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Epidemic hysteria following the National School Deworming Day, Zamboanga Peninsula, Philippines, 2015

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Introduction: In July 2015, the Philippines conducted a school-based mass drug administration using albendazole for soil-transmitted helminths infection. Reports of adverse events were subsequently made through the event-based surveillance system, mostly from the Zamboanga Peninsula on the island of Mindanao. A team from the Epidemiology Bureau investigated the reports of adverse events following mass drug administration (AEFMDA).

Methods: Five schools were identified for the investigation which comprised an unmatched case-control study, key informant interviews and laboratory examinations. AEFMDA cases were students who had sudden onset of abdominal pain, vomiting, diarrhoea, loss of consciousness, headache or dizziness within 24 hours after intake of deworming tablet; controls were healthy students who did not develop signs and symptoms after deworming.

Results: Most (85%) of the 7313 AEFMDA cases reported nationwide were from Zamboanga Peninsula. Most reports were made after rumours of deaths following deworming and of the use of expired drug were spread through the region. Many parents sent their children to hospital, even if asymptomatic. The case-control study found that being an AEFMDA case was associated with no history of previous deworming (odds ratio = 4.08, 95% confidence interval: 1.77–9.42).

Discussion: The investigation concluded that epidemic hysteria was the cause of the increased number of AEFMDA cases in the Zamboanga Peninsula. The false information, aggravated by social media, caused panic and an increase in reporting. Some cases had no history of deworming, and they may not have been aware that albendazole is safe and that side-effects are expected. Risk communication before, during and after future national deworming programmes are recommended to prevent unnecessary reporting of AEFMDA.

Over 2 billion people suffer from soil-transmitted helminths worldwide.[1] In the Philippines, soil-transmitted helminths affect all provinces.[2] Before the implementation of the National School Deworming Day (NSDD) in 2015, month-long nationwide deworming programmes were administered to preschool-age children (1–4 years old) in the community by City and Rural Health Units, while school-age students (5–18 years old) were dewormed by the Department of Education in public elementary and secondary schools.[2,3] The prevalence of soil-transmitted helminths has decreased from 66% among children aged 1–5 years old and 65% among children aged 6–14 years old in 2003 to 28.4% in school-aged children in 2013–2015.[4,5]

Mass deworming programmes in school-age children are recommended by the World Health Organization (WHO).[1,6] The Philippines Department of Health, in partnership with the Department of Education, conducted the first NSDD on 29 July 2015.[3] The NSDD aimed to deworm approximately 16 million school-age children enrolled in all public elementary schools in one day to reduce the burden of soil-transmitted helminths infections. It was anticipated that the NSDD strategy would have a major impact on the Integrated Helminth Control Program accomplishments, and pilot projects in Regions 6 and 11 showed that a one-day deworming programme is feasible and improves the efficiency of service delivery among the target population.[7]

On the day of the NSDD, cases of adverse events following mass drug administration (AEFMDA) were reported to the national event-based surveillance system from schools, health centres and hospitals. Most reports were from the Zamboanga Peninsula in Region 9 on the island of Mindanao. Therefore, a team from the Epidemiology Bureau of the Department of Health was sent to Zamboanga Peninsula to investigate the reports of AEFMDA.

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METHODS

Case finding

The Zamboanga Peninsula region had the highest number of reports of AEFMDA in the event-based surveillance system and was therefore selected for the investigation. Due to insurgency and armed conflict in some areas of the region, five schools that had reported cases and were identified as being safe by the Zamboanga Peninsula Regional Epidemiology Surveillance Unit were selected for the investigation.

Case-control study

A 1:2 unmatched case-control study was conducted in the five schools. A standard questionnaire with closed- and open-ended questions was used to identify sociodemographic risk factors and exposure history. An AEFMDA case was any student from the selected schools on the Zamboanga Peninsula who reported abdominal pain, vomiting, diarrhoea, loss of consciousness, headache or dizziness within 24 hours after intake of deworming tablet on 29 July 2015. A control was any healthy student from the same schools who did not develop any signs and symptoms after receiving the deworming tablet on 29 July 2015. Only those students whose parents and teachers consented to the interview were included in the study.

Cases were classified based on WHO guidelines for degree of severity.[8,9] Odds ratios (OR), 95% confidence intervals (CI) and *P*-values were calculated using Epi Info version 3.5.4. Risk factors approaching significance ($P < 0.2$) in bivariate analysis were included in a multivariable logistic regression using the backward elimination procedure. Significant level of $\alpha = 0.05$ and two-tailed *p*-value of the test was used.

Key informant interviews

Semi-structured interviews were conducted in person with Zamboanga Peninsula health and school personnel who were involved in the conduct of the NSDD. Information about activities before, during and after the NSDD were elicited.

Laboratory examination

Rectal swabs were collected from cases and sent to the Research Institute for Tropical Medicine for bacteriological culture for *Salmonella, Shigella, Vibrio* and *Staphylococcus* species.

Albendazole samples of the same batch and lot number as the deworming tablets used during the NSDD were collected from schools and health centres and sent to the Food and Drug Administration for testing for the active component.

RESULTS

Of the almost 12 million children administered deworming tablets during the NSDD, there were 7330 AEFMDA cases reported to the event-based surveillance system (0.06%). Most of these (6236/7330, 85%) were from the Zamboanga Peninsula, giving an incidence proportion of 1.28% (6236/486 490).

Case-control study

There were 77 cases of AEFMDA identified at the five selected schools included in the case-control study. Their ages ranged from 6 to 16 years (median = 10 years) and 39 (51%) were males. The most affected age group was the 10–14-year-olds. There were 154 controls identified, with the same age and sex distribution as cases (**Table 1**).

Signs and symptoms of the 77 AEFMDA cases included abdominal pain (95%), headache (47%) and vomiting (34%). Thirty-nine (51%) cases were hospitalized, and there were no deaths reported. There were 11 cases (14%) classified as severe, 20 (26%) as moderate and 46 (60%) as mild. The onset of symptoms ranged from less than 1 to 13 hours after deworming (median = 4 hours). The nutritional status of most cases was normal (91%). Respondents were asked if they had washed their hands before the deworming activity, and 45 (58%) cases reported handwashing. Sixty-five (84%) reported taking the tablet with food, and 17 (22%) had no previous history of deworming.

In the case-control analysis, having no history of previous deworming was associated with being

Table 1. **Factors associated with reporting adverse events following the National School Deworming Day, Zamboanga Peninsula, the Philippines, July 2015**

Variables	Case (*n* = 77)	Control (*n* = 154)	*P*-value	Crude OR (95% CI)	Adjusted OR* (95% CI)
Female	38	76	1.00	1.00 (0.58–1.73)	
0–10 years old	47	98	0.70	0.90 (0.51–1.57)	
Undernourished	5	7	0.37	1.46 (0.45–4.75)	
Administered by health-care worker	26	67	0.15	0.66 (0.37–1.17)	0.69 (0.37–1.28)
Reported handwashing before deworming	45	110	0.048	0.56 (0.32–0.997)	0.58 (0.32–1.06)
Received deworming tablet still In blister pack	29	57	0.92	1.03 (0.58–1.81)	
Deworming tablet taken with food	65	141	0.099	0.50 (0.22–1.15)	0.52 (0.21–1.28)
No previous history of deworming	17	10	<0.01	4.08 (1.77–9.42)	4.08 (1.77–9.42)
History of previous adverse event after deworming	0	2	0.44	0.00 (undefined)	
Has allergy	1	1	0.56	2.01 (0.12–32.63)	

95% CI = 95% confidence interval; OR = odds ratio

an AEFMDA case (OR = 4.08, 95% CI: 1.77–9.42), whereas the reporting of handwashing was inversely associated with being an AEFMDA case (OR = 0.56, 95% CI: 0.32–0.997). In the multivariable analysis, no history of deworming was the only risk factor associated with being an AEFMDA case (OR = 4.08, 95% CI: 1.77–9.42) (**Table 1**).

Key informant interviews

A total of 15 personnel were interviewed (five from the health department and 10 from schools). There was no remarkable incidents recorded during the deworming administration other than the chronology of events. The interviewees suggested that there was insufficient orientation in schools and for parents before the NSDD and that parents believed that their children were harmed due to the deworming.

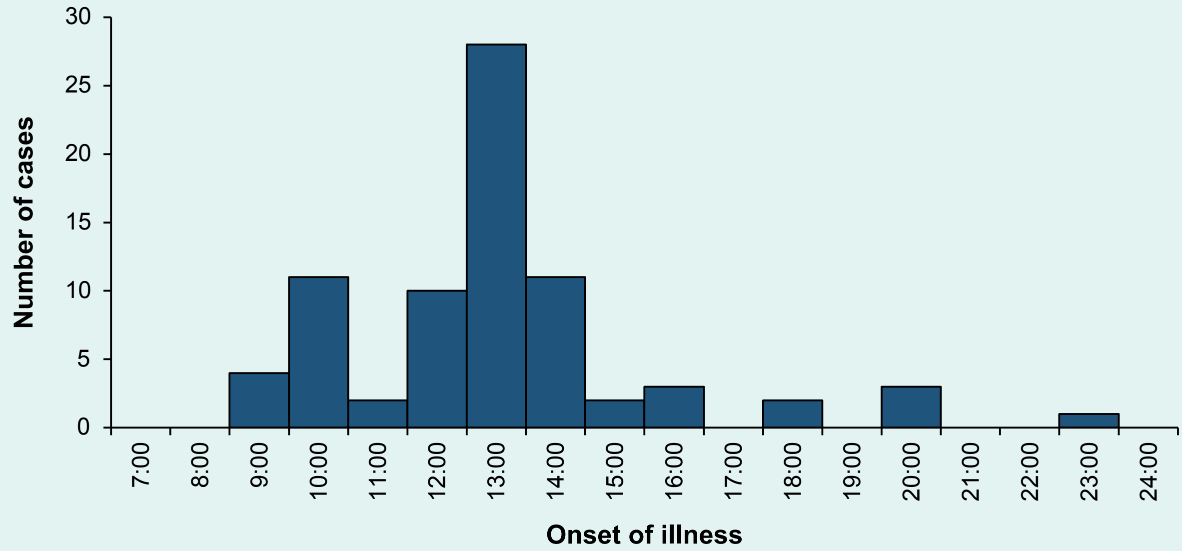
Schools that administered the deworming tablets before 10:00 experienced no problems. It wasn't until a text message circulated that reported that several students in the region had died due to the deworming activity that the reports of AEFMDA started. Pictures of expired albendazole tablets claimed to have been used during the NSDD were also circulated through social media. It was thought that these rumours resulted in panic at the schools and in the community as parents rushed to the schools and insisted their children be sent to hospital, even those children without symptoms.

It was also reported that when some children began to report abdominal pain and headache, other children within the same classrooms began to report the same symptoms. In some villages, the village head also announced that all children who received the deworming tablet should go to the hospital. Directly after this, there was a large increase in cases (**Fig. 1**).

Laboratory examination

Bacteriological culture of rectal swabs collected from 14 cases revealed one (7%) positive for *Vibrio mimicus,* with the remainder negative for all pathogens. All 24 albendazole samples conformed to the drug standard of active component.

Fig. 1. **Epidemic curve of cases that reported adverse events following the National School Deworming Day, Zamboanga Peninsula, the Philippines, July 2015 (*n* = 77)**



DISCUSSION

We concluded from this investigation that the AEFMDA cases reported in the Zamboanga Peninsula region after the NSDD were primarily due to epidemic hysteria. The high proportion of total AEFMDA cases reported from this region, coupled with the misinformation spread in the community, contributed to the increase of reported cases. The deworming tablets used conformed to drug standards, were used throughout the country and were therefore unlikely to have caused the high number of reported side-effects.

Epidemic hysteria has been defined as a group of symptoms suggestive of organic illness but without identifiable cause.[10] Schools are the most common setting for epidemic hysteria outbreak with triggering factors including events and rumours.[11] In this investigation, several triggers were identified, including the spread of a text message across the entire region during the NSDD that claimed there were children who died following the intake of the deworming tablet and the circulation of false reports in social media that the deworming tablets used by the Department of Health for the NSDD were expired; both falsehoods were aggravated by media coverage. That insufficient orientation was provided to the schools and parents about the expected side-effects of the deworming tablets also contributed to the increase in reported cases. Epidemics of mass hysteria attract media attention, which usually results in an escalation of such outbreaks.[12]

Having no history of previous deworming was significantly associated with AEFMDA cases. The children who had not been dewormed previously and their parents were perhaps less likely to know that taking albendazole is safe and that mild side-effects are expected as they had no experience with the drug. Side-effects occur as the worms pass through a child's body; mild and moderate adverse reactions are more common after the first dose as children dewormed for the first time are most likely to be heavily infected.[6,13]

Heavily infected children may experience mild side-effects following deworming, and their reports may trigger other school children to claim similar symptoms even when they are asymptomatic.[6] Mass hysteria following a health intervention has also been reported in schools of Islamic Republic of Iran, Italy, Canada, Jordan and China following vaccinations.[14] In 2007, epidemic hysteria occurred in Ghana during a mass elimination campaign of helminths where trained teachers administered mebendazole tablet to nearly 4.5 million children in public schools. Similar to this study, a few hours later, there was news on local radio of deaths due to the programme, which resulted in a wave of unrest and mass hysteria. Such incidents highlight the need for active pharmacovigilance, excellent risk communication and planning of crisis management.[15]

During this incident, the Department of Health and Department of Education used risk communication to appease the public. Community assemblies were held and national press releases explaining the NSDD, the potential side-effects of albendazole and the health importance of the programme were disseminated. The public were informed that the medications used during the NSDD were not expired, there had been no deaths related to the deworming tablet and that side-effects are expected, especially in heavily infected children. Risk communication efforts conducted following adverse events after health interventions in Bangladesh, Pakistan, India and Afghanistan have shown to be effective in regaining public trust.[16] In March 2016, guidelines on the implementation of the NSDD were amended.[17] All school-age children shall be dewormed in one month through the National School Deworming Month.

There are some limitations to this investigation. Psychological testing and assessment of general cognitive abilities of children were not conducted, which may have strengthened the diagnosis of mass hysteria. Another limitation was the unavailability of parasitological data, which may have shown the relationship between reported adverse events and severity of infection. The insurgency and armed conflict in some parts of the region limited the availability of schools to participate in the case-control study, and the small number of respondents may not be generalizable to the whole population of the region. *Vibrio mimicus* was isolated from one case but is unlikely the cause of this event since its incubation period (15-24 hours)[18] was not consistent with the event.

Although the reported AEFMDA was low during this deworming programme compared to other studies, the negative impact of the mass hysteria from false reporting may affect the future implementation of the national deworming programme. School and community education efforts that focus on providing a greater understanding of adverse reactions may prevent this and help to achieve the goal of the NSDD. Risk communication before, during and after NSDD in the future is highly recommended.

Conflict of interest

None.

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A retrospective cohort study on cassava food poisoning, Santa Cruz, Davao del Sur, Philippines, October 2015

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Objective: On 2 October 2015, the Event-Based Surveillance and Response Unit of the Department of Health (DOH), Philippines received a report of foodborne illness cases in Santa Cruz, Davao del Sur. A team from DOH was sent to conduct an investigation to identify the implicated source and determine risk factors.

Methods: A retrospective cohort study was done. A suspect case was defined as a previously well individual in Compound A, Santa Cruz who developed abdominal pain, headache, dizziness, diarrhoea or vomiting on either 1 or 2 October 2015. A confirmed case was a suspect case positive for cyanide in urine. Family members who prepared the food were interviewed. Urine specimens were collected to test for thiocyanate, and cassava tuber and soil samples were tested for cyanide and other chemicals.

Result: Fourteen cases with two deaths were identified (case fatality ratio: 14%). All cases consumed cassava on 1 October 2015 except for one child who spat it out. Urine samples were all negative (36, 100%) for thiocyanate so there were no confirmed cases. The cassava sample had a cyanide level of 68.94 ug/g and was identified as bitter cassava, also known as a potentially dangerous kind. Insufficient food preparation was noted. In the retrospective cohort study, intake of cassava (RR = 208, 95% CI: 19.94–2169.32) was associated with the illness.

Discussion: This study identified insufficiently processed cassava root crop as the source of the foodborne illness. The cassava consumed was the bitter variety that contains greater than 50 ug/g of hydrogen cyanide and requires thorough preparation before consumption. Community education was provided on identifying and preparing cassava appropriately.

Cassava is the third most important source of calories in the tropics.[1] Millions of people depend on cassava in Africa, Latin America and Asia both for food security and income generation.[2] In the Philippines, cassava is advocated as an alternative staple to rice under the Department of Agriculture – Food Staple Self-Sufficiency Program.[3]

However, several cases of acute poisoning, some leading to death, following consumption of a cassava-based meal have been reported.[4–7] Common symptoms include dizziness, nausea, headache, abdominal pain and diarrhoea.[8] This is due to the toxic chemical linamarin which occurs in varying amounts in all parts of the cassava plant. Ingested linamarin can release cyanide in the gut during digestion, causing illness and sometimes death.[9]

Cassava is generally classified into two main types: sweet cassava and bitter cassava. Cassava roots with less than 50 ug/g hydrogen cyanide on fresh weight basis are considered sweet; above this level, cassava roots are considered bitter.[10] Sweet cassava roots can be made safe to eat by peeling and thoroughly cooking. For bitter cassava, one traditional way to effectively reduce its cyanide content is by peeling the root crop followed by grating, prolonged soaking (18–24 hours), squeezing and thorough cooking.[11]

On 2 October 2015, the Davao Department of Health (DOH) Regional Office, reported to the Event-Based Surveillance and Response Unit of DOH several foodborne illness cases in Santa Cruz, Davao del Sur. Santa Cruz is a municipality located in Davao Region, which is part of the Mindanao group of islands. The municipality is situated about 988 km south-east of the Philippine capital Manila.

A team from DOH was sent to conduct an investigation to identify the implicated source and determine risk factors.

[a] Department of Health, Philippines.
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METHODS

Epidemiological investigations

A suspect case was defined as a previously well individual in Compound A, a residential area shared by seven families in Santa Cruz, who developed abdominal pain, headache, dizziness, diarrhoea or vomiting on either 1 or 2 October 2015. A confirmed case was defined as a suspect case positive for cyanide in the urine. Case finding was done by reviewing medical records in Cereville Medical Clinic, Davao del Sur Provincial Hospital and Southern Philippines Medical Center.

A retrospective cohort study was done in Compound A. All residents were interviewed using a standard questionnaire comprising questions on demographics, symptoms, hygiene practices and 24-hour food recall. A parent was interviewed for the two fatal cases, and children were interviewed along with their parents for all other cases. We calculated relative risks (RR), 95% confidence intervals (CI) and *p* values using Epi Info 3.5.4. Risk factors approaching significance ($P < 0.2$) in bivariate analysis were retained for multivariable logistic regression using a forward stepwise procedure.

Laboratory examination

Twenty-eight blood specimens (from nine ill and 19 not ill people) were collected to measure sulfhaemoglobin and methaemoglobin levels to determine exposure to oxidizing drugs or toxins. Thirty-six urine samples (from 10 ill and 26 not ill people) were collected for thiocyanate testing to identify the presence of cassava derivatives.[12]

Cassava tuber from the same cassava plant consumed by the families and soil samples from where it was planted were collected to test for cyanide and pesticides. A cyanide level of more than 50 ug/g would classify the cassava as bitter type.[10] All samples were collected on 6 October 2015. Blood specimens were sent to East Avenue Medical Center, Quezon City. Urine, cassava and soil samples were analysed at Chempro Analytical Services Laboratories Inc., Pasig City.

Environmental investigation

A site visit was conducted in Compound A to identify the circumstances surrounding the event. We interviewed family members who cooked the cassava crop about its source and preparation. We also inspected the source-farm where the raw cassava was harvested. Information on the variety of cassava was elicited from the municipal agriculturist. We asked the farmer about pesticides and other chemicals used in growing cassava.

RESULTS

Cases

Fourteen cases were identified. The incubation period ranged from one hour to 12 hours (median = 3.25 hours). The earliest onset of illness was at 17:00, one hour after intake of the cassava; this was the peak of the epidemic curve (**Fig. 1**). The last case was a 1-year-old child who was fed by her mother with two spoonfuls of cassava, which the child spat out. Most of the cases had abdominal pain (13/14, 93%) followed by diarrhoea (4/14, 29%), headache (3/14, 21%), dizziness (3/14, 21%) and vomiting (3/14, 21%). Thirteen cases sought medical care, but three refused hospital admission. Two cases were referred for further management but died before they were transported to another facility (case fatality ratio = 14%).

Cases ranged in age from 1 to 28 years (median = 11 years); seven (50%) were males. The most affected age group was 0–4 years old. All cases were from two families in Compound A. All of them ate cassava before the onset of illness except for one child who spat it out.

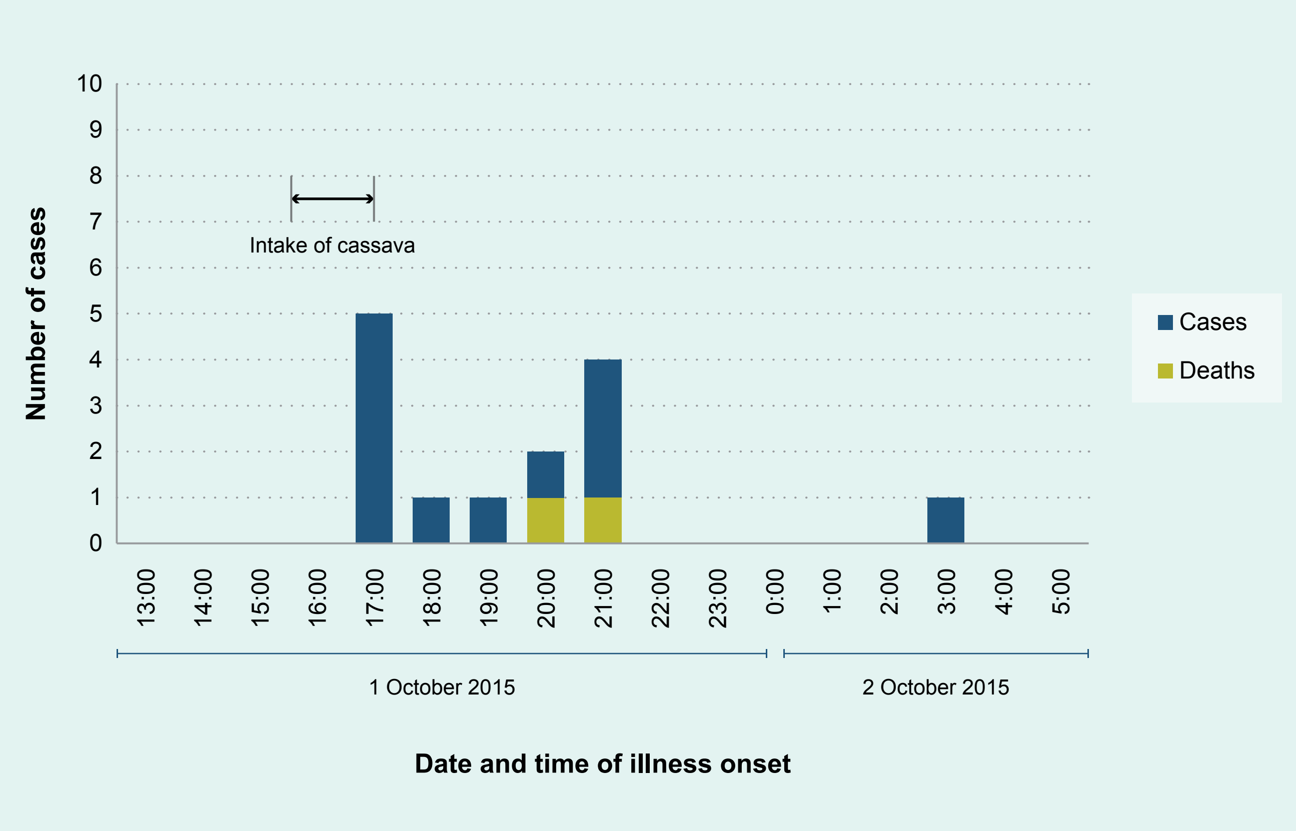
Profile of deaths

Ages of the two fatalities were 4 and 2 years. Both were males from the same household. The older child died three hours after manifesting symptoms. The other child was pronounced dead five hours after onset of illness. Both had consumed four slices of boiled cassava.

Retrospective cohort study

All (65, 100%) residents of Compound A were interviewed. Seventeen (25%) ate boiled cassava. On bivariate analysis, we found that age 0–5 years (RR = 4.91, 95% CI: 2.16–11.18) and intake of cassava (RR = 39.81, 95% CI: 5.64–280.99) were associated with the illness. Handwashing before eating (RR = 0.24, 95% CI: 0.11–0.52) was found to be inversely associated

Fig. 1. **Number of cases by date and time of illness onset, cassava poisoning, Compound A, Santa Cruz, Davao del Sur, October 2015 (*n*=14)**



with the event. After multivariable analysis, intake of cassava (RR = 208, 95% CI: 19.94–2169.32) was the only risk factor associated with the illness (**Table 1**).

Environmental investigation

The cassava was harvested by the father in Family A and was shared with Family B. The cassava was prepared by the father in Family A and by a daughter in Family B. The cassava was peeled, washed and boiled in water for one hour. No other ingredients were added. Family A shared the cooked cassava among themselves. Family B shared it with Families C and D.

The farmer who planted the cassava claimed that no fertilizer was used. Sweet and bitter varieties were grown in the field, and all were intended to be processed into animal feed and not for household consumption. The cassava had been harvested without permission.

Laboratory examination

Sulfhaemoglobin was not detected in 28 clinical specimens. Methaemoglobin was not detected in eight (29%) individuals and the rest were below 0.5 g/dL (normal limit). Urine tests for thiocyanate were all negative (36, 100%).

The cassava sample had a cyanide level of 68.94 ug/g. Organochloride and organophosphate pesticides were not detected in cassava and soil samples.

DISCUSSION

This foodborne outbreak was most likely due to consumption of insufficiently processed bitter cassava. The cassava sample had a cyanide level of 68.94 ug/g, which classified it as the bitter variety. Although there were no confirmed cases, all except one case had a

Table 1. **Factors associated with cassava poisoning, Compound A, Santa Cruz, Davao del Sur, October 2015**

Variables	Sick (*n* = 14) *n* (%)	Not sick (*n* = 51) *n* (%)	*P*-value	Crude RR (95% CI)	Adjusted RR** (95% CI)
Male	7 (50%)	16 (31%)	0.20	1.83 (0.73–4.56)	1.28 (0.31–5.21)
1–5 years old	7 (50%)	4 (9%)	<0.01	4.91(2.16–11.18)	4 964 152.23 (0.00 – >1.0E12)
Food eaten*					
Fish	14 (100%)	49 (96%)	0.61	Undefined	
Bread	2 (14%)	6 (12%)	0.55	1.19 (0.32–4.36)	
Egg	1 (7%)	4 (8%)	0.71	0.92 (0.15–5.69)	
Noodles	1 (7%)	0 (0%)	0.21	4.92 (3.03–8.00)	
Monggo	0 (0%)	2 (4%)	0.61	0 (undefined)	
Cassava	13 (93%)	3 (6%)	<0.01	39.81 (5.64–280.99)	208 (19.94–2169.32)
History of cassava intake	11 (79%)	46 (90%)	0.23	0.51 (0.18–1.46)	
Hygiene					
Washed hands before eating	11 (79%)	50 (98%)	0.03	0.24 (0.11–0.52)	0.14 (0.00–11.50)
Used soap in hand washing	14 (100%)	50 (98%)	-	-	
Used spoon and fork	0 (0%)	5 (10%)	0.28	0.00 (undefined)	
Ate food while hot	13 (93%)	42 (82%)	0.31	2.36 (0.35–16.11)	
Washed hands after toilet use	13 (93%)	51 (100%)	0.22	0.20 (0.13–0.33)	

CI, confidence interval; RR, relative risk

* May have more than one response

** Risk factors approaching significance ($P < 0.2$) in bivariate analysis were included in multivariable logistic regression using a forward stepwise procedure.

history of boiled cassava intake, and eating cassava was a significant risk factor (RR = 208, 95% CI: 19.94–2169.32). Signs and symptoms manifested by cases were consistent with those reported in other studies.[4,5,8] Insufficient processing of cassava was attributed to this outbreak as it has been in other outbreaks.[6,7]

Cassava varieties are usually differentiated from one another by their morphological characteristics such as colour of stems, petioles, leaves and tubers. Generally, the bitter varieties of cassava are recognized by dark leaves and stems, often tending to be reddish in colour, whereas the sweet varieties have light-green leaves and stems.[13] This does not apply in the Philippines where petioles and stems of several varieties of sweet cassava are pink or red. The two plants are extremely difficult to distinguish in the field, and distinction between them rests upon the content of hydrocyanic acid.[14] This could explain why the father harvested the bitter variety of cassava instead of the sweet type. The cassava he harvested was meant as animal feed.

The cases' sulfhaemoglobin and methaemoglobin levels were insignificant; organochloride and organophosphate pesticides were not detected in cassava or soil samples. This rejects a possible relationship of other chemicals to these food poisonings. However, it is also likely that sulfhaemoglobin and methaemoglobin tested normal or within limit because no samples were collected from the two fatalities who might have had higher exposures.

This study has some limitations. There was no leftover boiled cassava for testing, and no specimens were collected from the two fatalities. All urine samples were negative for cyanide, and there were no laboratory-confirmed cases. However, as the urine samples were collected four days after the incident, it is possible that thiocyanate in the urine was not detected because most of cyanide by-products leave the body within 24 hours after exposure.[15] Despite these limitations, valid statistical and cause-and-effect association strongly suggest cassava as the cause of this foodborne outbreak.

As a result of this outbreak, a DOH memorandum on health advice on common plants containing toxins was disseminated and reiterated by the Southern Philippines Medical Center and Davao DOH Regional Office. Health advice includes information on early signs of acute cyanide poisoning, management and the recommended processing (peeling outer skin, grating, soaking in water and squeezing) and cooking regardless of the variety of cassava. Community education was conducted in villages of Santa Cruz municipality. Public awareness on cassava varieties and its proper preparation is essential to prevent this kind of incident.

Conflict of interest

The author declares that there is no conflict of interest.

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Consumption of barracuda in the Caribbean Sea linked to ciguatera fish poisoning among Filipino seafarers

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Introduction: Ciguatera fish poisoning (CFP) is common in tropical and subtropical waters. On 13 November 2015, eight Filipino seafarers from a cargo ship sailing in the Caribbean Sea experienced a range of symptoms after consuming a barracuda. Upon their return to the Philippines, an investigation was conducted to describe the cases.

Methods: A case-series was conducted. A CFP case was defined as a previously well individual on the ship who developed at least one gastrointestinal symptom and at least one neurologic manifestation after eating barracuda on 13 November 2015. All cases were admitted to hospital in Manila, Philippines and were interviewed using a standard questionnaire. Urine and serum samples of cases were collected for ciguatoxin (CTX) testing by radiological and receptor-binding assay.

Results: Eight of the 25 seafarers on the ship ate the barracuda; all eight met the CFP case definition. The age of cases ranged from 37 to 58 years (median: 47 years) and all were males. Onset of symptoms ranged from 1 to 3 hours (median: 2 hours) from the time of ingestion of the barracuda. All cases experienced gastrointestinal (nausea, vomiting, diarrhoea) and neurologic (temperature allodynia, itchiness) symptoms but no cardiovascular manifestations. Urine and serum specimens of all eight cases showed CTX below the detection limit.

Discussion: The Philippines Epidemiology Bureau recommended that the Philippine Maritime Authority include CTX poisoning and its health risks in seafarers' training to prevent future cases of CFP. The Event-based Surveillance and Response system will continue to provide a mechanism for the reporting and appropriate management of CFP cases.

Ciguatera fish poisoning (CFP) is widespread in tropical and subtropical waters[1] and is acquired from consuming contaminated reef fish. The ciguatoxin (CTX) comes from the dinoflagellate *Gambierdiscus toxicus,* which grows predominantly in coral reefs in tropical and subtropical climates[2] and is consumed by herbivorous fish, which in turn are consumed by carnivorous reef fish and then by humans.[3] There are several reefs where fish such as barracuda and grouper are inedible because of the toxin; however, the toxin does not affect all reef fish, and deep-sea fish such as tuna and wahoo are unaffected.[4] Temperature, gastric acid and cooking method have no effect on the ciguatoxin, and its presence does not affect the odor, colour or taste of the fish.[5]

CFP is diagnosed clinically based on a cluster of symptoms temporally related to the ingestion of suspected fish products. All people can be affected by this toxin, and symptoms may persist for months or years.[6] Neurologic symptoms usually last for a few days to several weeks and may sporadically reoccur years later.[7] Triggers for reoccurrence may include consuming seafood, chicken, nuts, caffeine or alcohol and strenuous physical activity.[8]

CFP among seafarers is rarely documented, and treatment is usually delayed because they are at sea without medical facilities. Previously in the Philippines, an outbreak of CFP was documented in 2001 among 38 residents of Navotas who ate barracuda caught in Manila Bay; remnants of the implicated fish tested positive for CTX.[9] In 2010, two families with 22 members experienced gastrointestinal and neurologic symptoms after eating red snapper caught by a local fisherman in Iloilo, Philippines; it also subsequently tested positive for CTX.[10]

On 29 November 2015, the Epidemiology Bureau of the Philippines received a report of suspected CFP among

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seafarers who had consumed barracuda on 13 November 2015 in St Eustatius, a Dutch island in the Caribbean. Cases had been hospitalized in Trinidad and Tobago, then repatriated back to the Philippines and readmitted to a medical centre in Manila. An epidemiologic investigation was conducted to describe the cases.

METHODS

A descriptive study was conducted on 3 December 2015 while seafarers were still hospitalized in Manila. The cases were identified by the surveillance officer of the hospital from the list of admitted cases. A CFP case was defined as a previously well individual who developed at least one combination of gastrointestinal (diarrhoea, abdominal pain, nausea or vomiting) and neurologic manifestations (dizziness, weakness and itching or temperature allodynia) after eating barracuda on the cargo ship on 13 November 2015. Cases were interviewed to collect demographic and clinical information, food intake history and food preparation of barracuda using a standard questionnaire with both open- and close-ended questions developed by the investigators.

Urine and serum samples of cases were collected and submitted to the Philippines Nuclear Research Institute to detect CTX using receptor-binding assay (RBA).[11]

All data analyses were conducted using Microsoft Excel 2013. Ethical clearance was waived as this investigation was part of a response to an outbreak.

RESULTS

There were 25 seafarers on board the ship, with eight having lunch at 12:00 on 13 November 2015. All of the cases reported consuming the barracuda, with smaller numbers also consuming rice ($n = 7$), egg ($n = 4$), ham ($n = 4$) and chicken ($n = 2$). After 1 to 3 hours (median: 2 hours), all eight cases manifested symptoms of nausea, vomiting, diarrhoea, itchiness and temperature allodynia (reversal of thermal sensation) (**Fig. 1**). The age of cases ranged from 37 to 58 years (median: 47 years) and all were males. Cases were given liquid charcoal as first aid for food poisoning and antispasmodic medicine to help relieve diarrhoea. There was no cardiovascular manifestation observed. Patients had no previous history of CTX poisoning. There was also no history of alcohol consumption within the week leading up to the event.

Urine and serum samples were collected from all eight cases, but the toxin was not detected.

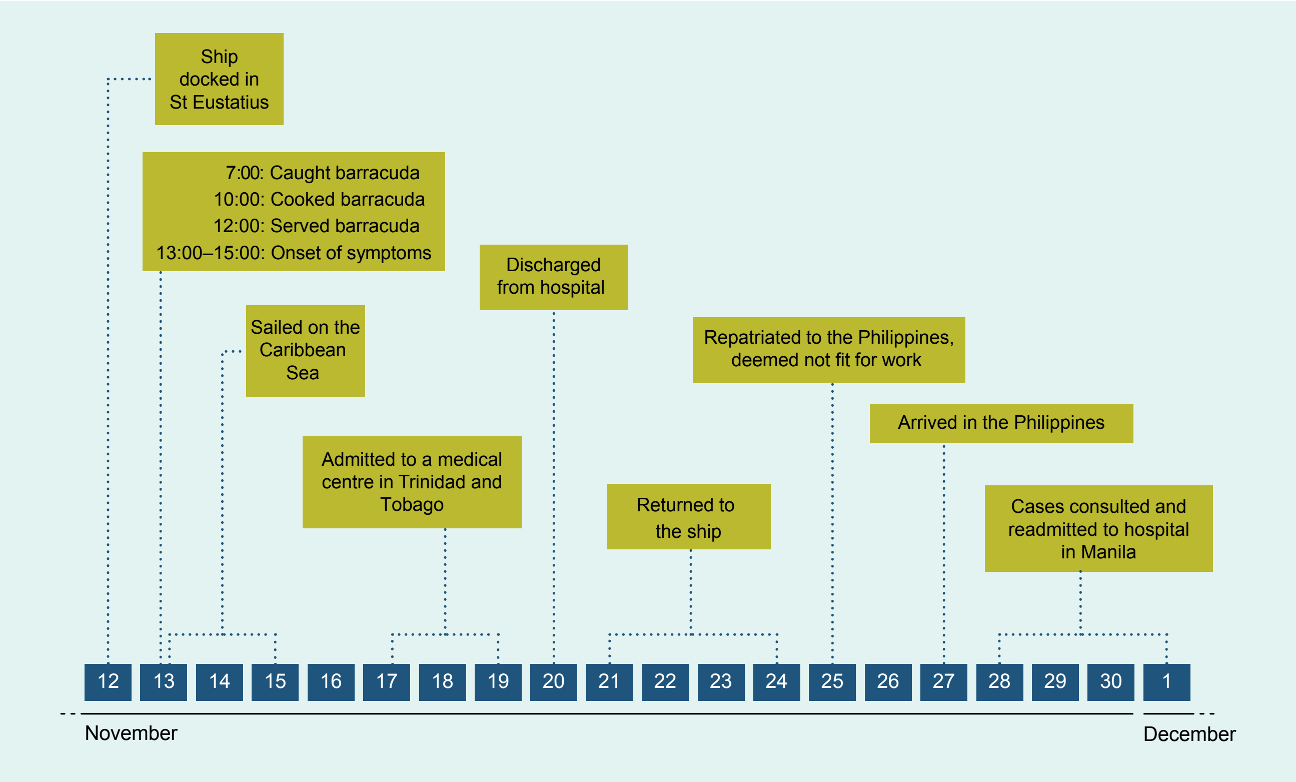
DISCUSSION

Eight cases of CFP were reported after consumption of barracuda in the Caribbean Sea. All seafarers who consumed the same barracuda experienced gastrointestinal and neurological signs and symptoms typical of CTX.[10,12] None of the cases had cardiovascular complications, which are observed in about 10–15% of CTX cases.[13] In humans, the average dose of CTX required to develop symptoms is estimated to be as low as 0.08 to 0.1 μg/kg of the body weight.[8]

Rising ocean temperatures can affect wind patterns, which can force warm tropical waters to non-CFP endemic coastal regions.[14] As a result, dinoflagellates producing ciguatoxins have expanded their presence to previously non-CTX affected oceans, increasing risk of CFP among those consuming fish from these oceans. CFP causes significant impact on marine operations because of the high attack rates and chronicity of symptoms, which can result in seafarers requiring long periods of recovery. Providing information about potential marine products that can be contaminated with CTX to this high-risk group may help mitigate the occurrence of CFP.

There were several limitations of this study. The outbreak occurred while the cases were sailing in the Caribbean Sea; hence, no leftover fish was available for toxin analysis and bacterial culture. The species of the fish was not confirmed; rather, the seafarers who caught the fish identified it as barracuda. Also, we were not able to interview the person who caught and prepared the food for the cases; hence, the food production chain could not be established and investigated. It is known that larger fish in the food chain have higher levels of accumulated toxins,[15] but no information on the actual size of the fish caught was elicited. That CTX was not detected could be attributed to the extremely low levels[11] and fast alpha half-life of the toxin, leaving undetectable concentrations of the toxin in the blood.[16] Bacterial culture was not done to test for

Fig. 1. **Timeline of events, CFP outbreak among Filipino seafarers who returned from St Eustatius, Kingdom of the Netherlands, 2015**



other pathogens because the time course, symptoms, food-specific attack rate and history of eating the fish strongly supported the CFP diagnosis.[8]

The Epidemiology Bureau recommended that the Philippine Maritime Authority include CTX poisoning and its health risks in the seafarers' training to prevent future cases of CFP. CTX continues to be reportable in the Event-based Surveillance and Response system of the Department of Health. Coordination with the Bureau of Fisheries, Philippine Nuclear Research Institute and Department of Health will enable immediate detection of CFP for appropriate management of cases, reducing serious implications of CFP.

Conflicts of interest

The authors state they have no conflicts of interest to declare.

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Tuberculosis among children, adolescents and young adults in the Philippines: a surveillance report

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The Philippines, a country with a young population, is currently experiencing an intense and persistent tuberculosis epidemic. We analysed patient-based national surveillance data to investigate the epidemiology of reported tuberculosis among children (aged 0–9 years), adolescents (aged 10–19 years) and young adults (aged 20–24 years) to better understand the burden of disease and treatment outcomes in these age groups.

Descriptive analyses were performed to assess age-related patterns in notifications and treatment outcomes. Data quality was assessed against international benchmarks at the national and regional levels.

Overall, 27.3% of tuberculosis notifications for the Philippines in 2015 pertained to children, adolescents and young adults aged 0–24 years. Treatment outcomes were generally favourable, with 81% of patients being cured or completing treatment. The data quality assessment revealed substantial regional variation in some indicators and suggested potential under-detection of tuberculosis in children aged 0–4 years.

Children, adolescents and young adults in the Philippines constitute a substantial proportion of patients in the national tuberculosis surveillance dataset. Long-term progress against tuberculosis in the Philippines relies on improving the control of tuberculosis in these key age groups.

The World Health Organization (WHO) estimates that 1.8 million people living in the Western Pacific Region developed active tuberculosis (TB) in 2016, and of these, 573 000 (32%) lived in the Philippines.[1] The Philippines has one of the highest TB incidence rates in the Region, estimated at 554 cases per 100 000 in 2016, a rate that has not declined significantly since 2007.[1]

Half (52%) of the population of the Philippines is under 25 years of age, compared to a regional average of 43%.[2] Age influences TB risk in a variety of biological and social ways, and TB epidemiology changes with population age structure as nations undergo demographic shifts.[3] Children under 5 years of age are at high risk of developing clinical TB after infection and are prone to developing severe forms of TB such as TB meningitis and disseminated TB, particularly if not protected by Bacillus Calmette-Guérin (BCG) vaccination.[4] In contrast, adolescents and young adults ("young people", aged 10–24 years) more often develop infectious pulmonary TB.[4] Young people who attend educational institutions or reside in institutional settings may have multiple extended respiratory contacts per day.[5] Furthermore, recent research suggests that young people may be at increased risk of discontinuing TB treatment before completion (previously referred to as "defaulting").[6]

The first step in improved TB control is to understand the epidemiology of the disease to inform and implement evidence-based interventions for at-risk groups. The aim of this study was to describe the age-related epidemiology and outcomes of reported TB in the Philippines using patient-based national TB surveillance data with a focus on individuals aged 0–24 years. The second aim was

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to evaluate surveillance data quality against international benchmarks for childhood TB.

METHODS

This analysis used data from the national TB surveillance system of the Philippines, the Integrated Tuberculosis Information System (ITIS).[7] This is a case-based electronic surveillance system with data entry performed at the health-facility level. We calculated crude notification rates nationally and for each of the Philippines' 17 regions for the 2015 calendar year. We also calculated age- and sex-specific rates using population estimates from the 2015 census.[8] We calculated the proportion of TB that was extra pulmonary by age group, and we assessed the risk of each unfavourable treatment outcome by age group and sex (using all registered patients of each group as the denominator).

For consistency with available population data, we analysed five-year age groups across the 0–24-year age span (young children aged 0–4, older children aged 5–9, young adolescents aged 10–14, older adolescents aged 15–19 and young adults aged 20–24) to allow detailed description of outcomes across different age groups. To compare the risks of unfavourable treatment outcomes (premature discontinuation, treatment failure, death or no recorded outcome) by age, we stratified the adult age group into 25–49 and ≥50 years as mortality on TB treatment is known to be higher among older adults.[3] We calculated risk ratios with 95% confidence intervals for successful treatment using the 25–49 year age group as the reference group.

To assess the quality of the surveillance data regarding child TB at national and regional levels, we evaluated data in ITIS using selected items from WHO's Standards and Benchmarks Checklist for TB surveillance data. We evaluated data quality using the two WHO benchmarks for TB surveillance relevant to childhood TB:[1] in a middle-income country, 5–15% of all new TB patients are expected to be younger than 15 years;[2] and the ratio of children 0–4 years old to those aged 5–14 years old is expected to be between 1.5:1 and 3.0:1.[9] We repeated this assessment by administrative region to determine the variability in these key indicators within the country. We also calculated the percentages of notifications by five-year age groups to compare regional variation in age-related burden of reported disease.

Unit record data were managed and analysed in Stata 13 (Statacorp, College Station, Texas, USA), and aggregate data were managed and analysed in Microsoft Excel (Microsoft, Redmond, Washington, USA). Patients with multidrug-resistant TB were excluded from all analyses.

Ethics

This study was approved by the Human Ethics Advisory Group at the Department of Paediatrics, University of Melbourne and by the National Tuberculosis Program of the Philippines, who provided access to the data.

RESULTS

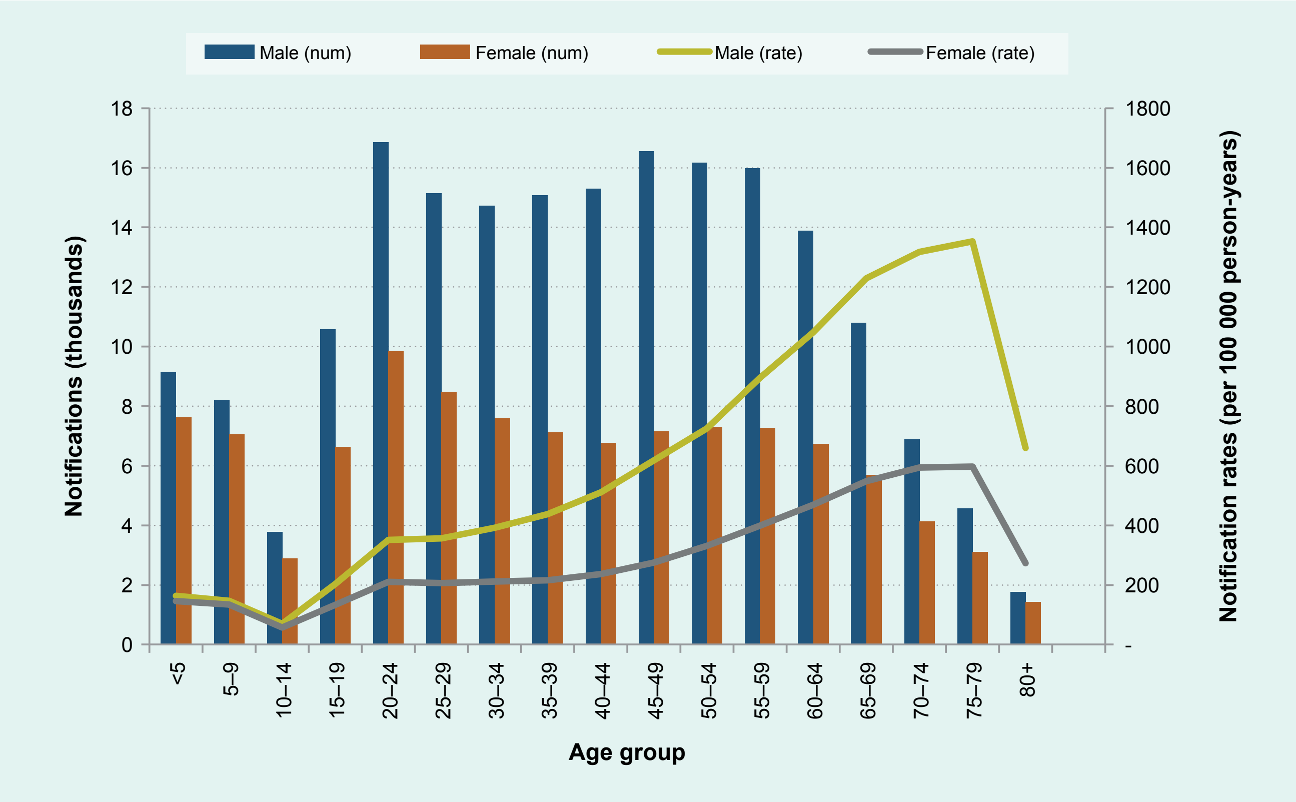
Epidemiology

There were 299 005 patients of known age and sex registered on treatment for new or relapsed TB in the Philippines in 2015. All records in the dataset were complete with regard to age, sex, registration date, treatment history and a patient identifier. A very small number (0.4%) of records did not specify the basis for diagnosis (clinical vs. microbiologic). The crude notification rate for the country was 296 cases per 100 000 person-years. At the regional level, notification rates varied from 144 cases per 100 000 person-years to 364 cases per 100 000 person-years (median rate = 291, interquartile range [IQR]: 262–333). Nationwide, 38 694 (12.8%) of the patients were children and young adolescents aged 0–14 years; 43 923 (14.5%) were older adolescents and young adults aged 15-24 years. Only 1.9% of all reported TB cases were classified as exclusively extrapulmonary in nature.

The frequency and rates of new or relapsed TB, stratified by age group and sex, are shown in **Fig. 1**. The number of notifications and the notification rates were higher in males than females in most age groups. The 20–24 year age group had the highest absolute number of notifications nationally in both sexes; however, per capita the rates of notification rose steadily across the adult age groups, peaking in the 75–79 year age group and then falling in the ≥80 year age group.

Of all new and relapsed patients registered in 2015, 242 629 (81.2%) were treated successfully according to their final recorded outcomes, 36 881 (12.3%) had no outcome recorded, and the remaining 19 495 (6.5%)

Fig. 1. **Notifications (thousands) and notification rates for TB by age and sex (thousands of cases per 100 000 person years), the Philippines, 2015**



experienced an unfavourable outcome (discontinuation, treatment failure or death). Young children (aged 0–4 years) were more likely to be treated successfully than adults aged 25–49 (risk ratio [RR]=1.06, 95% confidence interval [CI]: 1.05, 1.07). Compared to adults aged 25–49 years, young adults (aged 20–24 years) had the same likelihood of treatment success (RR=1.01, 95% CI: 1.00, 1.02), while adults over 50 years of age were slightly less likely to be treated successfully (RR=0.97, 95% CI 0.96–0.97). Missing outcome data were equally common in all age groups, varying between 11.2% in children under 5 and 13.0% in adolescents aged 10–14 years.

Treatment discontinuation was somewhat more common among adolescents and adults than among children. Young men aged 20–24 years had the highest risk of discontinuation of any age group: 5.1% of young men discontinued treatment prematurely (**Fig. 2**).

Data quality indicators

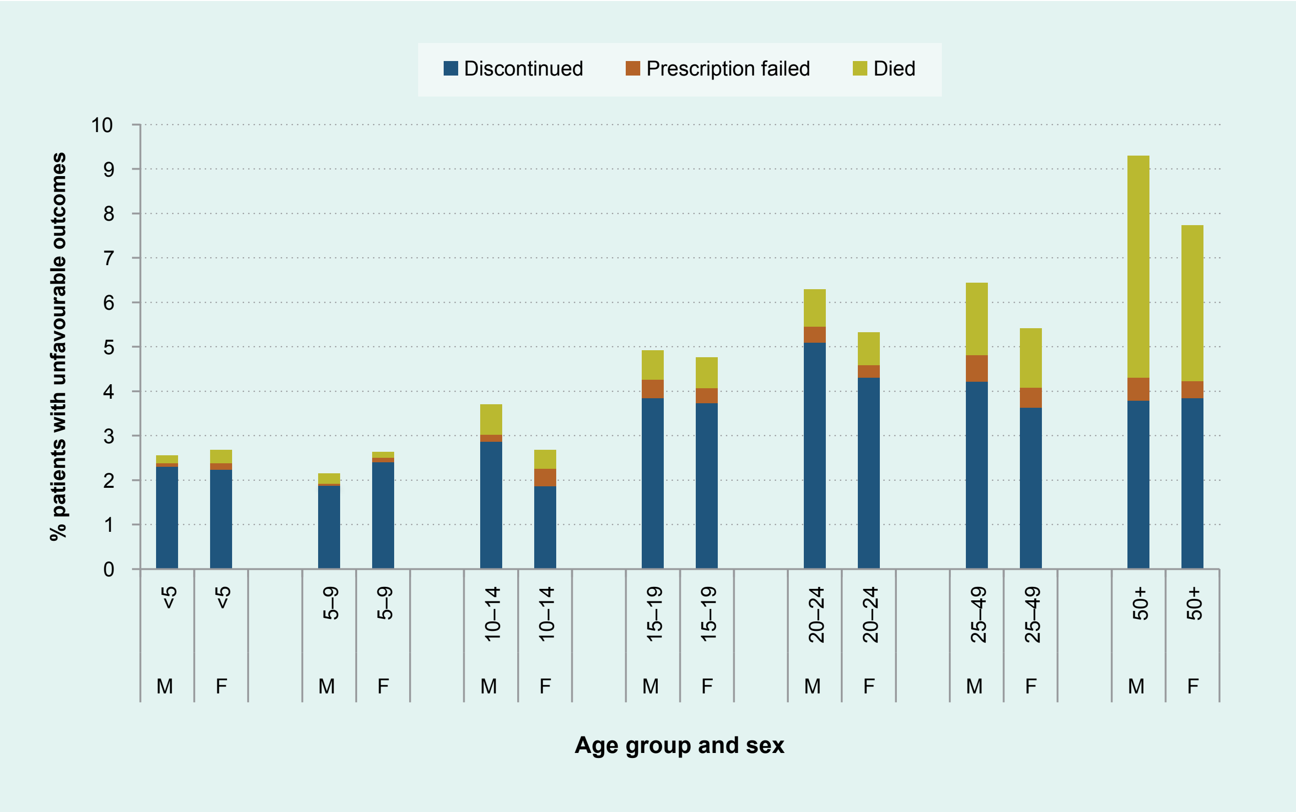
The proportion of new and relapsed TB among children and young adolescents aged 0–14 years was 12.8% nationally, but varied substantially by region, ranging from 3.5% to 27.9% of all TB cases, suggesting significant geographic variation in data quality regarding paediatric TB. The ratio of children under 5 to children and young adolescents aged 5–14 years ranged from 0.3:1 to 1.1:1 across the regions, with no region meeting the WHO benchmark of 1.5:1. Nationally, the ratio was 0.8:1.

DISCUSSION

This study reviewed the epidemiology and outcomes of TB in the Philippines in 2015 using the patient-based national surveillance dataset.[7] We observed a high proportion of notifications among children, adolescents and young adults albeit with regional variation in data quality indicators for childhood TB. Treatment outcomes were largely favourable, although outcome data were missing for a substantial proportion of patients across all age groups.

Consistent with the country's young population, over one quarter of TB patients in the Philippines are children, adolescents and young adults. This proportion is comparable to that seen in Cambodia (26%) but markedly higher than

Fig. 2. **Percentage of patients with unfavourable treatment outcomes by age and sex, new and relapse TB patients, the Philippines, 2015**



that in Viet Nam (9.6%) or the Lao People's Democratic Republic (9.5%), the other high-burden countries in the Western Pacific Region.[10] The high proportion of patients aged under 25 in the Philippines has implications both in the short term, during which the burden of disease among children and young people is substantial, and in the longer term, as the current generation ages with a high prevalence of latent TB infection. Improving the quality of TB prevention, diagnosis and management among these age groups would contribute to TB control in the Philippines both immediately and in the longer term.

We identified potential problems in surveillance data quality in some regions that warrant further investigation. The proportion of cases affecting children has risen considerably in recent years from 2.1% in 2013[10] to 12.8% in 2016, following national efforts to improve detection of childhood TB. In a high transmission setting, children aged 0–4 years are disproportionately impacted due to their high risk of progression to active disease relative to older children.[4] That the number of notifications from 0–4 year olds and 5–14 year olds is almost equal in the Philippines (rather than the expected ratio of 1.5–3.0:1)[9] suggests that TB in children aged 0–4 is being under-diagnosed or underreported.

The regional variability in the proportion of reported TB cases contributed by children and young adolescents aged 0–14 suggests substantial variation in diagnostic and reporting practices within the country. The low mortality rate among young children likewise suggests the possibility of under-diagnosis or underreporting of disseminated TB and TB meningitis.

The proportion of notifications in the 10–14 year age group was consistently low throughout the Philippines in spite of marked variations in other indicators between the regions. The transiently reduced risk of TB in this age group has been well described in historical TB epidemics,[11] though there may also be an elevated risk of under-detection in this age group, who can fall between child and adult health services.[12] Notification rates in the Philippines rise markedly across the adolescent and young adult age groups as seen in both historical and modern TB epidemics in many settings.[3,4]

The most recent national TB prevalence survey in the Philippines revealed substantial gaps in case detection in the country with a prevalence to notification ratio of 3.0.[13] The survey observed the greatest gap between notifications and prevalence in the 15–24 year age group (the youngest group included in the survey), suggesting that the true burden of disease in this age group is over fourfold higher than documented by the notification data presented here.[13]

The major limitations of this study reflect the limitations of the data source used. We used data from the first year in which ITIS was operational nationally, and some facilities and regions may still have been adjusting to the new system. TB surveillance systems capture a limited number of variables, and some details that would have been valuable were not available, for example, dates of diagnosis and subsequent disengagement from care or BCG vaccination status. If age, diagnostic data or treatment outcome were recorded inaccurately, this will have affected our results. Nonetheless, the data used in this study are the most detailed and complete source of data on TB in the Philippines, and a data quality evaluation was included in this analysis.

This study described the epidemiology and outcomes of TB among children and young people in the Philippines who constitute one quarter of all registered patients nationally. Our study together with the recent national prevalence survey[13] highlight the need for improved TB control in the younger age groups who will play a key role in the Philippines' progress against TB over the coming decades.

Conflicts of interest

None.

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Evaluation of an ad hoc paper-based syndromic surveillance system in Ibaraki evacuation centres following the 2011 Great East Japan Earthquake and Tsunami

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Outbreaks of infectious diseases can occur after natural disasters as vital services are disrupted and populations move into evacuation centres. National notifiable disease surveillance may be inadequate in these situations because of resource-consuming disease confirmation or system interruptions. Although syndromic surveillance has been used as an alternative in post-disaster situations, no systematic evaluations of it have been published. We evaluated the ad hoc paper-based syndromic surveillance system implemented in evacuation centres in Ibaraki prefecture after the 2011 Great East Japan Earthquake and Tsunami. We assessed the simplicity, acceptability, data quality, timeliness and portability of this system and reviewed its usefulness. We concluded that the system was simple, acceptable, portable and useful. The documentation and monitoring of disease events and trends were useful for developing interventions in evacuation centres and have since been used to improve post-disaster infectious disease and surveillance knowledge in Japan. We believe timeliness was a challenge due to the chain of data transmission and communication passing through an intermediary. Future implementations of this system could consider a more direct chain of data transmission and communication from collectors to analysers. Too few key informant interviewees and the inability to obtain original paper-based data from evacuation centres limited our findings; we conducted this evaluation four years after the response occurred. Future evaluations should be completed closer to when operations cease. The usefulness of the system suggests adopting it in future disasters. A simple, plain-language manual should be developed to improve future employment.

On 11 March 2011, the world's fourth most powerful earthquake since 1900 (magnitude 9.1), struck north-eastern Japan.[1] The earthquake and subsequent tsunami killed 15 894 people and injured 6152,[2] and 470 000 were moved into evacuation centres.[3] Although the National Epidemiological Surveillance of Infectious Diseases (NESID), Japan's passive system of sentinel and notifiable-disease reporting, was functional, surveillance staff in the affected areas were drawn into response activities that limited their time for NESID. The Infectious Diseases Surveillance Center (IDSC) in Japan's National Institute of Infectious Diseases, therefore, designed an ad hoc paper-based syndromic surveillance system in evacuation centres to detect outbreaks among displaced populations.

Syndromic surveillance of symptoms indicative of disease has been used in evacuation centres after previous disasters,[4–7] although no system has been systematically evaluated. We aimed to evaluate the ad hoc paper-based syndromic surveillance system implemented after the 2011 Great East Japan Earthquake and Tsunami to understand its performance and appropriateness for future disasters and to contribute to post-disaster surveillance knowledge.

METHODS

We conducted this evaluation according to the Centers for Disease Control and Prevention's (CDC) Updated Guidelines for Evaluating Public Health Surveillance Systems[8] four years after the Great East Japan Earthquake and Tsunami had occurred.

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System description

The objectives of the ad hoc paper-based syndromic surveillance system were to: (1) collect daily counts of syndromes of evacuation centre residents; (2) assess daily outbreak risk; (3) and generate timely recommendations to prevent the spread of disease.

IDSC requested that public health nurses and non-health-care staff at evacuation centres record the number of residents presenting with each syndrome (**Table 1**) by age group (<5 years, 5 to <65 years and ≥65 years) on paper forms and then fax them each day to the local public health centre or prefecture public health department, depending on jurisdictional arrangement. For cases of suspected influenza, public health nurses used rapid influenza kits to test for infection. Positive tests were to be reported as influenza and negative as acute respiratory infection syndrome. A form was to be submitted each day that residents were in the centre, and zero reporting was required. Local public health centres faxed the forms to the prefecture where they were compiled into an electronic spreadsheet and emailed to IDSC by 12:00 the following day.

IDSC monitored the data daily for unusual increases and, if detected, would communicate with the prefecture public health department to verify information and discuss response actions. Each week, IDSC also summarized the data, developed histograms for each syndrome, made maps of evacuation centre locations and stratified syndrome counts by municipality and evacuation centre. IDSC used this information, in combination with reported NESID data from surrounding areas, to assess the risk for outbreaks in evacuation centres using the World Health Organization's (WHO) Communicable Disease Risk Assessment: Protocol for Humanitarian Emergencies.[9] Summaries, assessments and recommendations were fed back weekly on electronic slides to the prefecture public health department, which distributed them to local public health and evacuation centres.

Evaluation description

This evaluation was conducted to assess the system's sensitivity, data quality, simplicity, acceptability, timeliness, and portability.[8,10] We could not assess sensitivity without a gold standard or comparative system with which to compare.

Data sources included forms submitted daily to IDSC from the Ibaraki Public Health Department with the numbers of syndromes, evacuation centres, and evacuation centre residents, as well as additional comments; electronic slides sent from IDSC to Ibaraki Public Health; e-mails containing those data and slides; and qualitative information obtained through interviews.

We interviewed a staff member of the Ibaraki Public Health Department who had worked on the surveillance system's operations and two staff from IDSC: one who oversaw the design and implementation of the system and one who designed and operated the system, analysed its data and developed and disseminated assessments and recommendations. We conducted interviews in November 2015–March 2016.

Attribute assessment

To assess data quality, we counted the number of missing values in cells where data were expected and expressed that number as a percentage of completeness. This included fields for syndrome counts and the number of evacuees, but not optional cells such as comments. We estimated validity by cleaning the data, counting the number of errors identified and expressing the sum as a percentage of the total number of non-missing values. Errors were defined as values out of the acceptable range or logically inconsistent with other values.

We assessed simplicity by reviewing information flow, case definitions and operating procedures. To assess portability, we reviewed procedural documentation as well as adaptations made to the system and their effects on performance. We assessed acceptability by reviewing prefecture and dissemination reports to determine what percentage conformed with the requirements that (1) a report be submitted each day by 12:00 from the prefecture public health department to IDSC; and (2) dissemination reports were fed back weekly from the IDSC to the prefecture public health department. All three attributes were included in the interviews.

To assess timeliness, we estimated reporting delay by calculating the number of hours between close of business and the time the e-mail containing data was sent from the public health department to IDSC as indicated in the e-mail time stamp and rounded to the closest hour. We then obtained range, interquartile interval (IQI) and median.

Table 1. **Definitions for reportable syndromes from evacuation centres following the 11 March 2011, Great East Japan Earthquake and Tsunami, Ibaraki prefecture, Japan, 21 March–15 May 2011**

Syndrome	Definition
Influenza	Sudden fever >38 °C, body pain, cough and sore throat and positive rapid test
Acute gastrointestinal infection	Diarrhoea, vomiting or bloody stool
Acute respiratory infection	Any respiratory system infection symptom, such as cough, sore throat, wheezing, that is not confirmed influenza
Acute neurological infection	Convulsions, difficulty opening mouth, difficulty swallowing or loss of consciousness
Fever with rash	Rash or blisters on the face or body plus fever
Wound-associated infection	Wound with pus or fever
Other	Any other symptom or syndrome

We calculated implementation time by counting the number of days, rounded to the nearest whole day, between the date of the disaster and the date of the first report from the public health department, based on the email time stamp. We asked key informants about their perceived timeliness of procedures and implementation.

We reviewed the usefulness of this system by asking interviewees about how the system-generated information was used to prevent disease or improve knowledge. We reviewed trends in reported syndromes to determine if any responses should have been triggered. We analysed quantitative data with Epi Info 7.1.5. (CDC, Atlanta, GA, USA).

RESULTS

System implementation

IDSC offered this system to the four most affected prefectures; Ibaraki prefecture was the only one to implement it. Of the others, one experienced massive population emigration, which led to the closure of evacuation centres; one developed a different surveillance system in collaboration with a local university; and one adopted parts of this system late in the post-disaster period but analysed their data internally.

There were 95 evacuation centres open in Ibaraki prefecture with residents reaching a single-day maximum of 3305 and minimum of 139. In total, 152 syndromes were reported: 127 acute respiratory infection syndromes, 15 acute gastroenteritis infection syndromes, five "other" without clarification, four influenza and one wound-associated infection (**Fig. 1**).

Data quality

Among 38 875 expected data cells, 18 665 were missing values (48%), and 403 of the non-missing values contained errors (2.0%). An additional 22 values should have been blank, giving 425 total errors (2.1%).

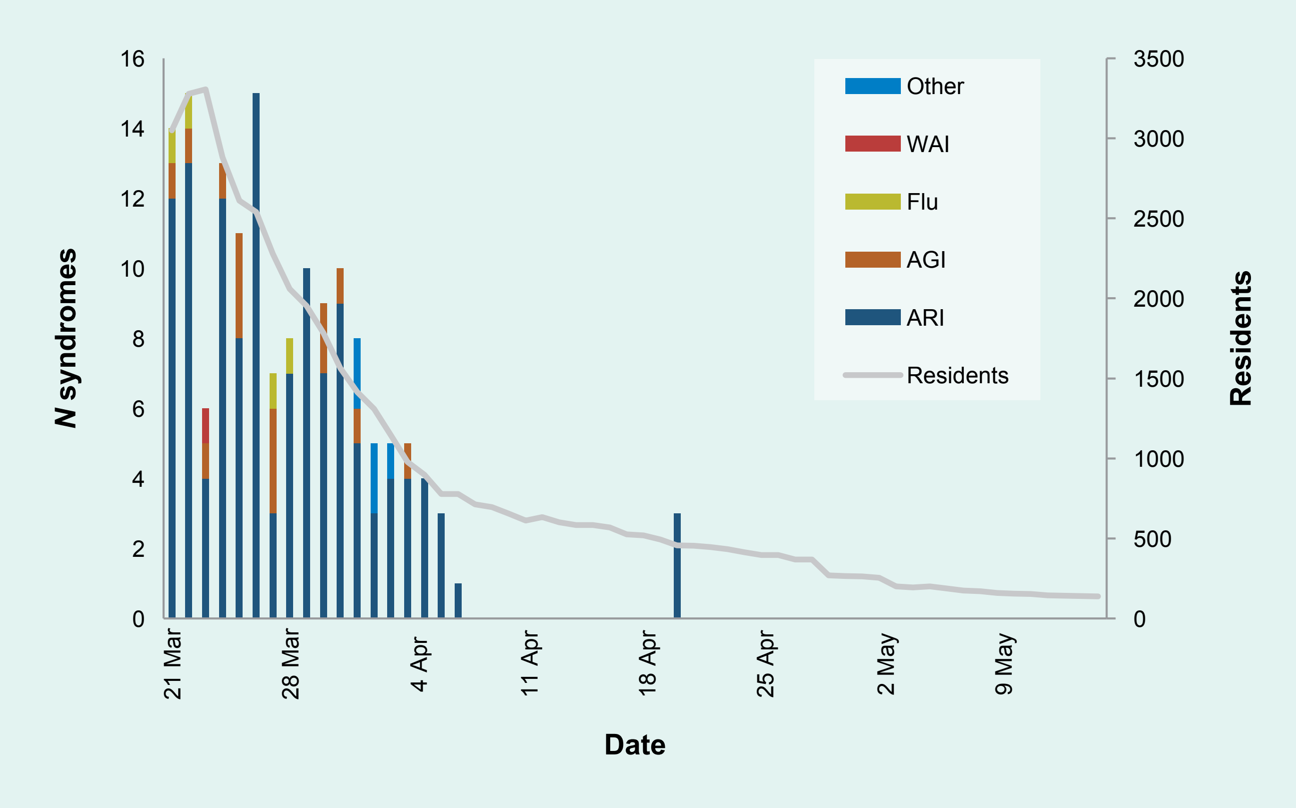
Simplicity

Case definitions were in plain language with recognizable symptoms. Syndrome counts were collected at the evacuation centres without investigation, follow-up or laboratory tests (except for suspected influenza that used rapid tests that could only be employed by public health nurses). These counts were recorded each day with a total evacuation centre resident count.

After the third day of system operations, the information flowed through three units only: evacuation centre, prefecture public health department and IDSC. Prior to this, there was an additional reporting unit. In addition, the reporting of all syndromes together and not by age group also changed from day three, which improved the simplicity of the system.

Data were analysed at IDSC by one person using descriptive statistics, histograms and maps. Risk assessments were performed according to an established tool. Interviewees perceived the system to be mostly simple, except that the risk assessments tried to cover too many topics, lacked local context and were not written in plain language.

Fig. 1. **Number of persons identified for each syndrome (*n* = 152) and number of evacuation centre residents, by date of report, following the 11 March 2011, Great East Japan Earthquake and Tsunami, Ibaraki prefecture, Japan, 21 March–15 May 2011**



WAI: wound-associated infection; Flu: influenza; AGI: acute gastrointestinal infection; ARI: acute respiratory infection.
Note: no syndromes for fever with rash or acute neurological infection were reported.

Portability

No procedural documentation or manual existed for the surveillance system, yet changes were made to the system without disruption. These included the submission of total syndrome counts only and direct reporting to the public health department instead of through public health centres first.

Acceptability

The public health department reported to IDSC on 52 of 53 days (98.1%) with seven reports (13.5%) received before the established time. Over eight weeks, seven (87.5%) dissemination reports were fed back. Interviewees revealed all evacuation centres were participating within three days of accepting residents and reported data on most non-holiday weekdays. Interviewees reported that most operators within the system were willing to participate.

Timelines

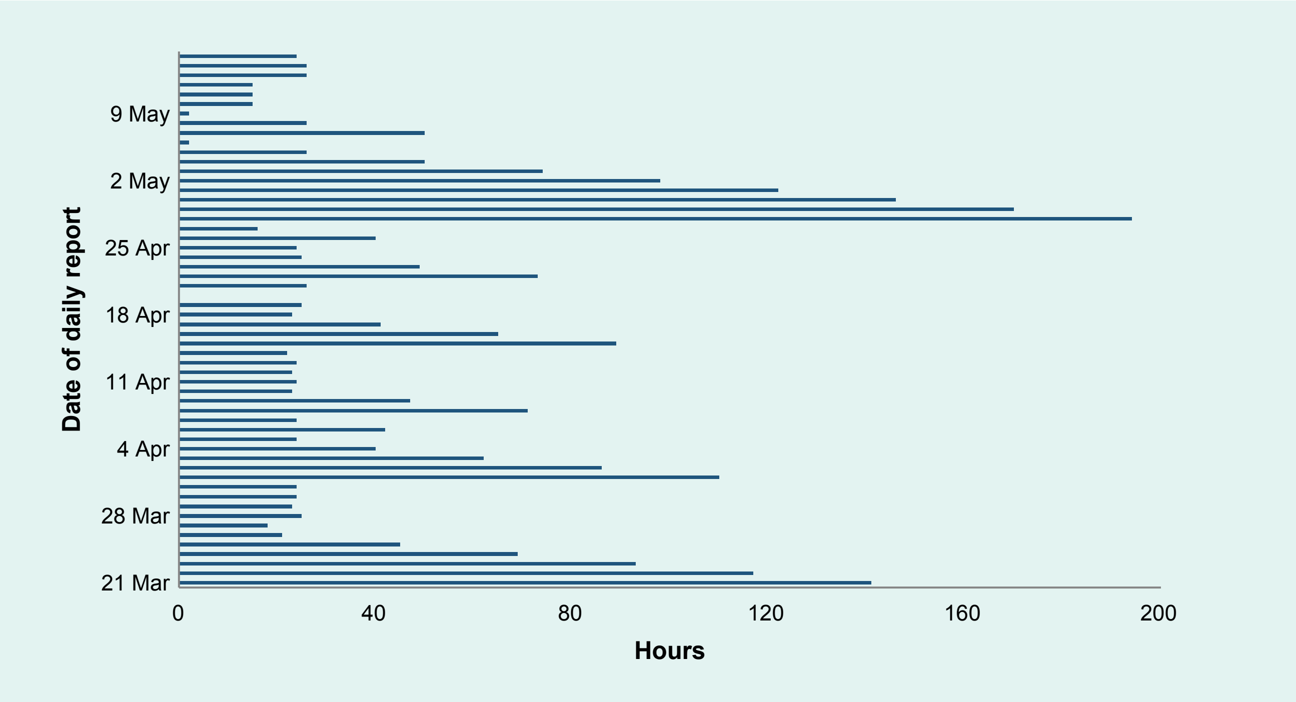
The median reporting delay between close of business on the day the data were collected and the time the email containing those data was sent from the public health department to IDSC was 26 hours (IQI: 24–71; range: 2–194) (**Fig. 2**). Implementation time was 10 days after the disaster occurred.

Usefulness

The system met its objectives: daily counts of syndromes for evacuation centre residents were collected on 52 of 53 days, the daily outbreak risk was assessed and weekly assessments with recommendations were generated. The surveillance system data had no trends that should have triggered a response.

Interviews revealed four usefulness themes: (1) risk assessments could have been more useful for evacuation

Fig. 2. **Reporting delay in hours from 18:00 on day of collection to receipt at IDSC, 21 March–15 May 2011**



Note: On 20 April, no report was submitted.

centre staff by prioritizing syndromes, considering local context and using language more appropriate for non-health care staff; (2) disease trends and risk assessments were valuable for prefecture authorities; (3) dissemination reports were used for developing interventions; and (4) disaster epidemiology knowledge increased since syndrome trends documented by this system have been presented to disaster and medical associations throughout Japan.

DISCUSSION

We evaluated the ad hoc paper-based syndromic surveillance system implemented in evacuation centres in Ibaraki prefecture, Japan, after the 2011 Great East Japan Earthquake and Tsunami. The straightforward collection, reporting, analysis and feedback procedures of the system made it simple; the influenza testing kits and language used for feedback were the major complications. Interviewee responses, daily reporting and weekly assessments with feedback showed the system's good acceptability. The simplicity of the system and evidence of adaptation without disruption showed its portability. Finally, the system met its objectives and contributed to situational awareness, interventions and post-disaster surveillance knowledge. Data quality and timeliness were the system's major challenges.

This is the first published report of a systematic evaluation of a syndromic surveillance system for outbreak detection in evacuation centres following a natural disaster. Similar surveillance system benefits have been identified from other disasters: documenting and monitoring disease events and trends,[4–7] measuring the burden of disease,[5] increasing awareness about reporting,[4] dispelling rumours[4] and serving as a daily interface with shelter residents.[7] Other benefits included measuring the effects of control measures and being timely.[4,5,7]

Timeliness issues may have been due to evacuation centres being operational every day, while the public health department kept its regular hours. The delay in reporting most likely occurred at the public health department since the longest delays occurred on Fridays, Saturdays and during the Golden Week (four national holidays that occur over seven days in late April and early May) when office hours were reduced. These delays improved over time, possibly due to an overworked public health department early on and then an improving post-disaster situation.

Challenges in post-disaster surveillance systems that have been previously published include changing evacuation centre status,[4,5] competing surveillance systems,[4] unstandardized patient recording systems[4] and limited coverage.[4] In this evaluation, we found that coverage was limited to one prefecture but included all evacuation centres in it. The patient recording systems used were simple and acceptable among participants within the system. There were no changes to evacuation centre status; when a centre closed, the health department reported zero residents.

Data quality was a challenge with low data completeness. Among missing values, >95% were for missing syndrome counts, potentially because zero reporting was not conducted. There was only one zero reported for a syndrome throughout the period. If missing syndrome counts did mean zero syndromes, then documented counts and trends remain valid; however, there is the possibility that some syndromes were not reported.

Ad hoc paper-based surveillance systems like this one can benefit public health professionals in disaster settings because of their ease of implementation and usefulness during and after the disaster. Fax machines, however, may not be operational in all situations, which may limit the usefulness of this system. Where there is greater destruction, alternative reporting methods may be necessary, such as mobile phone–based applications that have been shown to improve timeliness, although they require careful planning and training before the disaster.[11]

Our evaluation was limited by the lack of evidence from evacuation centres, no interviews with evacuation centre staff and no paper-based forms containing the original data. The small convenience sample of interviewees reduced the generalizability of findings, and the long duration between the disaster and interviews may have resulted in recall bias. Interviewees did consult emails, notes and other files to improve recall. Future evaluations should be completed soon after operations cease and include representation from all reporting levels of the system. Finally, we were unable to assess the sensitivity of the system because of a lack of comparative information.

For future post-disaster surveillance systems, we recommend that the chain of communication be as direct as possible: preferably, evacuation centre to central command. The public health department should receive the daily summaries but not be directly involved in the system. Removing influenza testing would increase simplicity and avoid needing trained professionals for confirmatory testing, and syndromic data should be sufficient. A manual of operations written in plain language is also recommended, and this should clearly describe zero reporting, the communication of risk assessment findings and the dissemination of reports to non-health care staff. Finally, we recommend pilot testing this system on a mobile phone application.

To conclude, this simple and acceptable ad hoc paper-based surveillance system can be employed quickly and usefully in disaster situations where there are no other options. A simple, plain-language manual should be developed to ensure optimal operation.

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Epidemic intelligence needs of stakeholders in the Asia–Pacific region

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Objective: To understand the global outbreak surveillance needs of stakeholders involved in epidemic response in selected countries and areas in the Asia–Pacific region in order to inform development of an epidemic observatory, Epi-watch.

Methods: We designed an online, semi-structured stakeholder questionnaire to collect information on global outbreak surveillance sources and limitations from participants who use epidemic intelligence and outbreak alert services in their work in government and nongovernment organizations in the Asia–Pacific region.

Results: All respondents agreed that it was important to remain up to date with global outbreaks. The main reason cited for following global outbreak news was as an early warning for serious epidemics. Mainstream media and specialist Internet sources such as the World Health Organization (n = 54/91; 59%), the Program for Monitoring Emerging Diseases (ProMED)-mail (n = 45/91; 49%) and the United States Centers for Disease Control and Prevention (n = 31/91; 34%) were the most common sources for global outbreak news; rapid intelligence services such as HealthMap were less common (n = 9/91; 10%). Only 51% (n = 46/91) of respondents thought that their sources of outbreak news were timely and sufficient for their needs.

Conclusion: For those who work in epidemic response, epidemic intelligence is important and widely used. Stakeholders are less aware of and less frequently use rapid sources such as HealthMap and rely more on validated but less timely traditional sources of disease surveillance. Users identified a need for more timely and reliable epidemic intelligence.

Emerging and re-emerging diseases are significant threats to global health security. The Asia–Pacific region has been the global epicentre for many emerging infectious diseases, including some with pandemic potential.[1] The emergence of new diseases such as severe acute respiratory syndrome and avian influenza, the threat of diseases external to the region such as Ebola, and recurring outbreaks of endemic diseases highlight the ongoing threat that infectious diseases pose to national, regional and international health security.[1–4] The Asia–Pacific region encompasses two World Health Organization (WHO) regions: South-East Asia and the Western Pacific, home to 3.4 billion people, or over 53% of the world's population.[5] The region is one of the most diverse areas in the world in terms of socioeconomic development, geography and geopolitical influence.[5] It is also particularly vulnerable to emerging and re-emerging infectious diseases due to several factors including increased population growth and movement, urbanization, globalization, limited access to health care, changes in food trade, land degradation and encroachment on natural habitats and antimicrobial resistance.[1,6,7] This rapidly changing landscape, along with weak health systems, limited health infrastructure, resource constraints (financial, human, technical), geographical isolation and poor population health, challenge countries' abilities to adequately prevent, detect and respond to public health threats.[8–11]

The ability to rapidly detect and respond to infectious diseases is critical to global health security. The International Health Regulations, or IHR (2005), provide the legal framework to protect the international community from these threats, requiring Member States to develop core capacities to detect, assess, notify and respond to public health threats and events of national and international concern.[12]

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IHR (2005) emphasize the importance of incorporating event-based surveillance with traditional systems to detect public health risks.[12] Event-based surveillance is "the organized and rapid capture of information about events that are a potential risk to public health".[13] Information can be reported through official or unofficial channels such as media reports, health-care workers and nongovernment organizations.[14,15] While traditional indicator-based surveillance systems are essential for collecting and analysing information on known diseases, event-based surveillance systems use broad definitions to detect rare or unusual events and are more timely and sensitive.[13,16,17] They are an essential tool for the rapid detection and assessment of events that could pose serious risks to public health.

Increased availability and reliance on the Internet has driven the development and acceptance of event-based Internet surveillance as a key tool and source of epidemic intelligence.[17,18] This method brings together disparate sources of data from the Internet to provide a comprehensive overview on the current state of global infectious disease events in near real-time for public health action.[19] There are three types of event-based Internet surveillance methods for rapid epidemic detection: (1) existing Internet-based surveillance systems and news aggregators that use event-based reporting and syndromic surveillance; (2) search query surveillance using web-based search engines; (3) social media.[20]

Understanding countries' needs to detect and respond to infectious disease risks is relevant to common frameworks such as IHR (2005) and the Asia Pacific Strategy for Emerging Diseases that require cost-effective surveillance tools to coordinate health security activities. There are limited studies on the epidemic intelligence needs of end-users. A review of evaluations of 11 global electronic event-based biosurveillance systems found that evaluations focused on the quantitative analysis of system performance.[16] The authors recommended that future evaluations assess the usefulness of systems for public health action for end-users. Stakeholder engagement in all stages of surveillance system development from planning to implementation is important to create a successful and useful system that meets end-users' needs.[16,21]

As part of the development of a new epidemic observatory, Epi-watch, we sought to understand the global outbreak surveillance needs of stakeholders involved in epidemic response and surveillance in Australia, Pacific island countries and territories (PICTs), Indonesia and Malaysia. Epi-watch is an epidemic observatory currently in development by Australia's National Health and Medical Research Council's (NHMRC) Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) that monitors and provides critical analysis of global outbreaks and epidemics of public health significance for use by policy-makers, governments and other stakeholders.

The aim of this survey was to understand the global outbreak surveillance needs of stakeholders involved in epidemic response in Australia, PICTs, Indonesia and Malaysia to inform the further development of Epi-watch.

METHODS

A semi-structured stakeholder survey was developed and administered electronically using SurveyMonkey (San Mateo, California, USA) between 27 June 2017 and 9 October. The survey questions pertained to respondents' employment characteristics (organization location and type, occupation and position level) and global outbreak surveillance sources (automated outbreak alerts, reasons for following outbreak news services, types of sources and services accessed, limitations of outbreak sources, timeliness and adequacy of outbreak news sources, types of journals accessed at least once a month and preferred format to receive information). Responses to questions consisted of pre-defined single and multiple choice options and a free text "other" option.

The survey was piloted in June 2017 on five individuals with infectious disease experience in government and academic institutions in Australia. Minor changes to the survey were made following feedback to improve the consistency and clarity of questions. Pilot participants were not included in the survey sample or results. The final survey was offered in English, French and Bahasa Indonesia. The survey questionnaire was forward-translated into French and Bahasa Indonesia.

We invited participants to complete the survey from the following countries and areas: Australia; PICTs (American Samoa, Cook Islands, Fiji, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Commonwealth of the Northern Mariana Islands, Samoa, Tokelau, Tonga, Vanuatu); Indonesia; and Malaysia. Our sample was targeted to selected countries so that results would be relevant to inform development of an epidemic intelligence system for use within the region. Malaysia and Indonesia were selected in particular because of ongoing, separate research on epidemic surveillance in the Malay and Indonesian languages.

We used several methods to recruit participants. Eligible participants were those who use epidemic intelligence and outbreak alert services in their work across government and nongovernmental organizations. Purposive and snowball sampling methods were used to select individual participants. Representatives of all PICTs were invited to participate through the Pacific Community (SPC).[22] In Australia, participants were identified through the Communicable Diseases Network of Australia, federal and jurisdictional health department websites, an existing list of public health contacts held by the study team, colleagues and organization websites. Malaysian and Indonesian participants were identified through ministries of health. Participants were chosen based on their role and field of employment meeting the study inclusion criteria.

The survey was emailed to 108 participants from Australia, 13 participants from PICTs, four from Malaysia and three from Indonesia. Participants were asked to forward the survey link to relevant colleagues. Three email reminders to complete the survey were sent to countries with a low response rate to meet our overall target sample size of 88.

In addition to emailing eligible participants, a stakeholder workshop was organized by ISER in October 2017 to explore in more depth the outbreak surveillance needs of stakeholders. Workshop attendees were required to complete the survey as a prerequisite for attendance. Eligible attendees at the Communicable Diseases Control Conference in Melbourne, Australia from 27 to 28 June 2017 were also invited to complete the survey.

Responses were downloaded from SurveyMonkey and imported into and analysed using STATA-SE (Version 14.0, StataCorp, College Station, Texas, USA). To calculate proportions, two denominators were used as relevant, total number of responses or respondents. To ensure confidentiality of the respondents and strengthen the analysis, employment characteristic results from PICTs were combined; results from Malaysia and Indonesia (Bahasa Indonesia and Bahasa Malaysia were considered part of a single language group, the Malay language) were also grouped together.

Ethics

Ethics approvals were obtained from the following committees: University of New South Wales (UNSW) Human Ethics Committee (HC17466), Australian National University Human Research Ethics Committees (2017/517), Malaysia Medical Research and Ethics Committee (NMRR-17–1784–37514), Indonesian Health Research Ethics Committee (LB.02.01/2/KE. 328/2017), Fiji National Health Research Ethics Review Committee (2017.145.MC), Tonga National Health Ethics and Research Committee (310817), and Samoa Health Research Committee (no reference number was allocated). The UNSW ethics approval for conduct of this research was accepted by ministries of health in American Samoa, Cook Islands, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Commonwealth of the Northern Mariana Islands, Tokelau and Vanuatu.

RESULTS

There were 96 responses to the survey and a 96% (92/96) completion rate. Of the 128 surveys emailed to participants, we received a completed response rate of 72% (92/128). Five responses were excluded because respondents did not meet the study inclusion criteria, completed only the first section of the survey or selected a country from which ethics approval was not obtained, leaving 91 (95%) eligible responses.

Survey respondent characteristics

Of the 91 respondents, 55% (50/91) worked in organizations based in Australia, 30% (27/91) in organizations in PICTs and 15% (14/91) worked in Malaysia or Indonesia. **Table 1** shows the employment characteristics of survey respondents by region.

Importance of global outbreak news

All 91 respondents agreed that it was important to be up to date with global outbreaks. When asked about sources of automated global outbreak alerts (such as Google alerts or Program for Monitoring Emerging Diseases [ProMED]-mail updates), 60% (55/91) reported receiving automated alerts, 18% (16/91) followed outbreak news

Table 1. **Employment characteristics of survey respondents by country, 2017***

	Australia		PICTs		Malaysia/ Indonesia	
	n	%	*n*	%	*n*	%
Respondents	**50**	**55**	**27**	**30**	**14**	**15**
Organization type						
Federal/central government	15	30	13	48	9	64
State/territory government	30	60	4	15	2	14
Local government	3	6	6	22	3	21
International health	0	0	4	15	0	0
Peak body/organization†	2	4	0	0	0	0
Position level						
Senior decision-maker‡	17	34	10	37	5	36
Mid-career§	28	56	9	33	5	36
Junior||	3	6	5	19	1	7
Other	2	4	3	11	3	21
Employment type**						
Surveillance, monitoring and control of communicable disease	29	58	22	81	12	86
Planning, prevention and preparedness	17	34	15	56	5	36
General public health	7	14	17	63	6	43
Policy	9	18	8	30	6	43
International emergency response	3	6	12	44	2	14
Domestic emergency response	8	16	2	7	0	0
Acute care	3	6	6	22	1	7
Environmental health	1	2	8	30	0	0
Defence/military	4	8	1	4	0	0
Other	3	6	4	15	1	7

* The total number of respondents by country/region was used as the denominator to calculate percentages separately by country/region.

† Peak body refers to an expert group that provides information, support, advocacy, coordination and strategic guidance to government or nongovernmental organizations.

‡ Senior decision-maker: manages a section/branch/division/head of an organization, has significant and/or final decision-making authority.

§ Mid-career: manages a small team, has some decision-making authority and/or influence.

|| Junior: no management role, has limited authority to make decisions.

** Categories were not mutually exclusive as respondents could select more than one option.

as required, 15% (14/91) sometimes received automated alerts and 7% (6/91) never got alerts.

The most common reasons for following outbreak news were as an early warning for serious epidemics (91% [83/91]); to inform health system planning, preparedness and response (68% [62/91]); and to inform local surveillance needs (65% [59/91]) (**Table 2**).

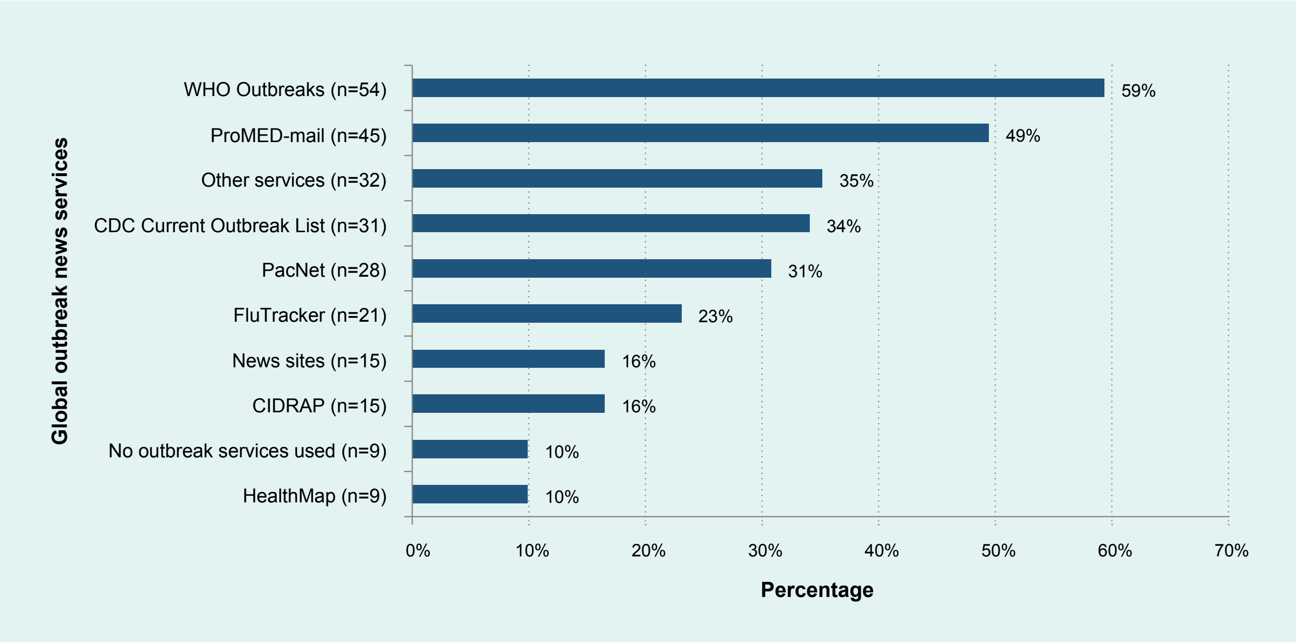
Global outbreak news sources

Fig. 1 shows the proportion of global outbreak information services used by respondents at least once a month. WHO Outbreaks[23] was used by 59% (54/91) of respondents and ProMED-mail[24] by 49% (45/91).

Other relevant services listed included Outbreak News Today[25] (6), Global Public Health Intelligence Network (GPHIN)[26] (5), EPICore[27] (4), Epi-watch[28] (4), Global Incident Map[29] (3) and UN Dispatch[30] (2). In the free text option, the International Biosecurity Intelligence System (25% [2/8]) and the European Centre for Disease Prevention and Control (ECDC) weekly reports and threat assessments (13% [1/8]) were also mentioned.

When asked about other global outbreak news sources, 64% (58/91) of respondents used mainstream media and Internet sources that target health professionals, 49% (45/91) relied on colleagues and 44% (40/91) on health practitioners (**Table 3**). Official sources such as National IHR Focal Points (29% [5/17]), the WHO Event Information Site (24% [4/17]), ECDC (24% [4/17]), the

Fig. 1. **Global outbreak news services used by respondents at least once a month, 2017*†**



* Categories were not mutually exclusive as respondents could select more than one option.

† Total number of survey respondents (*n* = 91) was used as the denominator to calculate percentages to identify the most common service used among all respondents.

CDC = Centers for Disease Control and Prevention; CIDRAP = Centre for Infectious Disease Research and Policy at the University of Michigan, USA; ProMED = Program for Monitoring Emerging Diseases; WHO = World Health Organization.

United States Centers for Disease Control and Prevention (USCDC) (18% [3/17]) and networks such as Pacific Public Health Surveillance Network (18% [3/17]) were reported as other sources used by respondents in the free text option.

Respondents were asked which journals they used at least once a month to access information on global outbreaks and infectious diseases. Multiple responses were allowed. Thirty-seven per cent (34/91) used the USCDC's Morbidity and Mortality Report, 35% (32/91) used the Bulletin of the World Health Organization, 24% (22/91) used the Western Pacific Surveillance and Response journal, 23% (21/91) used the Australian Department of Health's Communicable Diseases Intelligence journal and 20% (18/91) used ECDC's Eurosurveillance journal. Twenty-seven of 91 (30%) respondents did not use any of the journals from the options provided.

Limitations of global outbreak news

Just over half of respondents, 51% (46/91), thought their usual sources of global outbreak news were timely enough for their needs, 20% (18/91) did not find their sources timely and 29% (26/91) were unsure. Fifty-one

Table 2. **Reasons for following global outbreak news, 2017*†**

Reasons for following global outbreak news	*n* = 91	%
As an early warning for serious epidemics	83	91
To inform health system planning, preparedness and response	62	68
To inform local surveillance needs	59	65
To inform local clinical and health system needs	40	44
For general interest	35	38
To fulfil IHR (2005) requirements	27	30
For the safety of staff deployed to affected areas	21	23
Outbreak alerts are not relevant for my needs	0	0
Other	4	4

* Categories were not mutually exclusive as respondents could select more than one option.

† Total number of respondents (*n* = 91) was used as the denominator to calculate percentages to identify the most common reasons for following global outbreak news among all respondents.

Table 3. **Reported timeliness and sufficiency of global outbreak news sources, 2017***

Global outbreak news sources†	Are your sources of global outbreak news timely enough for your needs?						Are your sources of global outbreak news sufficient for your needs?					
	Yes		No		Unsure		Yes		No		Unsure	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Mainstream media (*n* = 58)	29	50	13	22	16	28	28	48	15	26	15	26
Specialist Internet sources‡ (*n* = 58)	36	62	10	17	11	19	32	55	14	24	11	19
Colleagues‡ (*n* = 45)	23	51	10	22	11	24	20	44	11	24	13	29
Health practitioners (*n* = 40)	19	48	9	23	12	30	19	48	10	25	11	28
Communicable Diseases Network Australia (CDNA) (*n* = 36)	21	58	4	11	11	31	25	69	6	17	5	14
Social media (*n* = 27)	14	52	9	33	4	15	14	52	9	33	14	15
Other (*n* = 17)	11	65	2	12	4	24	10	59	2	12	5	29

* Total number of responses for each global outbreak news source was used as the denominator to calculate percentages for timeliness and sufficiency for each source separately, as not all respondents used all sources.

† Categories were not mutually exclusive as respondents could select more than one when selecting global outbreak news sources.

‡ One respondent who used these sources reported that timeliness and sufficiency were not relevant to their needs.

per cent (46/91) of respondents thought that their usual sources of global outbreak news were sufficient enough for their needs. Twenty-four per cent (22/91) found their sources were insufficient, and an equal proportion were unsure. One respondent (1/91) reported that timeliness and sufficiency were not personally relevant.

The timeliness and sufficiency of outbreak news sources were cross-tabulated by respondent's usual sources of global infectious disease outbreak news (**Table 3**). Sixty-two per cent (36/58) of respondents thought that specialist Internet sources such as event-based Internet surveillance systems were timely enough for their needs, and 55% (32/58) found these sources sufficient (**Table 3**).

When asked about the limitations of global outbreak news sources, 42% (38/91) of respondents reported that there was not enough critical appraisal, and 40% (36/91) did not have enough time to read/watch or listen to information. Thirty-two per cent (29/91) of respondents identified that there was not enough information, 30% (27/91) that the sources were not timely enough, and 26% (24/91) that there were too many different sources and did not know which one was best. Twelve per cent (11/91) reported other reasons, such as a delay in or no reporting of events at the country level and lack of local relevance. Nine per cent (8/91) reported no limitations in their sources. Multiple responses were allowed for this question.

Preferred format to receive global outbreak news

Respondents overwhelmingly preferred email as a mechanism to receive global outbreak news. Eighty-seven per cent (79/91) of respondents selected this option; 7% (6/91) of respondents preferred websites; 3% (3/91) chose a weekly video presentation; and one each opted for the use of short message service (SMS), social media and other formats. This question did not allow for multiple responses, and feedback from some respondents indicated that they may have had several preferred methods for receiving information, depending on the nature of the outbreak.

A final question asked respondents to provide any other feedback. Answers included needing information for different purposes such as preparation of emergency plans, border health control and advice to traveller consultations; a need to better inform health officials for preparedness, planning and response; and a need for systematized unified surveillance.

DISCUSSION

Our survey provides insight into the epidemic intelligence needs of a diverse range of stakeholders from across the Asia–Pacific region. There was consensus that timely and easily accessible global outbreak notifications are essential to plan for and respond to public health risks. Respondents' professional needs are consistent with the key attributes of successful event-based surveillance systems: to be simple, flexible, timely and sensitive.[15] With automated alerts being the predominant information-seeking strategy employed by respondents, Internet-based services that provide this function can support the rapid and timely identification of events to limit the spread and severity of disease outbreaks.[31]

A limitation of event-based surveillance systems is that new information is not necessarily disseminated efficiently.[32] While HealthMap[33] is a rapid intelligence source, it was only used by 10% of participants, possibly reflecting low awareness of this resource. Consumers preferred global outbreak alert systems be flexible in the way information is accessed and disseminated. Email was identified by respondents as the preferred communication method to receive global outbreak news; however, these needs may change depending on the context of the outbreak and over time (reflecting generational change in the use of communication technology); systems should consider a range of media such as SMS and social media. Communication technologies such as social media can be harnessed for rapid access and dissemination of information to support emergency preparedness and response.[34]

The use of mainstream media and specialist Internet sources for global outbreak news is not surprising given the increased accessibility and reliance on the Internet for information and acceptability of event-based Internet surveillance systems. Approximately 65% of initial reports to WHO about infectious disease events come from informal sources such as the Internet.[35] A 2017 systematic review of event-based Internet biosurveillance systems identified 50 systems, 37 of which were online and fully functioning at the time.[36] Many of these systems use mainstream media as a key source of information.[17,36] The finding that the same proportion of respondents used both mainstream media and specialist Internet sources for global outbreak news suggests that Internet-based services are not meeting end-users' needs, and other media sources are required to supplement information leading to duplication of effort.

Timeliness of global outbreak news sources was a limitation identified by 51% of survey respondents. One study explored end-users' perceptions of the attributes of seven publicly available event-based Internet surveillance systems and found that timeliness scores ranged from 33% to 100%.[15] Official sources such as WHO Outbreaks[23] and the CDC's Current Outbreak List[37] were more commonly used by respondents over other services such as HealthMap[33] but are less timely. Previous studies have documented significant delays in official reporting of outbreaks compared to unofficial reports.[38,39] Research has identified that the majority of event-based Internet surveillance systems are generated from North America and Europe; few local systems in the Asia–Pacific region and event-based surveillance systems in general are not well understood in developed and developing countries.[32,36] Increased awareness of the availability and operability of systems providing timely, relevant and reliable information to professionals in the region could address some of these concerns.

Unofficial reports are key sources of information for Internet-based systems, but they can be subject to noise and false alerts, potentially causing unnecessary investigation or alert fatigue among responders.[18] Our findings suggest that reliability and accuracy are important considerations in the choice of global outbreak surveillance sources; however, many respondents were unable to identify the best sources to use. WHO Outbreaks[23] and ProMED-mail[24] were the most commonly accessed sources by many respondents. ProMED-mail is qualitative, but it uses human moderators to review alerts for relevance and accuracy before dissemination, increasing the reliability of reports.[40] A service that can provide critical appraisal, including risk assessment within the broader context of the region, could address the need for more reliable information and help facilitate countries' abilities to assess risks and inform decision-making for the response required.

This study had several limitations. Due to the cross-sectional online survey design, we were unable to monitor trends in responses/behaviour over time, and findings may not be representative because of the snapshot nature of the timing of the survey and possible non-response bias. As we were interested in stakeholder views at a point in time, this design was appropriate. The online nature of the survey meant that questions could not be explored in-depth; however, a free text option was provided for most questions. Limited access to the Internet and computers in remote and resource-constrained areas could have affected the response rate. Compared to positing surveys, this was the most feasible option, and with some of the most remote PICTs participating, we do not believe access was a major barrier. The study employed purposive sampling instead of probability sampling because of the small and highly specialized pool of eligible participants. While this approach ensured participation of professionals from a wide range of backgrounds and levels who use epidemic intelligence, it can create researcher bias because of the judgmental nature of sample selection. Epidemic response is a small and specialized field, so the sample frame from which we could draw was small, making purposive sampling the most appropriate. Limited inclusion of other large Asian countries, differences in participant selection across countries and low numbers of respondents meant that results could not be compared between countries and may not be generalizable to other countries or representative of the whole Asia–Pacific region. Finally, survey versions in languages other than English were not back-translated, which may have affected the quality of these responses. As 11% (n = 10) of respondents completed the survey in a language other than English, translation inaccuracies are unlikely to have any impact on the overall validity of the survey. Further research on language-specific needs for epidemic surveillance is warranted.

CONCLUSION

For those who work in epidemic response, epidemic intelligence is important and widely used. The choice of sources for global outbreak news varies, and there is less use and awareness of rapid sources such as HealthMap and more reliance on less timely, traditional sources such as WHO and public news media. We identified a need for more timely and reliable epidemic intelligence in the Asia–Pacific region. More effective and efficient sources and methods to deliver user-friendly intelligence to end-users should be explored. There are several global outbreak surveillance systems available; development of a new system should take into consideration how it can integrate into and add value to already established systems within the region.

Conflicts of interest

The authors declare no conflicts of interest.

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