be

Table 1. **Factors associated with PSP, Tarangnan, Western Samar, Philippines, June to July 2013**

Characteristics	Case *n* (%)	Control *n* (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Sex				
Male	18 (58)	33 (36)	2.5 (1.1–5.7)	–
Female	13 (42)	59 (64)	–	
Consumption of mussel broth				
1 cup or more	13 (42)	8 (10)	7.6 (2.5–23.9)	12.0 (2.1–63.2)
Less than 1 cup	18 (58)	84 (90)	–	
Food source				
Harvested	18 (58)	24 (26)	3.9 (1.6–10.2)	–
Bought	13 (42)	69 (74)		
Type of foods eaten				
Raw	27 (87)	44 (47)	7.5 (2.3–27.7)	–
Cooked	4 (13)	49 (53)	–	
Consumption of mussels				
1 mussel	0 (0)	2 (2)	0 (0–12.7)	–
2–4 mussels	0 (0)	8 (9)	0 (0–1.8)	
5–10 mussels	1 (3)	13 (14)	0.2 (0.01–1.6)	
11–14 mussels	2 (6)	21 (23)	0.2 (0.04–1.2)	
15 or more	28 (90)	49 (53)	8.4 (2.2–37.3)	
Consumption of carbonated beverages				
Yes	4 (0.1)	2 (0)	0.1 (0.0–0.9)	

OR, odds ratio; CI, confidence interval; PSP, paralytic shellfish poisoning.

heat stable in shellfish at a temperature of 100 °C in household processing and therefore can dissipate from green mussels into boiling water and become concentrated in broths.[7] In another outbreak, a butter clam broth was found to have high saxitoxin levels,[8] further supporting that boiling shellfish in water cannot destroy the toxin.

Another observation from the environmental investigation was poor sanitation practices of the villagers. Open defecation and garbage disposal in the coastal areas may have contributed to water pollution. Dumping of raw sewage makes more nutrients available for dinoflagellates and can increase occurrence of HAB.[9]

This study has some limitations. First, there was no green mussel left over from the implicated meals for testing. Second, while there were human serum specimens available for saxitoxin testing, delays in specimen collection and reagent availability may have limited testing yield as saxitoxins are only excreted in the urine eight hours after ingestion.[10] Third, the team arrived a week after the outbreak which possibly hindered testing of active and symptomatic cases. However, we were able to identify the source of this outbreak from both epidemiological and environmental results.

As a response to the outbreak, we recommended to the local government of Tarangan the banning of harvesting shellfish in Cambatutay Bay. Cambatutay Bay was also added as a sentinel site for dinoflagellate and saxitoxin monitoring. A "*Save Cambatutay Bay*" movement was created and core group members were mobilized in the community. This campaign focused on proper waste disposal practices and clean-up drives. There have been no HAB events or PSP cases since the outbreak stopped.

Conflicts of interest

None declared.

Funding

This foodborne outbreak investigation was funded by the Department of Health, Philippines.

Acknowledgements

We are grateful for the support of the Center for Health and Development-Eastern Visayas, Samar Provincial Health Office, the Local Government Unit of Tarangnan, Tarangnan Municipal Health Office and the residents during the field investigation. We are also thankful for Christopher Mendoza of the Marine Science Institute for the laboratory examinations.

References

1. Hughes JM, Merson MH. Current concepts fish and shellfish poisoning. *The New England Journal of Medicine*, 1976, 295: 1117–1120. doi:10.1056/NEJM197611112952006 pmid:988478
2. *Shellfish toxins in foods: a toxicological Review and risk assessment. Technical Report Series No. 14.* Canberra, Australia New Zealand Food Authority, 2001 (http://www.foodstandards.gov.au/publications/documents/TR14.pdf, accessed 20 April 2015).
3. Kao CY. Paralytic shellfish poisoning. In: Falconer IR (ed), *Algal Toxins in Seafood and Drinking Water*. London, Academic Press, 1993.
4. Rodriguez DC et al. Lethal paralytic shellfish poisoning in Guatemala. *The American Journal of Tropical Medicine and Hygiene*, 1990, 42:267–271. pmid:2316796
5. Azanza RV, Taylor FJ. Are Pyrodinium blooms in the Southeast Asian region recurring and spreading? A view at the end of the millennium. *Ambio*, 2001, 30:356–364. pmid:11757284
6. Hurley W et al. Paralytic shellfish poisoning: a case series. *The Western Journal of Emergency Medicine*, 2014, 15:378–381. doi:10.5811/westjem.2014.4.16279 pmid:25035737
7. Alexander J et al. Marine biotoxins in shellfish-Saxitoxin group. *EFSA Journal*, 2009, 1019:1–76.
8. State of Alaska Epidemiology. Paralytic shellfish poisoning-Alaska Peninsula, Kodiak. Bulletin No. 10, July 3, 1990. Juneau, State of Alaska, 1990 (http://www.epi.hss.state.ak.us/bulletins/docs/b1990_10.htm, accessed 24 April 2015).
9. Gessner BD, Middaugh JP. Paralytic shellfish poisoning in Alaska: a 20-year retrospective analysis. *American Journal of Epidemiology*, 1995, 141:766–770. pmid:7709919
10. García C et al. Human intoxication with paralytic shellfish toxins: clinical parameters and toxin analysis in plasma and urine. *Biological Research*, 2005, 38:197–205. doi:10.4067/S0716-97602005000200009 pmid:16238098

Investigation of hepatitis A outbreak in district of Manjung, Perak, Malaysia, October 2012

Faudzi Ahmad Yusoff,[a] Rusdi Abdul Rahman,[b] Ling He May,[c] Suzana Binti Budart[c] and Lokman Hakim Sulaiman[d]

Correspondence to Faudzi Ahmad Yusoff (e-mail: faudzi@imr.gov.my).

Background: In September 2012, 10 cases suspected to be hepatitis A were notified to the Manjung District Health Department. An investigation was conducted to identify the possible mode of transmission, source of the outbreak and to recommend prevention and control measures.

Methods: A case was a person with acute illness with discrete onset of symptoms and jaundice or elevated serum aminotransferase levels in September 2012 in the Manjung District. We conducted a case-control study and environmental assessments of processing plants and food premises.

Results: There were 78 confirmed cases of hepatitis A; an attack rate of 3.1 per 10 000 population. Multiple logistic regression showed that being male (odds ratio [OR]: 18.4 [5.13–65.9]; $P < 0.001$) and drinking toddy at processing place A (Adjusted OR: 2.70 [1.17–6.25]; $P < 0.05$) were associated with being a case. Environmental investigations of this and one other processing place found them to be unhygienic, and the pH of the toddy was at levels that encouraged growth of hepatitis A virus.

Conclusion: Toddy was possibly the primary source of this outbreak based on both epidemiological and environmental results. Both toddy preparation places and several food premises were closed as a result of this investigation.

Hepatitis A virus (HAV) infection occurs globally and is more common where sanitation is poor. HAV is primarily transmitted by the faecal–oral route, person-to-person contact or ingestion of contaminated food and drink.[1] One of the most common reported routes of foodborne-associated hepatitis A is shellfish consumption.[1,2] In India, cases of hepatitis A have been linked to the consumption of toddy, an alcoholic drink made from the sap of coconut and other palm trees.

Manjung is a district in the south-western part of the state of Perak, Malaysia. The most common ethnic groups are Malay (160 650), Chinese (76 500), Indians (12 750) and others (5100).[3,4] The major sectors of economy in the Manjung District are agriculture and tourism.[3] Coconut is one of the crops grown in Manjung with the sap used to produce toddy drinks. The flower clusters of the coconut are incised, fermented and drank as toddy. Toddy is usually served within a day, unless preserved in a chiller. The Manjung Health District Department received notification from the district hospital of 10 cases of suspected hepatitis A on 19 September 2012. Cases presented with the typical signs and symptoms of hepatitis A, and serology samples were positive for HAV IgM. We conducted an investigation to identify the source, mode of transmission and to recommend control measures.

METHODS

Epidemiological investigation

We conducted a case-control study. Routine notifications from health-care providers were reviewed, and active case finding was conducted among high-risk groups such as food handlers, workers at food premises and household members of cases. A suspect case of hepatitis A was a person with an acute illness with discrete onset of symptoms and jaundice or elevated serum aminotransferase levels from September 2012 in Manjung District. A confirmed case was serologically

[a] Unit of Epidemiology and Biostatistics, Medical Research Resource Centre, Institute for Medical Research, Ministry of Health, Kuala Lumpur, Malaysia.
[b] Melaka State Health Department (Public Health), Hang Tuah Jaya, Melaka, Malaysia.
[c] Manjung Health District Department, Perak Darul Ridzuan, Malaysia.
[d] Office of the Deputy Director General of Health (Public Health), Ministry of Health Malaysia, Putrajaya, Malaysia.
Submitted: 20 February 2015; Published: 27 May 2015
doi: 10.5365/wpsar.2015.6.1.012

positive for HAV IgM antibodies. Controls were randomly selected from the same housing area as cases, were without signs and symptoms and returned negative HAV tests.

We conducted face-to-face interviews using a structured questionnaire that included questions on socio-demographics, food items eaten and activities related to possible ways of transmission. We also included questions pertaining to eating seafood and drinking toddy. Questions pertaining to specific events in September 2012, such as the Eid al-Fitr festival, were also included.

Univariable and multiple logistic regression analyses were performed using STATA 11 software. A backward multiple logistic regression model was applied and multicollinearity and interaction terms were checked. A Hosmer-Lemeshow test, classification table and area under the ROC curve were applied to check the model of fitness.

Laboratory investigation

Blood specimens were sent to the Public Health Laboratory in Sungai Buloh, Selangor and Kinta, Perak for serological tests for HAV (IgM).

Food and environmental investigation

Investigations were conducted at two toddy processing places and 341 food premises. A selection of food handlers were tested for hepatitis A based on place of work and type of food they sold. Environmental samples such as ice cubes from the factory, toddy, seafood and well water were collected for laboratory test by polymerase chain reaction. The pH of toddy samples at various levels of manufacturing was also determined.

RESULTS

There were 78 cases of hepatitis A with an attack rate of 3.1 per 10 000 population. The majority of the cases were male (95%) with an age range of 13 to 72 years (mean 31.4 years). There was a higher proportion of cases in the subdistricts of Ayer Tawar (47.4%) and Sitiawan (37.2%). Most cases occurred among Indians (5.1 per 1000 population), were aged 25–40 years, worked as labourers and were of low income (**Table 1**). The date of onset for the first notified case was 8 September 2012 (**Figure 1**). The epidemic curve shows a propagated shape, as the cases increased until 19 September 2012 with a second peak on 24 September 2012. Then the cases gradually decreased to the lowest level after 25 September 2012, and only a few cases were reported since 11 October 2012.

Analytical study

Univariable analysis showed many significant variables ($P < 0.05$) including being male; eating outside the home; eating seafood; drinking alcohol, including toddy and beer; more frequent eating and drinking alcohol during the week of the Eid al-Fitr festival and several other variables regarding drinking toddy at different occasions (**Table 1**).

After multivariable analysis, only males (adjusted odds ratio [AOR]: 18.4 [5.13–65.0]) and those who drank toddy at processing place A (AOR: 2.7 [1.17–6.25]) were statistically significant.

Environmental assessment

Toddy is produced at processing places A and B, and it can be bought directly and consumed at the processing places or distributed to other food premises. Observation at the processing places showed both of them to be unhygienic. There were no toilets available; toddy was mixed with bare hands; a common bucket was used before bottling; and well water was used to wash at the premises, including the washing of utensils. The well water from processing place B was positive for coliforms. All environmental specimens were negative for HAV. The pH level of toddy at harvesting was 3.37–3.63 and at of bottling was 3.07–3.27. Toddy specimens were unable to be tested for HAV.

A total of 341 food premises were inspected; 10 premises were closed under the Malaysian Food Act 281 and four under the Centers for Disease Control Act 1988. All 67 food handlers tested for HAV were negative, although 71.6% were reactive to total antibody. Samples taken from restaurants such as ice cubes, treated water and piped water supply were all negative for HAV.

DISCUSSION

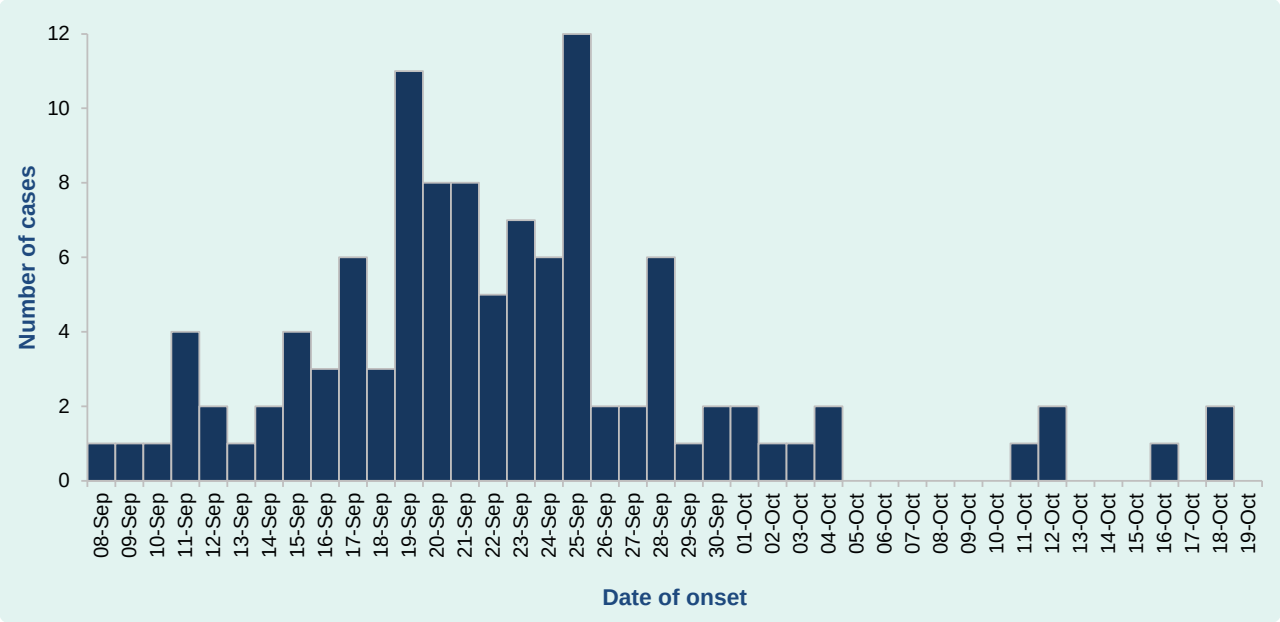
Despite many local officials speculating that seafood and water were the sources of this outbreak, the results

Table 1. **Univariate analysis of case control study, Manjung, Perak, Malaysia, October 2012**

Characteristic	Case (%)	Control (%)	OR (95 CI)	*P*-value
Gender				
Male	75 (96.2)	37 (47.4)	27.7 (8.0–95.4)	< 0.001
Female	3 (3.8)	41 (52.6)	Reference	
Age group				
<20	11 (14.1)	8 (10.3)	Reference	
21–30	28 (35.9)	27 (34.6)	0.8 (0.3–2.2)	0.600
31–40	25 (32.1)	17 (21.8)	1.1 (0.4–3.2)	0.905
41–50	10 (12.8)	8 (10.3)	0.9 (0.3–3.3)	0.886
51–60	3 (3.8)	12 (15.4)	0.2 (0.0–0.9)	0.032
60 and above	1 (1.3)	6 (7.7)	0.1 (0.0–1.2)	0.012
Ethnic group				
Indian	65 (83.3)	63 (80.8)	1.0 (0.1–16.9)	0.983
Chinese	12 (15.4)	13 (16.7)	0.9 (0.1–16.5)	0.957
Malay	0 (0)	1 (1.3)	Reference	
Others	1 (1.3)	1 (1.3)	–	
Occupation				
Student	5 (6.4)	6 (7.7)	Reference	
Housewife/not working	6 (7.7)	28 (35.9)	3.9 (0.9–17.1)	0.720
Driver/student	18 (23.1)	5 (6.4)	0.2 (0.1–1.1)	0.640
Government	5 (6.4)	5 (6.4)	0.9 (0.2–4.6)	0.835
Self-employed	8 (10.3)	4 (5.1)	0.4 (0.1–2.3)	0.309
Labourer	30 (38.5)	26 (33.3)	0.7 (0.2 -2.6)	0.623
Business	6 (7.7)	4 (5.1)	0.6 (0.1–3.1)	0.507
Food and drink exposures				
Eating out during Eid al-Fitr	72 (57.6)	53 (68.0)	5.7 (2.2–14.8)	0.000
More than once a week	63 (80.8)	27 (34.6)	1.8 (1.4–2.3)	0.000
Eating food outside				
Seafood	32 (41.0)	19 (24.4)	2.2 (1.1–4.3)	0.028
Fish	1.4	1	2.1	0.080
Drinking alcohol				
Any alcoholic drink	73 (93.6)	33 (42.3)	19.9 (7.2–54.7)	0.000
Beer	52 (66.7)	23 (29.5)	4.8 (2.4–9.4)	0.000
Toddy	56 (71.8)	21 (26.9)	6.9 (3.4–14.0)	0.000
More than once during Eid al-Fitr	72 (57.6)	53 (68.0)	5.7 (2.2–14.8)	0.000
More frequent during Eid al-Fitr	63 (80.8)	27 (34.6)	1.8 (1.4–2.3)	0.000
At a processing place	56 (71.8)	23 (29.5)	6.1 (3.0–12.2)	0.000
Processing place A	12 (15.4)	1 (1.3)	14.0 (1.8–110.5)	0.012
Processing place B	40 (51.3)	11 (14.1)	6.4 (3.0–13.9)	0.000
At a restaurant	32 (41.0)	12 (15.4)	3.8 (1.8–8.2)	0.001
Drink from bottles	20 (25.6)	8 (10.3)	3.0 (1.2–7.4)	0.015
Drink from stainless steel cup	26 (33.3)	7 (9.0)	5.1 (2.1–12.6)	0.000

CI, confidence interval; OR, odds ratio.

Figure 1. **Epidemic curve of the hepatitis A outbreak in Manjung, Malaysia, 8 September to 19 October 2012**



show that men who drank toddy were more likely to be hepatitis A cases. Even after controlling for all other foods items, seafood was not associated with being a case.

Toddy was the potential source of this outbreak with the time of exposure corresponding to when Malaysians celebrated the Eid al-Fitr festival. Although the Eid al-Fitr festival is a celebration for Muslim communities, almost all Malaysian communities celebrate the festival, too. Low standards of sanitation promote transmission of the HAV infection,[5] and the environmental investigation found unhygienic conditions at both processing places, although the epidemiological investigation found that drinking toddy from processing place A was associated with illness. HAV contamination of toddy can occur at any point of processing,[6] and there was potential contamination observed during preparation, mixing, serving or using utensils washed in contaminated well water. The pH of the toddy tested ranged from 3.0 to 3.8 in which HAV can survive and multiply. Toddy is easy to access and cheaper than other alcoholic drinks, and it contains only 4–5% alcohol.[7] Additionally, most cases occurred among Indians which may be related to their habit of drinking toddy. Attack rates among Chinese and Malays were very low, even though the majority of these two groups lived in the same outbreak areas. It should also be noted that all ethnic Malays are Muslim and therefore are prohibited to drink alcohol.

In this outbreak, we expect cases will continue to appear, which had been experienced elsewhere; outbreaks are often prolonged and difficult to control.[5] Usually outbreaks may persist for six to 18 months until the pool of susceptible people is exhausted.[8]

There are some limitations in our investigation. Recall bias on food intake is one limitation, but this was reduced by asking questions pertaining to the Eid al-Fitr festival. We were also unable to test the presence of HAV in the toddy due to the unavailability of laboratory testing during the outbreak.

Despite these limitations, the investigation suggests that toddy was the source of this hepatitis A outbreak. As a result of this investigation, the toddy preparation places were closed. Cases were followed up weekly as they had the potential to be the source of secondary infection. We also recommended improved sanitary facilities and appropriate water quality for the field workers.

Conflicts of interest

None declared.

Funding

The investigation was undertaken within the Ministry of Health activities.

Acknowledgements

We wish to acknowledge the Director General of Health Malaysia for his permission to publish this paper. We would like to thank the Director of the Perak State Health Department for his support of this study. We wish to extend our thanks to Dr Yeoh So Fan and Dr Haslinda Ismail and all staff of the Manjung District Health Department for helping us in this study, especially helping us with data entry, in addition to their role in preventing and controlling the disease. We also thank all staff of the Perak State Health Department for their contributions to this study.

References:

1. Yong HT, Son R. Review article: Hepatitis A virus – a general overview. *International Food Research Journal*, 2009, 16: 455–467.
2. Cliver DO. Scientific status summary: virus transmission via food. *Food Technology*, 1997, 51:71–78 (http://www.ift.org/~/media/Knowledge%20Center/Science%20Reports/Scientific%20Status%20Summaries/virustransmissionviafood_0497.pdf, accessed 4 May 2015).
3. *Report MHDA*. Perak Darul Ridzuan, Health State Department, 2011.
4. *Basic population characteristic report*. Putrajaya, Department of Statistics Malaysia, 2010.
5. Sowmyanaranan TV et al. Investigation of a hepatitis A outbreak in children in an urban slum in Vellore, Tamil Nadu, using geographic information systems. *Indian Journal of Medical Research*, 2008, 28:32–37.
6. Leong PC. The nutritive value of coconut toddy. *The British Journal of Nutrition*, 1953, 7:253–259. doi:10.1079/BJN19530030 pmid:13081939
7. Sarin SK, Kumar M. Viral hepatitis A. In: Monga SPS, editor. *Molecular Pathology of Liver Diseases.* Springer, 2011, 5:527–552.
8. Health T et al. A community-wide hepatitis A outbreak in the Shoalhaven region, New South Wales. *CDI*, 1997, 21:9.

Hepatitis A outbreak in Ba subdivision, Fiji, October–December 2013

Aneley Getahun,[a] Eric Rafai,[b] Maria Ximena Tolosa,[c] Akanisi Dawainavesi,[d] Anaseini Maisema Tabua[e] and Josefa Tabua[e]

Correspondence to Aneley Getahun (e-mail: aneley.getahun@fnu.ac.fj).

Objective: A cluster of suspected hepatitis A cases was notified to the Fiji Ministry of Health on 22 October 2013. An outbreak investigation team was mobilized to confirm the existence of an outbreak of hepatitis A and advise appropriate public health interventions.

Methods: A case definition for the outbreak investigation was established, and standardized data collection tools were used to collect information on clinical presentation and risk factors. An environmental assessment was also conducted.

Results: There were 160 clinical cases of hepatitis A of which 15 were laboratory-confirmed. The attack rate was 349 per 10 000 population in the Nukuloa nursing zone; there were no reported deaths. Residents of the Nukuloa settlement were 6.6 times more likely to present with symptomatic hepatitis A infection (95% confidence interval: 3.8–12.6) compared with residents of another village with a different water supply.

Discussion: This is the first significant hepatitis A outbreak documented in Ba subdivision and possibly in Fiji. Enhanced surveillance of hepatitis A may reveal other clusters in the country. Improving the primary water source dramatically reduced the occurance of disease in the affected community and adjacent areas.

Fiji is an archipelago in the South Pacific consisting of over 300 islands with an estimated population of 837 000 comprised of 58% Indigenous Fijians and 35% Fijians of Indian descent.[1] There is a paucity of information on the epidemiology of hepatitis A virus (HAV) in Fiji. The only published study on HAV seroprevalence was reported in 1976–1978 when about 84% of samples were positive for HAV-specific antibodies. The age-specific prevalence of anti-HAV was 13% in children under 5 years, 60% among 6–10 year olds and 90% by the age of 20.[2] There have been a few anecdotal or unpublished reports of hepatitis A in Fiji but no reported community outbreaks of significance.[3,4] Hepatitis A cases have been associated with Kava (a plant-based sedative) drinking among tourists returned from Fiji.[5]

Hepatitis A is one of the communicable diseases under routine surveillance in Fiji; it is also mandatory for an outbreak or cluster of suspected cases to be reported within 24 hours to the Ministry of Health and the Fiji Centre for Communicable Diseases Control (FCCDC).[6]

The study area for this investigation is Ba subdivision, an agricultural centre situated on the north-western side of Viti Levu, Fiji's main island. According to the Ba hospital, the estimated population of Ba subdivision is 55 805 with Fijians of Indian descent (72%) making up the largest proportion. The Ba subdivision has three health centres: Ba town, Balevuto and Nailaga. The Balevuto medical area consists of two nursing zones: Nukuloa and Moto, and the hospital estimated a population of 6255 of which 68% are Fijians of Indian descent.

On 22 October 2013, a cluster of eight cases of jaundice and fever was reported to FCCDC from the Balevuto medical area. A joint team from FCCDC and the Fiji National University conducted an investigation and recommended public health measures to control the outbreak and prevent further spread.

[a] School of Public Health and Primary Care, College of Medicine, Nursing and Health Sciences, Fiji National University, Suva, Fiji.
[b] Fiji Ministry of Health, Suva, Fiji.
[c] Australian Volunteer for International Development, Suva, Fiji.
[d] Fiji Centre Communicable Diseases Control, Ministry of Health, Suva, Fiji.
[e] Ba Medical Subdivision, Western Health Services, Suva, Fiji.
Submitted: 20 November 2014; Published: 10 June 2015
doi: 10.5365/wpsar.2014.5.4.006

METHODS

The outbreak investigation followed FCCDC outbreak response guidelines.[6] The investigation team was mobilized within 24 hours after the report of the jaundiced cases.

A suspected case of hepatitis A was defined as a patient presenting with an acute illness with two or more of the following symptoms: fever, headache, malaise, anorexia, nausea, vomiting, diarrhoea, abdominal pain and either jaundice or elevated serum aminotransferase between 8 October and 2 December 2013. A confirmed case was a suspected case with positive anti-HAV IgM or an epidemiological link with a laboratory-confirmed case.[7] A line list of patients who presented with jaundice and other related symptoms was obtained from the Ba subdivisional hospital and the Balevuto health centre, and the team conducted house-to-house visits for active case finding and health promotion activities.

A structured questionnaire that included demographics, clinical presentation, food, water, other risk factors and exposure history for the two to six weeks before onset was used. Risk and exposure factors collected as part of the outbreak investigation included history of eating raw/undercooked shell fish, contact with a jaundice patient or a confirmed hepatitis A patient, history of travel, and attending public/private gatherings two to six weeks before the onset of illness. Blood samples were collected for biochemistry (liver function and renal function tests), full blood counts, dengue and leptospirosis serology testing; 14 serum samples were sent to Suva Private Hospital for anti-HAV IgM testing using the ElecsysAnti-HAV IgM test (Roche Diagnostics, Germany).

An environmental assessment was conducted to determine potential sources of infection. Drinking-water samples were collected from the main water source and from selected households for analysis at the FCCDC public health laboratory. Coliform and *Escherichia coli* counts by the most probable number per 100 ml of sample were conducted to determine the level of contamination.

Data were entered and analysed using Microsoft Office Excel 2007. An epidemic curve used the date of onset of illness; if this was unknown, the date of blood sample collection. Attack rates and relative risk for exposure variables were calculated by medical areas. A spot map was used to assess cases by geographical areas.

RESULTS

Demographic profile of cases

There were 160 suspected cases of hepatitis A of whom 18 were confirmed (15 by serology and 3 by epidemiological link). The majority of cases were men (66%), and Fijians of Indian descent accounted for 93%. The mean age was 31 years with 46% aged between 10 and 29 years (range: 3–80 years). The attack rates were 246, 5 and 0.3 per 10 000 population in Balevuto, Nailaga and Ba medical areas, respectively. Within the Balevuto medical area, the attack rate for Nukuloa was 349 per 10 000 population, and 52 per 10 000 population in Moto.

Clinical presentation

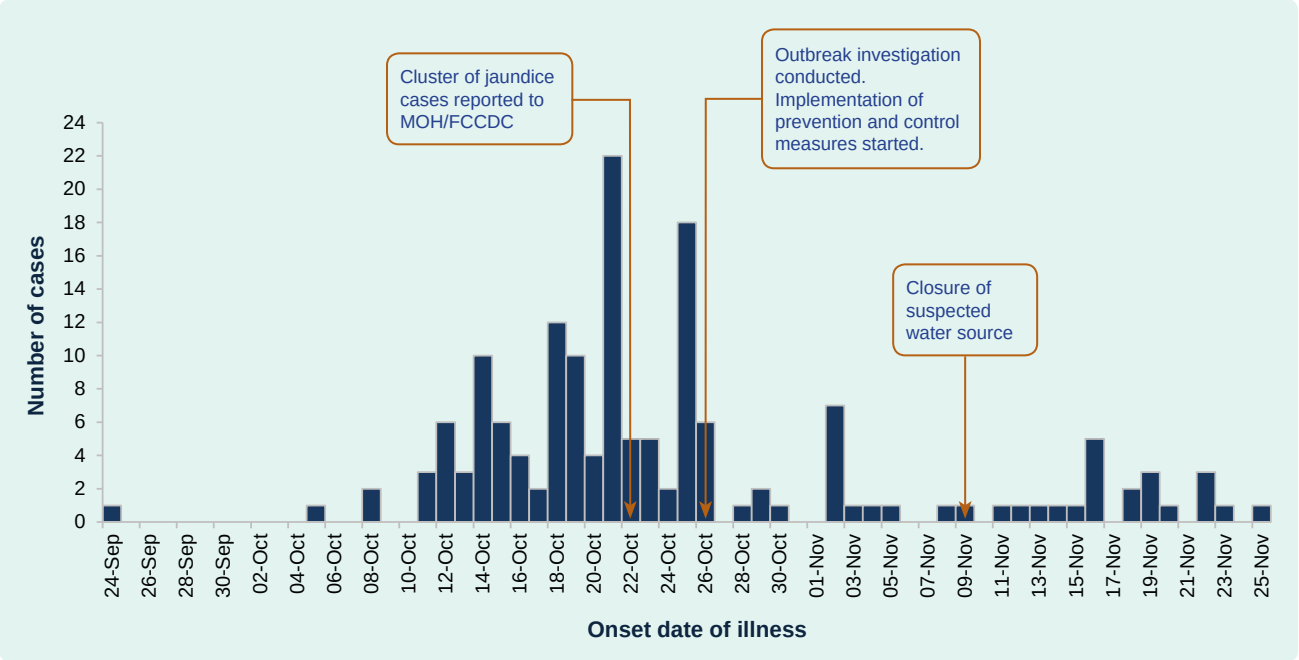
Common symptoms included fever (86%), jaundice (85%), anorexia (69%), malaise and/or nausea (65%), abdominal pain (63%) and vomiting (53%). Other less common symptoms included headache, body pain and dark urine. The mean serum aspartate transaminase (AST) and alanine transaminase (ALT) were 1165 and 1575 μ/L, respectively. There were no deaths.

The epidemic curve shows that about 30% (n = 48) of cases were reported within four days between 18 and 21 October (**Figure 1**). The index case was a 59-year-old female resident of the Nukuloa settlement area whose illness began on 24 September. Her initial symptoms included fever, vomiting and nausea followed by yellowish discoloration of the eyes. Her serum sample was insufficient for HAV serology test; her liver function had an AST of 2550 μ/L and ALT of 2610 μ/L. She had no history of travel outside of Ba or contact with a jaundiced patient.

Exposure and environmental assessment

Data on exposures and risk factors were collected from 50 cases. A total of 18 cases (36%) reported a history of contact with jaundiced patients, mainly another family member. Approximately one quarter (24%) of cases

Figure 1. **The epidemic curve of hepatitis A outbreak in Ba subdivision, Fiji (*n* = 160)**



FCCDC, Fiji Centre for Communicable Diseases Control; MOH, Ministry of Health.

attended social gatherings, public functions or family gatherings where food was served. All visited houses had toilets and there was no report of open defecation.

Ba town has access to a treated reticulated water supply provided by the Water Authorities of Fiji (WAF). However, most of the affected community of the Nukuloa settlement used the privately owned Waica dam (Dayal) (**Figure 2**), which was inspected by the outbreak investigation team. The Waica dam does not have a reservoir for treatment purposes and draws water directly from the river. At the time of the assessment, the water source had no surrounding barrier to prevent human or animal access to the dam. Water samples collected from the dam showed a high level of contamination with human or animal excreta (coliform: 43–153; *E. coli*: 5–43/100 ml) compared to samples taken from WAF water supply (coliform: < 3/100 ml; *E. coli*: nil). The relative risk of HAV infection for Nukuloa residents was 6.6 times more than those who reside in Moto who have a different water source (surface water) (95% confidence interval: 3.8–12.5).

Outbreak control measures

A taskforce was established to coordinate the outbreak response in Ba subdivision. Initial outbreak control measures included health promotion activities through mass media and community visits (schools, settlements and villages) with emphasis on boiling water, hand washing with soap, personal hygiene and food and water safety. Water purification tablets, water filters and hand sanitizers were also distributed to households in the Nukuloa settlement and schools. A health education pamphlet on hepatitis A was developed by the Ministry of Health and widely distributed to the affected areas. Outbreak-related information was posted on PacNet listserv in weeks 43 and 45.[8]

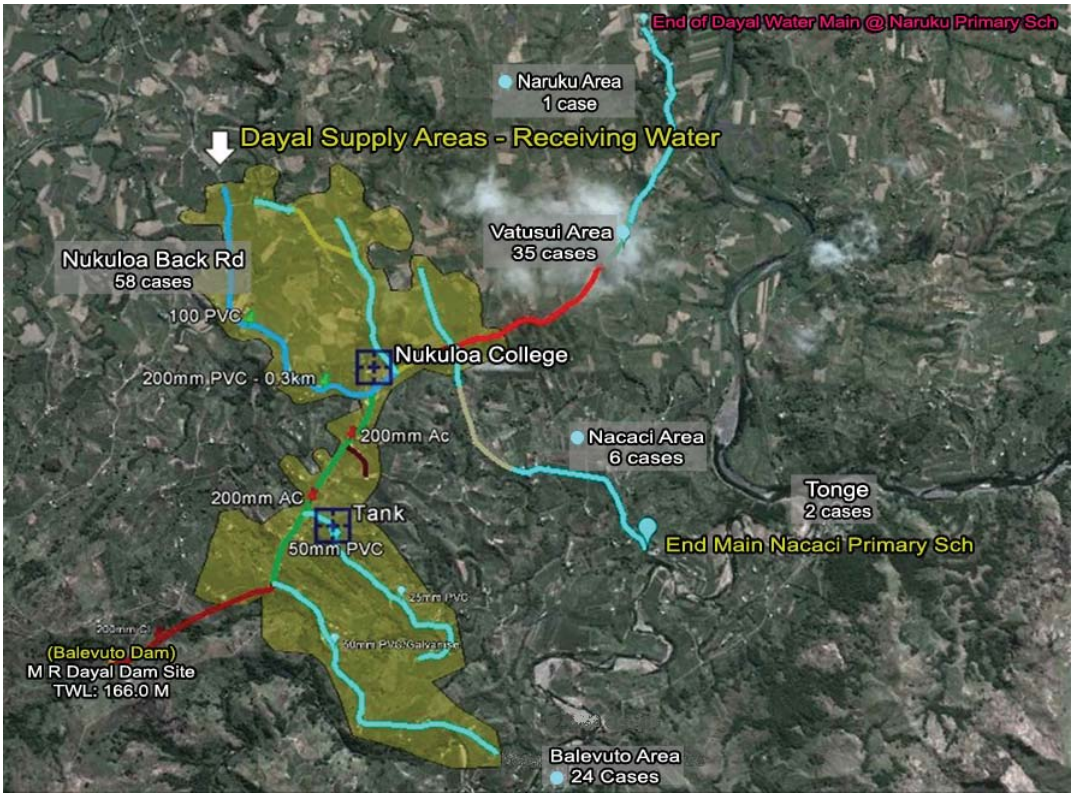
Case management

Health facilities in the affected areas were provided with additional medical supplies for supportive management of patients with hepatitis A. Outpatient department nurses conducted active triage to identify suspected cases for prompt review and management.

Environmental health interventions

The taskforce continued with the recommended community interventions and actively lobbied with landowners and government administration to ensure safe drinking-water was supplied to affected households. As a result, on 9 November 2013, the Waica dam was temporarily closed while WAF undertook major upgrading work to the dam and water system. This later included a

Figure 2. **The Dayal water distribution areas and reported cases of symptomatic hepatitis A cases in Ba subdivision, Fiji, October–December 2013**



Legend: Yellow shaded area – Dayal water distribution area; red line – old piping system that have been removed; and blue line – new water supply piping systems.

Source: Map courtesy of Water Authority of Fiji.

chlorination treatment plant and replacement of the old water piping system thus providing clean treated water to 600 households in the area.[9]

DISCUSSION

This is the first documented community outbreak of hepatitis A to occur in Ba, Fiji. The outbreak was most likely associated with a supply of untreated water to the Nukuloa settlement. There was geographic clustering of cases to areas that receive water from the Waica dam. Significant contamination of water (*E. coli* and coliform) taken from the dam on two occasions and the epidemic curve revealed a continuous source outbreak where cases increased over an extended period of time, approximately two weeks from 12 to 26 October.

Although about 30% of cases presented in four days, the epidemic curve does not exhibit the classic point source outbreak with significant clustering of cases in a short period of time. This is more compatible with a continuous source outbreak which could be attributed to prolonged common source exposure such as contaminated water. Community-based hepatitis A outbreaks from contaminated water have been reported in China and India.[10,11] The propagated nature of the outbreak indicates person-to-person transmission which is likely to have contributed to sustaining the outbreak as well as spreading the infection to other parts of the subdivision, resulting in sporadic cases observed in the two adjacent medical areas.

The significant majority (93%) of hepatitis A cases were Fijians of Indian descent. The occurrence of symptomatic infection with HAV in older age groups in this outbreak suggests no prior exposure to the virus. The prevalence studies in the 1970s estimated the majority of infections were acquired at an early age, and disease prevalence was found to be equal among the two main ethnic groups.[2] The findings from this outbreak investigation may indicate a change in the epidemiology of HAV in this subpopulation in Fiji.

This report is the first to document a hepatitis A outbreak at the community level in Fiji; however, it is limited in scope. It does not extensively examine the exposure and risk factors among the various communities, nor does it explain the difference in attack rates between the two ethnic groups. Detailed information on food eaten was not collected because of a long incubation period and recall bias concerns. Therefore, a foodborne cause cannot be ruled out. HAV surveillance in Fiji is from the passive detection of symptomatic patients mainly by public health facilities and does not include all patients treated in private health facilities or outside the Ba region. This may have underestimated the magnitude of the outbreak.

CONCLUSION

This is the first significant hepatitis A outbreak documented in Ba subdivision and possibly in Fiji. Improving surveillance for hepatitis A may reveal other clusters in the island. After improving the primary water source there was a reduction in cases in the affected community and adjacent areas.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

The authors would like to thank all the medical officers, nurses, laboratory staff and health inspectors in Ba subdivision for their support throughout the outbreak investigation process. We would like to thank the FCCDC team for their technical and laboratory support.

References:

1. *Fiji Bureau of Statistics*. Suva, 2015 (http://www.statsfiji.gov.fj/index.php/2007-census-of-population, accessed 26 March 2014).
2. Gust ID, Lehmann NI, Dimitrakakis M. A seroepidemiologic study of infection with HAV and HBV in five Pacific Islands. *American Journal of Epidemiology*, 1979, 110:237–242. pmid:224697
3. *Patient information system 2004–2007 (unpublished data).* Suva, Fiji Ministry of Health, 2008.
4. *Fiji: Country health information profile, 2011*. Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/countries/fji/7FIJtab2011_finaldraft.pdf, accessed 21 April 2015).
5. Parker JA, Kurien TT, Huppatz C. Hepatitis A outbreak associated with kava drinking. *Communicable Diseases Intelligence Quarterly Report*, 2014, 38:E26–28. pmid:25409352
6. *National Communicable Diseases Surveillance and Outbreak Response Guidelines*. Suva, Fiji Ministry of Health, 2010 (http://www.health.gov.fj/PDFs/CD%20Guidelines.pdf, accessed 21 April 2015).
7. National Notifiable Diseases Surveillance System. *Hepatitis A (Acute), 2012 case definition*. Atlanta, United States Centers for Disease Control and Prevention, 2015 (http://wwwn.cdc.gov/NNDSS/script/casedef.aspx?CondYrID=703&DatePub=1/1/2012, accessed 21 April 2015).
8. *Weekly Pacific Syndromic Surveillance Report – weeks 43 and 45*. Suva, World Health Organization, Division of Pacific Technical Support, 2013.
9. Nasiko R. Families to receive piped water. *The Fiji Times*, 8 April 2014 (http://www.fijitimes.com/story.aspx?id=265012, accessed on 21 April 2015).
10. Thuppal V et al. Investigation of a hepatitis A outbreak in children in an urban slum in Vellore,Tamil Nadu, using geographic information systems. *Indian Journal of Medicine*, 2008, 128:32–37.
11. Ye-Qing X et al. An outbreak of hepatitis A associated with a contaminated well in a middle school, Guangxi, China. *Western Pacific Surveillance and Response Journal*, 2012, 3:44–47. doi:10.5365/wpsar.2012.3.4.014 pmid:23908939

New South Wales annual vaccine-preventable disease report, 2013

Alexander Rosewell,[a] Paula Spokes[a] and Robin Gilmour[a]

Correspondence to Robin Gilmour (e-mail: rgilm@doh.health.nsw.gov.au).

Aim: To describe the epidemiology of selected vaccine-preventable diseases in New South Wales, Australia for 2013.

Methods: Data from the New South Wales Notifiable Conditions Information Management System were analysed by local health district of residence, age, Aboriginality, vaccination status and organism. Risk factor and vaccination status data were collected by public health units.

Results: Pertussis notification rates in infants were low, and no infant pertussis deaths were reported. Despite a high number of imported measles cases, there was limited secondary transmission. The invasive meningococcal disease notification rate declined, and disease due to serogroup C remained low and stable.

Conclusion: Vaccine-preventable diseases were relatively well controlled in New South Wales in 2013, with declining or stable notification rates in most diseases compared with the previous year.

Monitoring vaccine-preventable diseases is important to identify events that may require immediate public health control measures and to better inform policy and targeted immunization efforts.

New South Wales is Australia's largest state and is divided into 15 local health districts (LHDs).[1] Each LHD has a public health unit responsible for follow-up of all health-related issues including vaccine-preventable diseases. Under the state's public health legislation, medical practitioners, hospital general managers and laboratories are required to notify certain vaccine-preventable diseases.[2] Upon receipt of a notification, a surveillance officer from the relevant public health unit determines whether or not the notification meets the case definition of a vaccine-preventable disease according to national criteria.[3] If so, data on each notified case are entered into the New South Wales Notifiable Conditions Information Management System (NCIMS).

This report describes notification data for measles, pertussis, rubella, *Haemophilus influenzae* serotype b invasive infection, invasive meningococcal disease, mumps, tetanus, invasive pneumococcal disease and selected travel-related diseases in New South Wales, Australia in 2013.

METHOD

Data describing cases in NCIMS were extracted for selected vaccine-preventable diseases with a date of onset in 2013. Rates were calculated using 2011 Australian Bureau of Statistics population estimates and are presented as annual rates per 100 000 total population or population in age groups. The notification rates were analysed by geographic area of residence. Risk factor and vaccination status data were collected through follow-up with either general practitioners or the Australian Childhood Immunization Register (ACIR) and other sources such as cases or health-care provider reports.

RESULTS

Selected vaccine-preventable diseases

Haemophilus influenzae serotype b invasive infection

In 2013, nine cases of *H. influenzae* serotype b infection were notified; five were children under 5 years and six were female. All three infants under 1 year (one 1-month-old and two 9-month-old infants) were fully vaccinated for age (one and three doses respectively).

[a] Health Protection Unit, New South Wales, North Sydney, Australia.
Submitted: 8 December 2014; Published: 22 April 2015
doi: 10.5365/wpsar.2014.5.4.009

Table 1. **Vaccine-preventable disease notifications and rates per 100 000 population, New South Wales, Australia, 1991 to 2013**

Year	*H. influenzae* b infection		Measles		Meningococcal disease (invasive)		Mumps		Pertussis		Pneumococcal (disease) invasive		Rubella		Tetanus	
	n	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate
1991	208	3.5	492	8.3	127	2.2	8	0.1	47	0.8	NN	NN	57	1.0	5	0.1
1992	216	3.6	802	13.5	121	2.0	23	0.4	218	3.7	NN	NN	321	5.4	2	0.0
1993	123	2.0	2339	39.0	153	2.5	13	0.2	1531	25.5	NN	NN	1181	19.7	5	0.1
1994	61	1.0	1479	24.4	142	2.3	11	0.2	1403	23.5	NN	NN	227	3.7	4	0.1
1995	29	0.5	594	9.7	113	1.8	14	0.2	1367	22.3	NN	NN	2315	37.8	0	0.0
1996	13	0.2	191	3.1	161	2.6	27	0.4	1152	18.6	NN	NN	628	10.1	1	0.0
1997	17	0.3	271	4.3	218	3.5	29	0.5	4233	67.4	NN	NN	153	2.4	3	0.0
1998	11	0.2	119	1.9	187	2.9	38	0.6	2300	36.3	NN	NN	78	1.2	3	0.0
1999	13	0.2	34	0.5	217	3.4	32	0.5	1413	22.0	NN	NN	45	0.7	1	0.0
2000	8	0.1	31	0.5	251	3.9	91	1.4	3693	56.9	NN	NN	190	2.9	3	0.0
2001	7	0.1	30	0.5	231	3.5	28	0.4	4437	67.9	*	*	58	0.9	0	0.0
2002	10	0.2	7	0.1	215	3.3	29	0.4	2013	30.6	880	13.4	35	0.5	0	0.0
2003	6	0.1	18	0.3	198	3.0	36	0.5	2767	41.8	796	12.0	23	0.3	1	0.0
2004	4	0.1	12	0.2	149	2.2	64	1.0	3560	53.5	898	13.5	17	0.3	0	0.0
2005	7	0.1	5	0.1	139	2.1	109	1.6	5788	86.5	635	9.5	9	0.1	1	0.0
2006	11	0.2	60	0.9	106	1.6	154	2.3	4895	72.6	560	8.3	37	0.5	2	0.0
2007	7	0.1	3	0.0	111	1.6	317	4.6	2085	30.5	520	7.6	8	0.1	2	0.0
2008	8	0.1	39	0.6	81	1.2	76	1.1	8735	125.8	545	7.8	17	0.2	1	0.0
2009	6	0.1	19	0.3	95	1.3	39	0.6	12 514	177.4	474	6.7	7	0.1	1	0.0
2010	6	0.1	26	0.4	75	1.0	40	0.6	9307	130.3	491	6.9	13	0.2	1	0.0
2011	4	0.1	90	1.2	72	1.0	68	0.9	13 160	182.3	526	7.3	17	0.2	1	0.0
2012	2	0.0	172	2.4	65	0.9	105	1.4	5838	80.0	579	7.9	10	0.1	1	0.0
2013	9	0.1	34	0.5	46	0.7	91	1.2	2337	31.6	471	6.4	12	0.2	2	0.0

NN, not notifiable; * incomplete data. 1991–1992 data should be interpreted with caution as the notification system was just commencing.

Note: Major changes to the New South Wales Immunization Programme since 1991 include: *Haemophilus influenzae* serotype b immunization commencement in July 1993, second dose of measles-containing vaccine (measles–mumps–rubella, MMR) for all 10–16-year-olds recommended in 1993, Australian Measles Control Campaign: re–scheduling of the second dose of MMR to 4 years of age, catch–up vaccination for primary schoolchildren aged 5–12 years in 1998, MMR vaccine at 18 months as a replacement of MMR at four years in July 2013, conjugate meningococcal C vaccine introduction in 2003, 4CMenB registration in August 2013, the addition of a preschool pertussis booster in 1994, acellular vaccines (DTPa) replacement of the whole cell vaccine in the late 1990s, the replacement of the 18-month booster with an adolescent booster in 2003, dTpa funded by NSW for parents, grandparents and carers of infants aged < 12 months under cocoon strategy, 7-valent conjugate pneumococcal vaccination (PCV-7) for infants since 2005 and 13-valent conjugate pneumococcal vaccine (PCV-13) replaced PCV-7 from July 2011 (see link to further information – http://ncirs.edu.au/immunisation/history/index.php).

Of the two infants aged 12 months or older, one 19-month-old infant was partially vaccinated for age (one dose) and one 3-year-old was fully vaccinated for age (four doses). One case was identified as being Aboriginal and five lived in regional New South Wales.

Measles

In 2013, 34 cases of measles were notified in New South Wales, compared to 172 in 2012 (**Table 1**). The highest notification rates were reported among children aged 0–4 years (10 cases, 2.1 per 100 000 population), of whom four were too young to be vaccinated, and in children aged 5–9 years (six cases, 1.3 per 100 000 population) (**Table 2**). Seventeen cases (50%) were male. Of the 34 cases of measles, 22 were Australian-born, nine were born in countries other than Australia (mostly in the Asia-Pacific region and Europe) and no data was available on three cases.

Measles cases were notified from eight LHDs; the highest rate was in the Northern New South Wales LHD (six cases, 2.1 per 100 000 population) (**Table 3**).

Of the 34 cases, 18 (53%) were unvaccinated, 11 (32%) were vaccinated and five (15%) had missing vaccination status. Vaccination status was validated on the ACIR for four (all children under 5 years) and by

Table 2. **Number and rate per 100 000 population of case notifications for selected vaccine-preventable diseases by age group, New South Wales, Australia, 2013**

Age group (years)	*H. influenzae* b infection		Measles		Meningococcal disease (invasive)		Mumps		Pertussis		Pneumococcal disease (invasive)		Rubella		Tetanus	
	n	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate
0–4	5	1.0	10	2.1	16	3.3	9	1.9	444	92.4	60	12.5	0	0	0	0
5–9	0	0	6	1.3	2	0.4	2	0.4	515	111.1	9	1.9	0	0	0	0
10–14	0	0	3	0.7	4	0.9	4	0.9	277	62.2	7	1.6	0	0	0	0
15–19	0	0	3	0.6	8	1.7	15	3.2	68	14.7	3	0.6	4	0.9	0	0
20–24	0	0	1	0.2	2	0.4	9	1.8	52	10.4	8	1.6	1	0.2	0	0
25–29	0	0	3	0.6	1	0.2	9	1.7	67	12.6	7	1.3	3	0.6	0	0
30–34	0	0	3	0.6	1	0.2	12	2.3	80	15.2	14	2.7	2	0.4	1	0.2
35–39	0	0	3	0.6	0	0	7	1.4	110	22.1	19	3.8	0	0	0	0
40–44	0	0	2	0.4	0	0	5	1.0	151	28.9	22	4.2	0	0	0	0
45–49	0	0	0	0	2	0	4	0.8	95	19.5	21	4.3	1	0.2	0	0
50–54	0	0	0	0	2	0.4	4	0.8	88	17.7	22	4.4	0	0	0	0
55–59	0	0	0	0	1	0.2	3	0.7	75	16.5	35	7.7	1	0.2	0	0
60–64	0	0	0	0	2	0.5	2	0.5	103	25.8	45	11.3	0	0	0	0
65–69	1	0.3	0	0	1	0.3	3	0.8	77	21.5	52	14.5	0	0	0	0
70–74	1	0.4	0	0	2	0.8	2	0.8	57	21.8	34	13.0	0	0	0	0
75–79	0	0	0	0	0	0	0	0	38	19.0	32	16.0	0	0	0	0
80–84	0	0	0	0	0	0	0	0	27	17.6	39	25.4	0	0	1	0.7
85+	2	1.3	0	0	2	1.3	1	0.6	13	8.4	42	27.1	0	0	0	0

self or parent recall for seven. Of the four cases with vaccination validated on ACIR, only one 2-year-old with mild disease had evidence of receiving two doses of vaccine.

Of the 34 cases notified in 2013, 14 (41%) were acquired overseas, 19 (56%) were acquired in New South Wales, and one (3%) was acquired elsewhere in Australia. There were four cases infected with measles virus genotype B3 (acquired in the Philippines, Nepal, Pakistan), six with measles virus genotype D8 (acquired in Europe, Thailand, India, Victoria [Australia]) and six with measles virus genotype D9 (acquired in Indonesia). The longest duration of linked transmission (onset in primary case to onset in last case) was 29 days, which occurred in the largest cluster (n = 6 cases) (**Figure 1**).

Meningococcal disease (invasive)

In 2013, 46 cases of invasive meningococcal disease were notified in New South Wales compared with 65 cases notified in 2012 (**Table 1**). Two deaths were notified among cases in 2013; one was in the 50–54-year-old age group (serogroup C), and the other was 85 years or older (serogroup Y). This compares to two deaths in 2012 (both caused by serogroup B).

The highest case notification rates of invasive meningococcal disease were among children aged less than 5 years at onset of illness (16 cases, 3.3 per 100 000 population) and young people aged 15–19 years (eight cases, 1.7 per 100 000 population) (**Table 2**). Of the case notifications among children under 5 years, the highest rates were reported in infants under 12 months (six cases, 7.8 per 100 000 population) and children aged 2 years (four cases, 5.6 per 100 000 population).

In 2013, 24 cases (52%) with invasive meningococcal disease were male. Invasive meningococcal disease was notified in four Aboriginal people, all due to serogroup B infection. The highest case notification rates were from Northern New South Wales LHD (four cases, 1.4 per 100 000 population) (**Table 3**).

Of the 46 cases notified in New South Wales in 2013, a serogroup was identified for 43 (93%): 26 (60%) cases were serogroup B (for which there

Table 3. **Number and case notifications rate per 100 000 population for selected vaccine-preventable diseases by local health district, New South Wales, Australia, 2013***

Local health district	*H. influenzae* b infection		Measles		Meningococcal disease (invasive)		Mumps		Pertussis		Pneumococcal disease (invasive)		Rubella		Tetanus	
	n	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate
Sydney	0	0	8	1.4	0	0	10	1.7	99	16.5	36	6.0	0	0	0	0
South Western Sydney	0	0	2	0.2	4	0.4	12	1.3	192	21.2	60	6.6	3	0.3	0	0
South Eastern Sydney	3	0.3	4	0.5	3	0.3	11	1.3	273	31.4	46	5.3	0	0	0	0
Illawarra Shoalhaven	0	0	4	1.0	0	0	3	0.8	176	45.1	28	7.2	0	0	0	0
Western Sydney	0	0	3	0.3	5	0.6	13	1.5	203	23.0	49	5.6	1	0.1	0	0
Nepean Blue Mountains	1	0.3	0	0	3	0.8	6	1.7	122	34.3	32	9.0	1	0.3	1	0.3
Northern Sydney	0	0	6	0.7	9	1.0	23	2.6	317	36.2	35	4.0	1	0.1	1	0.1
Central Coast	0	0	0	0	2	0.6	0	0	42	12.8	20	6.1	0	0	0	0
Hunter New England	1	0.1	0	0	10	1.2	1	0.1	290	32.4	75	8.4	0	0	0	0
Northern New South Wales	2	0.7	6	2.1	4	1.4	10	3.4	99	34.0	17	5.8	6	2.0	0	0
Mid North Coast	0	0	0	0	1	0.5	1	0.5	68	32.4	7	3.3	0	0	0	0
Southern New South Wales	0	0.0	1	0.5	1	0.5	0	0	129	64.4	14	7.0	0	0	0	0
Murrumbidgee (including Albury LHD)	1	0.3	0	0	1	0.3	0	0	245	84.8	22	7.6	0	0	0	0
Western New South Wales	1	0.4	0	0	3	1.1	1	0.4	75	27.3	24	8.7	0	0	0	0
Far West	0	0	0	0	0	0	0	0	3	9.7	1	3.2	0	0	0	0
Justice Health	0	0	0	0	0	0	0	0	1	N/A	0	0	0	0	0	0

* Note: Missing and overseas-acquired notifications are not included.

N/A, not applicable.

was no vaccine), eight (19%) were serogroup Y, six (14%) were serogroup W135, and three (7%) were serogroup C. Of the three untyped cases, two were not typeable (**Figure 2**). Of the three cases of disease due to serogroup C, two were ineligible for vaccination through the National Immunization Programme, and one was vaccinated against meningococcal C disease in 2004. The overall decline in notifications from 2012 to 2013 was associated with a decline in serogroup B disease from 43 to 26 notifications (**Figure 2**).

Mumps

In 2013, 91 cases of mumps were notified in New South Wales compared to 105 in 2012 (**Table 1**). The highest case notification rates of mumps were among young adults aged 15–19 years (15 cases, 3.2 per 100 000 population) (**Table 2**). In 2013, 50 cases (55%) were male. In New South Wales, notified cases of mumps are not routinely followed up by public health units.

Pertussis

In 2013, 2337 cases of pertussis were notified in New South Wales compared to 5838 in 2012 (**Table 1**). The highest age-specific pertussis case notification rates were in children aged 5–9 years (515 cases, 111.1 per 100 000 population) and 0–4 years (444 cases, 92.4 per 100 000 population) (**Table 2**), a decrease from 2012. Of the children under 5 years, the highest notification rates were in children aged 3 years (115 cases, 157.1 per 100 000 population). Notification rates among infants under 12 months decreased from

Figure 1. **Measles transmissions by local health district, epidemiological week, import status, place of acquisition and genotype, New South Wales, Australia, 2013**

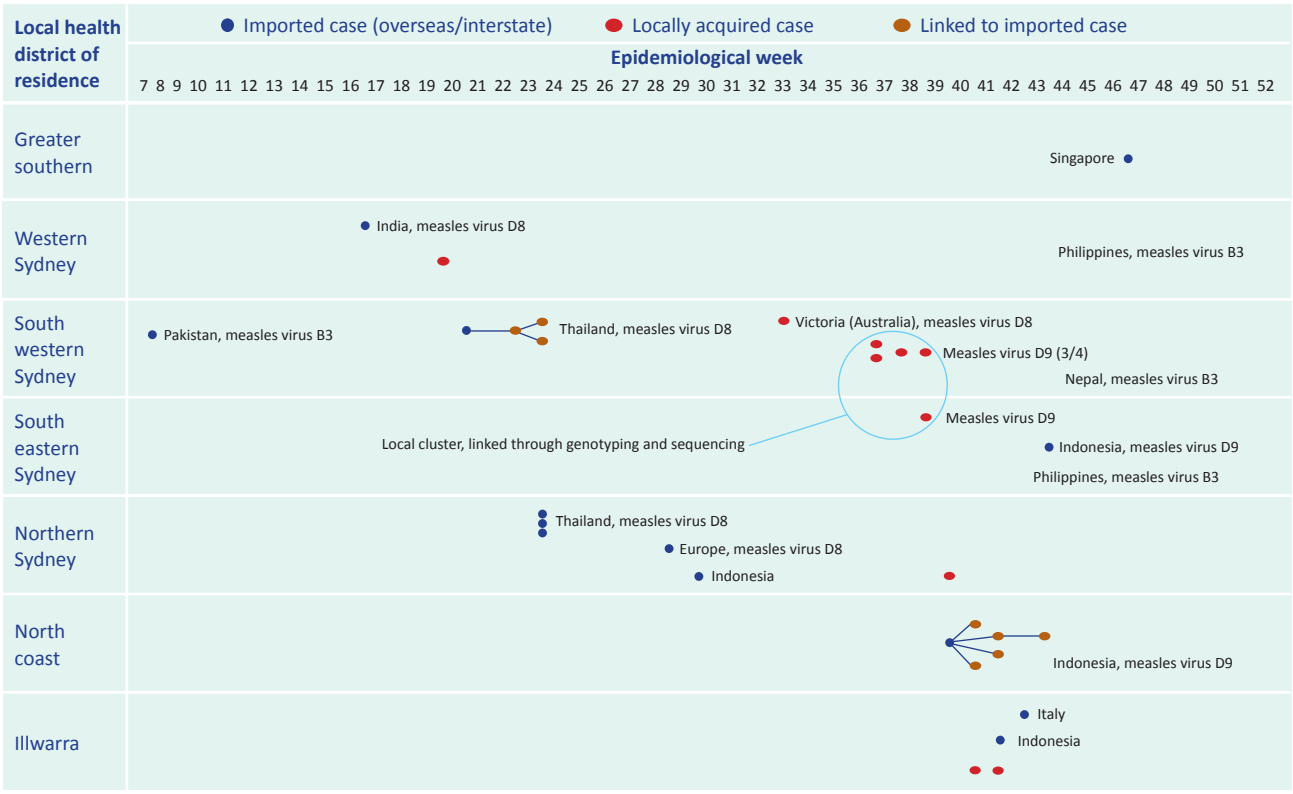
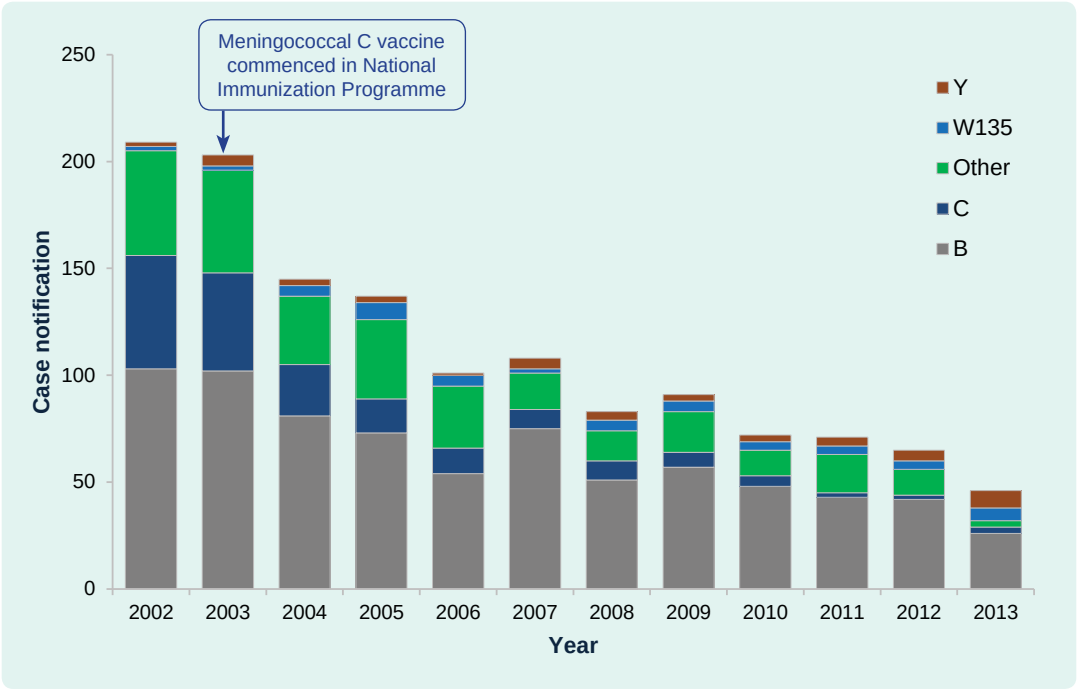


Figure 2. **Annual case notifications of invasive meningococcal disease by serogroup, New South Wales, Australia, 2002 to 2013**



2012 to 2013. There were no infant pertussis deaths in 2013.

In 2013, 1324 cases (57%) were female. Of the 444 cases aged 0–4 years, 37 (8%) were Aboriginal. Geographically, the highest case notification rates were reported in Murrumbidgee (including Albury) (245 cases; 84.8 per 100 000 population) and Southern New South Wales (129 cases; 64.4 per 100 000 population) (**Table 3**).

In total, 102 cases were younger than 12 months: 56 (55%) were infants too young to have received three doses of vaccine. Of the 342 cases aged 1–4 years, 24 (7%) were reported to be not immunized, nine (3%) reported less than three doses of vaccine and 289 (85%) reported three or more doses. For the remainder of cases (5%), vaccine dosages were not reported.

Pneumococcal disease (invasive)

In 2013, 471 cases of invasive pneumococcal disease were notified compared to 579 in 2012 (**Table 1**). Forty deaths occured: two were children, one aged 1-year-old (serotype 15C, non-vaccine type) and one 2-year-old (19A, vaccine type, child fully vaccinated). Of the remaining deaths, two were people aged 35–49 years, eight were 50–64-year-olds and 28 were aged 65 years and older. Notification rates by LHD varied from 3.2 per 100 000 population in Far West LHD to 9.0 per 100 000 population in Nepean Blue Mountains LHD (**Table 3**). Of the 361 cases aged 0–4 years or older than 50 years (age groups which are followed up by public health units), 10 (3%) were notified in Aboriginal people, among whom notification rates were higher than in non-Aboriginal people (17.0 and 11.9 per 100 000, respectively).

Notification rates in children under 5 years was 12.5 per 100 000 population. Serotype 19A was the leading cause of disease (22%) in children under 5 years. Vaccination data were available for 100% (60 cases) of notifications under the age of 5 years. Forty (67%) cases were fully vaccinated, and eight (13%) were either partially vaccinated or too young to have received the first dose. There were eight cases of vaccine serotype disease in fully vaccinated children. Serotype 19A accounted for 63% of vaccine failures and serotypes 3 (25%) and 23F (12%) were responsible for the remainder of cases. From 1 July 2011, 13-valent conjugate pneumococcal vaccine (PCV-13) replaced 7-valent conjugate pneumococcal vaccine (PCV-7) on the New South Wales immunization schedule. The PCV-13 vaccine includes protection for additional serotypes 1, 3, 5, 6A, 7F and 19A. The rate of disease in children under 5 years in New South Wales declined from 19.0 per 100 000 in 2011 to 12.5 per 100 000 in 2013 after the introduction of PCV-13. The percentage of disease due to vaccine serotypes fell by 29% post introduction; however, the percentage of disease due to non-vaccine serotypes increased by 29%.

Rubella

In 2013, 12 cases of rubella were notified in New South Wales compared to 10 in 2012 (**Table 1**). All cases were aged between 15 and 60 years. Seven cases (58%) were male. The highest notification rates were in the Northern New South Wales LHD (six cases, 2.0 per 100 000 population) (**Table 3**). Notifications have not changed markedly over the previous five years.

Tetanus

In 2013, two cases of tetanus were notified in New South Wales. One case was a 30-year-old male construction worker who reported being vaccinated. The other was an 82-year-old male who reported being vaccinated more than 10 years earlier.

The number of notified cases of tetanus has remained relatively unchanged over the past five years, ranging from one to two cases annually.

Other travel-associated vaccine-preventable diseases

Cholera

In 2013, two cases of cholera were notified in New South Wales. One case in an unvaccinated person was acquired during a visit to Bangladesh, and an occupationally acquired case was notified in a laboratory worker.

Hepatitis A

In 2013, 62 cases of hepatitis A were reported of which 47 (75%) were acquired overseas. One case reported vaccination against hepatitis A five years before

leaving Australia. Another seven (11%) were household contacts of those that had travelled overseas, and two (3%) reported consuming food acquired overseas. The remaining six (10%) cases were acquired locally with no source identified.

Typhoid

In 2013, there were 59 notifications of typhoid; 54 (93%) were acquired overseas. Of these 54 notifications, six reported being vaccinated against typhoid before travelling. Five cases reported no overseas travel. Of these, three had household contact with a confirmed case, one reported contact with overseas visitors, and the source was not identified for one case.

DISCUSSION

In 2013, pertussis notification rates were the lowest across all age groups since 2007. The 2013 pertussis epidemiology is consistent with a low transmission period in the three- to four-year cycle of pertussis epidemics. The high vaccination coverage among adult caregivers during the New South Wales Health funded cocooning vaccination programme may have also contributed to the low rates.[4] As with previous years, the highest notification rates were in 5–9-year-old children.

Endemic measles has been eliminated in New South Wales since the late 1990s;[5] however, outbreaks of increasing size and duration were reported in New South Wales in 2011 and 2012.[6,7] In 2013, measles epidemiology was characterized by a high number of overseas-acquired infections (n = 14, 41%) with little secondary transmission. This was likely due to high levels of immunity to measles among contacts of cases and effective systems for public health response. The highest notification rates were reported in Northern New South Wales LHD where vaccination coverage rates are the lowest in New South Wales.[7]

The number of notified cases of invasive meningococcal disease has declined significantly since the National Meningococcal C Immunization Programme commenced in 2003.[8] Serogroup B remains predominant in New South Wales; however, the largest serogroup-specific reduction in meningococcal notifications in 2013 compared to 2012 was for serogroup B notifications in the absence of vaccination.[9] The death in an elderly person due to serogroup Y is a reminder of increased mortality in the elderly, particularly for this serogroup.[10] The meningococcal C vaccine failure may have been due to waning immunity, host factors or issues with the storage or administration of the vaccine. With the newly available vaccine against meningococcal serogroup B disease (not included in the current immunization schedule), consideration should be given to the potential impact on strain variation and carriage, adverse events following immunization, as well as how vaccine effectiveness and failure will be defined and monitored following its introduction.[11]

The *H. influenzae* serotype b immunization programme, which commenced in 1993, has achieved great success in achieving and maintaining low notifications for several years; notifications of other vaccine-preventable diseases (such as mumps, rubella and tetanus) have remained stable or declined over recent years. While there are limitations to these data, vaccine-preventable disease surveillance in New South Wales enables the implementation of timely public health measures, a better understanding of disease trends and informs policy.

The extremely low number of cholera, hepatitis A and typhoid cases that were vaccinated before travelling to high-risk countries highlights the great potential for pre-travel immunization. Health-care providers who see travellers before travel should consider country- and region-specific vaccination, prophylaxis, and disease avoidance recommendations during the consultation.[12] Employers should implement a comprehensive occupational vaccination programme for workers at significant risk of acquiring a vaccine-preventable disease.[13] The Australian Immunization Handbook could consider the inclusion of cholera (and possibly other pathogens) under recommendations for vaccination of those routinely working with this pathogen.

Invasive pneumococcal disease continued to decline post introduction of the 13-valent conjugate pneumococcal vaccine in 2011 with overall reduction of disease in the majority of age groups. Notification rates in children under 5 years in New South Wales has fallen from 19.0 per 100 000 in 2011 to 12.5 per 100 000 in 2013. Serotype 19A continues to be the leading cause of disease in children and also accounts for the majority of vaccine failures in this age group (0–5 years). While notification

rates are not increasing in children, notification rates caused by non-vaccine-related serotypes continue to increase.

Notifications included in the New South Wales notifiable disease database under the *Public Health Act 2010*[14] have laboratory evidence or a link to a laboratory-confirmed case. The number of notifications reflects health-care-seeking behaviour and testing practices which vary across New South Wales. Consequently, the data analysed likely understates the true incidence of infection in New South Wales.

Conclusion

Vaccine-preventable disease surveillance has enabled enhanced monitoring of disease trends, implementation of outbreak control measures and evaluation of prevention programmes in New South Wales. The highlights of the prevention and control programmes in 2013 include the low pertussis notification rates in infants, no infant pertussis deaths, extremely limited measles transmission following overseas importation and low rates of invasive meningococcal disease due to serogroup C. Challenges remain in closing the measles immunity gaps in at-risk populations, ensuring new mothers have been adequately immunized against pertussis (and influenza) as well as improved uptake of vaccination in travellers and other risk groups. High vaccination coverage and timely vaccination for infants and children is important to maintain low rates of disease. Improving vaccination coverage in Aboriginal communities is crucial for successful disease prevention strategies.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

We wish to acknowledge disease notifiers and Public Health Network staff who conduct investigations and follow up notifications and the New South Wales Health Laboratory Network.

References:

1. Health New South Wales. *Local Health Districts and Specialty Networks*. North Sydney, New South Wales Health, 2014 (http://www.health.nsw.gov.au/lhd/pages/default.aspx, accessed 15 March 2015).
2. Rosewell A, Spokes PJ, Gilmour RE. NSW Annual vaccine-preventable disease report, 2011. *New South Wales Public Health Bulletin*, 2012, 23:171–178. doi:10.1071/NB12086 pmid:23442994
3. Communicable Diseases Network Australia. *Australian national notifiable diseases and case definitions*. Canberra, Department of Health, 2014 (http://www.health.gov.au/casedefinitions, accessed 16 May 2014).
4. Quinn HE et al. Parental Tdap boosters and infant pertussis: a case-control study. *Pediatrics*, 2014, 134:713–20. doi:10.1542/peds.2014-1105 pmid:25225136
5. Heywood AE et al. Elimination of endemic measles transmission in Australia. *Bulletin of the World Health Organization*, 2009, 87:64–71. doi:10.2471/BLT.07.046375 pmid:19197406
6. Hope K et al. Measles transmission in health care waiting rooms: implications for public health response. *Western Pacific Surveillance and Response Journal*, 2012, 3:33–8. doi:10.5365/wpsar.2012.3.3.009 pmid:23908937
7. Health New South Wales. *Percentage of children in NSW fully immunised by age group and Local Health District – March 2011 – March 2014*. North Sydney, New South Wales Health, 2014 (http://www.health.nsw.gov.au/immunisation/Documents/coverage-by-LHD.pdf, accessed 3 November 2014).
8. Booy R et al. Impact of meningococcal C conjugate vaccine use in Australia. *Medical Journal of Australia*, 2007, 186:108–109. pmid:17309394
9. Rosewell A, Spokes PJ, Gilmour RE. New South Wales annual vaccine-preventable disease report, 2012. *Western Pacific Surveillance and Response Journal*, 2014, 5(2):15–22. doi:10.5365/wpsar.2014.5.2.004 pmid:25077033
10. Gunaratnam P et al. Invasive meningococcal disease in elderly people, New South Wales, Australia, 1993 to 2012. *Western Pacific Surveillance and Response Journal*, 2013, 4(4):4–10. doi:10.5365/wpsar.2013.4.4.001 pmid:24478917
11. Kaaijk P, van der Ende A, Luytjes W. Routine vaccination against Men B: considerations for implementation. *Human Vaccines and Immunotherapies*, 2014, 10:310–6. doi:10.4161/hv.26816 pmid:24141209
12. Surveillance for Travel-Related Disease — GeoSentinel Surveillance System. United States, 1997–2011. *MMWR. Surveillance Summaries*, 2013, 62:1–23 (http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6203a1.htm accessed 28 May 2014).
13. Australian Technical Advisory Group on Immunization. *The Australian Immunisation Handbook 10th Edition*. Canberra, Australian Government Department of Health, 2013 (http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home, accessed 16 May 2014).
14. *Public Health Act 2010 No 127*. North Sydney, New South Wales Consolidated Acts, 2013 (http://www.legislation.nsw.gov.au/inforcepdf/2010-127.pdf?id=e20f1d11-6a0d-ec9a-fe79-d31ae57c52c3, accessed 8 April 2015).

Risk posed by the Ebola epidemic to the Pacific islands: findings of a recent World Health Organization assessment

Adam T Craig,[ab] Axelle Ronsse,[a] Kate Hardie,[a] Boris I Pavlin,[c] Viema Biaukula[a] and Eric J Nilles[a]

Correspondence to Eric J Nilles (e-mail: nillese@wpro.who.int).

Objective: To assess the public health risk posed by the ongoing Ebola virus disease (EVD) epidemic in West Africa to Pacific island countries and areas and to highlight priority risk management actions for preparedness and response.

Method: The likelihood of EVD importation and the magnitude of public health impact in Pacific island countries and areas were assessed to determine overall risk. Literature about the hazard, epidemiology, exposure and contextual factors associated with EVD was collected and reviewed. Epidemiological information from the current EVD outbreak was assessed.

Results: As of 11 March 2015, there have been more than 24 200 reported cases of EVD and at least 9976 deaths in six West African countries. Three EVD cases have been infected outside of the West African region, and all have epidemiological links to the outbreak in West Africa. Pacific island countries' and areas' relative geographic isolation and lack of travel or trade links between countries with transmission means that EVD importation is very unlikely. However, should a case be imported, the health and non-health consequences would be major. The capacity of Pacific island countries and areas to respond adequately varies greatly between (and within) states but in general is limited.

Discussion: This risk assessment highlights the needs to enhance preparedness for EVD in the Pacific by strengthening the capacities outlined in the World Health Organization *Framework for Action on Ebola*. Priority areas include the ability to detect and respond to suspected EVD cases quickly, isolation and management of cases in appropriately resourced facilities and the prevention of further cases through infection prevention and control. These efforts for Ebola should enhance all-hazards public health preparedness in line with the International Health Regulations (2005).

Ebola virus disease (EVD) – previously known as Ebola haemorrhagic fever – is a severe, often fatal illness of humans. The disease first appeared in 1976 in two simultaneous outbreaks in South Sudan (formerly part of Sudan) and the Democratic Republic of Congo (formerly Zaïre).[1] The origin of the virus is unknown, but fruit bats are considered the likely reservoir of the Ebola virus.[2,3] Initial symptoms include fever, fatigue, muscle pain, headache and sore throat followed by vomiting and diarrhoea. EVD can result in hepatic damage, renal failure, terminal shock and multiorgan dysfunction.[2,4,5] The case fatality rate associated with previous EVD outbreaks has been between 25% and 90%;[2,3,6–12] the rate associated with the current outbreak in West Africa – the largest ever recorded – is estimated to be 60–70%.[12] Children aged less than five years, the elderly and pregnant women are particularly vulnerable.[5] Appropriate clinical management has been shown to improve survival.[13]

The Pacific covers almost one third of the earth and comprises approximately 11.4 million people (excluding Australia and New Zealand). Of these, 8.2 million reside in Papua New Guinea with the remaining 3.2 million dispersed over many hundreds of islands and atolls that make up the other 20 Pacific island countries and areas. Eight Pacific island countries and areas have populations of less than 25 000, three have populations of less than 10 000; Niue and Tokelau each have populations of approximately 1200 people. Fourteen Pacific island countries are States Parties to the International Health Regulations (IHR 2005), and seven are territories or administrative areas for which IHR (2005) responsibilities are delegated to their metropolitan country. The majority of the Pacific island countries and areas are considered to be lower-middle income.[14]

Risk assessment is a systematic process for gathering, documenting and assessing information about

[a] Emerging Disease Surveillance and Response Unit, Division of Pacific Technical Support, World Health Organization, Suva, Fiji.
[b] The University of Newcastle, Callaghan, New South Wales, Australia.
[c] Office of the WHO Representative, Papua New Guinea Country Office, Port Moresby, Papua New Guinea.
Submitted: 22 January 2015; Published: 7 April 2015
doi: 10.5365/wpsar.2015.6.1.009

the public health risk posed by a threat to inform actions based on the level of risk, resource availability, competing health priorities and other context considerations.[15] The objective of this risk assessment was to estimate the likelihood of EVD importation into Pacific island countries and areas and to assess the magnitude of public health and societal impact should a case be imported.

METHOD

This paper reports the risk assessment conducted by the World Health Organization (WHO) Division of Pacific Technical Support in Suva, Fiji as at March 2015. Pacific island countries and areas included American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, New Caledonia, Niue, the Commonwealth of the Northern Mariana Islands, Palau, Papua New Guinea, the Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna. The assessment of the likelihood of EVD importation and its impact on public health follow the WHO guidance for undertaking risk assessments of acute public health events.[15]

The risk assessment was conducted by experienced specialists in public health surveillance and response, epidemiology and virology; all have experience in public health in Pacific island countries and areas. This includes experience in monitoring IHR (2005) core capacities in the Pacific.[14] Their findings were reviewed by a broader group of WHO experts with expertise in laboratory methods, epidemiology, infectious diseases, risk communication and emergency planning.

Scientific literature about the epidemiology of the Ebola virus and the current Ebola epidemic was collected from co-authors, WHO situation reports and through MEDLINE.

RESULTS

Hazard assessment

EVD is a severe, often fatal, illness readily transmitted from an infected human if adequate personal protective measures are not in place; it is believed there is no risk of transmission before symptom onset.[2] The incubation period for EVD is two to 21 days.[12,16]

Human-to-human transmission of EVD is usually by direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other body fluids of a symptomatic EVD case or person who has died of EVD.[3,17] Indirect exposure through contact with surfaces or materials (e.g. bedding, patients' clothes) contaminated with these fluids is possible, although not common. Fomite-mediated transmission in a clinical setting, where surface decontamination occurs frequently, is unlikely.[18] People with direct exposure to infected cases or their blood or body fluids, such as health-care workers without appropriate personal protective equipment (PPE), other caregivers in hospitals or home settings, or persons handling bodies of deceased EVD cases are at high risk of Ebola virus exposure and infection.[3,12,19–21]

The Ebola virus is detectable at low levels in the blood of an infected case at the time of symptom onset; however, it may take up to three days of illness for virus levels to reach reliably detectable levels. The viral load increases logarithmically during the acute phase of illness and decreases during clinical recovery. Bodies of deceased EVD patients remain highly viraemic and hence are highly contagious. Ebola virus has been detected in other body fluids such as semen, breast milk and saliva during the acute and convalescent phase of illness.[22]

Exposure assessment

As of March 2015 the EVD outbreak was contained in West Africa with only three EVD cases having being infected outside of this region. All cases infected in non-West African countries had clear epidemiological links to the outbreak in West Africa.[19,23]

Importation of EVD into the Pacific would require an infected traveller to arrive in the Pacific undetected. There is very limited travel and/or trade links between West Africa and the Pacific, suggesting that the likelihood of a traveller, let alone a traveller who has been in direct contact with the blood or body fluids of an EVD-infected case, arriving in the Pacific is very low. There is no direct flight from West Africa to the Pacific; passengers are required to transit a minimum of three major international airports. Therefore an infected traveller would have to pass through several airport and airline EVD surveillance procedures undetected before reaching the Pacific

islands. Airport-based and airline EVD surveillance includes collecting information about travellers' health (to detect potential symptomatic EVD-infected travellers) and their recent travel history (to identify travellers who have been to an EVD-affected country and may have been exposed regardless of symptom status). Patients travelling for medical care are unlikely to choose a route that passes through the Pacific, rather seeking care in countries within direct flight reach (i.e. United States of America, European or African countries).

Health-care workers, including medical and nursing staff, laboratory scientists, ancillary health staff and volunteer carers of EVD cases in West Africa, have an elevated risk of exposure to the Ebola virus.[12] Members of this group, if travelling to the Pacific within the disease's incubation period, pose a potential importation risk to the Pacific. At the time of writing there were approximately 90 aid and military personnel from Pacific island countries and areas and neighbouring countries serving in EVD-affected countries. These included 27 Fijian United Nations peace keepers and one New Zealand health worker in Liberia, one New Zealand water engineer, one New Zealand security guard and 10 New Zealand and 50 Australian health workers in Sierra Leone (V Biaukula, WHO Division of Pacific Technical Support, personal communication, 18 December 2014; J Mansour, Australia Department of Health, personal communication, 17 December 2014; and S Gilbert, New Zealand Ministry of Health, personal communication, 17 December 2014). According to national health agency protocols in Australia, New Zealand and Fiji, all returning health workers (whether symptomatic or asymptomatic) will perform daily home-based health screening and be monitoring for 21 days (the maximum incubation period for the virus) after leaving an EVD-affected country (V Biaukula, WHO Division of Pacific Technical Support, personal communication, 18 December 2014).[17,24,25]

Context assessment

Context assessment examines setting-related factors that influence the vulnerability of the population to health impacts associated with a hazard.[15] For EVD, capabilities to implement prevention, preparedness and control measures to decrease the level of risk are pertinent. The assessment was undertaken in the context of the broader global public health response to the EVD epidemic and the resulting protective influence these actions have on risk of EVD importation into Pacific island countries and areas.

While the likelihood of a symptomatic or asymptomatic EVD-infected person arriving in the Pacific and evading all screening mechanisms on route is very low, it is possible. The capacity of Pacific island countries and areas to detect and respond to EVD in the community and to undertake the associated community-based public health control measures required (e.g. contact tracing, risk communication) varies between states but in general is limited. All Pacific island countries and areas are enhancing preparedness for EVD; however, existing resource and workforce limitations, geographic isolation and limited communication infrastructures, and logistic constraints pose major barriers to achieving event readiness in a short time frame.

Results of a survey of Member States in the WHO Western Pacific Region (of which 14 are Pacific island countries) conducted in October 2014 aimed to assess states' preparedness to respond to EVD. The survey highlighted that achieving the necessary core capacities in Pacific island countries (and areas) is difficult. The survey found that four (31%) of the 13 Pacific island countries that responded reported not yet having a health care facility designated to isolate suspected or confirmed cases of EVD. Further, only two (15%) reported having adequate supplies of PPE in country for EVD rapid response and containment operations. The survey reported that awareness of the EVD situation was high and that the governments of all Pacific island countries were monitoring the global situation; however, few (n = 4; 31%) had conducted country-specific risk assessments. Nine (69%) surveyed Pacific island countries self-reported having adequate early warning surveillance systems to detect potential EVD; however, only four (31%) reported having EVD-specific investigation protocols developed or having trained rapid response teams in EVD response procedures.[26]

Globally, governments, airlines and major international travel hubs are conducting surveillance for EVD (including exit health screening in affected countries) in a concerted effort to stop the global spread of the disease. International airports in the Pacific have introduced EVD-specific health and travel history declaration cards to screen arriving passengers, have

Table 1. **Risk characterization matrix for the importation of Ebola virus disease (EVD) into Pacific island countries and areas, February 2015**

	Hazard	Exposure	Context
Potential for EVD importation into Pacific island countries and areas	A highly infectious virus. Transmission requires direct contact with blood or body fluids of a symptomatic infected case or person who has died due to EVD infection or direct contact with environments soiled with blood or body fluids of an infected person. No evidence of fomite transmission in clinical settings. Cases have a high viral load and the infectious dose is low.	Currently the EVD outbreak is contained in West Africa, distant from Pacific island countries and areas. Few, if any, travel or trade links exist between affected countries and Pacific island countries and areas. A long incubation period means that international travel of asymptomatic cases is possible. A small number of aid and military personnel from Pacific island countries and areas and neighbouring countries have been deployed to EVD-affected areas. A post-deployment quarantine period applied to returning travellers involves home-based self-monitoring and reporting if symptoms develop for 21 days (the maximum incubation period).	Global EVD surveillance efforts are in place that reduce the likelihood of EVD case importation into the Pacific. If the virus were imported, the ability of Pacific island countries and areas to respond would be variable. Limited access to laboratories able to test for EVD may result in lengthy delays and require public health response based on clinical presentation. This may have major resource implications.
Impact on public health	Infection results in severe, often fatal illness. High hospitalization and case fatality rates. Possible negative impact on other health programmes, such as redirection of resources away from other programmes.	Health-care workers and those caring for EVD-infected cases or those that come into contact with the blood, body fluids or organs of a deceased case are at elevated risk of becoming infected. Children under the age of five years, the elderly and pregnant women are at higher risk of death if infected.	Gaps in key EVD response preparedness areas in many Pacific island countries and areas settings.

EVD risk communication messages displayed in airport arrival halls, and have mechanisms in place to isolate and interview sick travellers. Such efforts further reduce the risk of importation of EVD into the Pacific.

Access to laboratory facilities able to test for EVD is limited in Pacific island countries and areas. The closest laboratories able to test for EVD are the Victorian Infectious Diseases Reference Laboratory in Melbourne, Australia (preliminary testing only) and the WHO Collaborating Centre Laboratory at the United States Centers for Disease Control and Prevention in Atlanta, USA (definitive testing).[27] The time required to transport specimens to these facilities range from one to seven days; therefore, health authorities will need to initially act based on a clinical diagnosis.

Risk characterization

The information from the risk characterization (summaries in **Table 1**) suggests that the likelihood of EVD importation into the Pacific is very low, especially as the outbreak Guinea, Liberia and Sierra Leone is stabilizing. However, if it were to occur, the existing gaps in surveillance, response and infection prevention and control capacity in many Pacific island countries and areas would mean that both the public health and broader societal consequences could be major. Building core IHR (2005) and EVD-specific capacities in surveillance, infection prevention and control and outbreak response is warranted and will help to strengthen all-hazards alert and response capacities in the Pacific region.

DISCUSSION

Although the likelihood of EVD importation into the Pacific is low, this risk assessment highlights that Pacific island countries and areas need to assess and enhance their core public health capacities to be able to effectively detect and respond to suspected or confirmed EVD cases. EVD preparedness should focus on the capacities outlined in WHO's *Framework for Action on Ebola*,[28] which include: command and control, surveillance, risk assessment and response, laboratory, clinical management and infection prevention and control, public health interventions (including those at international points of entry) and risk communication. As these capacities are required for most public health emergency responses, efforts for an EVD-specific threat should have long-term value by enhancing an all-hazards approach to public health preparedness in line with the IHR (2005).

While it is important to address all capabilities in the *Framework for Action on Ebola*, an immediate

priority for Pacific island countries and areas is to ensure suitable isolation facilities are identified to accommodate and treat suspected and confirmed EVD cases. These facilities need to be adequately resourced with staff trained in the clinical management of EVD and EVD-related infection prevention and control, appropriate stock of PPE and systems for timely deployment and mechanisms for safe management of clinical and human waste.

This risk assessment has some limitations. As it was defined by the epidemiological and contextual situation at one point in time (in this case March 2015), it will need updating as the situation evolves or new information surfaces. The assessment applies to the Pacific region as a whole and did not assess variability in risk or capacity to respond for individual Pacific island countries or areas. Pacific islands are encouraged to build on this risk assessment by further exploring their jurisdictions' specific level of exposure, vulnerability and resilience to EVD. Finally, risk assessments, by their nature, are subjective; therefore, other risk assessments may have different outcomes.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

We acknowledge the ongoing support provided by the WHO Regional Office for the Western Pacific Ebola Emergency Support Team. We acknowledge and thank Professor David Durrheim and Dr Beverly Paterson of the University of Newcastle (Australia) for reviewing this risk assessment and for their valuable contributions.

References:

1. United States Centers for Disease Control and Prevention. *Outbreaks Chronology: Ebola Virus Disease*. Atlanta, United States Centers for Disease Control and Prevention, 2014 (http://www.cdc.gov/vhf/ebola/outbreaks/history/chronology.html, accessed 15 December 2014).
2. *Ebola virus disease*. Geneva, World Health Organization, 2014 (http://www.who.int/mediacentre/factsheets/fs103/en/, accessed 15 December 2014).
3. Dowell SF et al. Transmission of Ebola hemorrhagic fever: a study of risk factors in family members, Kikwit, Democratic Republic of the Congo, 1995. *The Journal of Infectious Diseases*, 1999, 179 (Suppl 1):S87–91. doi:10.1086/514284 pmid:9988169
4. Heymann DL. *Control of Communicable Disease Manual*. Washington, DC, American Public Health Association and World Health Organization, 2008.
5. Chertow DS et al. Ebola virus disease in West Africa–clinical manifestations and management. *The New England Journal of Medicine*, 2014, 371:2054–2057. doi:10.1056/NEJMp1413084 pmid:25372854
6. Roels TH et al. Ebola haemorrhagic fever, Kikwit, Democratic Republic of the Congo, 1995: risk factors for patients without a reported exposure. *The Journal of Infectious Diseases*, 1999, 179 (Suppl 1):S92–97. doi:10.1086/514286 pmid:9988170
7. Kerstiëns B, Matthys F. Interventions to control virus transmission during an outbreak of Ebola hemorrhagic fever: experience from Kikwit, Democratic Republic of the Congo, 1995. *The Journal of Infectious Diseases*, 1999, 179 (Suppl 1):S263–267. doi:10.1086/514320 pmid:9988193
8. Baron RC, McCormick JB, Zubeir OA. Ebola virus disease in southern Sudan: hospital dissemination and intrafamilial spread. *Bulletin of the World Health Organization*, 1983, 61:997–1003. pmid:6370486
9. Muyembe T, Kipasa M; International Scientific and Technical Committee and WHO Collaborating Centre for Haemorrhagic Fevers. Ebola haemorrhagic fever in Kikwit, Zaire. *Lancet*, 1995, 345:1448. doi:10.1016/S0140-6736(95)92640-2 pmid:7760645
10. Ebola haemorrhagic fever in Zaire, 1976. *Bulletin of the World Health Organization*, 1978, 56:271–293. pmid:307456
11. Ebola haemorrhagic fever in Sudan, 1976. Report of a WHO/International Study Team. *Bulletin of the World Health Organization*, 1978, 56:247–270. pmid:307455
12. WHO Ebola Response Team. Ebola virus disease in West Africa–the first 9 months of the epidemic and forward projections. *The New England Journal of Medicine*, 2014, 371:1481–1495. doi:10.1056/NEJMoa1411100 pmid:25244186
13. Fowler RA et al. Caring for critically ill patients with ebola virus disease. Perspectives from West Africa. *American Journal of Respiratory and Critical Care Medicine*, 2014, 190:733–737. doi:10.1164/rccm.201408-1514CP pmid:25166884
14. Craig A, Kool J, Nilles E. The Pacific experience: supporting small island countries and territories to meet their 2012 International Health Regulations (2005) commitments. *Western Pacific Surveillance and Response Journal*, 2013, 4(3):14–18. doi:10.5365/wpsar.2012.3.4.007 pmid:24319608
15. *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 3 March 2015).
16. Eichner M, Dowell SF, Firese N. Incubation period of ebola hemorrhagic virus subtype zaire. *Osong Public Health and Research Perspectives*, 2011, 2(1):3–7. doi: 10.1016/j.phrp.2011.04.001 pmid: 24159443
17. Drazen J et al. Ebola and quarrantine. *The New England Journal of Medicine*, 2014, 370:2. doi: 10.1056/NEJMe1413139
18. Bausch DG et al. Assessment of the risk of Ebola virus transmission from bodily fluids and fomites. *The Journal of Infectious Diseases*, 2007, 196 (Suppl 2):S142–147. doi:10.1086/520545 pmid:17940942

19. *Ebola Situation reports – 11 March 2015*. Geneva, World Health Organization, 2015 (http://www.who.int/csr/disease/ebola/situation-reports/en/, accessed 22 February 2015).

20. Towner JS et al. Rapid diagnosis of Ebola hemorrhagic fever by reverse transcription-PCR in an outbreak setting and assessment of patient viral load as a predictor of outcome. *Journal of Virology*, 2004, 78:4330–4341. doi:10.1128/JVI.78.8.4330-4341.2004 pmid:15047846

21. Hayden EC. Ebola threatens a way of life. *Nature*, 2014, 516:295–296. pmid:25519108

22. Beeching NJ, Fenech M, Houlihan CF. Ebola virus disease. *BMJ (Clinical Research Ed.)*, 2014, 349:g7348. pmid:25497512

23. United Kingdom National Health Service. News update: UK Ebola case confirmed. London, National Health Service, 2014 (http://www.nhs.uk/news/2014/07July/Pages/Ebola-threat-to-the-UK-is-very-low.aspx, accessed 31 December 2014).

24. *Protocol for individuals entering New Zealand after assisting in the Ebola response in affected countries.* Wellington, New Zeland Ministry of Health, 2014 (http://www.health.govt.nz/our-work/diseases-and-conditions/ebola-updates/protocol-individuals-entering-new-zealand-after-assisting-ebola-response-affected-countries, accessed 18 December 2014).

25. *Ebola virus disease (EVD) – CDNA National Guidelines for Public Health Units*. Canberra, Australian Government, Department of Health, 2014 (http://health.gov.au/internet/main/publishing.nsf/Content/ohp-ebola.htm/$File/EVD-SoNG.pdf, accessed 28 December 2014).

26. Xu Z et al. Ebola reparedness in the Western Pacific Region, 2014. *Western Pacific Surveillance and Response Journal*, 2015, 6:1–7. doi:10.5365/wpsar.2014.5.4.004 pmid:25960917

27. Biaukula V. PacNET post – *Ebola Pacific Update #12 – Laboratory Testing 2014*. Hawaii, Pacific Forum CSIS, 2014 (http://www.wpro.who.int/southpacific/programmes/communicable_diseases/disease_surveillance_response/pacnetebola13.pdf, accessed 10 December 2014).

28. *Preparedness for potential outbreak of Ebola virus disease: a framework for action in the Western Pacific Region.* Manila, World Health Organization Regional Office for the Western Pacific, 2014.

Responding to a measles outbreak in a Pacific island community in western Sydney: community interviews led to church-based immunization clinics

Nicola Scott,[ab] Salwa Gabriel,[c] Vicky Sheppeard,[d] Alisa Peacock,[c] Caroline Scott,[c] Kristina Flego,[c] Bradley Forssman[e] and Holly Seale[b]

Correspondence to Nicola Scott (e-mail: nicolascott11@hotmail.com).

Introduction: There are large Pacific island communities in western and south-western Sydney, New South Wales, Australia. In 2011 and 2012, measles outbreaks disproportionally affected children and youth within these communities. The objectives of this study were to explore barriers to immunization in a Pacific island community from the perspectives of community members and health professionals and to conduct a pilot programme whereby immunization catch-up clinics were held in a Samoan church in western Sydney.

Methods: Interviews were conducted with Pacific island community members ($N = 12$) and health professionals connected with the Pacific island community ($N = 7$) in 2013. A partnership with a local Samoan church was established to provide an accessible venue for immunization catch-up clinics.

Results: Among the community members there were high levels of belief in the importance of immunization and a positive view regarding the protection offered by immunization. A key barrier reported by community members was being busy and therefore having limited time to get children immunized. The important role of the church within the community was emphasized in the interviews, and as a result, two immunization catch-up clinics were held in a Samoan church in western Sydney. The age range of attendees was 7–33 years. A total of 31 measles, mumps and rubella doses and 19 meningococcal C doses were given during the two clinics.

Discussion: The outcomes of the interviews and the subsequent clinics highlighted the potential of churches as a venue for providing public health interventions such as catch-up immunization.

Despite Australia eliminating the transmission of endemic measles in 2005,[1] sporadic measles outbreaks continue to occur. In New South Wales from 2010 to 2013, there were 323 measles notifications with large outbreaks occurring in both 2011 and 2012.[2] There were 168 cases in the 2012 measles outbreak in New South Wales,[3] with most cases occurring in south-western and western Sydney with an overrepresentation among people of Pacific island descent.[3] The 2011 measles outbreak in western Sydney also disproportionally affected the Pacific island population, with 46% of the 26 cases being of Pacific island descent.[4]

"Pacific island population" refers to people from the islands of Melanesia, the Federated States of Micronesia and Polynesia,[5] although populations from these different regions are heterogeneous with diverse cultures, languages and religions.[5] Australia has sizable Pacific island communities in Sydney, Melbourne and Brisbane.[6]

The Blacktown Local Government Area is the largest in New South Wales by population with 312 479 residents[7] and is multicultural with 38% of all residents reporting they were born overseas and 37% of residents speaking a primary language other than English.[8] Samoan is the fifth most common language spoken at home[9] and is ranked as the 12th (4624 people) most common ancestry, followed by Fijian at 13th (4105) and Maori at 15th (3282).[10] Using ancestry, which is the cultural association and ethnic background of an

[a] New South Wales Public Health Officer Training Program, Ministry of Health, New South Wales, Australia.
[b] School of Public Health and Community Medicine, University of New South Wales, New South Wales, Australia.
[c] Western Sydney Local Health District Public Health Unit, New South Wales, Australia.
[d] Health Protection New South Wales, Australia.
[e] Nepean Blue Mountains Local Health District Public Health Unit, New South Wales, Australia.
Submitted: 28 July 2014; Published: 6 April 2015
doi: 10.5365/wpsar.2014.5.3.004

individual going back three generations, provides a more accurate reflection of Pacific island population size than country of birth.[6]

To date, very little research has been undertaken into immunization among Pacific island communities in Australia. New Zealand research has found that children with Pacific island backgrounds have a greater risk of poor health and hospitalization for respiratory infections, skin infections and a higher incidence of infectious diseases such as meningococcal disease and measles than New Zealand Maori or other New Zealand children.[11] Factors found to be significantly associated with incomplete immunization of Pacific island infants in New Zealand include: (1) maternal birthplace (Pacific island born rather than New Zealand born); (2) parity (more than five children); (3) maternal smoking; and (4) difficulty with transport.[12,13]

As Pacific island children and youth were predominant among the people affected in measles outbreaks in New South Wales in 2011 and 2012, we attempted to increase immunization in this group by: (1) exploring the barriers to immunization in the Pacific island community by conducting interviews with community members; and, (2) conducting a pilot programme whereby two immunization catch-up clinics were held in a Samoan church in western Sydney. This paper describes both of these.

METHODS

Interviews with Pacific island community members

Study design and sample

Semi-structured interviews were conducted in 2013 with Pacific island community members and health professionals who worked with or were connected with the Pacific island community. Health professional participants were recruited through the public health unit. A Pacific island community health worker, with in-depth knowledge of the community and extensive experience with community engagement, assisted with the recruitment of community participants. Eligible participants were Pacific island community members with children recruited through local Pacific island women's support groups and a Pacific island church. A verbal explanation of the study was provided in English or Samoan and written participant information and consent forms were provided in English, Samoan and Tongan. Completed consent forms were returned to the researcher via the community health worker. Approximately 80% of the people who were provided with a consent form returned them; participants were then contacted by the researcher to arrange an interview.

The interviews aimed to gather information on barriers to immunization and views on proposed pilot immunization catch-up clinics. Questions were asked in English in an open-ended manner to allow for expansion. Interviews were conducted in private and lasted approximately 30 minutes each. Community participants were provided with a voucher as reimbursement for their time.

Data analysis

The interviews were recorded, transcribed verbatim and analysed thematically using QSR International's NVIVO10 qualitative data analysis software. This was then verified with secondary coding.

Ethics approval was obtained from the University of New South Wales.

Immunization catch-up clinics

Target population and immunization offered

The primary target population for the immunization catch-up clinics was Pacific island youth aged 10–19 years, as this was the age group commonly affected in the 2011 and 2012 outbreaks.[3,4] The Australian Childhood Immunization Register (ACIR) is a national register, established in 1996, that records details of vaccinations given to children under seven years of age who live in Australia.[14] All children who are registered with Medicare (the Australian universal health insurance scheme) are automatically included on the ACIR unless their parents actively seek their removal. Because 99% of children are registered with Medicare by the age of 12 months, it can be considered a near complete national record.[15] As ACIR commenced operations in 1997, older Pacific island youth (> 19 years) may not have received or have a record of receiving two doses of measles, mumps and rubella (MMR) vaccine, so this age group was also included as

a secondary target. As well as MMR vaccine, both target populations were also offered meningococcal C vaccine if it was absent from their records.

Venue and logistics for clinics

Two immunization catch-up clinics were held in a large Samoan church in western Sydney in 2013. The clinics were advertized through a flyer and word of mouth within the community. The first clinic was held on a rehearsal day for a Samoan festival, which was suggested by the church leader, because many children and youth from the congregation would be present. As the completion of a two-dose vaccine schedule for MMR requires a subsequent dose of MMR to be provided at least four weeks after the first valid dose,[16] the second clinic was held one month after the first clinic.

RESULTS

Interviews with Pacific island community members

Participants

The majority of community participants (N = 12) originated from Samoa (n = 10) with one participant from the Cook Islands and one from Tonga. Reflective of the recruitment process, the majority of participants were female (n = 11). All participants had two children or more with half reporting that their children were born in Australia. Of the children born overseas, the majority were born in New Zealand. One quarter of the participants reported they had grandchildren.

Of the seven health professionals interviewed, three were Samoan, two Tongan and two non-Pacific islanders. At the time of the interviews, the health professionals worked in community health, primary care or tertiary hospital care.

Knowledge of immunization

Community participants stated that immunization was important and spoke positively about immunization protecting their children and themselves from diseases.

> Immunization is good for prevention of diseases coming up, and it is good to have some antibodies against diseases in the future. – community member

All participants were able to name at least two diseases that could be prevented by immunization. The majority of participants said whooping cough, measles or chickenpox, with a few participants providing a more comprehensive list including meningococcal disease and hepatitis.

Participants reported feeling there were minimal risks involved with immunization. One participant described a severe adverse reaction to immunization that her brother had back in the islands; however, she felt that this was not a risk in Australia. Reported benefits of immunization included: preventing disease; facilitating good health; and helping children to be safe, active and happy. There was some acknowledgement of the importance of other people immunizing their children and also reference to costs involved with children getting sick if they are not immunized.

> Because I don't want them to be sick. I want them to be healthy and it is more helpful to me cause if they are sick I have to take them to the doctor and spend a lot of money. – community member

Barriers to immunization

Busy lives

When asked their current views on barriers to immunization, the majority of participants reported that being busy was a factor, which also leads to them forgetting or having limited time to take their children to the doctor. For some participants, there was no sense of urgency around immunization.

> My son, he turned four and I forgot, I had it on my reminder and then forgot again. So I didn't get him done until he was four years and four months. And I kept having it on my reminder. It didn't feel like it was urgent. Just business got in the way and I forgot, I'll do it next week. – community member

Migration

Missing out on immunization due to migration was raised as an issue by the majority of community participants and health professionals. Community members reported that movement frequently occurs from Samoa to New Zealand and then to Australia. This was also highlighted by the health professionals; one specifically identified that some of the Pacific island families move

when their children are adolescents and they have missed out on some of their immunizations.

> … I think it is just the time when they move over and they get missed that way. – health professional

Communication

Language barriers and lack of communication were not identified as barriers to immunization for the majority of community participants, although this outcome may have been influenced by the fact that the interviews were conducted in English.

In comparison, all of the health professionals interviewed felt this was a key barrier with misinformation and myths about immunization and low levels of health literacy within the Pacific island community.

> Low level of understanding and communication, it's more of an education issue that the people don't really understand and the communication is very difficult. – health professional

Strategies to improve immunization rates

In contrast to the findings from the community members, health professionals felt it was important to provide information and education about immunization including the risks associated with not being immunized.

> Organize interpreters to speak with the group and provide information about the value of vaccination, about the risks of not getting your child vaccinated. – health professional

Due to previous advice given to the public health unit regarding the importance of church in the Pacific island community, interviewees were asked their views on providing information on immunization through church. Both groups agreed with this approach; however, the positive response from the community members may have been influenced by their links to local churches.

> Most Pacific island people go to church. Maybe this is one of the best channels to go through. To remind people, through ministers, because their job is spiritual health as well, they will give out information for the health of their people. – community member

> I guess more awareness, through church, cause that is where most of them go to. The communities move around the church area, so that's one way to improve the awareness and communication through church. – health professional

Table 1. **Participants of the immunization catch-up clinics by immunization status and whether vaccine given, western Sydney, Australia, 2013**

Immunization status	Number of people	
	Clinic 1	Clinic 2
Fully vaccinated for age (no vaccine required)	27	1
Vaccine given	36	14
Not vaccinated	34	4
1 documented dose of MMR	2	10*
Total number of people attending clinic	63	15

* All received their MMR dose 1 at the first clinic.
MMR, mumps, measles and rubella.

Interviewees were asked their views on the use of churches to pilot immunization catch-up clinics. The majority of community members said they would be happy for their children or grandchildren to be immunized at church. All of the health professionals agreed with the approach.

> The parents go there and seem to respect the leadership from the ministers, so I think we will have more success that way. – health professional

Immunization catch-up clinics

Approximately 70 children and youth were in attendance at the first clinic held on a festival rehearsal day. An older age group was in attendance at the second clinic held on a fundraiser day for the church. On both clinic days, completed consent forms were used to check ACIR and school vaccination records to determine the need for MMR or meningococcal C vaccine.

There were 63 participants at the first clinic (approximately 10 people did not consent) and 15 at the second (**Table 1**). Of these, 27 at the first clinic and one at the second clinic were appropriately vaccinated; a total of 50 doses of vaccine were provided: 36 at the first clinic and 14 at the second (**Table 1**).

Participants already vaccinated with MMR had an age range of 7–17 years (median = 12 years), and for

those that received MMR the age range was 10–29 years (median = 20 years). For those already vaccinated for meningococcal C, the age range was 7–27 years (median = 16 years), and for those provided with meningococcal C vaccine, the age range was 10–33 years (median = 20 years).

The important role of the church within the community was emphasized in the interviews and as a result, two immunization catch-up clinics were held in a Samoan church in western Sydney.

DISCUSSION

The Pacific island community in western Sydney has been disproportionally affected by measles outbreaks in recent years. This study indicates that among Pacific island community members interviewed, there were high levels of belief in the importance of immunization and a positive view of protection offered by immunization. A key barrier reported by the community members were being busy and forgetting immunization due to time limitations. Health professionals interviewed felt that a key barrier was low levels of knowledge and health literacy affecting immunization. Both groups agreed that missing out on immunization occurs in the Pacific island community due to migration between countries.

Immunization clinics held in a Samoan church in western Sydney provided an easily accessible venue for church attendees to receive catch-up immunizations. As a pilot programme, gaining consent, checking the registry and providing the required immunizations on the same day was a successful model. However, this approach is resource and time intensive and requires a good relationship with the community. In comparison to a previous Pacific island community-based catch-up clinic held by the same public health unit, where there were no attendees, this church-based clinic immunized a relatively large number of people. This may have been due to factors such as the church venue, that there was a rehearsal for a festival and that the clinics were held on weekends. The median age of people requiring both MMR and meningococcal C vaccine was 20, suggesting that young adults may require future targeted strategies to improve immunization. Susceptibility of the teenage/young adult age group to measles has also been seen across New South Wales; 15–19 year olds were the second highest age group affected in the 2012 measles outbreak.[3]

The interviews, although conducted with a small number of Pacific island community members, provided information on knowledge and attitudes towards immunization. This is important as attitudes, perspectives, health beliefs and health-seeking behaviour are shaped by ethnicity and culture[17] with different cultural groups understanding and experiencing health, health care, disease and treatment differently.[17] A Pacific island and Maori health needs assessment conducted by Queensland Health found that health literacy was very poor among all Pacific island communities; there were low levels of health-seeking behaviour, as well as a lack of knowledge of services and how to navigate the health system.[6] Traditional beliefs about health were also prevalent, but these beliefs were not discussed in relation to immunization. Churches and religious groups were identified as having a positive influence on social cohesion and health outcomes within the Pacific island community.[6]

Our interviews also highlighted the influence of the church and that it may be a suitable location for catch-up immunization for this high-risk group. To our knowledge, there have been no other reports of immunization clinics being held in churches.

Attitudes and beliefs about immunization in the Pacific island community in Australia may be influenced by experiences in the country of origin. Some Pacific island countries record high incidences of infant and child mortality rates. As well as neonatal causes, other causes of death among children under five include diarrhoeal disease, pneumonia and measles.[18] Immunization data show varying levels of coverage for measles-containing vaccine (MCV) among Pacific island countries. From 2008 to 2012, MCV coverage ranged from 99% to 95% in Tonga, from 95% to 97% in Cook Islands, and from 45% to 85% in Samoa.[19] There is inconsistency in coverage rates over the five year period; however Tonga and Cook Islands report they are able to sustain consistently high levels of coverage. The lower MCV coverage rates in Samoa may effect immunization coverage in Samoan communities in Australia. The inconsistencies between Pacific island countries may be due to differences in systems of primary

health care and immunization service delivery among countries; there appears also to be a knowledge gap that could be addressed with further research.

In Australia, little is known about Pacific island communities' knowledge, attitudes and beliefs towards primary health care services such as immunization. There has been one study of accessibility and utilization of health services conducted in Brisbane in four culturally and linguistically diverse communities in 2011. This found that in the Pacific island community there was lack of knowledge of available health services, reported communication issues due to use of medical terminology by health workers and acknowledgement of a preference for accessing doctors from a similar cultural background.[17] While our study focused only on immunization, these broader insights could be useful for improving delivery of culturally appropriate primary health care such as immunization clinics in the Pacific island community in New South Wales.

This study had some limitations: interviews were only conducted with a small group of participants; conducting the interviews in English may have resulted in selection bias towards those able to converse in English; detailed socioeconomic and demographic information was not collected; and community participants were linked to the women's group and the church from which they were recruited. This reduces the representativeness to the rest of the Pacific island community and also the possibility that other important emergent themes were not discovered. Limitations of the clinics were that some of the first clinic attendees did not return to receive their second MMR dose and that the clinics focused on one Pacific island community and one religious denomination within that community. Using open-ended questions enabled a greater depth of information and secondary coding verification strengthened the analysis.

CONCLUSIONS

By interviewing a small number of community members and health professionals, the influence of the church was identified, and, as a result, two immunization clinics were held in a large Samoan church in western Sydney. This alternative approach for providing immunization to most-at-risk group was successful and highlighted that a partnership between a local church and public health unit can be effective in providing catch-up immunization. However, this approach is resource and time intensive and requires a good relationship with the community to ensure success. Rather than implementing a regular programme, a church or similar community location could be used to target high-risk groups for immunization in outbreak situations.

Conflicts of interest

None declared.

Funding

Holly Seale is supported by an NHMRC Australian-based Public Health Training Fellowship (1012631).

Acknowledgements

This work was completed while Nicola Scott was an employee of the New South Wales Public Health Officer Training Program, funded by the New South Wales Ministry of Health, while based at the Western Sydney Public Health Unit.

References:

1. Heywood AE et al. Elimination of endemic measles transmission in Australia. *Bulletin of the World Health Organization*, 2009, 87:64–71. doi:10.2471/BLT.07.046375 pmid:19197406
2. *Measles notification in NSW residents*. Sydney, New South Wales Ministry of Health, 2013 (http://www0.health.nsw.gov.au/data/diseases/measles.asp, accessed 2 February 2014).
3. Najjar Z et al. Sustained outbreak of measles in New South Wales, 2012: risks for measles elimination in Australia. *Western Pacific Surveillance and Response Journal*, 2014, 5:14–20. doi:10.5365/wpsar.2013.4.4.001 pmid:25635228
4. Flego K, Sheppeard V, McPhie K. A recent measles outbreak in Western Sydney – diagnosis and population vaccination status. *Broad Street Pump*, 2011, 23:1–2.
5. White R et al. *Ethnic gangs in Australia: do they exist? - Report No. 3 Pacific Islander Young People*. Melbourne, Australian Multicultural Foundation, 1999.
6. *Queensland Health response to Pacific Islander and Maori Health needs assessment*. Brisbane, Queensland Health, Division of the Chief Health Officer, 2011.
7. *Demographics*. Sydney, Blacktown City Council, 2013 (http://www.blacktown.nsw.gov.au/Discover_Blacktown/Statistics/Demographics, accessed 5 March 2015).
8. Blacktown City Council. Birthplace. Sydney, Blacktown City Council, 2013 (http://profile.id.com.au/blacktown/birthplace, accessed 5 March 2015).
9. *Language spoken at home*. Sydney, Blacktown City Council, 2013 (http://profile.id.com.au/blacktown/language, accessed 5 March 2015).
10. *Ancestry*. Sydney, Blacktown City Council, 2013 (http://profile.id.com.au/blacktown/ancestry, accessed 5 March 2015).

11. Tukuitonga CR, Bell S, Robinson E. Hospial admission among Pacific children Auckland 1992–97. *The New Zealand Medical Journal*, 2000, 113:358–361. pmid:11130369

12. Paterson J et al. Maternal and demographic factors associated with non-immunisation of Pacific infants living in New Zealand. *The New Zealand Medical Journal*, 2004, 117:U994. pmid:15475977

13. Paterson J et al. Immunisation of a cohort Pacific children living in New Zealand over the first 2 years of life. *Vaccine*, 2006, 24:4883–4889. doi:10.1016/j.vaccine.2006.02.050 pmid:16644070

14. *Australian childhood immunisation register*. Canberra, Department of Human Services, 2013 (http://www.medicareaustralia.gov.au/provider/patients/acir/, accessed 11 February 2014).

15. Hull BP, Deeks SL, McIntyre PB. The Australian Childhood Immunisation Register-A model for universal immunisation registers? *Vaccine*, 2009, 27:5054–5060. doi:10.1016/j.vaccine.2009.06.056 pmid:19576945

16. *The Australian Immunisation Handbook – 10th edition*. Canberra, Department of Health and Ageing, 2013.

17. Henderson S, Kendall E. Culturally and linguistically diverse peoples' knowledge of accessibility and utilisation of health services: exploring the need for improvement in health service delivery. *Australian Journal of Primary Health*, 2011, 17:195–201. doi:10.1071/PY10065 pmid:21645477

18. Gani A. Some aspects of communicable and non-communicable diseases in Pacific Island countries. *Social Indicators Research*, 2009, 91:171–187. doi:10.1007/s11205-008-9276-x

19. *WHO-UNICEF Estimates of measles containing vaccine (MCV) coverage*. Geneva, World Health Organization, 2014 (http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tswucoveragemcv.html, accessed 5 March 2015).

Strengthening capacity for local evidence to inform local responses to HIV in a remote Solomon Islands health service

David MacLaren,[a] Michelle Redman-MacLaren,[a] Relmah Timothy-Harrington,[b] Rowena Asugeni,[b] Elmah Muse,[b] Emmy Jimuru,[b] Kenny Moutoa[b] and Rick Speare[cd]

Correspondence to David MacLaren (e-mail: david.maclaren@jcu.edu.au).

Background: Documenting specific knowledge and attitudes about HIV in the culturally diverse nation of Solomon Islands is essential to inform locally targeted public health responses. As part of a large capacity-strengthening project at Atoifi Adventist Hospital in East Kwaio, Solomon Islands, researchers, using a 'learn-by-doing' process, worked with participants in public health research methods.

Methods: Overall, 43 people attended research capacity building workshops in 2011; eight joined the HIV study group. A cross-sectional survey including semi-structured interviews on HIV was conducted by the group. In February 2014, a hospital administrator was interviewed about how the 2011 study informed local HIV responses.

Results: Of the 53 survey participants, 64% self-assessed as having little or no HIV knowledge, but 90% knew HIV could be transmitted between men and women during sex. Less than 50% knew HIV could be transmitted between two men having sex, 45% thought HIV could be transmitted by mosquitoes and 55% agreed condoms help protect from HIV. Most participants reported negative attitudes towards people with HIV. Three years later the health administrator reported ad hoc responses to HIV because of low HIV prevalence, increasing noncommunicable diseases, staff turnover and resource shortages.

Discussion: This HIV study was used to strengthen research skills in local health professionals and community members in Solomon Islands. It showed that community members require accurate information about HIV transmission and that entrenched stigma is an issue. Although results provided local evidence for local response, ongoing health system challenges and little local HIV transmission meant HIV services remain rudimentary.

Reducing the burden of HIV remains a global challenge. Despite the declining number of new infections of HIV globally, there was still an estimated 1.9 million people newly infected in 2013.[1] In Oceania, up to 51 000 people are living with HIV with almost 2100 new infections in 2012.[2] Papua New Guinea has the greatest burden of HIV in Oceania with an estimated 21 459 people living with HIV.[3] Solomon Islands has dramatically fewer cases with only 22 reported cases since 1994 with 14 people living with HIV.[4] Solomon Islands has a population of 610 800 people speaking 63 languages.[5,6] The majority (over 80%) live in rural villages, and around 40% are under 14 years of age.[7] The country shares a border with Papua New Guinea and they share many social, cultural, economic, political and health system characteristics. People regularly travel between the countries. This all puts the people of Solomon Islands at risk of HIV.[7]

Since 2009, there has been a concerted effort to have operational research embedded into the way local health services and community leaders engage with public health issues in East Kwaio on the remote eastern coast of the island of Malaita. This has included theoretical training and practical workshops in public health research methods using decolonizing methodologies and participatory research frameworks.[8–10] Much of the training has been at Atoifi Adventist Hospital (AAH), a 65-bed general hospital with an attached Atoifi College of Nursing (now Pacific Adventist University – Atoifi

[a] College of Medicine and Dentistry, James Cook University, McGregor Road, Smithfield, Cairns, Australia.
[b] Atoifi Adventist Hospital, East Kwaio, Malaita, Solomon Islands.
[c] College of Public Health, Medical and Veterinary Sciences, James Cook University, James Cook Drive, Douglas, Townsville, Australia.
[d] Tropical Health Solutions, 72 Kokoda Street, Idalia, Townsville Australia.
Submitted: 29 January 2015; Published: 6 May 2015
doi: 10.5365/wpsar.2015.6.1.015

Campus). AAH is the largest nongovernmental hospital in the country, and the College (now University) educates almost half of the country's nurses. There are no roads, so village people access AAH by canoe or walking. Communication is by high frequency radio, landline, mobile telephone and periodic Internet. Electricity is provided by hydroelectric and diesel generators. Research capacity-strengthening for staff, students and community leaders has focused around local issues of parasitic disease, tuberculosis (TB) and HIV.[11–14]

Documenting specific knowledge and attitudes about a health issue such as HIV across the many divergent cultural groups in Solomon Islands is essential to inform locally targeted public health responses.[15–19] Although Solomon Islands has low HIV prevalence (< 0.01%), there is a concerted effort to prevent HIV from expanding as it has in neighbouring Papua New Guinea (HIV prevalence 0.5%).[3] Voluntary confidential counselling and testing (VCCT) is established in many locations, but as in other countries in the region, VCCT is challenged by limited human and physical resources and a concern about lack of confidentiality.[20]

This study was the HIV component within a larger capacity-strengthening project with health professionals and community leaders.[8–10] The overall aim was to strengthen research capacity at AAH and in surrounding communities using a 'learn-by-doing' process. The specific aims of the HIV study were to: (1) document people's knowledge of HIV transmission; and (2) examine attitudes and practices relevant to HIV transmission.

METHODS

In April 2011, 43 village leaders, other community members, health professionals and researchers from AAH and Australia participated in the capacity-strengthening workshop at AAH.[9] A subsection of eight people from the main group formed a team to investigate HIV. All described HIV as a public health concern. Despite the low prevalence in the country, all team members were concerned that the large HIV epidemic in neighbouring Papua New Guinea heightened the risk of HIV for Solomon Islanders. Many people from the villages of East Kwaio travel throughout Solomon Islands and perceive a risk of local villagers acquiring HIV when travelling. The team designed and implemented a study using two methods to document HIV knowledge, attitudes and practices in East Kwaio. Ethical approval was obtained from James Cook University Human Research Ethics Committee (H4002) and the AAH Research Ethics Committee (AAHREC3).

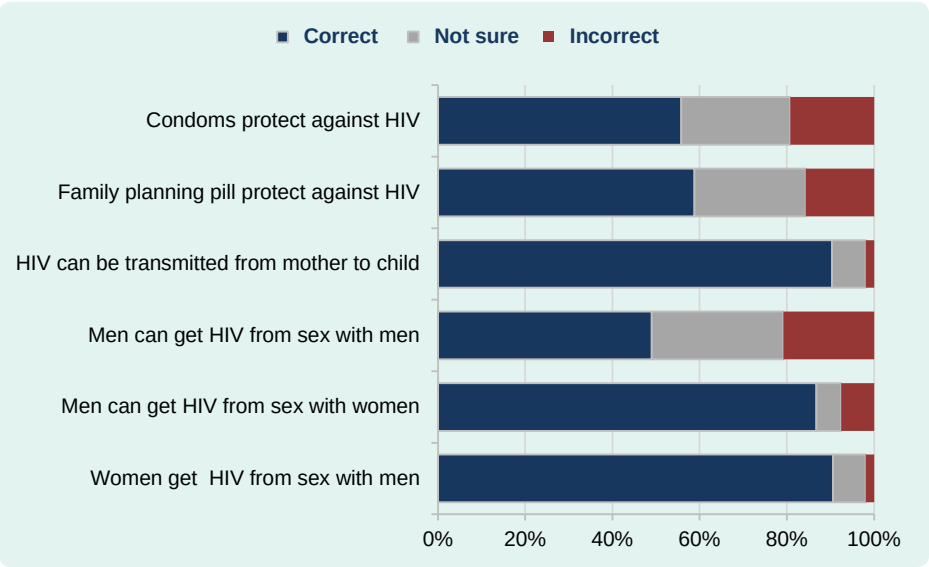
A cross-sectional survey was collaboratively designed based on knowledge, attitude and practice questions used in Papua New Guinea.[21,22] Each question allowed for yes, no or unsure response. Open-ended questions included: "What do people in the community think about someone who has HIV?" and "Would people be willing to have confidential counselling and testing?" Questions about male circumcision for HIV prevention were asked of men. Semi-structured interviews were also conducted with key informants about male circumcision. Australian researchers co-facilitated training in survey design and data collection.

A convenience sampling method was used, with AAH patients or their family members on the hospital campus. An information sheet and consent form was provided to explain the study. If participants had limited or no literacy, the researcher explained the contents of the information sheet and consent form. Participants then signed or placed a thumbprint on the consent form. Researchers orally translated questions from English into Solomon Islands Pijin or Kwaio languages as required. Participant responses were written on forms in English or Pijin. Interviews were transcribed from digital voice recorders.

Data analysis was conducted by the research team at AAH. Quantitative data were entered into MS Excel and analysed using descriptive statistics. Data from open-ended questions were typed into MS Word. These data were analysed for codes and inductive in-vivo themes using a manual technique of printing transcripts, cutting transcripts into sentences or paragraphs and collating into themes. Consensus was reached within the research group before a sentence or paragraph was assigned to a theme or a new theme was created.

At the completion of the April 2011 workshop, results were presented to hospital and village leaders with the intent that they inform local HIV prevention responses. In February 2014, the Director of Nursing at AAH (who is responsible for both hospital and community outreach programmes) and an Australian researcher

Figure 1. **Proportion of correct responses to questions about HIV transmission through sexual and reproductive activities, Solomon Islands, 2011**



discussed two questions to document changes that had occurred at AAH because of the research findings. Questions were:

(1) How would you describe the HIV-related health services being provided at AAH in 2011 and 2014?

(2) What changes have been made to HIV-related health services at AAH in response to results from the HIV study?

Responses were analysed for inductive themes.

RESULTS

Cross-sectional survey

In total, 53 people (27 female [51%]) from 33 villages completed questionnaires. The median age of participants was 26 years (range 18–70 years). The majority of participants (52%) were between 18 and 29 years with 58% currently married. Participants' religions included South Sea Evangelical Church (53%), Catholic (21%), Seventh-Day Adventist (17%), Jehovah's Witness (7%) and Ancestral religion (2%).

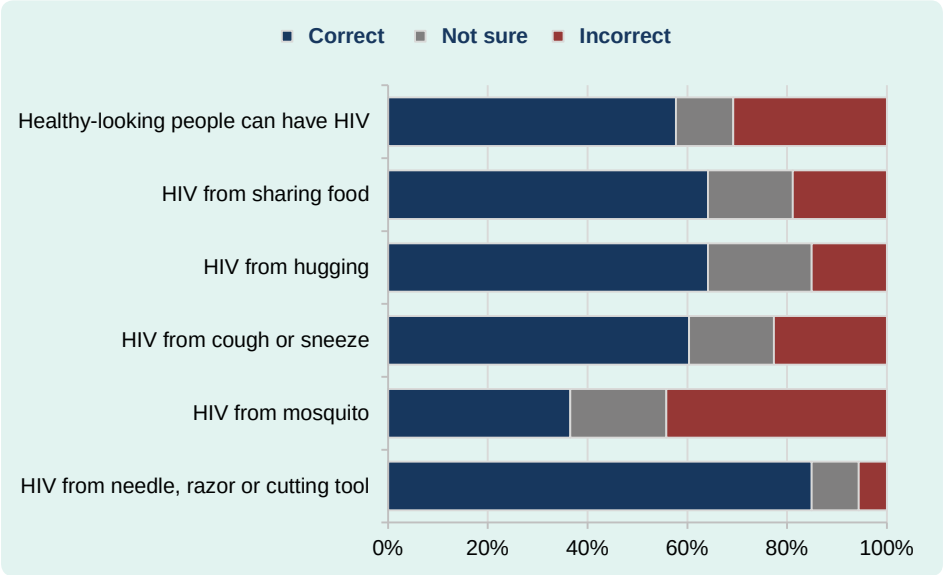
Quantitative data were generated in two major areas: (1) sexual and reproductive health and HIV knowledge, and (2) knowledge of HIV transmission (**Figures 1** and **2**). The majority of participants (89%) knew HIV could be transmitted through heterosexual sex, but only half (49%) knew HIV could be transmitted by men having sex with men. Around 45% thought HIV could be transmitted by mosquitoes and just over 20% by a cough or sneeze. Just over half (56%) thought condoms could protect from HIV, and 16% thought the family planning (oral contraceptive) pill could protect from HIV.

For the open-ended question, "What do people in the community think about someone who has HIV?", three major in-vivo themes were: (1) "send him/her somewhere else"; (2) "not close–might spread to others"; (3) "people may get cross [angry] or hate that infected man [person]". These in-vivo themes all expressed explicit stigma towards people living with HIV.

The first theme "send him/her somewhere else" related to physical and/or geographic proximity as demonstrated in the following response: "*People in my community would not want people who have HIV in the village therefore they are planning to cut* [with a machete] *someone who has HIV in the village because if he lives he might spread it to the members of the community.*"

The second theme "not close–might spread to others" was about the potential of a HIV-positive person to infect others. "*The people really don't want to stay or live with any person who has this sickness (HIV).*

Figure 2. **Proportion of correct responses to questions about other routes of HIV transmission, Solomon Islands, 2011**



People have the feeling of disliking any infected person to share with them in any means." There were also perceptions presented that HIV-positive people would deliberately attempt to infect others. "*Some people will have this idea to pass the disease to others that is why the people will not accept the infected person*."

The third theme "people may be cross [angry] or hate that infected man [person]" was a collection of responses about feelings towards people living with HIV. The feelings expressed by participants included anger, fear, hatred and public humiliation (including mocking and gossip). One participant reported, "*People in the community can talk spoil* [verbally put down] *the person and also even parents of the infected person*." The strongest responses suggested a person should be killed for being HIV-positive: "*They should be killed so they won't spread more HIV/AIDS" and "Olketa stap for dae blong olketa nao. Bae iumi kilim olketa nomoa*" (they are going to die so let us just kill them). This was the theme with the most responses.

Despite these responses, the majority of participants reported that they would be willing to have an HIV test at AAH. Of the 53 participants, 64% said they would be willing to have an HIV test, 26% were not willing and 6% were unsure. Participants explained their answers across three major topics: (1) willingness to test for HIV; (2) personal feelings about HIV status and test results; and (3) need for information about HIV.

Reasons given by participants were both individual concerns "*Yes because I want my blood to be checked so that I know I am free from HIV*" and consideration about their relationships/social relations: "*I am not sure whether my husband is still faithful to me. So I would really like to know my status*."

Concern was expressed about how others might treat the person if their HIV status became known: "*Reason is that – they might make fun of me; people would hate me; not talk with me; my name would spread everywhere*." There was also concern expressed about confidentiality with some stating that testing might be more acceptable if provided away from the local area: "*If the service was available in Honiara* (capital city) *then would go because it is far from my community, no one will see me or take note of me*."

Several participants requested more information about HIV:"*I want to get right information so I can keep myself from the disease*," and "*If I might have HIV I will come and get more information*."

Male circumcision for HIV prevention

The final question (for males only) asked about practices of male circumcision. One of the 26 male respondents had his foreskin cut and stated hygiene and Biblical reasons: "*To avoid smell and also since during times of Moses (Jesus) God told them to circumcise*

that is why I must circumcise too. Therefore I cut my foreskin."

Many others also invoked a religious theme, but with a contrasting rationale that since God created us, we should not do anything to our body. Custom and/or cultural beliefs were seen as important in deciding about male circumcision. One male cited the collective decision of men from his tribe not to cut their foreskins: "*I was a heathen guy so not sure what reason I had to cut my foreskin. Such kind of things are bound to all our tribe not to cut our foreskin. If anyone did he will die, therefore all males of our tribe will not cut their foreskin*." Other reasons given for not cutting their foreskin included health, shame and no one to do the procedure. Some said they had no reason and/or no interest in circumcision, "*No interest in it because I do not like to spoil my body*."

Health service response to 2011 study findings

Between April 2011, when the HIV study was conducted and reported, and February 2014 numerous challenges and opportunities emerged in response to HIV at AAH.

The Director of Nursing explained that in 2011, a certified VCCT counsellor provided HIV services from the AAH Outpatients Department. The VCCT counsellor was a female Registered Nurse and provided services to antenatal mothers during routine antenatal screening; testing was conducted using Rapid Test Kits in the AAH laboratory. Patients with positive results were referred to Honiara for confirmation and further testing. Occasionally, members of the general public (mostly women) directly requested VCCT services. The service was not promoted publically and very few village people knew about the service. At the end of 2011, the VCCT counsellor left AAH with no female VCCT counsellor since then. In 2011, the male TB nurse was trained and certified to provide VCCT services. HIV testing is now routinely offered to patients that test positive for TB. There has been no routine HIV screening of antenatal mothers since the end of 2011, and no community-based HIV services operate from AAH.

Information about HIV is included in community health education programmes delivered by the Primary Health Care Outreach team. However, with low HIV prevalence, a need to maintain immunization coverage and escalating diabetes and hypertension, HIV is not prioritized. In addition, there are no specific sexually transmitted infections (STI) services at AAH. This means when village people suspect an STI they seek out hospital nurses they trust will not disclose their STI status to ask for diagnosis and treatment. In this context, there is almost no contact tracing or partner treatment. A lack of STI/HIV services, limited knowledge of STI/HIV policies, staff shortages and competing demands of other diseases all mean there is an ad hoc approach to STI/HIV in East Kwaio.

Following this reflection on the lack of progress since the HIV research study, the Director of Nursing said that steps to prioritize HIV services must be revitalized. *"Everitin slip bek nomoa, hem mus wek up moa"* (everything went back to sleep, it must wake up). AAH management plans to identify an STI nurse to lead the local STI response, including HIV, beyond the current ad hoc response. *"We don't want to wait until there is a crisis."*

DISCUSSION

This study showed that people living in remote East Malaita have a fragmented understanding of HIV transmission. Levels of knowledge about heterosexual transmission and transmission from mother to child were high, but they were low for transmission between men who have sex with men. Levels of knowledge about the ability of condoms to prevent HIV were also low. Levels of knowledge about other routes of perceived transmission were inadequate, particularly transmission by mosquitoes, coughing and hugging. Most participants reported negative attitudes towards people living with HIV. These results are arguably due to the low HIV prevalence and limited HIV education in the area. Most participants would have had little or no experience of, or interaction with, people living with HIV. The findings from this study in East Malaita are consistent with other survey data reported from Solomon Islands showing moderate knowledge and negative attitudes towards people living with HIV.[7,23]

The overall aim of the study was to strengthen research capacity at AAH in partnership with Australian researchers and local communities to systematically conduct locally relevant health research to inform local responses.[24–30] This HIV study has demonstrated that,

similar to neighbouring Papua New Guinea,[19,31] locally responsive studies can be conducted with input from key hospital and community partners and that data can be collected on the sensitive sexual health topic of HIV, including practices of male circumcision.

This study has highlighted many of the challenges of delivering HIV and STI services in remote parts of Solomon Islands. Low HIV prevalence, staff turnover, maintaining technical capacity, social and cultural expectations of patients seeking specific staff and the competing demands of both communicable and noncommunicable diseases all resulted in relatively few of the study results directly informing STI/HIV services.[16,32,33] This is in contrast to the outcome of the TB component of the overall study which informed dramatic and fundamental changes to TB services at AAH,[12,13,25] most likely due to TB having a much higher prevalence. Given the seriousness of the stigma and exclusion against people with HIV highlighted in this study, there is substantial risk for people wishing to have an HIV test at AAH. HIV and STI services need to ensure confidentiality and that stigma is constantly challenged.

Results from small studies can provide evidence to directly inform specific health messages to be delivered locally. The parallel TB study at AAH documented that culturally appropriate health information delivered in the local Kwaio language can reduce the proportion of people who think TB is caused by sorcery.[13] Given many people in East Kwaio have limited literacy and there are very few health information resources, the hospital outreach team regularly delivers oral presentations in open village meetings. It is therefore essential that the hospital outreach team deliver specific presentations to dispel perceived risk of HIV from mosquitoes, coughing and hugging, provide accurate information about men having sex with men and the protective effects of condoms.

When this study commenced in 2011, there were projections of rapidly expanding HIV epidemics in both Solomon Islands and neighbouring Papua New Guinea and a desire for locally informed response at AAH. However, the epidemic did not occur and the health service has since focused on other issues. Had the HIV epidemic projections been realized, HIV testing and treatment services would have needed to be given a greater priority. However, as reported in 2014, the STI response (including HIV) in East Malaita needs improvement, and the results of this study can inform HIV education and testing within antenatal clinics, TB services and a re-designed STI service.

There are several limitations in this study, including the modest number of participants, convenience sampling method and that some of the researchers were learning research skills as they conducted the study. The fact that the structured questionnaires were written in English and orally translated into Pijin or Kwaio by the interviewer may have influenced the results, including the nuances of responses to open-ended questions. However, strengths of the study included that hospital and village leaders identified the topic as a priority and data were successfully collected using a gendered approach relevant to the local context. Data were collectively analysed and highlighted issues of importance to both local and outside members of the study team. This is the first report of HIV knowledge and of people's intentions to access HIV services at AAH in East Malaita.

CONCLUSION

This study in remote East Kwaio, Solomon Islands, showed there was accurate knowledge about heterosexual and mother-to-child HIV transmission but poor knowledge about transmission between men who have sex with men and the role of condoms. These gaps need to be addressed, including the important role of condoms in HIV prevention. Health services have the opportunity to integrate HIV into existing or new health programmes to maximize staff and resources and public health need. Ongoing operational research is required to document the changing nature of HIV services and knowledge required for local health responses in an area with limited resources. This study demonstrates that a modest project undertaken within an ongoing research capacity-strengthening programme can provide locally relevant information to inform local responses to HIV despite the challenges of working and conducting research in remote Pacific island locations.

Conflicts of interest

None declared.

Funding

Funding for research capacity-strengthening at AAH, which included this study, was provided by James Cook University through the Research Infrastructure Block Grant Scheme.

Acknowledgements

Thank you to East Kwaio community members Rex Fo'olego, Wallace Arifanaboo and Silas Laubeu who contributed to the study design, data collection, analysis and reporting of this study. Thank you very much to the East Kwaio community members who generously volunteered to participate in the study. A Research Infrastructure Block Grant funded by James Cook University and in-kind contributions from AAH and Atoifi College of Nursing enabled the research.

References:

1. *Global summary of the AIDS epidemic 2013*. Geneva, World Health Organization, 2014 (http://www.who.int/hiv/data/epi_core_dec2014.png?ua=1, accessed 2 April 2015).
2. *Global Report: UNAIDS report on the global AIDS epidemic 2013*. Geneva, Joint United Nations Programme on HIV/AIDS, 2013.
3. *Papua New Guinea 2013 HIV&AIDS estimations & projections*. Port Moresby, National Department of Health, National AIDS Council Secretariat, and UNAIDS, 2013.
4. *Solomon Islands global AIDS response progress report 2014*. Honiara, Ministry of Health and Medical Services, 2014.
5. *2013 Pocket Statistical Report*. Noumea, Secretariat of the Pacific Community, 2014.
6. Tryon D, Hackman B. *The languages of the Solomon Islands: an internal classification*. Canberra, Pacific Linguistics, 1983.
7. *Bad sickness rubbish sicki: understanding HIV and AIDS risk and vulnerability among Solomon Islands youth*. Suva, UNICEF Pacific, 2011.
8. Redman-Maclaren ML et al. "We can move forward": challenging historical inequity in public health research in Solomon Islands. *International Journal for Equity in Health*, 2010, 9:25. doi:10.1186/1475-9276-9-25 pmid:21050492
9. Redman-MacLaren M et al. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *International Journal for Equity in Health*, 2012, 11:79. doi:10.1186/1475-9276-11-79 pmid:23249439
10. Redman-Maclaren ML et al. Research workshop to research work: initial steps in establishing health research systems on Malaita, Solomon Islands. *Health Research Policy and Systems*, 2010, 8:33. doi:10.1186/1478-4505-8-33 pmid:21034512
11. Massey PD et al. TB questions, East Kwaio answers: community-based participatory research in a remote area of Solomon Islands. *Rural and Remote Health*, 2012, 12:2139. pmid:23094978
12. Massey PD et al. Progress towards TB control in East Kwaio, Solomon Islands. *Rural and Remote Health*, 2013, 13:2555. pmid:23731167
13. Massey PD et al. Steps on a journey to TB control in Solomon Islands: a cross-sectional, mixed methods pre-post evaluation of a local language DVD. *BMC International Health and Human Rights*, 2015, 15:1. doi:10.1186/s12914-015-0041-3 pmid:25644087
14. Harrington HA et al. A practical strategy for responding to a case of lymphatic filariasis post-elimination in Pacific Islands. *Parasites and Vectors*, 2013, 6:213. doi:10.1186/1756-3305-6-218 pmid:23880226
15. MacLaren D, Kekeubata E. Reorienting health services through community health promotion in Kwaio, Solomon Islands. *Promotion & Education*, 2007, 14:78–79. doi:10.1177/10253823070140021701 pmid:17665704
16. MacLaren D et al. Incorporating sociocultural beliefs in mental health services in Kwaio, Solomon Islands. *Australasian Psychiatry*, 2009, 17 Suppl 1;S125–127. doi:10.1080/10398560902948381 pmid:19579125
17. Furusawa T. The roles of western biomedicine and folk medicine in rural Solomon Islands: a quantitative analysis of villagers' response to illness. *Tropical Medicine and Health*, 2006, 34:83–91. doi:10.2149/tmh.34.83
18. Kelly A et al. *The art of living: the social experience of treatments for people living with HIV in Papua New Guinea*. Goroka, Papua New Guinea Institute of Medical Research, 2009.
19. Vallely A et al. Male circumcision for HIV prevention in PNG: A summary of research evidence and recommendations for public health. *Papua New Guinea Medical Journal*, 2011, 54:91–108. pmid:24494506
20. Butt L. Can you keep a secret? Pretences of confidentiality in HIV/AIDS counseling and treatment in Eastern Indonesia. *Medical Anthropology*, 2011, 30:319–338. doi:10.1080/01459740.2011.560585 pmid:21590584
21. MacLaren D et al. Foreskin cutting beliefs and practices and the acceptability of male circumcision for HIV prevention in Papua New Guinea. *BMC Public Health*, 2013, 13:818. doi:10.1186/1471-2458-13-818 pmid:24015786
22. Buchanan H et al. *Behavioural surveillance research in rural development enclaves in Papua New Guinea: a study with the Oil Search Limited workforce – Presentation*. Port Moresby, National Research Institute, 2010.
23. National Statistics Office. *Solomon Islands Demographic and Health Survey*. Noumea, Secretariat of the Pacific Community, 2009.
24. Kekeubata E et al. *Community-based research for improved TB services*. East Kwaio, Atoifi Adventist Hospital, Atoifi Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).
25. Asugeni R et al. *Community and health service responses to culturally safe tuberculosis ward at Atoifi Adventist Hospital, Solomon Islands*. East Kwaio, Atoifi Adventist Hospital, Atoifi Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).
26. Oloifana-Polosovai H et al. A marked decline in the incidence of malaria in a remote region of Malaita, Solomon Islands, 2008 to 2013. *Western Pacific Surveillance and Response Journal*, 2014, 5:30–39. doi:10.5365/wpsar.2014.5.3.002 pmid:25320674
27. Harrington H et al. *Is lymphatic filariasis still in Shortland Islands?* Noumea, Atoifi Adventist Hospital, Atoifi Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).
28. Harrington H. *Elimination of soil transmitted helminths: one village at a time*. East Kwaio, Atoifi Adventist Hospital, Atoifi

Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).

29. Jimuru C et al. *Infection control at Atoifi Adventist Hospital: responding to the measles epidemic*. East Kwaio, Atoifi Adventist Hospital, Atoifi Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).
30. Fa'anuabae C. *Investigating an outbreak of bloody diarrhoea - Sinalagu, Kwaio Region*. East Kwaio, Atoifi Adventist Hospital, Atoifi Health Research Symposium, 2015 (http://www.atoifiresearch.org.sb/node/92, accessed 27 April 2015).
31. Tommbe R et al. Researching male circumcision for HIV prevention in Papua New Guinea: a process that incorporates science, faith and culture. *Health Research Policy and Systems/BioMed Central*, 2013, 11(1):1–8.
32. Harrington H, Asugeni R, MacLaren D. Comment: Inter-Island referrals in Solomon Islands: a remote hospital perspective. *Rural and Remote Health*, 2013, 13:2415. pmid:23600912
33. Harrington H, Taolo L, MacLaren D. Triathlon in the Tropics – South Pacific Style. In: Edwards A, Leicht A, editors. *Science of sport, exercise and physical activity in the tropics*. New York, Nova Science Publishers, Inc, 2014, pp 83–90.

Leveraging social networking sites for disease surveillance and public sensing: the case of the 2013 avian influenza A(H7N9) outbreak in China

Emma Xuxiao Zhang,[a*] Yinping Yang,[b*] Richard Di Shang,[c] Joseph John Pyne Simons,[b] Boon Kiat Quek,[b] Xiao Feng Yin,[b] Wanhan See,[a] Olivia Seen Huey Oh,[a] Khine Sein Tun Nandar,[a] Vivienne Ruo Yun Ling,[a] Pei Pei Chan,[a] Zhaoxia Wang,[b] Rick Siow Mong Goh,[b] Lyn James[a] and Jeannie Su Hui Tey[a]

Correspondence to Jeannie Su Hui Tey (e-mail: jeannie_tey@moh.gov.sg).

We conducted in-depth analysis on the use of a popular Chinese social networking and microblogging site, Sina Weibo, to monitor an avian influenza A(H7N9) outbreak in China and to assess the value of social networking sites in the surveillance of disease outbreaks that occur overseas. Two data sets were employed for our analysis: a line listing of confirmed cases obtained from conventional public health information channels and case information from Weibo posts. Our findings showed that the level of activity on Weibo corresponded with the number of new cases reported. In addition, the reporting of new cases on Weibo was significantly faster than those of conventional reporting sites and non-local news media. A qualitative review of the functions of Weibo also revealed that Weibo enabled timely monitoring of other outbreak-relevant information, provided access to additional crowd-sourced epidemiological information and was leveraged by the local government as an interactive platform for risk communication and monitoring public sentiment on the policy response. Our analysis demonstrated the potential for social networking sites to be used by public health agencies to enhance traditional communicable disease surveillance systems for the global surveillance of overseas public health threats. Social networking sites also can be used by governments for calibration of response policies and measures and for risk communication.

On 31 March 2013, China announced the world's first three human cases of avian influenza A(H7N9) in Shanghai and Anhui provinces.[1] This was followed by reports of further cases in over 16 provinces/municipalities of China and exportation of infection to China, Hong Kong Special Administrative Region, Malaysia and Taiwan, China. Most human cases of A(H7N9) infection were severe and were characterized by rapidly progressive pneumonia and acute respiratory distress syndrome.[2] There was significant international concern about the impact of this novel infection on global health and security.[3,4]

In Singapore, to follow the rapidly evolving A(H7N9) outbreak in China, we supplemented information obtained from conventional public health information channels with posts from Sina Weibo (www.weibo.com; Weibo). Weibo is a popular social networking site in China with more than 500 million registered users as of February 2013. It was one of the fastest social networking platforms to report breaking news on A(H7N9) and was leveraged by health authorities, media and the public to monitor outbreak-related information.[5]

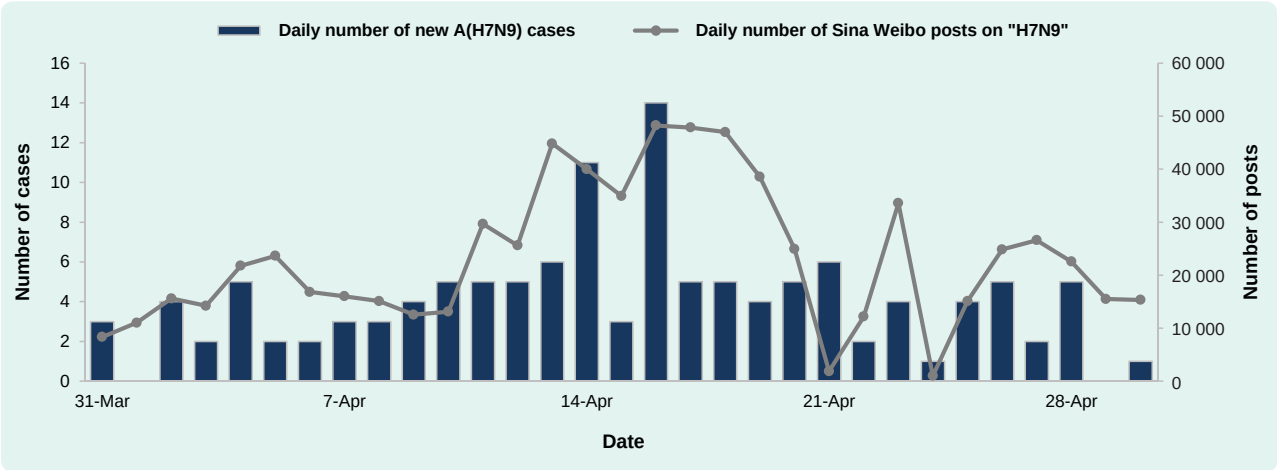
To evaluate the relevance of social networking sites as a new platform in the global surveillance of disease outbreaks external to Singapore, we carried out an in-depth analysis to review and verify the functions of Weibo in the monitoring of the A(H7N9) outbreak in China.

METHOD

For our analysis, we consolidated two data sets. The first included a line listing of confirmed cases obtained from conventional public health information channels, including the official website of Chinese

[a] Epidemiology and Disease Control Division, Public Health Group, Ministry of Health, Singapore.
[b] Social and Cognitive Computing Department and Computing Science Department, Institute of High Performance Computing (IHPC), Agency for Science, Technology and Research (A*STAR), Singapore.
[c] School of Business, Public Administration and Information Sciences, Long Island University Brooklyn, New York, United States of America.
* The first two authors contributed equally to this study.
Submitted: 28 January 2015; Published: 18 May 2015
doi: 10.5365/wpsar.2015.6.1.013

Figure 1. **The number of Weibo posts on "H7N9" and the number of of new A(H7N9) cases confirmed by authorities by day, 31 March to 30 April 2013**



National Health and Family Planning Commission (NHFPC); the Event Information Site of the World Health Organization (WHO) and email alerts from a leading international news agency, Agence France-Presse (AFP). The second data set included Weibo posts containing the search phrase "H7N9". We obtained the Weibo data set from an authorized provider. To ensure data quality and reduce data noise, we solicited posts from authenticated users whose identities had been verified by Weibo. We focused our analysis period from 31 March to 30 April 2013 for two reasons: (1) the outbreak started on 31 March and the majority of cases during the first wave of the outbreak were recorded in April (126 cases of the total of 133); (2) daily reporting of cases by the NHFPC website was only available during the first wave.

We performed two types of analysis: (1) quantitative analysis to compare the timeliness of reporting of new cases by the various information channels; (2) qualitative analysis on the Weibo users with the timeliest posts on new cases. Weibo posts that were the first to report the 126 cases were retrieved, and information including time of reporting, reporter account and epidemiological information of the cases was recorded. To identify the timeliest reporter of each case, we used the advanced search function of Weibo. Key phrase "h7n9" was used, and the search was restricted to authenticated users. Time duration was narrowed down to only one hour to allow retrieval of all posts as Weibo tends to automatically exclude posts if the volume is too large. The location of posts was left unspecified. The search results were compared against the line listing of cases confirmed by WHO to identify the earliest reporter.

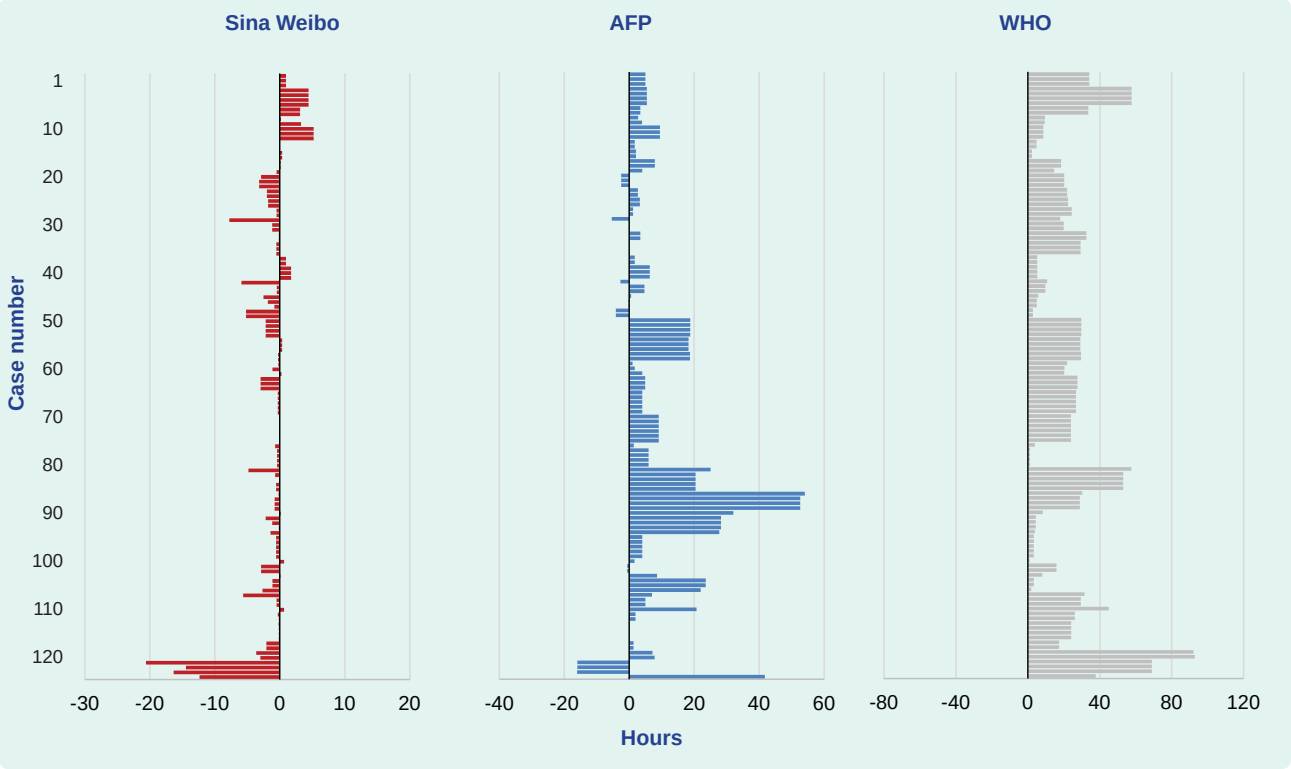
For comparison of timeliness of reporting by various channels, statistical analysis was performed to assess the significance of any temporal differences in the reporting. Non-parametric Wilcoxon signed-rank test was used as the temporal differences were not normally distributed. The analysis was performed in SPSS 16.0. A statistically significant result was defined as $p < 0.05$.

To explore the factors contributing to the timeliness of reporting by Weibo, we performed qualitative analysis to examine the characteristics of the users with the timeliest post on new cases. We also analysed the content of the posts to qualitatively assess other aspects in which Weibo was used. To ensure data reliability, we checked the information manually against the line listing of the corresponding cases confirmed by WHO.

RESULTS

Between 31 March and 30 April 2013, China reported 126 cases of A(H7N9). Correspondingly, 718 419 posts, or an average of about 23 175 per day, were posted on Weibo. The volume of social media discussion corresponded to the number of reported cases (**Figure 1**). The increasing number of cases from 10 April onward was accompanied by a surge in the number of posts, indicative of the public's heightened awareness of the disease while the outbreak appeared to be gaining momentum. A peak of 48 255 daily posts was recorded on 16 April when the highest daily number of 16 cases was reported. Weibo users' interest in A(H7N9) plummeted briefly on 21 April and 24 April, probably due to a shift in attention toward other major

Figure 2. **Timeliness of reports on A(H7N9) cases by Weibo, AFP and WHO compared with NHFPC, 31 March to 30 April 2013***



* The zero-hour baseline represents the time of reporting by the NHFPC.

AFP, Agence France-Presse; NHFPC, National Health and Family Planning Commission of China; WHO, World Health Organization.

events: an earthquake in China's Sichuan province on 21 April and social unrest in China's Xinjiang province on 24 April.

A comparison of reporting times revealed that Weibo was significantly faster in reporting new cases than the conventional public health channels including the NHFPC, AFP and WHO (*p*s < 0.001) (**Figure 2**). Reporting of new cases on Weibo was an average of 1 hour 2 minutes before the NHFPC website with a maximum lead time of 20 hours and 35 minutes. This lead was even greater when Weibo reporting was compared with that of AFP with the latter reporting an average of 8 hours and 14 minutes after the NHPFC. The average lead was more pronounced when compared to WHO that reported cases an average of 23 hours and 13 minutes after the NHPFC (**Figure 2**). The delay in the announcement by WHO was expected as WHO reports only cases that are notified to them by Member States (China in this case) in accordance with the International Health Regulations (2005).[6] In addition, further time lag would be incurred if clarification or confirmatory testing of the cases were required.

The Weibo users with the timeliest report on new cases comprised province/municipality-based news agencies, including Zhejiang Daily (the official newspaper of Zhejiang provincial government), Modern Express and China Exclusive (both belong to Xinhua News Agency, the official news agency of the Chinese central government) (**Table 1**). The veracity of the data reported from these users is likely to be high, and this was confirmed when manual verification of the information from these posts and those from official reports showed high level of concurrence. Upon release of information by the provincial/municipal health authorities, these news agencies posted the news on their Weibo account immediately, before reporting on their conventional websites. In contrast, announcement at the NHFPC website typically lagged behind and was probably due to the additional time taken to collate information from the various provincial/municipal health authorities for the Chinese central government's daily updates.

In addition to monitoring outbreak development, the use of Weibo enabled timely monitoring of other

outbreak-relevant information. On 24 April, WHO held a press conference on its investigation findings in China; the transcript was posted in real-time on the NHFPC's Weibo feed, allowing instant access to the information from anywhere in the world.

Weibo also provided access to additional crowd-sourced epidemiological information on infected cases, such as updates on patients' health conditions, exposure history and family contacts that were not readily available through official sources (**Table 2**). Such additional insights from Weibo usually came from informants in the community whose ready access to social media enabled them to actively participate in disease surveillance.

From the perspective of the Chinese health authorities, the rapid disclosure of information on social media appeared to have helped accelerate official response and reporting. For example, on 5 April, a Weibo user posted pictures of dead sparrows in a Nanjing residential area. The local authority promptly responded by cleaning the implicated premises and testing samples from the dead sparrows that were found to be negative for A(H7N9). In another case on 2 April, a medical document of a new case was disclosed by a Weibo user. This was soon followed by the official announcement of the case by the implicated hospital on Weibo along with official confirmation of four new cases by the NHFPC.

Social networking sites were leveraged by the Chinese health authorities as an interactive platform for risk communication with the general public. During the outbreak, the Chinese health authorities held many real-time question-and-answer sessions on Weibo. In these sessions, doctors and experts addressed queries from the public in a real-time and interactive manner.

Weibo was also used by the Chinese health authorities as a tool for assessing public sentiments to proposed outbreak response measures to guide policy decisions. In April 2013, a local news media conducted a survey on Weibo to seek citizens' views on permanent closure of live poultry markets (LPMs) in Shanghai.[7] A total of 28.6% of the respondents supported permanent closure, while 30.4% opposed the idea. Among all the

Table 1. **Timeliest reporting of new A(H7N9) cases on Weibo, 31 March to 30 April 2013**

Weibo user	Number of occasions in which the source was the first reporter of the event
Zhejiang Daily	8
Modern Express	6
Zhejiang Voice	6
China Exclusive	4
12320 China Health	4
CCTV News	2
Win in China News	2
Dajiang Net	2
People's Daily	2
Others (Qianjiang Evening, Yangzi Evening, etc)	24

Table 2. **Examples of crowd-sourced epidemiological information on Weibo**

Date of post	User	Content of post (translated)	Epidemiological information
8 April 2013	Youth Times (news media) http://weibo.com/qnsblh	Wife of the 67-year-old case from Hangzhou said during an interview, "Apart from shopping for groceries, my son and I avoid close contact with any person. After my husband fell sick, my son came to stay with me."	Status of family members of the case
9 April 2013	Gan Yuxiang (a celebrity) http://weibo.com/ganyuxiang	The 67-year-old male case resides near Wushan district with his wife. Both persons have hypertension. Their diet contains mainly fish and vegetables, and they did not eat chicken recently. Before the onset of illness, the case ate a quail he had bought from the Bin Sheng Market in Shang Chen district.	Exposure history; underlying co-morbidities of the case
11 April 2013	Zhejiang Mobile Newspaper (news media) http://weibo.com/zjsjb001	The female case from Huzhou reported yesterday is currently in a stable condition. The male case from Hangzhou has been placed under mechanical ventilation. The condition of another case, whose surname is Shen Tu, deteriorated rapidly.	Update on cases' situations

respondents, over 77% suggested enhanced animal surveillance and better management of poultry in farms and markets. The Shanghai health authority later ordered the temporary closure of LPMs during the peak of the outbreak. In addition, the authorities initiated various infection control measures, including enhanced poultry surveillance and restriction of live poultry trading to designated markets which were subjected to weekly closure for disinfection and cleaning. From 27 April to 4 May the China NHFPC conducted a poll on Weibo to survey public attitudes, concerns and expectations.[8] The results showed that 93.4% of the respondents were satisfied with the information released by NHFPC's Weibo page and expressed support for continued transparent information-sharing to be conducted by the NHFPC via Weibo.

DISCUSSION

Our study was conducted from the perspective of public health agencies involved in the global surveillance of overseas public health threats. The findings of our analysis demonstrate the potential for public health agencies to acquire time-sensitive information on rapidly evolving outbreaks occurring outside of their countries through social networking sites. In our analysis, Weibo served as a platform leveraged by central/provincial governments, local news agencies and the public for the timely release and retrieval of information. The Chinese social networking sites' timeliness of reporting are significantly better compared to international mainstream media in English, official websites of the central Chinese government and WHO. Information was released by the local news agencies on the social networking site in the local language before any reports in the conventional news websites or government websites. The information was subsequently amplified by the social networking sites through re-posting of the original report. This allowed the international community greater access to more detailed and timely information compared to that released at the central government level to the international media. The central Chinese government may have allowed the provincial/municipal health authorities to release information on new cases when available to ensure transparency and timeliness of public communications. The access to such timely, crowd-sourced information on infected cases greatly facilitated the understanding of the epidemiology of an unknown disease, which is key in developing effective prevention and control measures.

In view of the vast number of posts on various social networking sites, it would be important to employ the site(s) that have the most relevant user profiles, language medium and context to the country of interest. One limitation of the social media surveillance system is the initial difficulty in identifying reliable, consistent and timely information sources at the outset of surveillance since countless numbers of users would be posting on the topic of interest. Time is usually required to monitor the information put out by various users and to compare them against verified reports to insure their relevance for inclusion into the surveillance system. The other limitation is the veracity of the information. While the analyses of posts could be limited to those from verified users only, we observed that the study of posts from layman users provided an understanding of the actual situation and sentiments in the affected country. This additional viewpoint could have a significant impact on outbreak control and consequently influence the risk assessment of the outbreak. There is also a possibility of inaccurate or false information being purposely propagated through social media that could affect the quality of the intelligence acquired from this source. To overcome this, verifying information against credible sources, including WHO and the health authorities of the affected country, is necessary. For the social media platform to be effective, there is also a need for the disease to be sufficiently novel to warrant the interest and concern of the people in the affected country for significant re-posting of information to occur; the affected population must have a thriving social networking scene with high participation and connectivity. Despite this, re-posting can be still be insignificant due to apathy, low media coverage or diversion of public interest to other events as illustrated by the plunge in number of posts on 21 and 24 April in our study.

Our qualitative analysis showed the effective use of social media by the Chinese health authorities in risk communication as well as gathering public sentiments on response options is an innovative strategy in public education, social mobilization and garnering support for the outbreak response measures. This echoes a previous study that demonstrated that social media could be a useful tool for public health practitioners to understand public reaction to disease outbreak information released by health authorities.[9] An analysis of Internet data during the A(H7N9) outbreak suggested that the early stage of the outbreak was accompanied by rapidly increasing public attention and thus was considered the best time

frame for health authorities to engage the public, conduct education campaigns and control rumours.[10]

Although social media is considered a less formal platform, health authorities around the world are increasingly using it for information access and dissemination.[11–13] Social media has been used as a central platform for the retrieval of information from various official sources; such use was highlighted by epidemiologists from the United States Centers for Disease Control and Prevention who used social media to monitor the A(H7N9) outbreak.[14] There are, however, challenges to the use of social networking sites. Constant monitoring and real-time analysis of a large influx of data with a high level of background noise, including rumours and unrelated information, is labour-intensive. Identifying the most appropriate social media platform to use is also critical to ensure effectiveness. In this case, the use of Weibo for the A(H7N9) outbreak in China would be more appropriate than global social media platforms such as Twitter. Language barriers can pose additional challenges; our ability to access and accurately interpret information from Weibo was partly due to our being based in Singapore where Mandarin is an official language. Our experience showed that it may be beneficial for public health agencies to recruit and maintain a workforce of epidemiologists who are multilingual for international disease surveillance in a foreign language.

One limitation of our study is the selection of AFP to represent international mainstream news media, particularly since Chinese news media such as Xinhua News Agency would likely be faster in reporting new cases. AFP was included in our comparison because global surveillance is carried out primarily in English, and we noted that AFP was consistently one of the fastest global news agencies, along with Reuters, British Broadcasting Company, Cable News Network and Associated Press, to deliver accurate and comprehensive news on global disease outbreaks. While Xinhua News Agency may report news on outbreaks located in China in a timelier manner compared to AFP, we find it less relevant as a generic source of information for the surveillance of outbreaks outside of China.

We envisage significant potential for social media surveillance to be incorporated into mainstream disease surveillance and response systems. For international public health practitioners, social media surveillance could provide early warning for unusual public health events in a foreign country and serve as an additional source of epidemiological intelligence to complement conventional surveillance tools. For local public health authorities, social media surveillance could function as an effective platform for public education and social mobilization. The underlying value coupled with the challenges of using social media warrants future research and collaboration between public health agencies and computational scientists to enhance its use in disease outbreak surveillance and response.

Conflicts of interest

None declared.

Funding

This study was supported in part by the Social Technologies+ Programme funded by Agency for Science, Technology and Research (A*STAR) Joint Council Office, Singapore.

Acknowledgements

The authors are grateful to Dr Derrick Heng (Group Director of the Public Health Group, Singapore), Ms Ang Li Wei and Ms Cindy Lim of the Singapore Ministry of Health for helpful discussion.

References

1. *Questions and answers about human infection with A(H7N9) avian influenza virus*. Beijing, Chinese Center for Disease Control and Prevention (CDC), 2013 (http://www.chinacdc.cn/en/ne/201303/t20130331_79282.html, accessed 15 August 2014).
2. Li Q et al. Epidemiology of human infections with avian influenza A(H7N9) virus in China. *The New England Journal of Medicine*, 2014, 370:520–532. doi:10.1056/NEJMoa1304617 pmid:23614499
3. Uyeki TM, Cox NJ. Global concerns regarding novel influenza A(H7N9) virus infections. *The New England Journal of Medicine*, 2013, 368:1862–1864. doi:10.1056/NEJMp1304661 pmid:23577629
4. Meng Z et al. Possible pandemic threat from new reassortment of influenza A(H7N9) virus in China. *Euro Surveillance: European Communicable Disease Bulletin*, 2014,19(6):pii=20699. pmid:24556346
5. Salathé M et al. Influenza A (H7N9) and the importance of digital epidemiology. *The New England Journal of Medicine*, 2013, 369:401–404. doi:10.1056/NEJMp1307752 pmid:23822655

6. *International Health Regulations (2005), Second edition*. Geneva, World Health Organization, 2008 (http://www.who.int/ihr/9789241596664/en/, accessed 21 April 2015).
7. Survey on public opinion toward permanent closure of live poultry market in Shanghai. [In Chinese] *Jf Daily*, 2013 (http://newspaper.jfdaily.com/xwcb/html/2013-04/10/content_1004412.htm, accessed 18 August 2014).
8. *12320 public health hotline conducted survey on public opinions toward infection control measures against avian influenza A(H7N9).* [In Chinese] Beijing, China National Health and Family Planning Commission (NHFPC), 2013 (http://www.moh.gov.cn/zhuzhan/zsdwgzdt/201306/070c3ca66f604c1aa4ec5f65761ede76.shtml, accessed 18 August 2014).
9. Fung IC et al. Chinese social media reaction to the MERS-CoV and avian influenza A(H7N9) outbreaks. *Infectious Diseases of Poverty*, 2013, 2:31. doi:10.1186/2049-9957-2-31 pmid:24359669
10. Gu H et al. Importance of Internet surveillance in public health emergency control and prevention: evidence from a digital epidemiologic study during avian influenza A H7N9 outbreaks. *Journal of Medical Internet Research*, 2014, 16:e20. doi:10.2196/jmir.2911 pmid:24440770
11. *World Health Organization Twitter* (https://twitter.com/who, accessed 29 March 2015).
12. *European Center of Disease Prevention and Control Twitter* (https://twitter.com/ECDC_EU, accessed 29 March 2015).
13. *United States Centers for Disease Control and Prevention Twitter* (https://twitter.com/CDCgov, accessed 29 March 2015).
14. Fung ICH, Wong K. Efficient use of social media during the avian influenza A(H7N9) emergency response. *Western Pacific Surveillance and Response Journal*, 2013, 4:1–3. doi:10.5365/wpsar.2013.4.3.005 pmid:24478916

First round of external quality assessment of dengue diagnostics in the WHO Western Pacific Region, 2013

Kwoon Yong Pok,[a*] Raynal C Squires,[b*] Li Kiang Tan,[a] Tomohiko Takasaki,[c] Sazaly Abubakar,[d] Futoshi Hasebe,[e] Jeffrey Partridge,[b] Chin Kei Lee,[b] Janice Lo,[f] John Aaskov,[g] Lee Ching Ng[a] and Frank Konings[b]

Correspondence to Frank Konings (email: koningsf@wpro.who.int).

Objective: Accurate laboratory testing is a critical component of dengue surveillance and control. The objective of this programme was to assess dengue diagnostic proficiency among national-level public health laboratories in the World Health Organization (WHO) Western Pacific Region.

Methods: Nineteen national-level public health laboratories performed routine dengue diagnostic assays on a proficiency testing panel consisting of two modules: one containing commercial serum samples spiked with cultured dengue viruses for the detection of nucleic acid and non-structural protein 1 (NS1) (Module A) and one containing human serum samples for the detection of anti-dengue virus antibodies (Module B). A review of logistics arrangements was also conducted.

Results: All 16 laboratories testing Module A performed reverse transcriptase polymerase chain reaction (RT-PCR) for both RNA and serotype detection. Of these, 15 had correct results for RNA detection and all 16 correctly serotyped the viruses. All nine laboratories performing NS1 antigen detection obtained the correct results. Sixteen of the 18 laboratories using IgM assays in Module B obtained the correct results as did the 13 laboratories that performed IgG assays. Detection of ongoing/recent dengue virus infection by both molecular (RT-PCR) and serological methods (IgM) was available in 15/19 participating laboratories.

Discussion: This first round of external quality assessment of dengue diagnostics was successfully conducted in national-level public health laboratories in the WHO Western Pacific Region, revealing good proficiency in both molecular and serological testing. Further comprehensive diagnostic testing for dengue virus and other priority pathogens in the Region will be assessed during future rounds.

Dengue is a mosquito-borne viral infection associated with significant morbidity and mortality caused by any of four closely related virus serotypes (DENV-1,-2,-3 and -4), all of which circulate in the World Health Organization (WHO) Western Pacific Region.[1,2] Dengue presentation is broad and non-specific, which may confound clinical diagnosis. The majority (~75%) of infections in humans are asymptomatic, but a small proportion of symptomatic patients develops severe dengue characterized by rapid progression into shock, severe bleeding and/or multiorgan impairment, which leads to death if unattended or mismanaged.[2,3]

In the Western Pacific Region, dengue outbreaks occur yearly in multiple countries, driven by a complex interplay of virus, vector and host biology, climatic and socioeconomic factors as well as international travel and trade.[1,4–7] Different case definitions are used for dengue surveillance throughout the Region; some countries (e.g. Singapore, Australia) include only laboratory-confirmed cases, while others include all clinical diagnoses with only a subset (e.g. paediatric patients) being laboratory-confirmed. In 2013, outbreaks resulted in 44 098 dengue cases in the Lao People's Democratic Republic, 39 222 cases in Malaysia, 10 548 cases in New Caledonia and

[a] WHO Collaborating Centre for Reference and Research of Arbovirus and their Associated Vectors, Environmental Health Institute, National Environment Agency, Singapore.
[b] Emerging Disease Surveillance and Response Unit, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.
[c] National Institute of Infectious Diseases, Tokyo, Japan.
[d] WHO Collaborating Centre for Arbovirus Reference and Research (Dengue/Severe Dengue), Tropical Infectious Diseases Research and Education Centre, Department of Medical Microbiology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia.
[e] WHO Collaborating Centre for Reference and Research on Tropical and Emerging Virus Diseases, Nagasaki University, Nagasaki, Japan.
[f] Public Health Laboratory Services Branch, Centre for Health Protection, Department of Health, Hong Kong Special Administrative Region, China.
[g] WHO Collaborating Centre for Arbovirus Reference and Research, Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, Australia.
[*] Both authors contributed equally in the writing of this paper.

Submitted: 23 February 2015; Published: 30 June 2015
doi: 10.5365/wpsar.2015.6.1.017

22 170 cases in Singapore.[8,9] Analysis of the outbreaks in Singapore, Malaysia and later Fiji (> 20 000 cases as of 22 April 2014) revealed DENV serotype switches from the previous year.[10,11] Secondary heterotypic infection is believed to foreshadow larger numbers of dengue and severe dengue cases.[12] Surveillance detection of a switch in the prevalent serotype within a population is thus cause for concern.

Accurate laboratory testing is a critical component of dengue surveillance and control. During the acute phase of infection, detection is targeted to DENV RNA and/or the virus non-structural protein 1 (NS1), while anti-DENV antibodies IgM and/or high titre IgG are the diagnostic targets in the convalescent phase. Several commercial diagnostic tests for dengue are available that detect DENV RNA or determine serotype using reverse transcription polymerase chain reaction (RT-PCR), or detect NS1, or IgG and IgM antibodies against the virus. A common mechanism used by laboratories to maintain accuracy and quality of diagnosis is external quality assessment (EQA) or proficiency testing, whereby an external agency distributes blinded samples to a laboratory for analysis and then verifies and reports the results. EQA can be used to compare laboratory performance, reveal potential problems associated with diagnostic kits or procedures, indicate areas in a laboratory requiring improvement and identify training needs.[13]

The WHO Regional Office for the Western Pacific recently launched an EQA for dengue diagnostics testing in 2013, under the Asia Pacific Strategy for Emerging Diseases (APSED) 2010.[14] This EQA is based largely on the WHO EQA for influenza[15] and uses proficiency testing to assess national-level public health laboratory performance in detecting DENV nucleic acid, NS1 antigen and anti-DENV antibodies using molecular and serological assays. It is proposed that it will be an annual exercise, free of charge or at low cost to the laboratories and with the gradual inclusion of other pathogens. As well as ensuring the accurate diagnosis of dengue, the EQA programme also links participating laboratories with international reference laboratories that can assist in more specialized diagnostics or analytical functions as required.

The objective of this manuscript is to summarize the first round of EQA of dengue diagnostics undertaken in the WHO Western Pacific Region in 2013.

METHODS

Participating laboratories

Nineteen national-level public health laboratories from 18 countries and areas (two in Viet Nam) in the WHO Western Pacific Region where dengue is endemic or where imported cases have been detected were invited to participate in the EQA; all 19 agreed (**Figure 1**). An EQA panel was dispatched to these laboratories between May and July 2013.

Preparation of EQA panel

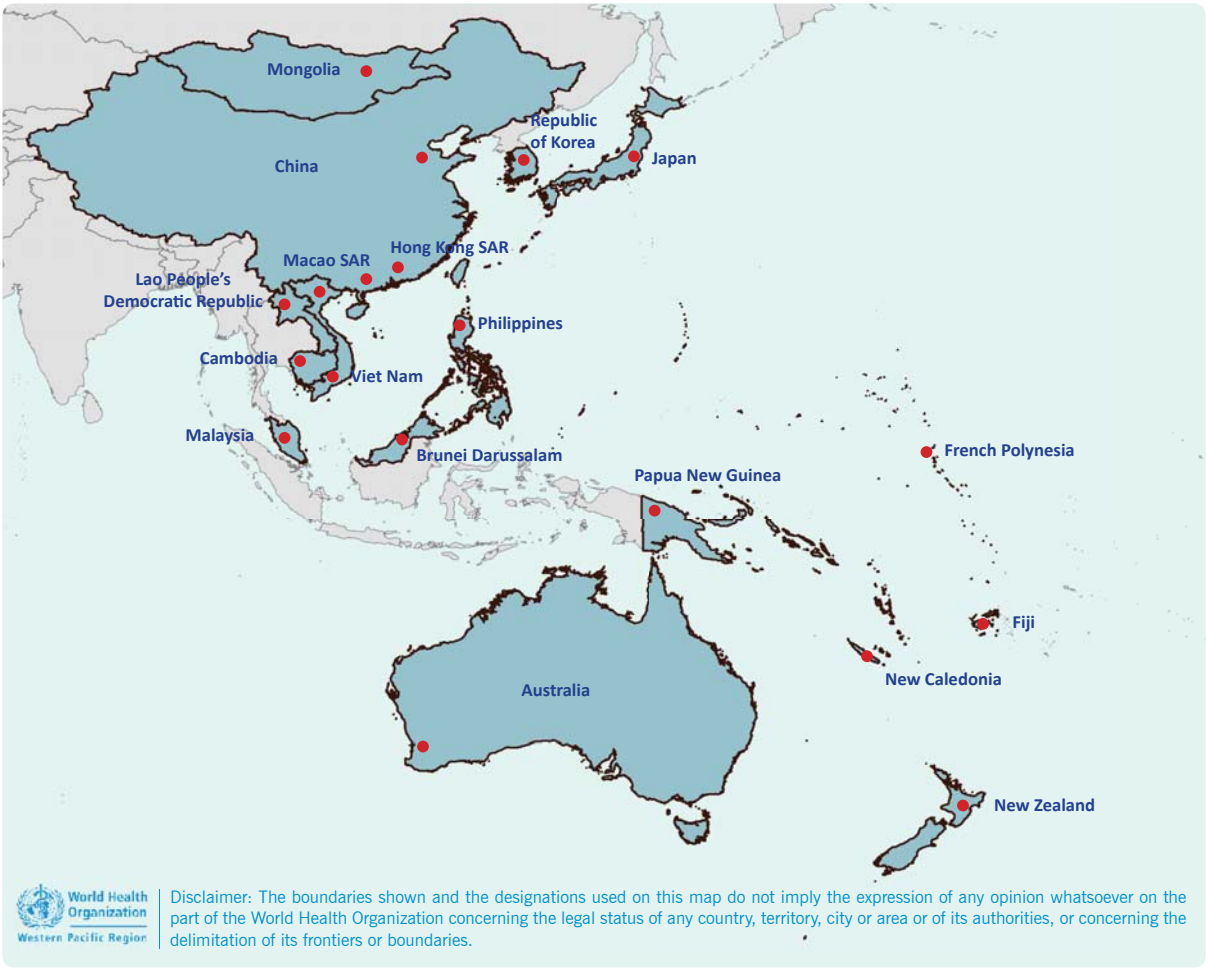
The WHO Collaborating Centre for Reference and Research of Arbovirus and their Associated Vectors, located at the Environmental Health Institute of the National Environment Agency in Singapore, was selected as the EQA provider as it had the necessary technical expertise, access to samples and the required resources.

The panel for the 2013 EQA of dengue diagnostics consisted of two modules (A and B) containing serum with inactivated DENV (Module A) and serum samples from a dengue patient (Module B) (**Table 1**). All samples were heat-inactivated and contained no detectable HIV, hepatitis B surface antigen or hepatitis C virus antibody.

For Module A, samples A2013-V01 and A2013-V03 contained at least 10^6 RNA copies/mL of *in vitro*-cultured DENV of different serotypes – DENV-1 genotype III and DENV-2 cosmopolitan clade II, deposited in Genbank with accession numbers KP685233 and KP685236, respectively. These were diluted in pathogen-free human serum (SeraCare Life Sciences, Milford, Massachusetts, USA). The presence of NS1 antigen in the samples was confirmed using commercial dengue NS1 assays, and virus non-infectivity after heat-inactivation was verified through three passages of an in-house cell-based viral infectivity assay. Sample A2013-V02 (serum only) was confirmed DENV-negative by real-time RT-PCR[16] and commercial dengue NS1 assays, and negative for anti-dengue antibodies using commercial enzyme-linked immunosorbent assay (ELISA) and the plaque-reduction neutralization technique (PRNT).[17]

For Module B, samples B2013-S01 and B2013-S02 were split serum samples from a convalescent dengue patient included to assess reproducibility of testing by the participating laboratories. These samples were confirmed

Figure 1. **National-level public health laboratories that participated in EQA of dengue diagnostics, WHO Western Pacific Region, 2013**



SAR, Special Administrative Region.

Table 1. **Characteristics of modules used in EQA of dengue diagnostics, WHO Western Pacific Region, 2013**

Module	Sample ID	Contents	Serotype	Antibodies
Viral RNA/ NS1 antigen (Module A)	A2013-V01	Inactivated dengue virus in serum	DENV-2	–
	A2013-V02	Serum alone	Not applicable	–
	A2013-V03	Inactivated dengue virus in serum	DENV-1	–
Antibody (Module B)	B2013-S01*	Convalescent serum	–	IgM, IgG
	B2013-S02*	Convalescent serum	–	IgM, IgG
	B2013-S03	Negative human serum	–	Negative control

* B2013-S01 and B2013-S02 were the same sample collected from a recently recovered dengue patient used to assess the reproducibility of laboratory results.

ID, identification; NS1, non-structural protein 1.

by PRNT to contain neutralizing antibodies against DENV 1–4 (> 1:1000) and confirmed DENV-negative as described above. They were additionally verified using several commercial dengue antibody-based detection assays (Alere, Waltham, Massachusetts, USA; Standard Diagnostics Inc., Yongin-si, Gyeonggi-do, Republic of Korea; Focus Diagnostics Inc., Cypress, California, USA; and Bio-Rad Laboratories Inc., Hercules, California, USA). SeraCare human serum was used as the negative sample B2013-S03.

All EQA samples were confirmed externally by an independent International Organization for Standardization (ISO) 15189-accredited laboratory before dispatch to participating laboratories.

Participating laboratories could request to receive either one or both of the modules shipped on dry ice from the EQA provider by courier. The laboratories were requested to inform the EQA provider when they received the panels and to report whether the samples arrived frozen. Participants were provided with a unique identifier, an instruction and results submission form, a good laboratory practices survey and quality of shipment and feedback forms. Participants were requested to test samples in triplicate independent runs (to assess reproducibility) by the routine methods used in their laboratories and to submit background technical information on methods, kits and reagents used. Test results were required within 30 days.

Analysis of results

In Module A, two points each were awarded for the correct detection of DENV by RT-PCR or NS1 assay and accurate serotyping of DENV. In Module B, two points each were awarded for the correct detection of anti-DENV IgG and IgM antibodies. Using in-date reagents scored an additional three points. Awardable points were based solely on the assays performed on each sample. The final score was the proportion of points earned out of the possible awardable points. Accuracy for each assay (e.g. serotyping) was defined as the proportion of laboratories scoring 100% for that assay.

Quantitative data (RT-PCR cycle threshold values and ELISA values) submitted were used for reference and for assessing reproducibility of laboratory results. For ELISA assays, the percentage coefficient of variation (CV) was calculated from values recorded in triplicate runs to evaluate the reproducibility of results. A limit of ≤ 15% CV was used,[18] mirroring manufacturers' guidelines on inter-/intra-sample variation specified in the product inserts accompanying commercial ELISA kits. Large variations were flagged for attention in assessment reports sent to each laboratory.

RESULTS

Laboratory proficiency in dengue diagnostics

The most common assay performed was the anti-DENV IgM ELISA; 16 of the 18 laboratories that conducted this test detected IgM in all of the samples (two laboratories detected IgM in only one of the split samples), achieving an overall accuracy of 88.9% for this assay (**Figure 2**).

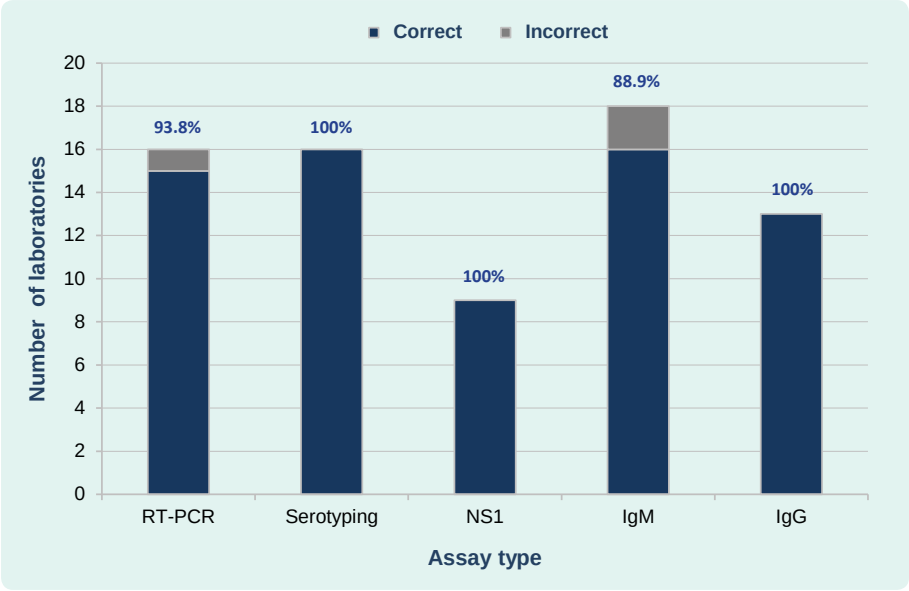
Sixteen laboratories used RT-PCR for nucleic acid detection. As one laboratory reported equivocal results for the negative sample in Module A, the overall accuracy for RT-PCR was 93.8%. These 16 laboratories also conducted virus serotyping with 100% accuracy (**Figure 2**). One laboratory conducted RT-PCR only, while another used an expired reagent for a viral RNA assay, although this had no effect on accuracy. The capacity to detect ongoing or recent dengue infection was demonstrated by the 15 laboratories that conducted both RT-PCR and IgM anti-DENV ELISA.

Testing for anti-DENV IgG and NS1 antigen were the next most common assays, employed by 13 and nine laboratories, respectively, with 100% accuracy for both tests (**Figure 2**). The seven laboratories that conducted all five assays (RT-PCR, serotyping, NS1, IgM and IgG assays) achieved 100% accuracy in each of them.

Module A: Viral RNA and NS1 antigen

Of those laboratories using RT-PCR in Module A, the majority (11/16) used the QIAmp Viral RNA Mini Kit (Qiagen, Valencia, California, USA) for extraction and purification of DENV RNA and commercial kits to perform RT-PCR. More than half (56.3%) used real-time RT-PCR, while the remainder used conventional RT-PCR methods (**Table 2**). The laboratory reporting equivocal results for the negative sample in Module A used the real-time methodology. Most laboratories (87.5%) used in-house positive controls for viral detection and serotyping. DENV genome regions targeted for virus detection

Figure 2. **Proportion of participating laboratories by test conducted and results, EQA of dengue diagnostics, WHO Western Pacific Region, 2013**



NS1, non-structural protein 1; RT-PCR, reverse transcription polymerase chain reaction.

and serotyping varied, with non-structural protein 5 and capsid being the most commonly used. To detect NS1 antigen, seven of nine laboratories employed the Platelia Dengue NS1 Ag kit (Bio-Rad Laboratories Inc.), one used the SD Dengue NS1 Ag ELISA (Standard Diagnostics Inc.) and the other an in-house ELISA.

Of seven laboratories detecting NS1 in triplicate runs using commercial ELISA kits, three demonstrated lower reproducibility (up to 30% CV) between runs. Though the final interpretation of results was not affected, large deviations in CV warrant greater adherence to work processes.

Module B: Serology

All 18 laboratories that requested Module B chose the ELISA methodology to detect anti-DENV IgM (**Table 2**). Half used the Panbio Dengue IgM Capture ELISA (Alere Inc.) with two also using a rapid diagnostic test (Panbio Dengue Duo Cassette, Alere Inc.). The two laboratories detecting anti-DENV IgM in only one of the split samples used an in-house IgM MAC-ELISA protocol and a commercial Dengue IgM ELISA kit (Euroimmun, Luebeck, Germany), respectively. These were not used by any other laboratories. ELISA was also the methodology of choice for anti-DENV IgG detection, with 11 out of 13 (84.6%) of laboratories using commercial indirect ELISA and/or high titre IgG capture ELISA kits. The remaining two laboratories performed in-house DENV haemagglutination inhibition assays.

Participating laboratories demonstrated reproducible IgG assay results (≤ 15% CV on average) in Module B; however, a ≥ 30% CV between sample runs for IgM assays was observed in a third of the participating laboratories. This included the two laboratories with incorrect results for the split samples.

Logistics

Most (17/19) laboratories returned results within the month allotted; the average time between receipt of samples and completed results was 27.8 days. One laboratory was five days late and another requested a 13-day extension while waiting for the delivery of reagents. There were no major logistics issues with shipping the panels to participating countries; all deliveries arrived on time and with cold chain intact. Flight rescheduling was announced ahead of time and deliveries were targeted to ensure a laboratory member was available and that national holidays or weekends were avoided.

Obtaining import permits from respective governments or agencies added a significant amount of time to the preparatory work before sending the panels. Eleven laboratories had to request permits, which

Table 2. **Number and proportion of participating laboratories by assay type used, EQA of dengue diagnostics, WHO Western Pacific Region, 2013**

Assay type	Number/total	%
Viral nucleic acid detection (RT–PCR)	16/19	84.2
Real-time RT–PCR methodology	9/16	56.3
Conventional RT–PCR methodology	7/16	43.8
Commercial RT–PCR kits	11/16	68.8
In-house RT–PCR controls	14/16	87.5
Viral antigen detection (NS1)	9/19	47.4
Commercial NS1 ELISA kits	8/9	88.9
Antibody detection	18/19	94.7
IgM antibody detection	18/18	100.0
ELISA methodology	18/18	100.0
Commercial IgM ELISA kits	15/18	83.3
IgG antibody detection	13/18	72.2
ELISA methodology	11/13	84.6
Commercial IgG ELISA kits	11/11	100.0

ELISA, enzyme-linked immunosorbent assay; NS1, non-structural protein 1; and RT–PCR, reverse transcriptase polymerase chain reaction.

took a median of 1.5 months to obtain (ranging from one week to 2.5 months). One laboratory had a standing import permit. The EQA time frame was also delayed as some participating laboratories had to be recruited through official ministry/department of health channels rather than directly; the longest recruitment took 1.5 months.

DISCUSSION

This study reports on an EQA programme established for dengue diagnostics for national-level public health laboratories in the Western Pacific Region. It provided the first indication of the proficiency of the participating laboratories in diagnosing dengue samples and demonstrated the range of assays used by participants to diagnose dengue. It also facilitated communication between national laboratories and the WHO Collaborating Centre for Reference and Research of Arbovirus and their Associated Vectors, which will be useful for future public health emergencies.

The appropriate dengue diagnostic tools must be employed at the correct time to ensure the most effective diagnostic capability.[19] It is therefore important for national/reference laboratories to be equipped with the tools to detect both DENV RNA/NS1 antigen and anti-dengue antibodies. It is encouraging that 15 of the 19 participating laboratories employed assays to detect both DENV RNA and anti-DENV IgM as part of their routine diagnostic algorithm for ongoing/recent dengue infection. Of the remaining four laboratories, one performed RT-PCR but not antibody testing, and three performed antibody testing but not RT-PCR. The diagnostic capacity of these laboratories could be quickly strengthened through the use of commercial ELISA assays for the detection of NS1 antigen or anti-DENV antibodies.

Anti-DENV IgM assays were performed by all 18 laboratories that tested Module B. Using commercial ELISAs for anti-DENV IgM detection was the most common approach and the majority of laboratories delivered accurate and reproducible results on almost

all samples. Discrepancies reported in anti-DENV IgM assay results may be attributed to operational issues (such as unfamiliarity with ELISA, insufficient adherence to work processes, inadequate reagent handling skills and pipetting techniques). In-house ELISAs were used by three laboratories, one of which reported incorrect results. While in-house assays may appear to be economical, the maintenance of test validity, reagent quality and appropriately trained staff must remain a priority. As anticipated, dengue rapid diagnostic tests were rarely employed at the national laboratory level.

Thirteen of the 18 laboratories participating in Module B also performed assays for the detection of anti-DENV IgG. Two types of commercial anti-DENV IgG ELISAs were employed; four laboratories used high titre IgG ELISAs suitable for detecting ongoing/recent infections, six used low titre IgG ELISAs for the detection of a prior dengue infection (such as in seroprevalence studies) and one laboratory used both. High titre IgG ELISAs, when used on acute-phase sera, can differentiate between primary and secondary dengue infections in endemic areas; however, low titre ELISAs have no diagnostic value unless they are used in conjunction with an IgM ELISA. The presence of IgM alone is highly indicative of an ongoing/recent infection, whereas detection of IgG at low titre can occur indefinitely after dengue infection. As national laboratories are more likely to test samples from ongoing/recent infections, this may explain the more prevalent use of IgM kits. Several of the laboratories that did not test for anti-DENV IgG reported this was because they did not have IgG kits available or did not routinely test for IgG.

Reproducibility is also an important component of EQA. High variability (≥ 15% CV) between experimental runs was observed in several laboratories participating in Module B, particularly in two laboratories incorrectly diagnosing the split samples in Module B. This highlights the importance of using validated assays and adhering to standard operating procedures to ensure accurate and reproducible test results, as well as the continual training of laboratory technicians. The interpretation of this calculation is limited due to the small number of samples used (the two samples repeated in triplicate gives only six data points per laboratory); however, the results have provided an indication of variability and potential operational issues, which was the aim of this initial exercise. Participation in audits, such as EQA, is useful for laboratories to ascertain areas requiring improvement.

The high accuracy of participating laboratories to diagnose dengue using serological and molecular tests were similar to that observed by the European Network for Diagnostics of "Imported" Viral Diseases (ENIVD) for their initial four-sample panel for serology but not for their EQA panel of 20 samples where 79% of participating laboratories required improvement in correctly detecting anti-DENV antibodies.[20] Likewise, the recent ENIVD EQA for molecular detection of DENV found that 80.4% of laboratories needed improvement in identifying dengue and non-dengue samples and serotypes.[21] In contrast to our EQA, participating laboratories were in countries where dengue is not endemic, and samples were composed of different dilutions of DENV or patient serum and included other arboviruses or anti-sera against them as controls. Panels in upcoming rounds of the EQA in the Western Pacific Region will be composed of more dengue serotypes and titre ranges, as well as other arboviruses of priority to the Region.

Despite encountering no major logistical issues and EQA being executed mostly as intended, valuable administrative lessons were learnt. The delays in acquiring import permits and recruiting laboratories through government channels were unexpected. More time to accommodate these steps will therefore be allotted in the future.

This first round of EQA of dengue diagnostics had some limitations. The modules comprised three samples each, limiting the variety of samples that could be included such as blinded samples to assess reproducibility. Module size also prevented the inclusion of other arboviruses or anti-sera against them and the inclusion of multiple titrations of virus for determining assay sensitivity. However, the aim of this first round of EQA was to attain an initial overview of dengue diagnostic testing in the Region. The findings presented here need to be further substantiated during upcoming rounds of EQA with more comprehensive panels.

This first round of EQA in the Western Pacific Region showed that using the existing influenza EQA programme facilitated EQA for another priority pathogen. Despite the

small number of samples tested, this exercise showed that laboratory diagnosis of dengue in the Western Pacific Region is good and provided lessons for subsequent iterations. Therefore this ongoing EQA programme for dengue, which will be expanded to include other priority pathogens, should strengthen the regional public health laboratory system for detecting emerging infectious diseases, in line with APSED (2010).

Conflicts of interest

None declared.

Funding

This programme was in large part financially supported by the U. S. Agency for International Development Emerging Pandemic Threats (EPT) programme's IDENTIFY project.

Acknowledgements

The authors are grateful to the national-level public health laboratories that participated in the EQA and to Professor Leo Yee Sin of the Tan Tock Seng Hospital, Singapore, for assistance in obtaining dengue antibody-positive serum samples. We would also like to thank Sandy Walker for critical reading of the manuscript.

List of participating laboratories

PathWest Laboratory Medicine, QEII Medical Centre (Australia), Ministry of Health, Department of Laboratory Services (Brunei Darussalam), Institut Pasteur du Cambodge (Cambodia), Chinese Center for Disease Control and Prevention, National Institute for Viral Diseases Control and Prevention (China), Fiji Centre for Communicable Disease Control (Fiji), Institut Louis Malardé (French Polynesia), Public Health Laboratory Centre, Virology Division (Hong Kong SAR, China), National Institute of Infectious Diseases, Virology 1st (Japan), Korea National Institute of Health, Division of Arboviruses (Republic of Korea), National Center for Laboratory and Epidemiology (the Lao People's Democratic Republic), Health Bureau, Public Health Laboratory (Macau SAR, China), Department of Medical Microbiology, University of Malaya (Malaysia), National Center for Zoonotic Diseases, Ministry of Health (Mongolia), Institut Pasteur de Nouvelle-Calédonie, Laboratoire de Biologie Médicale (New Caledonia), Institute of Environmental Science and Research Ltd, Clinical Virology (New Zealand), Papua New Guinea Institute of Medical Research, Environmental & Emerging Diseases Unit (Papua New Guinea), Research Institute for Tropical Medicine, Department of Virology (the Philippines), National Institute of Hygiene and Epidemiology, Virology Department, and Pasteur Institute in Ho Chi Minh, Laboratory of Arboviruses (Viet Nam).

References:

1. Arima Y et al. Epidemiologic update on the dengue situation in the Western Pacific Region, 2012. *Western Pacific Surveillance and Response Journal*, 2015, 6(2). doi:10.5365/wpsar.2014.5.4.002
2. *Dengue: guidelines for diagnosis, treatment, prevention and control*. Geneva, World Health Organization, 2009 (http://www.who.int/tdr/publications/documents/dengue-diagnosis.pdf, accessed 17 June 2015).
3. Bhatt S et al. The global distribution and burden of dengue. *Nature*, 2013, 496:504–507. doi:10.1038/nature12060 pmid:23563266
4. Lee KS et al. Dengue virus surveillance in Singapore reveals high viral diversity through multiple introductions and in situ evolution. *Infection, Genetics and Evolution*, 2012, 12:77–85. doi:10.1016/j.meegid.2011.10.012 pmid:22036707
5. Ritchie SA. Dengue vector bionomics: why *Aedes aegypti* is such a good vector. In: Gubler DJ, Ooi EE, Vasudevan S and Farrar J, eds. *Dengue and dengue hemorrhagic fever*. Oxfordshire, CABI. 2014, 455–480. doi: 10.1079/9781845939649.0455
6. Banu S et al. Dengue transmission in the Asia-Pacific region: impact of climate change and socio-environmental factors. *Tropical Medicine & International Health*, 2011, 16:598–607. doi:10.1111/j.1365-3156.2011.02734.x pmid:21320241
7. Wilder-Smith A, Gubler DJ. Geographic expansion of dengue: the impact of international travel. *The Medical Clinics of North America*, 2008, 92:1377–1390, x. doi:10.1016/j.mcna.2008.07.002 pmid:19061757
8. *Dengue Situation Update – 25 December 2013*. Manila, World Health Organization Regional Office for the Western Pacific, 2013 (http://www.wpro.who.int/entity/emerging_diseases/Dengue.Biweekly.24Dec2013.pdf, accessed 17 June 2015).
9. *Communicable Disease Surveillance in Singapore 2013*. Singapore, Ministry of Health, 2014 (https://www.moh.gov.sg/content/moh_web/home/Publications/Reports/2014/communicable-diseases-surveillance-in-singapore-2013.html, accessed 25 June 2015).
10. Governments of Malaysia and Singapore. *Joint Media release: UNITEDengue cross-border data sharing provides countries with timely risk alerts*. Singapore, National Environment Agency, 2014 (http://www.moh.gov.my/index.php/database_stores/attach_download/337/573, accessed 17 June 2015).
11. *Dengue Situation Update - 22 April 2014*. Manila, World Health Organization Regional Office for the Western Pacific, 2014 (http://www.wpro.who.int/emerging_diseases/Dengue.Biweekly.22Apr2014.pdf, accessed 17 June 2015).
12. Guzman MG, Alvarez M, Halstead SB. Secondary infection as a risk factor for dengue hemorrhagic fever/dengue shock syndrome: an historical perspective and role of antibody-dependent enhancement of infection. *Archives of Virology*, 2013, 158:1445–1459. doi:10.1007/s00705-013-1645-3 pmid:23471635

13. *Laboratory quality management system*. Geneva, World Health Organization, 2011 (http://www.who.int/ihr/training/laboratory_quality/10_b_eqa_contents.pdf, accessed 17 June 2015).

14. *Asia Pacific Strategy for Emerging Diseases (2010).* Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/emerging_diseases/documents/ASPED_2010/en/, accessed 17 June 2015).

15. *WHO External Quality Assessment Project for the detection of influenza virus type A by PCR.* Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.who.int/influenza/gisrs_laboratory/external_quality_assessment_project/en/, accessed 17 June, 2015).

16. Lai YL et al. Cost-effective real-time reverse transcriptase PCR (RT-PCR) to screen for Dengue virus followed by rapid single-tube multiplex RT-PCR for serotyping of the virus. *Journal of Clinical Microbiology*, 2007, 45:935–941. doi:10.1128/JCM.01258-06 pmid:17215345

17. Morens DM et al. Simplified plaque reduction neutralization assay for dengue viruses by semimicro methods in BHK-21 cells: comparison of the BHK suspension test with standard plaque reduction neutralization. *Journal of Clinical Microbiology*, 1985, 22:250254. pmid:4031038

18. Food and Drug Administration. *Guidance for Industry: bioanalytical method validation*. Maryland, United States Department of Health and Human Services, 2001 (http://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidances/ucm070107.pdf, accessed 17 June 2015).

19. Peeling RW et al. Evaluation of diagnostic tests: dengue. *Nature Reviews Microbiology*, 2010, 8 Suppl;S30–38. doi:10.1038/nrmicro2459 pmid:21548185

20. Donoso Mantke O et al. Quality control assessment for the serological diagnosis of dengue virus infections. *Journal of Clinical Virology*, 2004, 29:105–112. doi:10.1016/S1386-6532(03)00110-0 pmid:14747029

21. Domingo C et al. 2nd International external quality control assessment for the molecular diagnosis of dengue infections. *PLoS Neglected Tropical Diseases*, 2010, 4:e833. doi:10.1371/journal.pntd.0000833 pmid:20957194

Epidemiological update on the dengue situation in the Western Pacific Region, 2012

Yuzo Arima,[a] May Chiew[a] and Tamano Matsui[a] on behalf of the Emerging Disease Surveillance and Response Team, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific

Correspondence to the Emerging Disease Surveillance and Response Unit (e-mail: outbreak@wpro.who.int).

Dengue has caused a substantial public health burden in the Western Pacific Region. To assess this burden and regional trends, data were collated and summarized from indicator-based surveillance systems on dengue cases and deaths from countries and areas in the Western Pacific Region. In 2012, dengue notifications continued to increase with 356 838 dengue cases reported in the Region (relative to 244 855 cases reported in 2011) of which 1248 died. In the Asia subregion, the notification rate was highest in Cambodia, the Philippines and the Lao People's Democratic Republic (316.2, 198.9 and 162.4 per 100 000 population, respectively), and in the Pacific island countries and areas, the notification rate was highest in Niue, the Marshall Islands and the Federated States of Micronesia (8556.0, 337.0 and 265.1 per 100 000 population, respectively). All four serotypes were circulating in the Region in 2012 with considerable variabilitiy in distribution. Regional surveillance provides important information to enhance situational awareness, conduct risk assessments and improve preparedness activities.

In recent years, dengue has become a major public health concern in the Western Pacific Region, resulting in substantial morbidity, mortality and economic cost.[1–3] Such public health and economic burdens have become clear not only from national surveillance data but also from operational research studies aimed at estimating the dengue disease burden.[4] The epidemiology and virology of dengue continues to display complex behaviour with serotype interactions, antibody-dependent enhancement and cross-immunity, climate and notable gender and age distributions.[5–8] Notifications of dengue cases – most likely an underestimate of the true burden[4,9] – have increased over the past decade, with more than 200 000 annual cases consistently reported in the Western Pacific Region since 2007,[1,2] and nearly 250 000 dengue cases reported in the Region in 2011.[2]

This analysis reports the 2012 annual regional dengue surveillance data collated by the World Health Organization (WHO) Western Pacific Regional Office.

METHODS

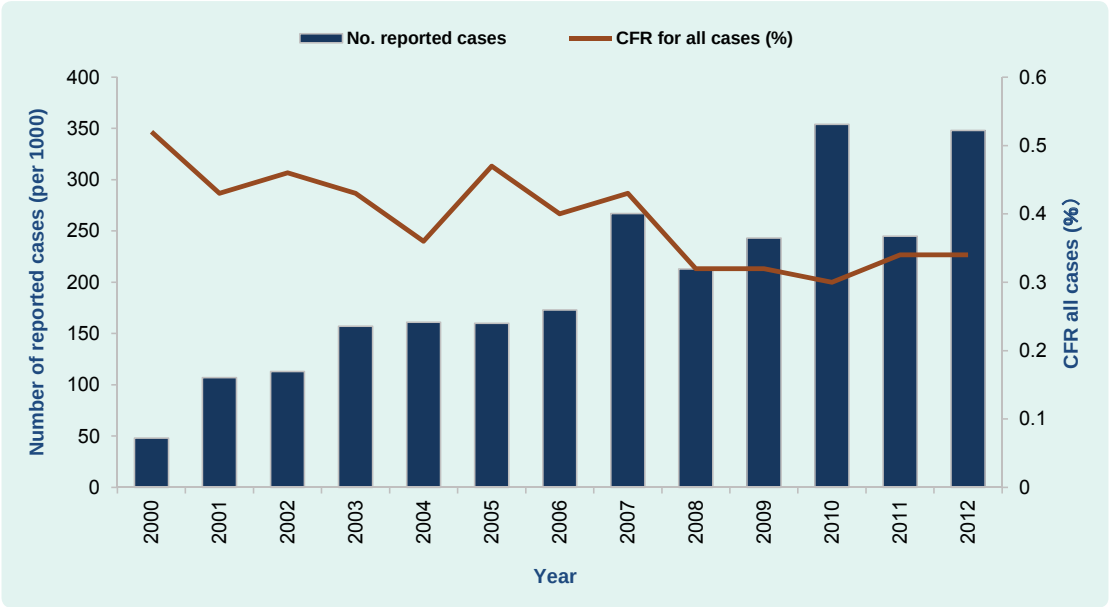
Regional dengue data for 2012 were collated from indicator-based surveillance systems from countries and areas in the Region. Data were either sent to WHO from the ministries of health or collected from their websites.

Additional data were provided from Australia, Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore and Viet Nam. A summary of the dengue surveillance systems, case definitions, laboratory sampling methods and serotype data are included. Malaysia and the Philippines were the only countries with changes since the 2011 annual report.[2] For Malaysia, all cases fulfilling the clinical criteria for dengue or those with a positive laboratory confirmation were reported; for the first time, NS1 antigen detection was included as a testing method. In the Philippines, the 2009 dengue case classification system continued to be rolled out in 2012 following training at the regional, provincial and municipal/city

[a] Emerging Disease Surveillance and Response, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

Submitted: 4 October 2014; Published: 20 April 2015
doi: 10.5365/wpsar.2014.5.4.002

Figure 1. **Number of reported dengue cases and case fatality rates in the Western Pacific Region, 2000 to 2012***



Source: World Health Organization Regional Office for the Western Pacific.

* Dengue surveillance and reporting systems vary by country.

CFR, case fatality rate.

health offices. Training was ongoing at the end of 2012, and hence the new case definition was not applied nationwide by the year end.

RESULTS

Dengue in the Western Pacific Region

In 2012, Western Pacific Region Member States reported a total of 356 838 dengue cases of which 1248 died for a case fatality rate of 0.34% (**Figure 1**). In the Asia subregion, both the notification rate and the absolute number of reported dengue cases were highest in the Philippines (**Table 1**). In the Pacific subregion, there were large increases in notification rates in Niue, Fiji and New Caledonia relative to 2011.[2] While Australia reported more than 1500 laboratory-confirmed cases (**Table 2**), the majority were imported cases.

While laboratory sampling schemes and confirmation methods vary by country, most of the countries in this report were using the updated (2009) dengue case classification system in 2012 (**Table 3**).

For those countries providing additional data, all except for Singapore reported a higher number of cases in 2012 compared with 2011 (**Table 2**). Overall, the number of cases reported in 2012 was more than 40% higher than in 2011.[2]

Asia subregion

Cambodia

In 2012, Cambodia reported 42 362 clinical dengue cases (189 fatal), considerably more than the 15 980 cases reported in the previous year (**Table 3**). Notifications peaked in week 27 (n = 2447 cases) in July (**Figure 2**), similar to 2011 (peak in July) and 2010 (peak in August). Among those aged more than 15 years, there was a higher proportion of males (male-to-female ratio: 1.2 to 1). Among the 500 laboratory-tested cases, 463 (93%) were confirmed. Three serotypes circulated with the predominant serotype being DEN-1 (DEN-1 n = 368 [98%], DEN-2 n = 5 [1%] and DEN-4 n = 3 [1%]).

The Lao People's Democratic Republic

In 2012, 9952 clinical dengue cases (22 fatal) were reported, more than double that of 2011 (**Table 2**). Notifications peaked in week 40 (n = 555 cases) in October (**Figure 2**), later than in 2011 (peak in September) and 2010 (peak in August). Among the 871

Table 1. **Cases of dengue, including imported cases, and dengue-attributed deaths reported in the Western Pacific Region for 2012***

Countries/territories†	Cases	Notification per 100 000	Deaths	Case fatality rate (%)	Population (in thousands)
Asia subregion					
Brunei Darussalam	290	71.43	0	0.00	406
Cambodia	42 362	316.23	189	0.45	13 396
China	575	0.04	0	0.00	1 370 537
China, Hong Kong Special Administrative Region	53	0.75	0	0.00	7068
China, Macao Special Administrative Region	24	4.35		0.00	552
Japan	220	0.17	0	0.00	128 056
Republic of Korea	145	0.30		0.00	48 875
Lao People's Democratic Republic	9952	162.40	22	0.22	6128
Malaysia	21 900	77.52	35	0.16	28 251
Mongolia	0	0.00	0	–	2780
Philippines	187 031	198.94	921	0.49	94 013
Singapore	4632	89.35	2	0.04	5184
Viet Nam	86 026	100.00	79	0.09	86 025
Total for subregion	**353 210**	**19.72**	**1248**	**0.35**	**1 791 271**
Pacific subregion					
Australia	1542	6.90	0	0	22 342
Fiji	705	82.55	0	0	854
Kiribati	243	240.59	0	0	101
Marshall Islands	182	337.04	0	0	54
Micronesia (Federated States of)	273	265.05	0	0	103
New Caledonia	478	194.31	0	0	246
New Zealand	77	1.86	0	0	4 143
Niue	128	8556.00	0	0	1.5
Total for subregion	**3 628**	**13.03**	**0**	**0**	**27 845**
TOTAL	**356 838**	**19.62**	**1248**	**0.35**	**1 819 116**

Source: World Health Organization Regional Office for the Western Pacific

* Dengue surveillance and reporting systems vary by country.

† The following countries and territories did not report dengue data: American Samoa, Cook Islands, French Polynesia, Guam, Nauru, the Commonwealth of Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna.

laboratory-tested cases, 449 (52%) were confirmed. While all four serotypes circulated, the predominant serotype was DEN-3 (DEN-3 n = 164 [80%], DEN-1 n = 23 [11%], DEN-2 n = 18 [9%] and DEN-4 n = 1 [< 1%]).

Malaysia

In 2012, Malaysia reported 21 900 cases (35 fatal), similar to 2011 and relatively low compared to years before 2011 (**Table 3**). However, this was the first year that those with a laboratory confirmation, regardless of clinical manifestation, were included (**Table 3**). The highest number of cases (n = 602) was reported during week 8 in February; higher notifications were observed from December through February (**Figure 2**), similar to 2011 when a peak was observed in January. Among the 7797 laboratory-tested cases, 6506 (83%) were confirmed. All four serotypes were detected with an almost equal distribution (DEN-3 n = 263 [31%], DEN-1 n = 222 [26%], DEN-4 n = 185 [22%] and DEN-2 n = 184 [22%]).

The Philippines

In 2012, the Philippines reported 187 031 clinical cases (921 fatal), a 48% increase compared with 2011 (**Table 2**), with a peak in the month of August (n = 31 999) (**Figure 2**). Those aged 5–14 years were the age group with the largest number of cases. Among the

Table 2. **Reported number of dengue cases, deaths and case fatality rates from Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore, Viet Nam and Australia, 2008–2012***

Countries	2008			2009			2010			2011			2012		
	Cases	Deaths	CFR (%)	Cases	Deaths	CFR (%)	Cases	Deaths	CFR (%)	Cases	Deaths	CFR (%)	Cases	Deaths	CFR (%)
Cambodia	9 542	65	0.68	11 699	38	0.32	12 500	58	0.30	15 980	73	0.46	42 362	189	0.45
Lao People's Democratic Republic	4 149	21	0.51	7 214	12	0.17	22 929	46	0.20	3 905	7	0.18	9 952	22	0.22
Malaysia	49 335	112	0.23	41 486	88	0.21	46 171	134	0.29	19 884	36	0.18	21 900	35	0.16
Philippines	39 620	373	0.94	57 819	548	0.95	135 355	793	0.59	125 975	654	0.52	187 031	921	0.49
Singapore	7 031	10	0.14	4 497	8	0.18	5 363	6	0.11	5 330	6	0.11	4 632	2	0.04
Viet Nam	96 451	97	0.10	105 370	87	0.08	128 831	55	0.04	69 680	61	0.09	86 026	79	0.09
Australia	563	0	0	1 401	0	0	1 171	0	0	820	0	0	1 542	0	0
Total	**206 692**	**678**	**0.33**	**229 486**	**781**	**0.34**	**352 321**	**1070**	**0.30**	**241 574**	**837**	**0.35**	**353 445**	**1 248**	**0.35**

Source: World Health Organization Regional Office for the Western Pacific

* Dengue surveillance and reporting systems vary by country.

CFR, case fatality rate.

Figure 2. **Reported number of dengue cases by calendar week (Cambodia, the Lao People's Democratic Republic, Malaysia, New Caledonia and Singapore) and month (Australia and the Philippines), 2012**

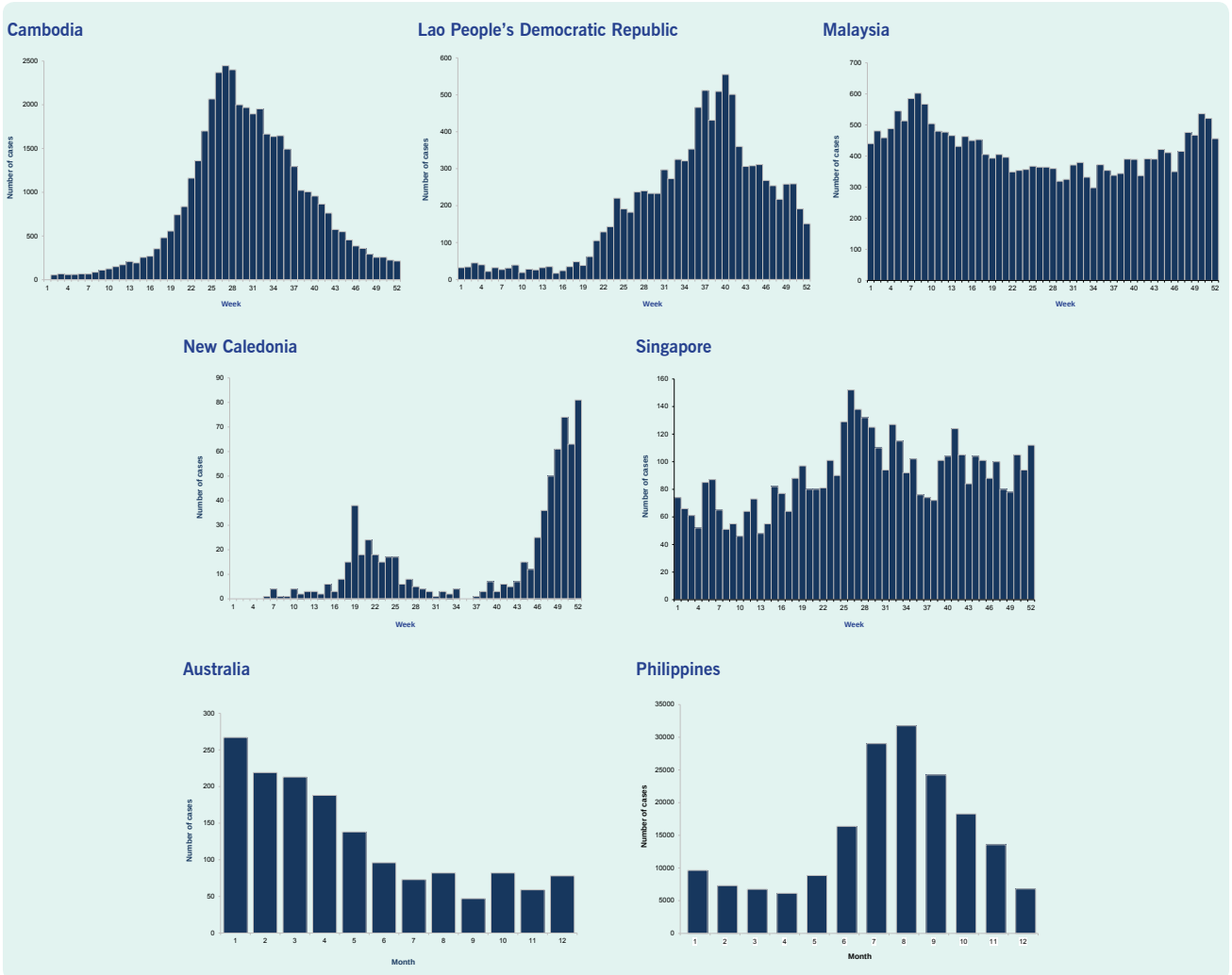


Table 3. **Dengue case definitions, laboratory sampling and testing methods used for surveillance in Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore, Viet Nam and Australia, 2012***

Country	Case definition		Laboratory sampling and testing method
	Clinical criteria†	Laboratory confirmation	
Cambodia	2009 dengue case classification†	No	Five sentinel sites send maximum of 5 samples per week for testing, focusing primarily on children. Confirmation is based on enzyme-linked immunosorbent assay (ELISA), polymerase chain reaction (PCR) and/or virus isolation. If the time interval between date of onset and sample collection is within 5 days, ELISA, haemagglutination inhibition assay, PCR and virus isolation are performed; if this interval is > 5 days, only ELISA and haemagglutination inhibition assay are performed.
Lao People's Democratic Republic	2009 dengue case classification†	No	A proportion of dengue cases, such as ad hoc outbreak specimens and samples sent from provincial hospitals, are tested by ELISA. IgM positive specimens for which the time between date of onset and collection is < 5 days were selected for serotyping at one facility, while another serotyped all specimens received.
Malaysia	Fever or history of fever AND ≥ 2 of the following: headache, retro-orbital pain, myalgia, arthralgia, rash, haemorrhagic manifestation, leucopenia OR cases with positive laboratory result	No	No sampling scheme: confirmation based on serology (IgM) or antigen detection (NS1).
Philippines	2009 dengue case classification† Acute onset of fever 2–7 days with ≥ 2 of following: headache, retro-orbital pain, myalgia, arthralgia, rash, haemorrhagic manifestations, leucopenia	No	A proportion of suspected dengue cases are tested by serology (IgM) or PCR.
Singapore	Acute onset of fever lasting 2–7 days with ≥ 2 of following: headache, backache, myalgia, rash, retro-orbital pain, bleeding, leucopenia	Required	All clinically diagnosed cases are laboratory tested and only those positive by serology (IgM) or PCR/NS1 are registered.
Viet Nam	2009 dengue case classification†	No	A proportion of dengue cases are tested through serology and a limited number by virus isolation.
Australia	Fever, headache, arthralgia, myalgia, rash, nausea and vomiting	Required	All clinically diagnosed cases are laboratory tested and only those confirmed by the following method are registered: isolation/detection of dengue virus OR IgG seroconversion or significant increase in antibody level or ≥ 4-fold rise in titre to dengue virus OR detection of dengue virus-specific IgM in cerebrospinal fluid OR detection of dengue virus-specific IgM in serum.

* Only the minimum criteria required for fulfilling a clinical dengue case definition are included here; additional signs and symptoms required for more severe forms (e.g. dengue haemorrhagic fever, dengue shock syndrome) are not listed here.

† A probable dengue case is defined as any case with fever and two or more of the following: nausea, vomiting, rash, aches and pains, positive tourniquet test, leucopenia and any warning sign. A case with warning signs is defined as a clinically diagnosed case with any of the following: abdominal pain or tenderness, persistent vomiting, clinical fluid accumulation, mucosal bleed, lethargy, restlessness, liver enlargement > 2 cm and increase in haematocrit concurrent with rapid decrease in platelet count. Severe dengue is defined as severe plasma leakage leading to any of the following: shock, fluid accumulation with respiratory distress OR severe bleeding as evaluated by clinician OR severe organ involvement of liver (aspartate amino transferase or alanine amino transferase ≥ 1000), central nervous system (impaired consciousness) or heart and other organs.

165 laboratory-tested cases, 142 (86%) were confirmed and among the serotyped cases, DEN-1 predominated (DEN-1 *n* = 128 [90%], DEN-2 *n* = 10 [7%] and DEN-3 *n* = 4 [3%]).

Singapore

In 2012, Singapore reported 4632 laboratory-confirmed cases of dengue (2 fatal), less than that reported in 2011 or 2010 (**Table 2**), with a peak in week 26 (*n* = 152 cases) in June (**Figure 2**), similar to 2011 which peaked in July. While all four serotypes were detected, the predominant serotype among 1333 serotyped cases was DEN-2 (DEN-2 *n* = 988 [74%], DEN-1 *n* = 258 [19%], DEN-3 *n* = 76 [6%] and DEN-4 *n* = 11 [1%]).

Viet Nam

In 2012, Viet Nam reported 86 026 clinical cases (79 fatal), greater than that reported in 2011 (**Table 3**). Among the 13 222 laboratory-tested cases, 5317 (40%) were confirmed. All four serotypes were detected with DEN-1 most common (DEN-1 *n* = 319 [32%], DEN-2 *n* = 262 [26%], DEN-4 *n* = 235 [23%] and DEN-3 *n* = 188 [19%]).

Pacific subregion

Australia

In 2012, Australia reported 1542 laboratory-confirmed dengue cases (0 fatal), the largest number reported in the past five years (**Table 2**), with a peak in the month of January (*n* = 267 cases) (**Figure 2**) similar to 2011. In North Queensland, among 28 locally acquired dengue cases, the predominant serotype was DEN-1 (14 DEN-1, 7 DEN-3, 1 DEN-2 and 6 untyped); 13 of the 28 cases were male. Among 41 imported cases, 22 were DEN-2, 13 were DEN-1, 3 were DEN-3, 1 was DEN-4 and 2 were not typed (personal communication, Dr Sonia Harmen, Tropical Public Health Services Cairns, Division 1 Family Health and Well-being Cairns and Hinterland Hospital and Health Service, Queensland Government).

From the Pacific subregion, Niue had the highest notification rate (8556 per 100 000 population; 128 cases), Fiji reported more than 700 cases (82.6 per 100 000 population) and New Caledonia had a large increase in notifications in the last quarter of 2012 (**Figure 2**) with nearly 500 cases (194.3 per 100 000 population) reported compared with a single case in 2011 (**Table 1**). In New Zealand, where dengue is not endemic, 77 cases were reported in 2012 with 76 being classified as imported cases.

DISCUSSION

Dengue continued to burden the Western Pacific Region in 2012 with the overall number of notifications greater than previous years. More than 1000 cases were reported each from Australia, Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore and Viet Nam; except for Singapore, they all reported an increase in cases compared with 2011. Seasonally, dengue notifications followed historic patterns, increasing and peaking during the wet season in Cambodia, the Lao People's Democratic Republic, the Philippines and Viet Nam. While some countries had the same serotype predominate as in the previous year (Cambodia, Malaysia, Singapore and Viet Nam), others saw a change, including Australia and the Lao People's Democratic Republic. In the latter, DEN-3 became predominant in 2012 compared with DEN-1 during 2010[1] and 2011.[2]

In the Pacific subregion, although large outbreaks were observed in the Federated States of Micronesia and the Marshall Islands in 2011, notifications were lower in 2012. However, Fiji and Niue experienced a high number of dengue notifications, and there was an increase in notifications observed in New Caledonia that was the beginning of the largest outbreak ever reported in the territory.[10] Although dengue-specific surveillance is not conducted in Papua New Guinea, circulation of the virus there is well recognized from epidemiologic and phylogenetic analyses of imported cases in Australia and elsewhere.[11]

The notable changes in notification rates and shifts in serotype distribution since 2011 highlight once again the need for ongoing surveillance, information-sharing and assessment. Timely notification at the local level acts as a trigger for early response, such as vector control and outbreak investigations to interrupt transmission locally. At a country or regional level, routine and timely information-sharing enhances situational awareness and feeds into risk assessment and preparedness activities such as risk communication for neighbouring countries or those with close trade/travel links (e.g. dengue has been introduced from Asia to isolated Pacific islands[12]).

Importantly, since routine biweekly reporting of the regional dengue situation started in 2010, information has been regularly shared through wider public health surveillance networks such as ProMED[13] and translated for local use by Member States to raise awareness for travellers' health.[14] Regional information-sharing activities to promote early response are in line with the WHO Asia Pacific Strategy for Emerging Diseases framework to strengthen national and regional capacities for surveillance and response.

As for previous regional analyses of dengue,[1,2] there are important limitations in the surveillance data, both for interpreting the actual burden of dengue (e.g. underreporting) and trends over time (e.g. changes in disease awareness, diagnosis/testing/reporting behaviour). For example, in Malaysia, NS1 antigen positive specimens were added as an approved laboratory testing method for surveillance, and regardless of clinical manifestation, patients with laboratory confirmation were included as cases in 2012. In the Philippines, the 2009 dengue classification system continued to be rolled out to replace the clinical case definition that was still in much use during 2011. Comparisons across countries also require caution, as Australia and Singapore report laboratory-confirmed cases only, while Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines and Viet Nam primarily clinically suspected cases; such practices may lead to under- or over-reporting. Importantly, case fatality rates are affected not only by clinical management but also by health-care-seeking behaviour, reporting practices of clinicians, case definitions, timing of report, follow-up and verification procedures; these factors can also differ across Member States and over time. Sampling schemes for laboratory confirmation also differ across Member States and may not be systematic or representative, potentially limiting the interpretability of the reported serotype distribution. Lastly, the 2009 dengue case classification scheme became incorporated by many Member States with dengue surveillance systems during 2011 and 2012, affecting comparability with previous years.

While acknowledging these limitations, there will continue to be a need for region-wide sharing of dengue data on a routine and timely basis. Direct comparisons of notification rates and case fatality rates between countries should be avoided; within countries, however, historic and consistent seasonal trends have been observed along with potentially important changes such as serotype distribution. Such surveillance data can also be used for mathematical models[6] and to provide baseline dengue surveillance data when a dengue vaccine enters the market. Lastly, in this rapidly developing and interconnected region, the ever-increasing importation of cases into non-endemic areas signifies the importance of monitoring and sharing dengue information by all countries.[15]

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

The authors would like to thank all the WHO country fffice staff and Member States in the Western Pacific Region for assisting with the surveillance data collection and reporting.

References:

1. Arima Y, Matsui T. Epidemiologic update of dengue in the Western Pacific Region, 2010. *Western Pacific Surveillance and Response Journal*, 2011, 2(2):4–8. doi:10.5365/wpsar.2011.2.2.005 pmid:23908882
2. Arima Y et al. Epidemiologic update on the dengue situation in the Western Pacific Region, 2011. *Western Pacific Surveillance and Response Journal*, 2013, 4(2):47–54. doi:10.5365/wpsar.2012.3.4.019 pmid:24015372
3. Shepard DS, Undurraga EA, Halasa YA. Economic and disease burden of dengue in Southeast Asia. *PLoS Neglected Tropical Diseases*, 2013, 7:e2055. doi:10.1371/journal.pntd.0002055 pmid:23437406
4. Vong S et al. Under-recognition and reporting of dengue in Cambodia: a capture-recapture analysis of the National Dengue Surveillance System. *Epidemiology and Infection*, 2012, 140:491–499. doi:10.1017/S0950268811001191 pmid:21733251
5. Duong V et al. Complex dynamic of dengue virus serotypes 2 and 3 in Cambodia following series of climate disasters. *Infection, Genetics and Evolution*, 2013, 15:77–86. doi:10.1016/j.meegid.2012.05.012 pmid:22677620
6. Reich NG et al. Interactions between serotypes of dengue highlight epidemiological impact of cross-immunity. *Journal of the Royal Society, Interface*, 2013, 10:20130414. doi:10.1098/rsif.2013.0414 pmid:23825116
7. Anker M, Arima Y. Male-female differences in the number of reported incident dengue fever cases in six Asian countries. *Western Pacific Surveillance and Response Journal*, 2011, 2(2):17–23. doi:10.5365/wpsar.2011.2.1.002 pmid:23908884
8. Prasith N et al. Assessment of gender distribution in dengue surveillance data, the Lao People's Democratic Republic. *Western Pacific Surveillance and Response Journal*, 2013, 4(2):17–24. doi:10.5365/wpsar.2012.3.4.020 pmid:24015367

9. Undurraga EA, Halasa YA, Shepard DS. Use of expansion factors to estimate the burden of dengue in Southeast Asia: a systematic analysis. *PLoS Neglected Tropical Diseases*, 2013, 7:e2056. doi: 10.1371/journal.pntd.0002056 pmid:23437407

10. Dupont-Rouzeyrol M et al. Epidemiological and molecular features of dengue virus type-1 in New Caledonia, South Pacific, 2001–2013. *Virology Journal*, 2014, 11:61. doi:10.1186/1743-422X-11-61 pmid:24684835

11. Warrilow D, Northill JA, Pyke AT. Sources of dengue viruses imported into Queensland, Australia, 2002–2010. *Emerging Infectious Diseases*, 2012, 18:1850–1857. doi:10.3201/eid1811.120014 pmid:23092682

12. Wilder-Smith A, Gubler DJ. Geographic expansion of dengue: the impact of international travel. *The Medical Clinics of North America*, 2008, 92:1377–1390, x. doi:10.1016/j.mcna.2008.07.002 pmid:19061757

13. ProMED. Published Date: 2012–09–17 16:43:48. *Subject: PRO/EDR> Dengue/DHF update 2012 (43): Asia Archive Number: 20120917.1297396* (http://www.promedmail.org/direct.php?id=20120917.1297396, accessed 26 February 2015).

14. *Quarantine Information - dengue situation updates – Asia* [in Japanese]. Tokyo, Office Ministry of Health, Labour and Welfare Japan, 2014.

15. Nakamura N et al. Incidence of dengue virus infection among Japanese travellers, 2006 to 2010. *Western Pacific Surveillance and Response Journal*, 2012, 3(2):39–45. doi: 10.5365/wpsar.2011.2.3.002 pmid:23908911

Chelonitoxism outbreak: Sorsogon, Philippines, October 2014

Imelda Deveraturda,[ab] Ray Justin Ventura,[ab] Vikki Carr de los Reyes,[b] Ma Nemia Sucaldito,[b] Michael O'Reilly[c] and Enrique Tayag[b]

Correspondence to Imelda Deveraturda (email: deveraturdamel@gmail.com).

Recently, a chelonitoxism (turtle poisoning) outbreak in Arteche, Eastern Samar, Philippines was featured by the *Western Pacific Surveillance and Response Journal* (WPSAR) describing the dangers of turtle meat consumption.[1] As highlighted by the authors, 68 cases were identified with a 6% case fatality ratio (CFR). Also, the results revealed that there was a dose-dependent relationship between turtle meat or soup consumption and risk of illness.

We investigated another episode of a chelonitoxism outbreak in the village of Liang, Irosin, Sorsogon, Philippines in October 2014. A clinical chelonitoxism case was defined as a well individual who developed epigastric pain, nausea, vomiting or diarrhoea[2] in the village of Liang, Irosin, Sorsogon from 8 to 10 October 2014. We reviewed medical records of all clinically defined cases at the Irosin district hospital, and we interviewed the clinically defined cases using a standard questionnaire developed by our field investigators. Questions included demographic profile and history of food intake with emphasis on the food intake time. Data were stratified by age, familial unit, food items and incubation period for analysis using Microsoft Excel.

A total of six clinically defined chelonitoxism cases were identified among 33 people who ingested turtle meat (attack rate = 18%). Age of the six cases ranged from 1 to 48 years (median = 19 years). Three out of six (50%) were children aged between 1 and 5 years, four (66%) were male, and five out of six (83%) cases came from the same household. All cases had ingested turtle meat within two days of symptom onset. The most common symptoms were epigastric pain (83%), vomiting (83%) and dizziness (67%). The incubation period ranged between 1 and 45 hours (median = 4 hours). Four (66%) cases developed symptoms within 5 hours of consuming turtle meat/soup while two (33%) cases developed symptoms between 44 and 45 hours after exposure. The CFR was 50% (**Figure 1**). All human deaths occurred in one household. Three out of three (100%) paediatric cases (age < 5 years) died, while all three adult cases survived. Meanwhile, one household reported that two pet dogs died after eating the vomitus of one of the household members who later died.

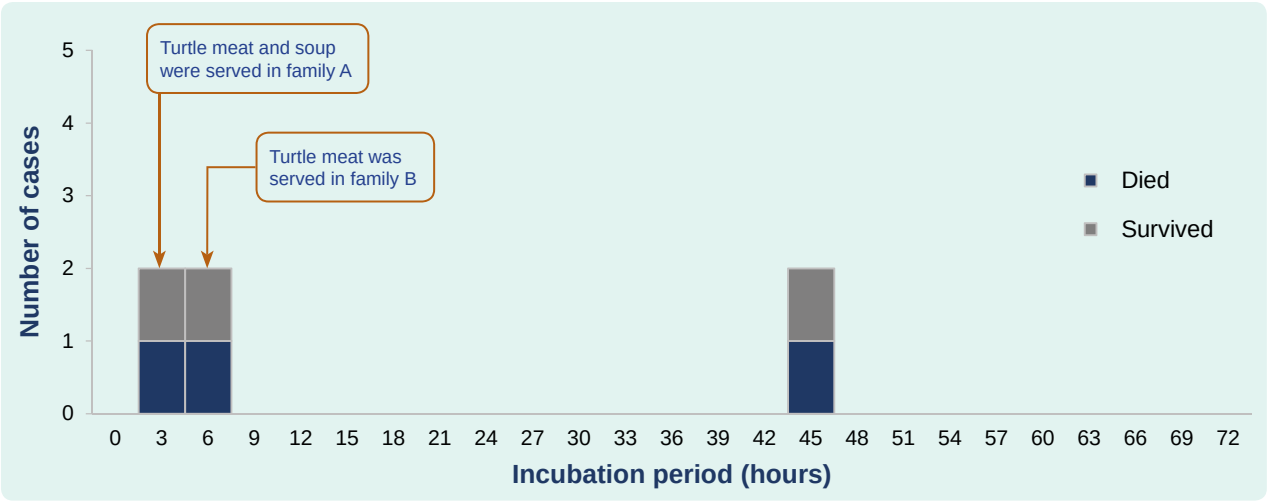
According to the investigation results, we did not find any association between dose of turtle meat ingested and probability of survival. Two rectal swab specimens were collected from two available cases for bacteriologic culture and no enteropathogenic isolates were yielded. Unfortunately, as with many turtle meat poisoning outbreaks in south-eastern Asia,[3] we were not able to confirm chelonitoxism directly via laboratory confirmation of toxins due to insufficient laboratory capacity.

Based on the results, we characterized this outbreak to be: (1) familial clustering; (2) bimodal distribution of incubation period; and (3) mortality restricted to children. As clinical case definitions for chelonitoxism are nonspecific, we recommend building referral mechanisms to existing laboratories doing chelonitoxism outbreak confirmation. Stricter enforcement of existing laws against hunting and sea turtle consumption could limit the morbidity and mortality of chelonitoxism in the Philippines and other countries with turtles as a common food source.[4]

[a] Field Epidemiology Training Program, Epidemiology Bureau, Department of Health, San Lazaro Compound, Sta Cruz, Manila, Philippines.
[b] Department of Health, San Lazaro Compound, Sta Cruz, Manila, Philippines.
[c] Emerging Disease Surveillance and Response Unit, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

Submitted: 30 March 2015; Published: 11 June 2015
doi: 10.5365/wpsar.2015.6.1.021

Figure 1. **Case distribution after consuming turtle meat or soup, Sorsogon, Philippines, 8 to 10 October 2014 (*n* = 6)**



Conflicts of interest

None declared.

Funding

None.

References

1. Ventura RJ et al. Chelonitoxism outbreak caused from consuming turtle, Eastern Samar, Philippines, August 2013. *Western Pacific Surveillance and Response Journal*, 2015, 6(2):12–16. doi: 10.5365/wpsar.2015.6.1.003
2. *Chelonitoxism – clinical signs* [Internet]. Tokyo, MedQA-jp , 2010.
3. Pavlin BI et al. Mass poisoning after consumption of a hawksbill turtle, Federated States of Micronesia, 2010. *Western Pacific Surveillance and Response Journal*, 2015, 6(1):25–32. doi:10.5365/wpsar.2014.5.3.006 pmid:26045970
4. *Republic Act No. 9147: Wildlife resources conservation and protection act*. Quezon City, Eleventh Congress of the Philippines, 2001 (http://www.lawphil.net/statutes/repacts/ra2001/ra_9147_2001.html, accessed 8 May 2015).

Short report: 2014 Pacific meeting on implementation of the International Health Regulations (2005)

Adam T Craig,[a] Eric Rafai,[bf] Marcus Samo,[cf] Aaron Oritaimae,[df] Losii Samse[eg] and Eric J Nilles[a]
Correspondence to Eric J Nilles (email: nillese@wpro.who.int).

From 24 to 26 November 2014, 44 delegates representing 20 of the 22 Pacific island countries and areas, programme directors and technical experts from the World Health Organization (WHO) Regional Office for the Western Pacific and development partners met in the tranquil setting of Denarau Island, Fiji to attend the third biannual *Pacific Meeting on Implementation of the International Health Regulations (2005)*.

The Pacific region covers one third of the earth and is home to approximately 11.4 million people (excluding Australia and New Zealand).[1] Pacific populations are dispersed over many thousands of islands and atolls that make up the region's 22 countries and areas. Fourteen Pacific island countries are states parties to the International Health Regulations (IHR 2005),[2] and seven are territories for which IHR (2005) responsibilities are delegated to other countries.

As the title indicates, the meeting's purpose was to discuss progress in meeting the global public health security objectives of IHR (2005) in the Pacific, and to explore avenues to strengthen infectious disease (and other public health emergency) surveillance and response capacities required to achieve IHR (2005) compliance.

The meeting's programme was ambitious, aiming to provide delegates with an update on global public health infectious disease emergencies; to review the progress of Pacific islands' core capacity-building activities under the IHR (2005); to review the Pacific Syndromic Surveillance System (PSSS) to identify its strengths and limitations; to explore the role of Pacific Public Health Surveillance Network in supporting IHR (2005) implementation; and to recommend common IHR (2005) capacity-building priorities that focus over the 2014–2016 period. Due to global concern about the Ebola virus disease (EVD) epidemic in West Africa at the time of the meeting, specific discussion about EVD preparedness was also included. Finally, the meeting was an opportunity to undertake preliminary consultation with delegates about the future direction of the Asia Pacific Strategy for Emerging Diseases (APSED)[3] and the roadmap for IHR (2005) implementation in the Western Pacific.

The first day of the meeting focused on global and Pacific emerging and re-emerging infectious diseases. The discussion centred on the EVD situation in West Africa and the risk posed to populations in the Pacific. WHO reiterated that the risk of EVD importation to the Pacific was low, however emphasized that the impact, if imported, would potentially be devastating and hence pre-emptive preparedness was encouraged.[4] Further, discussion about the emergence of Zika and chikungunya viruses, and the re-emergence of dengue virus in the Pacific islands in recent years was held.[5] Pacific island countries and areas were advised to prepare for ongoing transmission of all three arboviruses over the coming two to five years. The afternoon of day one was spent for reviewing the PSSS, the premier early warning surveillance system for infectious disease outbreaks used by countries and areas in the Pacific. The PSSS is performing well and meeting IHR (2005) obligations for indicator-based early warning surveillance; however, it was noted that the event-based surveillance component

[a] World Health Organization, Division of Pacific Technical Support, Suva, Fiji.
[b] Fiji Ministry of Health, Suva, Fiji.
[c] Department of Health, Education and Social Affairs, Pohnpei, Federal States of Micronesia.
[d] Ministry of Health and Medical Services, Honiara, Solomon Islands.
[e] Ministry of Health, Ngerulmud, Palau.
[f] Meeting Chairperson.
[g] Meeting Rapporteur.

of the system needs to be formalized and strengthened to ensure rapid identification of events that cannot be captured by the system's indicator component. While increasing the number of PSSS reporting sites (to increase system coverage and function) was a topic of discussion, it was noted that given the resource limitations in most Pacific islands, redistribution of human, material and financial resources for additional surveillance activities may affect other health programmes and therefore needs to be rationalized and justified.

The second day of the meeting focused on enhancing Pacific islands' EVD preparedness plans. Delegates discussed key issues related to Ebola virus epidemiology with WHO staff recently returned from West Africa. Time was allocated for peer discussion to refine national EVD preparedness plans. The day concluded with a simulation exercise that reinforced the importance of national preparedness for major public health events, both for known and unknown nature.

The third day of the meeting focused on future priorities for IHR (2005) core capacity-building in the Pacific. Delegates identified infectious disease surveillance and response; public health workforce development; and public health preparedness at international points of entry as the core capacity areas on which to focus in the period of 2014 to 2016. The meeting continued with a consultation on future directions of APSED and determination of its usefulness in the Pacific. Delegates expressed strong support and appreciation of APSED in endorsing the strategy as the leading framework for infectious disease and IHR (2005) public health core capacity-building.

As a key outcome of the meeting, Pacific island countries and development partners agreed to support the three priority IHR (2005) core capacity-building areas mentioned above; to work collaboratively for strengthening the PSSS, including enhancement of the event-based surveillance component of the system; and to continue to develop, test and refine national public health emergency preparedness and response plans.

Pacific islander delegates and partners articulated the value of IHR (2005) and APSED as a clear and logical framework within which national public health core capacity-building is, and will continue to be, developed in the Pacific islands. Other outcomes of the meeting are recorded in the meeting report available at http://www.wpro.who.int/emerging_diseases/meetings/docs/report_pacificmeetingonihr_nov2014.pdf?ua=1.

References:

1. Secretariat of the Pacific Community. Pacific Island Populations – Estimate and projections of demographic indicators for selected years. In: *Community SotP*, editor. September 2013 ed. Noumea, Secretariat of the Pacific Community, 2013.
2. *International Health Regulations (2005) Second edition*. Geneva, World Health Organization, 2008 (http://www.who.int/ihr/9789241596664/en/, accessed 12 May 2015).
3. *Asia Pacific Strategy for Emerging Diseases: 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 12 May 2015).
4. Craig AT et al. Risk posed by the Ebola epidemic to the Pacific islands: findings of a recent World Health Organization assessment. *Western Pacific Surveillance and Response Journal*, 2015, 6(2).
5. Roth A et al. Concurrent outbreaks of dengue, chikungunya and Zika virus infections – an unprecedented epidemic wave of mosquito-borne viruses in the Pacific 2012–2014. *Euro Surveillance: European Communicable Disease Bulletin*, 2014, 19. pmid:25345518

World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

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