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Contamination of Potable Water at Penang International Airport – a Disaster Averted

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Abstract

On 1 Oct 2010, the Penang International Airport started major renovation and construction. Water was distributed by a network of pipes for use on flights and at the airport. On 7 Oct 2010, coliforms were found in the water during routine sampling. Subsequent sampling showed further contamination at other areas in the water distribution system. An investigation was carried out to determine the scope and extent of the problem, identify the source of contamination and make sure that the water consumed at the airport was potable. Environmental inspection and observation were performed, workers were interviewed and surveillance data were reviewed. The water reticulation system was studied and water was sampled. Surveillance data showed that the contamination was localized within the airport only. Coliforms were detected at many water outlets along the various distribution lines. The pipes were flushed with disinfectant and water filters were provided to food outlets. This water contamination occurred after the onset of construction. The earthworks damaged the pipelines. After the remedial actions, the contamination was cleared and the water supply was kept safe until the completion of new pipes in July 2011.

Key words: water contamination, airport, potable water

Introduction

The leading causes of waterborne outbreaks in Malaysia are cholera, typhoid fever, hepatitis A, dysentery and food poisoning. The contributing factors identified are related to unhygienic food handling practices followed by inadequate safe water supply and poor environmental sanitation.[1] In general, increased level of fecal coliform in water provides a warning of water treatment failure, a break in integrity of the distribution system or contamination with pathogens.

Penang International Airport serves as the main airport for the northern region of Malaysia. Over 3.4 million passengers passed through the terminal in 2008.[2] The airport is the hub for low cost carriers and serves a terminal for 14 other airlines. The airport water is used for drinking on all flights, food outlets at the terminal and food preparation for flights.

On 1 Oct 2010, the airport started major renovation and construction. On 7 Oct 2010 (epidemiology week 40), coliforms were found in the water samples during monthly microbial sampling at the airport. Subsequent samplings showed that there was more contamination at other areas in the distribution system.

Following discovery of contamination, an investigation was carried out to determine the scope and magnitude of the problem, identify the source of contamination and make sure that the water consumed at the airport was potable.

Methods

This is a descriptive study on water safety at the Penang International Airport. To determine the scope and magnitude of the problem, we examined surveillance data for acute gastroenteritis in the community and within the airport. Acute gastroentiritis is daily and weekly monitored at all health districts. The airport comes under the purview of the Barat Daya District Health Office where the data are captured and monitored. Data were analyzed for epidemiology weeks 30 to 42 (25 Jul to 23 Oct 2010) to compare if there was an increase in incidence of acute gastroenteritis in the community. Acute gastroenteritis was defined as diarrhea with abdominal cramps or pain, bloody stools, nausea and vomiting.

All workers and staff at the airport terminal were interviewed about presence of acute gastroenteritis over the epidemiology weeks 41 to 42 (10-23 Oct 2010) .

We also reviewed the data on routine drinking water quality, monitoring outside the airport perimeter. Water was sampled every month for chemical and microbiological contamination at the five fixed sampling points and was sent to the Chemistry Laboratory in Penang for analysis. This sampling was carried out by the water quality team from the Barat Daya District Health Office. The results were sent to the State Engineer at the State Health Department, who compiled and analyzed the data for the whole state. We reviewed the data from these five sampling points for presence of coliforms and *E. coli*.

In order to identify the source of contamination, we interviewed the supervisor of the construction site and manager of the Malaysian Airports to determine if any broken pipes or any other unusual events occurred during the construction.

Map of the water reticulation system in the airport was reviewed to determine the distribution lines that went through the airport. Outlets fed by the various lines were identified and water was sampled from the point of use for microbiological contaminants. Sampling was carried out according to the guidelines of the Engineering Department under the Ministry of Health, Malaysia. Disinfection of the pipe opening was carried out prior to sampling. At the water source pipe, because all were metal pipes, area around the pipe was first wiped clean with a wet cotton swab. The water was allowed to flow for about 2-5 minutes. The pipe was wiped with 70% methyl alcohol solution using a cotton swab and was then burned with a blow torch. Water was again allowed to flow freely for 2-5 minutes before it was collected in a thiobag containing sodium thiosulphate. Water was filled up to the 100ml line. The bag was then transported in a cool box to maintain the temperature at 4-10 degrees centigrade. The samples were sent on the same day to the Chemistry Laboratory in Penang for analysis by membrane filter for total coliforms and *E. coli*.

We evaluated the presence of contamination by regularly collecting water samples at the distribution lines and at the points of use. Since coliforms were still present at two out of seven lines, we carried out further investigations and observation to determine the cause of the problem.

Results

Surveillance of Community and Workers

There was no unusual increase in acute gastroenteritis cases at Barat Daya District (Figure 1).

Surveillance carried out amongst 681 out of 685 staff and airport workers for epidemiology weeks 41 and 42 showed that one case of acute gastroenteritis was reported in week 41 and two cases in week 42. There was no increase in incidence of acute gastroenteritis.

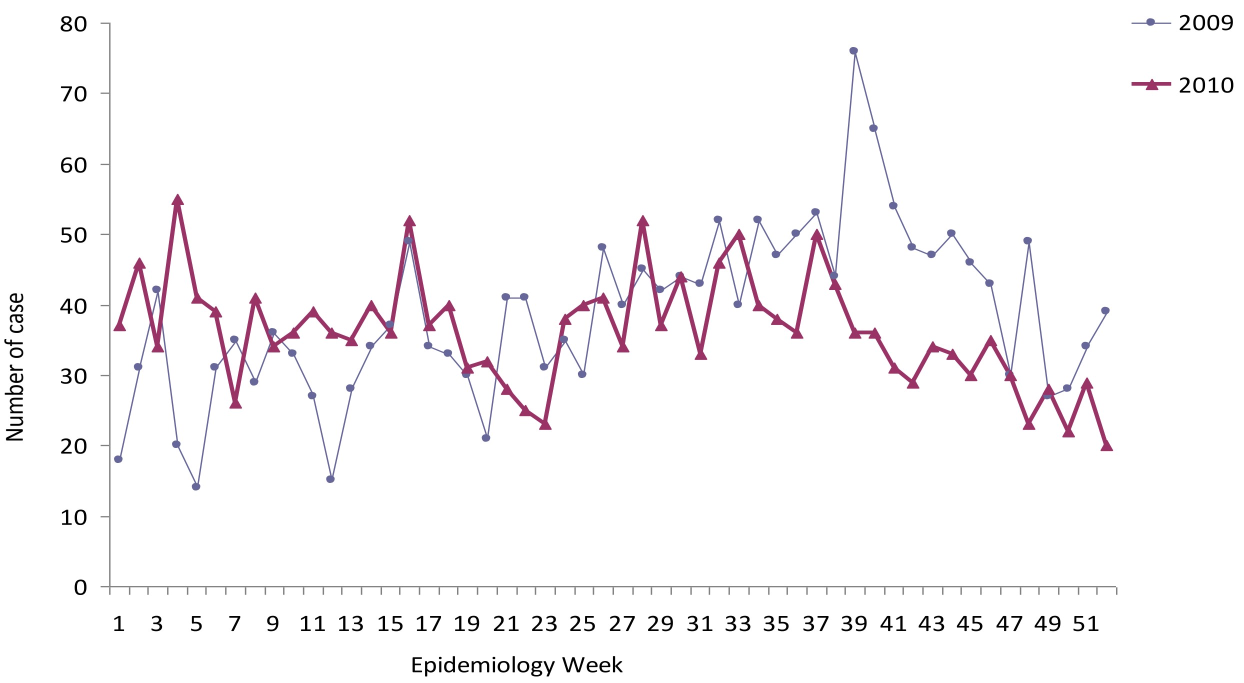

Figure 1. Acute gastroenteritis cases reported to Barat Daya District Health Office in 2009 and 2010

Water Monitoring Outside the Airport Perimeter

Routine monthly monitoring of drinking water outside the airport perimeter was carried out at five points closest to the airport by the Barat Daya District Health Office. Sampling was carried out on 11 Oct 2010 and there was no coliforms present in any of the samples. Up till November 2011, sampling was negative for coliforms.

Identification of Contaminated Source

During interview, we learned that the water hydrant located near the northern end of the terminal building had been relocated when the earthworks was started and the pipes in the area were submerged in a pool of stagnant water. On 24 Oct 2010, the hydrant was moved again and the submerged pipes were removed.

Provision of Potable Water

At 19:10 on 27 Oct 2010, bleach (sodium hypochlorite) at a concentration of five ounces per 1,000 gallons was put into the water tower and the water supply was shut off for 12 hours. It was then flushed out at 07:00 in the following morning. Water sample on 28 Oct 2010 showed presence of coliforms at the Outlet 12 (Table 1). On 30 Oct 2010, coliforms were present in two of the seven lines which included one line to the Outlet 5 and 6 at aircraft area, and one line to the food outlets 20 and 21 located at Level 2 (Figure 2).

From our investigation, the Outlet 20 never used water from the main water supply. They collected water from sinks in the restroom and the water was used at that food outlet for drinks and snacks preparation. After that, a pump channeled the water to a filter and then to the tap. The filter was observed to be in brown color.

The Outlet 21 at Level 2 used water from an extension pipe that was channeled from the lines above the ceiling. Even though they used a filter, it had not been cleaned.

After flushing with bleach, water filters were provided to all food and beverage outlets. A monthly schedule for changing the membrane was put up. These filters were used temporarily until the pipes for extensions to the airport were laid. The Outlet 20 was ordered to set up a water pipe in order to provide potable water. In the meantime, they were allowed to sell only ready to eat foods.

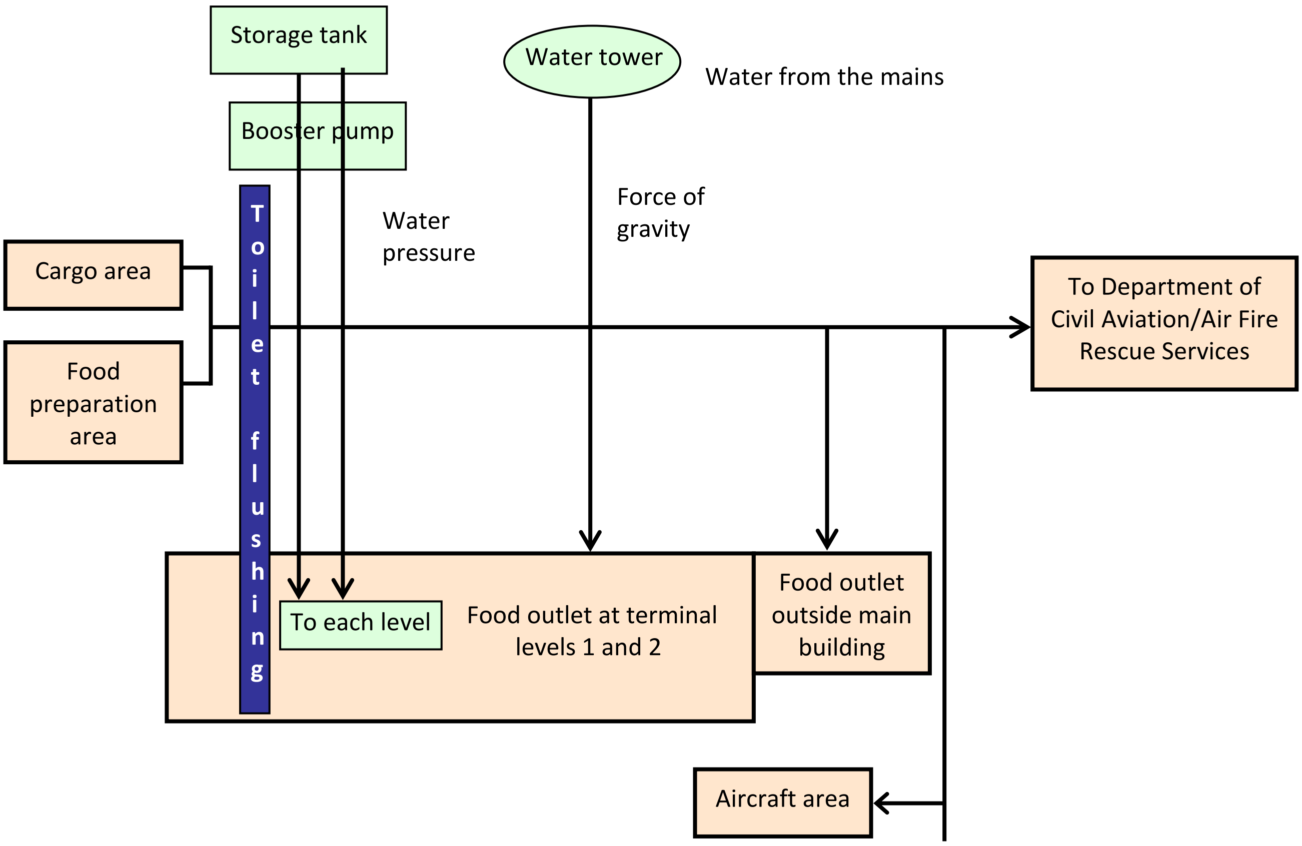

Figure 2. Schematic map of the water reticulation system at the Penang International Airport in October 2010, showing the areas covered by water sampling from 27 Oct to 2 Nov 2010

Table 1. Total coliforms level in drinking water supply collected from reticulation lines at Penang International Airport, 22 Oct to 4 Nov 2010

Location of line	Outlet	Date of water sampling													
		22 Oct	23 Oct	24 Oct	25 Oct	26 Oct	27 Oct	28 Oct	29 Oct	30 Oct	31 Oct	1 Nov	2 Nov	3 Nov	4 Nov
Aircraft area	1	-	-	-	●	●	●	-	●	●	-	●	●	-	-
	2	-	-	-	-	-	1	-	-	-	-	●	●	-	-
	3	-	-	-	●	●	●	-	-	-	-	-	●	-	-
	4	-	-	-	-	●	-	-	-	-	-	-	-	-	-
	5	-	-	-	●	1	●	-	●	1	-	-	●	-	-
	6	-	-	-	-	-	-	●	●	9	-	-	●	-	-
Food outlet outside main building	7	-	-	-	●	●	●	-	●	●	1	●	●	-	-
Booster pump	8	-	-	-	1	-	-	●	●	●	●	●	-	-	-
Food preparation area	9	●	-	-	2	-	-	●	●	●	●	-	●	-	-
Cargo area	10	-	-	-	37	-	-	●	-	●	-	-	●	-	-
Water tower	11	-	-	-	-	1	-	●	-	●	●	●	-	-	-
Food outlet at level 1	12	90	-	-	●	●	-	66	●	●	●	●	●	-	-
	13	-	-	-	●	-	●	-	●	●	●	●	-	-	-
	14	-	-	-	3	●	1	●	●	●	●	●	●	-	-
	15	-	-	-	9	-	-	●	●	-	●	●	-	-	-
Food outlet at level 2	16	-	-	-	>100cfu	●	●	●	-	●	●	●	-	-	-
	17	-	-	-	●	●	●	●	-	●	●	●	-	-	-
	18	-	-	-	13	-	-	●	-	●	●	-	-	-	-
	19	-	-	-	●	-	-	●	●	●	●	●	-	-	-
	20	-	-	-	-	-	-	25	10	2	1	-	●	-	-
	21	-	-	-	-	-	3	1	●	3	●	●	●	-	-
	22	-	-	-	19	-	●	●	-	●	●	-	-	-	-
	23	-	-	-	100	-	1	●	●	●	●	-	-	-	-

● – < 1cfu (acceptable)

> 100cfu – Too numerous to count

(-) – No water sample collected on that date

Note: All samples were tested for total coliforms and E. coli. All samples were less than 1cfu for E. coli.

Since 1 Nov 2010, there was no more contamination and subsequent samplings conducted later in this month showed that the water was free of coliforms. *E. coli* was less than 1cfu per 100ml in all the samples.

In summary, water contamination with coliforms was localized to the airport. It coincided with the earthworks in the area where the water pipes were broken. Initially, all the lines were contaminated. Flushing and disinfection with chlorine cleared the coliforms from all, except four out of 23 points. Two (Outlets 20 and 21) out of these four points had contaminated filters, which was rectified with changing of the filters, while the other two (Outlets 5 and 6) were the furthest from the flushing point and took longer to clear the contamination. With these actions, all lines were supplied with potable water.

Discussion

This incident in the international airport had the potential to cause severe morbidity. Airlines staff and airport workers depend on foods that were prepared using the tap water. Typhoid and hepatitis A are endemic waterborne pathogens in Malaysia.[3]

The contamination was detected through routine water sampling at fixed points which were situated along only one distribution line. Since the policy on monitoring of drinking water quality in Malaysia was to monitor water monthly at fixed points but not at the points of use, this may not detect any contamination. Thus, importance of testing water at the points of use was recommended after this incident. As a result, the number of formal sampling points was increased to cover all the lines, including the points of use at the food outlets. In addition, these sampling points were ordered to be well closed in order to prevent external contamination.

Although food and waterborne illnesses associated with air travel is not common today, it may have serious implications. Safety may be threatened if the crew are affected. Quality of inflight catering depends on high standards of food preparation and safe water.[4] The water from the airport is transported for use on aircrafts. World Health Organization has set up guidelines on water safety for use on aircrafts which cover the water provided at source, transport and transfer to the aircraft as contamination can occur anywhere along the process.[5] There is no evidence of water being tested in this country after it has been transferred to the flights. In a study carried out by the Environmental Protection Agency (EPA) in the Unites States in 2004, approximately 15% of 327 water samples on flights tested positive for coliforms.[6] In another series of data on aircraft water tested in February 2008 released by the EPA, 10% out of 2,258 aircrafts had water positive for coliforms.[7] As budget airlines do not provide free water on flights and it has to be bought at a high cost, people may consume the tap water. Similarly, with the new regulations of not allowing bottled water taken into the departure area and the high price of bottled water, more people would resort to drinking from the water fountains, thereby being at risk.

Quick action helped to avert a potential disaster. As renovation was going on, there was a constant risk of pipes being broken. To overcome this, water at the points of use needs to be potable at all times. This was done by using the filters as specified standards of drinking water quality from Ministry of Health. The cost of fixing these filters was born by the airport management team.

The renovation to replace the old lines was previously planned by mid 2012. However, the process of laying new pipes was expedited after this incident and was completed in July 2011. During this period, there was no more contamination identified.

Limitations

We did not carry out surveillance of the passengers. As there was no sampling of water at food outlets prior to this incident, we could not know if the water was contaminated before that. However, disinfection and chlorination removed coliforms from all the lines.

Conclusion

Water contamination with coliforms occurred at the Penang International Airport after the onset of construction work. It might be due to the broken pipes. After repairing the pipes and flushing and disinfection with chlorine, the contamination was removed.

Public Health Actions and Recommendations

To ensure that water on flights is always potable, it is recommended that water onboard should be regularly tested for microbilogical contaminants.

On follow up in May 2012, massive renovations and construction in most of the outlets were moved out or relocated to elsewhere.

Suggested Citation

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<http://www.osirjournal.net/issue.php?id=38>.

References

1. Ismail A. An update on diarrhoeal diseases in Malaysia. Southeast Asian J Trop Med Public Health. 1988 Sep;19(3):397-400.

2. Penang International Airport. [cited 2011 Dec 7]. <http://www.malaysiaairports.com.my/index.php/international/penang-international-airport.html>.

3. Malaysia. Ministry of Health. Annual Report 2008.

4. McMullan R, Edwards PJ, Kelly MJ, Millar BC, Rooney PJ, Moore JE. Food-poisoning and commercial air travel. Travel Med Infect Dis. 2007 Sep;5(5):276-86. Epub 2007 Aug 22.

5. World Health Organization. Guidelines for drinking-water quality. Vol 1: recommendations. 3rd ed. 2004.

6. Rapid Microbiology. EPA announces new aircraft drinking water quality data. [Cited 2011 Dec 7]. <http://www.rapidmicrobiology.com/news/0501240.php>.

7. Summary of Airplane Water Tests released by EPA through February 11, 2008. [Cited 2012 May 31]. <http:ablocal.go.com/image/kgo/air-water-data revised022708.pdf>.

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Investigation on a Dog Rabies Case and Rabid Dog Meat Consumption, Nakhon Phanom Province, Thailand, 2011

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Abstract

In March 2011, public fear on health risk of rabid dog meat consumption was emerged in Nakhon Phanom Province. Investigation was conducted to identify extent of exposure and recommendation for rabies prevention. We surveyed in affected villages to find out rabies cases and exposed contacts among dogs, cats and humans. Persons who had contacted with the rabid dog, its carcass or meat were interviewed about their contacts, knowledge, attitudes and practices (KAP) towards rabies. The survey revealed that three owned dogs had been bitten by the rabid dog and 58 persons contacted it. Among the contact persons, 11.3% (bitten by the rabid dog, contact with carcass or saliva, butchered or cooked) and 19.0% (contacted dogs bitten by the rabid dog) fit in the WHO criteria as exposed and possible exposed persons respectively. Thirty two persons who ate well cooked meat of the rabid dog were classified as non-exposed persons. One third of the contact persons did not know about rabies. Persons who ate rabid dog meat had less knowledge on rabies reservoir and transmission compared with those did not eat (P-value <0.05). Contact persons and dogs were provided with post-exposure vaccination; none of them developed rabies. Several types of exposure, except ingesting well cooked meat, posed risk of rabies and local public should be educated about these for better personal protective practices.

Key words: rabies, dog, dog meat consumption, KAP, Nakhon Phanom

Introduction

Rabies is a fatal infectious disease transmitted from animals to humans. It is caused by rabies virus while dogs are the major reservoirs.[1] Since the principle route of rabies transmission is through saliva, most human rabies is infected by dog bites, scratch or lick on the broken skin. However, human cases due to contact with infectious saliva or neurological tissues through mucous membranes are rarely occurred. There were reports of rabies transmission from ingestion in experimental setting and anecdotal viral transmission to a lamb and a human infant by milk.[2] Human rabies caused by eating dog meat has been reported in Vietnam.[3] The National Association of State Public Health Veterinarians (NASPHV) recommends against consuming tissues and milk from rabid animals.[1]

Rabies is still endemic in Thailand with annual reported cases of 10-20 in humans and 200-300 in animals. Dog meat is regarded as a traditional cuisine in some areas of Thailand. The meat is butchered and sold locally without any inspection, which may pose risk of rabies transmission to people consuming dog meat. Risk behaviors, knowledge, attitude and practices (KAP) towards rabies among the risk groups should be explored to identify recommendations for rabies prevention that fit in the local context. In March 2011, public fear on rabies from dog meat consumption was emerged in Nakhon Phanom Province. Some people in Village 5, Nathon Sub-district, That Phanom District, Nakhon Phanom Province had consumed dog meat served in a funeral ceremony. Brain specimen of that dog was subsequently tested positive for rabies. Thus, an investigation team conducted survey in the affected villages to identify extent of exposure and provide recommendations for rabies prevention.

Methods

Active Case Finding in Dogs and Cats

A survey was conducted in March 2011 to identify rabies contacts and cases in dogs and cats. The survey was focused on Village 5 where the laboratory confirmed rabid dog was found. We interviewed owners of dogs and cats whether their pets have received rabies vaccination during previous 12 months, were bitten by the rabid dog and exhibited particular signs and symptoms, and also whether they observed any stray dog in the village. Owned dogs and cats were defined as suspected or confirmed cases based on the criteria developed by Tepsumethanon V and et al.[4]

A suspected rabid case was a dog or a cat in Village 5 that was reported to die or get lost by the owner within 10 days after the onset of illness and had at least one of the following signs or symptoms during 1 Jan to 23 Mar 2011: aggression, running without apparent reason, stiff walk, scratching mouth, drooped jaw and salivation, depression, laying in a dark place, could not swallow water or food, or vomiting. A confirmed rabid case was a suspected case that was tested positive for rabies by Indirect Fluorescence Antibody (IFA) test from brain specimen.

Environmental Study

Environment of the village was observed to identify the population and habitat of stray dogs. Villagers were asked to locate dog meat shops and explain the cooking procedures of dog meat.

Investigation on Human Exposure to Rabies

The contact person was the one who had contacted with the rabid dog, its carcass, its victim, rabid dog meat or cooking utensils. We interviewed those contacts about demographic characteristics, type of exposure, medications and personal protective practices. Human rabies exposure was identified based on the criteria developed by the World Health Organization.[5]

A possible exposed person was a person who had close contact with secretion from a rabies suspected animal. A probable exposed person was a person who had close contact (was bitten or scratched, killed or dissected) with an animal displaying clinical signs consistent with rabies. An exposed person was a person who had close contact (as described in probable exposure) with an animal that was laboratory confirmed to have rabies.

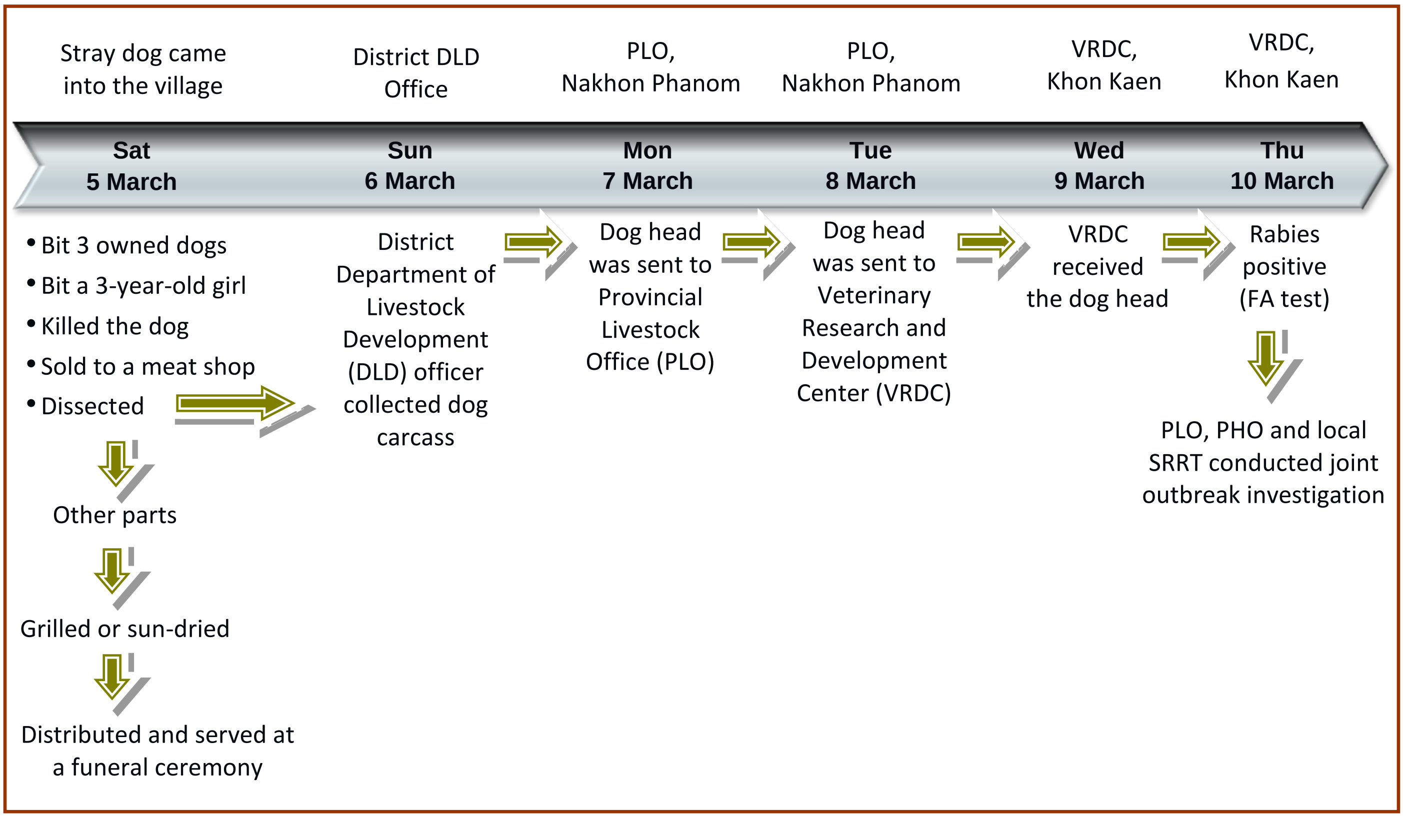

Figure 1. Chronology of events relating to the rabid dog in Village 5, Nathon Sub-district, That Phanom District, Nakhon Phanom Province, 5-10 Mar 2011

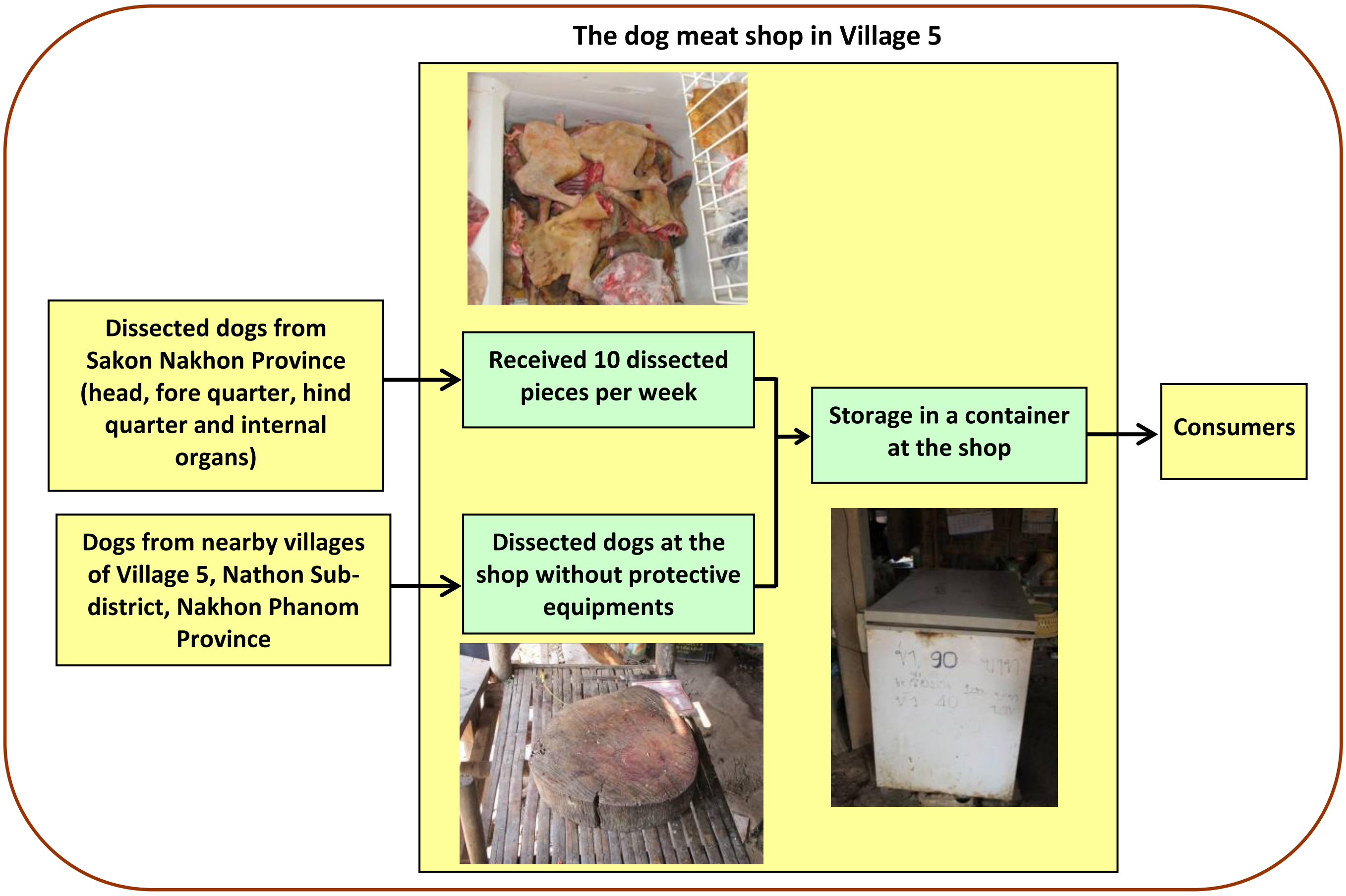

Figure 2. Pathway demonstrating sources, processing and storage in the dog meat shop in Village 5, Nathon Sub-district, That Phanom District, Nakhon Phanom Province, March 2011

Knowledge, Attitudes and Practices (KAP) Survey towards Rabies

We interviewed all contacts with a questionnaire, including information on demography, knowledge about rabies, meat consumption behavior, personal protective practices and rabies prevention practices.[6]

Descriptive statistics and chi-square test were employed for data analysis using Epi Info software (US CDC).[7]

Results

Active Case Finding in Dogs and Cats

Sixty one owned dogs and cats were identified in 35 of 85 households in Village 5. Medians of dogs and cats in each household were 1 and 2 respectively. None of the owned dogs and cats met rabies case definition. The owners reported that 64% of owned dogs and cats had been vaccinated before. As three owned dogs were bitten by the rabid dog, they were revaccinated and quarantined for 45 days. The villagers reported no other stray dog in the village.

The rabid dog was a stray dog while its origin could not be identified. It appeared in the village on 5 Mar 2011 and bit three owned dogs and a 3-year-old girl in the village before it was killed and sold to a local meat shop. Its head was collected by local Department of Livestock Development (DLD) officer and sent to the Veterinary Research and Development Center (VRDC) in Khon Kaen Province for rabies testing as the dog had suspicious signs of rabies. The head was tested rabies positive by Fluorescent Antibody (FA) Test on 10 Mar 2011 (Figure 1).

Environmental Study

No stray dog was seen in the affected village during the survey. There was one dog meat shop in Nathon Sub-district. Dog meats sold in the shop were from dogs butchered in the village or dissected dogs imported from other villages (Figure 2).

The seller did not wear gloves or apron while preparing and selling the meat. All interviewed villagers confirmed that dog meat was cooked well before serving. After slices of dog meat were grilled or sun-dried for 3-4 days, the slides were fried or mixed with herbs, spiced in a bucket and kept for five hours before steaming.

Investigation on Human Exposure to Rabies

Human exposed persons were identified by interviewing 58 contact persons in Villages 1, 2, 5, 6 and 12 of Nathon Sub-district. Contact persons were identified as exposed (10.3%), possible exposed (19.0%) and non-exposed (70.7%) respectively (Table 1).

Table 1. Type of exposure with the rabid dog based on WHO classification criteria, Nathon Sub-district, That Phanom District, Nakhon Phanom Province, March 2011 (n=58)

Type of exposure	Number of people	Percent	Classification of exposure
Bitten by the rabid dog	1	1.7	Exposed
Direct contact with the rabid dog carcass	1	1.7	Exposed
Direct contact with the rabid dog saliva	1	1.7	Exposed
Butchered the rabid dog carcass	2	3.4	Exposed
Cooked the rabid dog meat	1	1.7	Exposed
Ate the rabid dog meat	32	55.2	Non-exposed
Contacted person bitten by the rabid dog	3	5.2	Non-exposed
Contacted dog bitten by the rabid dog	11	19.0	Possible exposed
Submitted specimens	2	3.4	Non-exposed
Cleaned cooking utensils	4	6.9	Non-exposed
Total	58	100	

Table 2. Comparison of knowledge between contact persons who ate and did not eat rabid dog meat, Nathon Sub-district, That Phanom District, Nakhon Phanom Province, March 2011 (n=51)

Knowledge	Total (n=51)		Ate (n=28)		Did not eat (n=23)		P-value
	Number	Percent	Number	Percent	Number	Percent	
Know what rabies is							
Yes	33	64.7	18	64.3	15	65.2	0.94
No	18	35.3	10	35.7	8	34.8	
Know the main reservoir of rabies in Thailand							
Yes	30	63.8	11	44.0	19	83.4	0.01
No	17	36.2	14	56.0	3	16.6	
Know source of rabies information							
Yes	47	92.2	25	89.3	22	95.7	0.62
No	4	7.8	3	10.7	1	4.3	
Know that consuming well cooked meat cannot transmit rabies							
Yes	33	64.7	20	71.4	13	56.5	0.27
No	18	35.3	8	28.6	10	43.5	
Know that consuming raw rabid meat may transmit rabies							
Yes	43	84.3	21	75.0	22	95.7	0.04
No	8	15.7	7	25.0	1	4.3	
Know to send suspected rabid animal to laboratory for confirmation							
Yes	45	88.2	25	89.3	20	87.0	1.00
No	6	11.8	3	10.7	3	13.0	
Know that rabies patients will die							
Yes	41	80.4	23	82.1	18	78.3	0.73
No	10	18.6	5	17.9	5	21.7	
Know that rabies could be prevented by vaccination							
Yes	47	92.2	25	89.3	22	95.7	0.62
No	4	7.8	3	10.7	1	4.3	
Know the places to get vaccination							
Yes	44	86.3	23	82.1	21	91.3	0.67
No	6	11.8	4	14.3	2	8.7	

Table 3. Comparison of attitudes and practices between contact persons who ate and did not eat rabid dog meat, Nathon Sub-district, That Phanom District, Nakhon Phanom Province, March 2011 (n=51)

Attitudes and practices	Total (n=51)		Ate (n=28)		Did not eat (n=23)		P-value
	Number	Percent	Number	Percent	Number	Percent	
Inform authorities if bitten by rabid dog or cat, or found them							
Yes	47	92.2	24	85.7	23	100	0.12
No	4	7.8	4	14.4	0	0	
Seek for treatment if bitten by dog							
Yes	47	92.2	26	92.9	21	91.3	1.00
No	4	7.8	2	7.1	2	8.7	
Destroy rabid owned animals							
Yes	31	60.8	20	71.4	11	47.8	0.08
No	20	39.2	8	28.6	12	52.2	
Destroy rabid unowned animals							
Yes	36	70.6	22	78.6	14	60.9	0.17
No	15	29.4	6	21.4	9	39.1	
Send suspected rabid animal to laboratory for confirmation							
Yes	43	84.3	24	85.7	19	82.6	0.76
No	8	15.7	4	14.3	4	17.4	

KAP towards Rabies in Contact Persons

We interviewed 51 of 58 contacts to assess their knowledge, attitudes and practices towards rabies. Median age was 44 years old, with the range of 10-73 years. Among them, 69% were male, 77% owned dogs or cats, and 51% graduated primary school.

One third of the contacts (35.3%) did not know about rabies. Persons who ate the rabid dog meat had less knowledge on main reservoir of rabies in Thailand and transmission of rabies through consumption of rabid meat compared with those who did not eat (P-value <0.05) (Table 2).

Most of the contacts would inform authorities if they were bitten or found rabid dogs or cats, seek for treatment if bitten by dog and send rabies suspected dog for laboratory testing. Contact persons who ate the rabid dog meat were more willing to kill rabid dog than those who did not eat (Table 3).

Discussion

This study investigated a dog case of rabies, in which many people were involved from preparing and eating the rabid dog meat. Only one person was a true victim who was bitten by the rabid dog. The rest contacted accidentally with ignorance and lack of personal protective practices. Types of exposure included bitten by the rabid dog, direct contact with carcass or saliva of the rabid dog, or contact with dogs bitten by the rabid dog. Ingestion of rabid dog meat can be risky if the meat was not cooked well before serving. In Vietnam, there was a report of two laboratory confirmed rabies cases who developed rabies after butchering, preparing and consuming a dog and a cat.[3] Rabies virus is killed at 50°C, or by sunlight and common chemicals in soap.[2] In communities where dog or cat meat is a traditional cuisine and rabies is also endemic, risk of rabies transmission from rabid animals (dog, cat, cow, etc) to human cannot be overlooked. Although ingesting of well cooked meat of rabid animals is safe for rabies infection, the critical point is the exposure during processing without or insufficient personal protection.

Consuming dog meat is a common habit in the affected villages. This study suggested that the villagers did not have the risk of contracting rabies via ingestion as the meat was thoroughly cooked. Despite that, dog carcass butchers were at higher risk of contracting rabies. A research conducted as a part of the South East Asian Infectious Diseases Clinical Research Network has discovered a potentially lethal risk associated with preparation of dog meat through contact with animal secretion during dissecting without appropriate protection.[3]

All human contacts and the three dogs bitten by the rabid dog received rabies post-exposure prophylaxis (PEP) and none developed rabies. Rabies PEP was provided to excessive number of people in this study because it was also given to non-exposed cases. There was an increasing trend of rabies PEP in Thailand although the incidences of humans and animals rabies have dramatically decreased.[8,9] In Nakhon

Phanom Province, rabies PEP had increased from 4,000 doses in 2007 to 7,000 doses in 2010.[10] Based on our findings, the number of PEP could be reduced if the prescription is adhered to the WHO guideline which recommends to immunize exposed and probable exposed persons.[5]

In addition, resources should be proportionally allocated to vaccinate the principal reservoirs in order to interrupt the rabies transmission cycle. The required vaccination coverage in reservoir population to effectively stop rabies transmission is 80%[11] which was not reached in this setting. As the dogs bitten by the rabid dog had been vaccinated six months ago, one booster dose was provided to them. Unvaccinated dog should be eliminated if it was bitten by rabid animals.[12,13] However, this strategy is not well accepted by the community. Guideline on PEP in animals should be developed for better rabies management in animals.[14]

Public Health Actions and Recommendations

Immediate actions to prevent rabies should include identification of contacts and provision of PEP according to the guideline. The KAP study results should be brought into local contexts to guide people to apply personal protective practices. At last, sustainable rabies prevention and control program should be strengthened by improving rabies vaccination coverage in dogs.

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<http://www.osirjournal.net/issue.php?id=37>.

References

1. World Organisation for Animal Health. Rabies a priority for humans and animals. OIE Bulletin. 2011;3. [cited 5 Feb 2013] <http://www.oie.int/fileadmin/Home/eng/Publications_%26_Documentation/docs/pdf/bulletin/Bull_2011-3-ENG.pdf>.
2. The Center for Food Security and Public Health. Rabies and rabies-related Lyssaviruses. 2012 Nov. [cited 5 Feb 2013]. <http://www.cfsph.iastate.edu/Factsheets/pdfs/rabies.pdf>.
3. Wertheim HF, Nguyen TQ, Nguyen KA, de Jong MD, Taylor WR, Le TV, et al. Furious rabies after an atypical exposure. PLoS Med. 2009 Mar 17;6(3):e44. [cited 5 Feb 2013] <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2656546/>.
4. Tepsumethanon V, Wilde H, Meslin FX. Six criteria for rabies diagnosis in living dogs. J Med Assoc Thai. 2005 Mar;88(3):419-22.
5. World Health Organization. Rabies surveillance. [cited 5 Feb 2013]. <www.who.int/rabies/epidemiology/Rabiessurveillance.pdf>.
6. Matibag GC, Kamigaki T, Kumarasiri PV, Wijewardana TG, Kalupahana AW, Dissanayake DR, et al. Knowledge, attitudes, and practices survey of rabies in a community in Sri Lanka. Environ Health Prev Med. 2007 Mar;12(2):84-9.
7. Centers for Disease Control and Prevention. Epi Info. [cited 5 Feb 2013]. <http://wwwn.cdc.gov/epiinfo/>.
8. Kasempimolporn S, Jitapunkul S, Sitprija V. Moving towards the elimination of rabies in Thailand. J Med Assoc Thai. 2008 Mar;91(3):433-7.
9. Puanghat A, Hunsoowan W. Rabies situation in Thailand. J Med Assoc Thai. 2005 Sep;88(9):1319-22. Thai.
10. Nakhon Phanom Provincial Health Office. Haman rabies situation in Nakhon Phanom. 2011.
11. World Health Organization, Regional Office for South-East Asia. Rabies in the South-East Asia Region. p. 9. [cited 5 Feb 2013]. <http://209.61.208.233/LinkFiles/CDS_rabies.pdf.pdf>.
12. National Association of State Public Health Veterinarians, Inc. Compendium of animal rabies prevention and control, 2011. MMWR Recomm Rep. 2011 Nov 4;60(RR-6):1-17.
13. Hanlon CA, Niezgoda M, Rupprecht CE. Postexposure prophylaxis for prevention of

rabies in dogs. Am J Vet Res. 2002 Aug;63(8):1096-100.

14. Wilson PJ, Oertli EH, Hunt PR, Sidwa TJ. Evaluation of a postexposure rabies prophylaxis protocol for domestic animals in Texas: 2000-2009. J Am Vet Med Assoc. 2010 Dec 15;237(12):1395-401.

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An Evaluation of Influenza-like Illness (ILI) Epidemic Alert Thresholds in Two Provinces of Thailand, 2007-2010

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Abstract

Following introduction of influenza A (H1N1) pdm09 in Thailand during 2009, the national influenza-like illness (ILI) reporting system and short message alert signals was established by the Thailand Bureau of Epidemiology as a tool for early detection of influenza outbreaks. However, no specific threshold for determining the epidemic alert status existed. The objectives of this study were to determine baseline and epidemic alert thresholds of ILI proportions for different hospital sizes. The study was conducted in nine hospitals (three small, three medium and three large hospitals) in two provinces of Nakhon Ratchasima and Nakhon Si Thammarat. We reviewed hospital databases and collected data on ILI and all hospital visits during 2007-2010 from hospital databases. Then, we calculated mean, median and standard deviation (SD) of the weekly ILI proportions by hospital size over the 4-year period. We also used the Early Aberration Reporting System (EARS-X v2.8) to determine an aberration from baseline by calculating cumulative sum (CUSUM) by hospital types. We found that large hospitals had baseline ILI proportion lower than medium hospitals while baseline ILI proportion of medium hospitals was lower than that of small hospitals. The seasonality of the peak ILI proportions in 2009-2010 was different from pre-pandemic years of 2007-2008. Mean and median ILI proportions before the pandemic were lower than that of after the pandemic. Among individual hospitals, weekly ILI reporting was highly varied which prevented the use of CUSUM analyses. Aggregate reporting from several hospitals produced more reliable data for CUSUM analyses. No single signal in the EARS-X v2.8 software reliably predicted increased flu activity without signaling many false alerts. However, the combination of signals in the software reliably predicted the start of flu season with rare false alerts. We concluded that in Thailand, the baseline ILI proportion depended on hospital size. Due to variability in reporting from individual hospitals, we suggested choosing a method of epidemic alert threshold detection by level of health facilities using the CUSUM technique at the national level and median + 2 SD method at the hospital level.

Key words: influenza-like illness (ILI), epidemic alert threshold, cumulative sum

Introduction

In April 2009, the first case of influenza A (H1N1) pdm09 was reported in the United States by US CDC.[1] This virus rapidly spread to other regions of the world and a pandemic was declared on 11 Jun 2009.[2] Thailand identified the first case of influenza A (H1N1) pdm09 in May 2009 from a patient who had a travel history to Mexico. Shortly after the first case was reported, there was a rapid spread of influenza A (H1N1) pdm09 throughout the country.[3]

At the beginning of the epidemic in Thailand, the influenza-like illness (ILI) reporting system was established in all provinces by the Bureau of Epidemiology (BOE) as a tool for early detection of influenza outbreaks.[3] Initially, provincial health offices gathered total number of ILI visits (in-patients and out-patients with ICD10 codes J00, J02.9, J06.9, J09, J10 and J11) and all-cause visits (in-patients and out-patients) from all hospitals every day. The data were reported daily to BOE to monitor trend of ILI and discover epidemic areas. Although this practice of daily reporting by all hospitals was continued throughout the first wave of the epidemic in Thailand, it required significant amount of time, resources and situation analytic capabilities that was difficult to sustain.

In January 2010, the ILI reporting system was revised and all registered hospitals began to electronically report number of ILI cases and total number of hospital visits to the ILI surveillance system website weekly (http://164.115.5.58/ili) where proportions of ILI cases and total out-patient visits were displayed for the whole country and also by districts.[4] The revised national system also added an alert system which delivered a short message (SMS) to executives, epidemiologists at hospitals and health departments in different levels when ILI proportion of all visits at a reporting facility reaches 5% and 10% (Figure 1).[2]

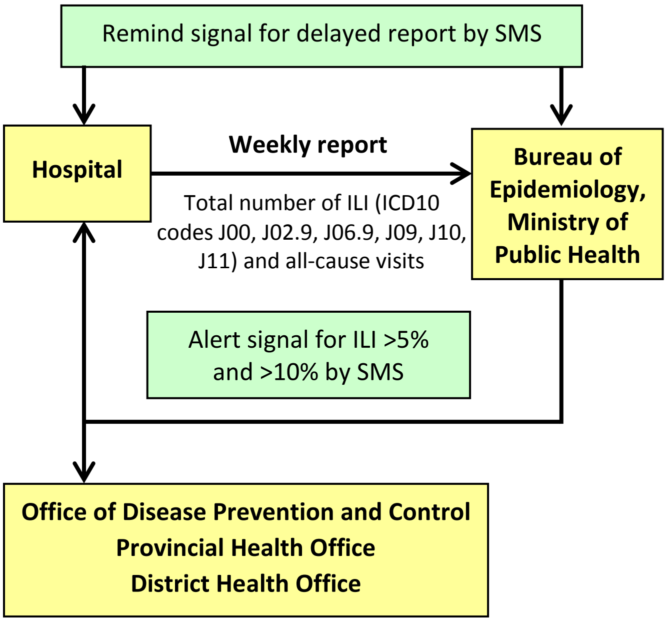


Figure 1. Data flow of influenza-like illness (ILI) reporting system in Thailand

For the alert system with SMS, the 5% and 10% were selected based on the literature reviews.[4] Not only the utility of these alerts was to assess influenza activities on level of warning and control implementation, but the alert system was used for triaging to separate ILI patients from other patients in the hospital, enlist more health care workers, open a temporary ILI clinic and ILI ward, order and store drugs and laboratory equipment such as influenza rapid tests, personal protective equipment (PPE) including face masks, gloves and alcohol gel, and prepare teams for outbreak investigation.[5]

The objectives of this study were to determine the baseline ILI proportions in 2007-2010 using data from nine hospitals in two provinces and to determine hospital-type-specific epidemic alert thresholds for ILI outbreak alerts from seasonal and pandemic data using two methods: median + 2 standard deviations (SD)[6] and a one-sided positive cumulative sum aberration detection method.[7]

Methods

We conducted the study in Nakhon Ratchasima and Nakhon Si Thammarat Provinces of Thailand where high number of influenza A (H1N1) pdm09 cases were reported in 2010 compared to other provinces. In each province, we reviewed a list of all registered hospitals in the ILI reporting system and divided them into three categories based on number of beds: small (30 beds), medium (60-90 beds) and large (120 or more beds). Then, we selected hospitals from each category by simple random sampling. We selected two hospitals in each category for Nakhon Ratchasima Province and one hospital in each category for the Nakhon Si Thammarat Province. In total, our study was conducted in nine hospitals (three small, three medium and three large hospitals) in two provinces.

We reviewed and collected data on out-patient ILI cases and all out-patient visits during 2007-2010 from hospital databases. We calculated weekly ILI proportions in 2007-2010 to understand trends of ILI proportions by hospital size. We also calculated mean, median and SD of weekly ILI proportions in 2007-2010, and before and after the epidemic peak in 2009 for each category to estimate baseline and epidemic alert thresholds. The epidemic peak was occurred during week 26 of 2009.

We used the Early Aberration Reporting System (EARS-X v2.8, US CDC) to determine an aberration of baseline by calculating one-sided positive cumulative sum (CUSUM). EARS uses three limited baseline aberration detection methods called C1-MILD, C2-MEDIUM and C3-ULTRA.[7] As data were tabulated weekly; our time unit for analysis was one week. C1-MILD has the lowest sensitivity, and mean and SD for C1-MILD were obtained from previous data for seven weeks in the closest proximity to the current value, week (t-7) through week (t-1). C2-MEDIUM, used a 7-week baseline period based on week (t-9) through week (t-3). C3-ULTRA used the same baseline period as C2-MEDIUM, but the threshold was based on a 3-week average run length of the one-sided positive CUSUM (Figure 2).[7]

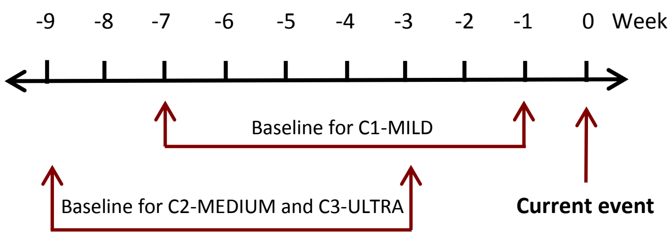


Figure 2. Baseline periods for 3 methods of cumulative sum calculation

Table 1. Mean, median and standard deviation (SD) of baseline ILI proportions in 2007-2010, and before pandemic and after epidemic peak in 2009-2010 by hospital size in Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand

Hospital size	2007 – 2010			Before pandemic (week 1 of 2007 to week 25 of 2009)			After pandemic (week 26 of 2009 to week 52 of 2010)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Large	3.5	3.2	1.5	3.3	3.2	1.1	3.8	3.3	1.9
Medium	6.3	5.8	2.7	5.9	5.7	2.2	7.0	6.4	2.9
Small	9.1	8.7	3.6	8.7	8.4	2.7	9.9	9.2	3.8

For C1 and C2, the method was based on CUSUM, but the threshold reduced to the mean + 3 SD. For C3, the method was also based on CUSUM and calculated by summing the positive differences of the current value from the mean for three weeks and comparing the CUSUM to the baseline period to determine its significance.[7] If the calculated value was more than two, a C3 warning was produced.

Results

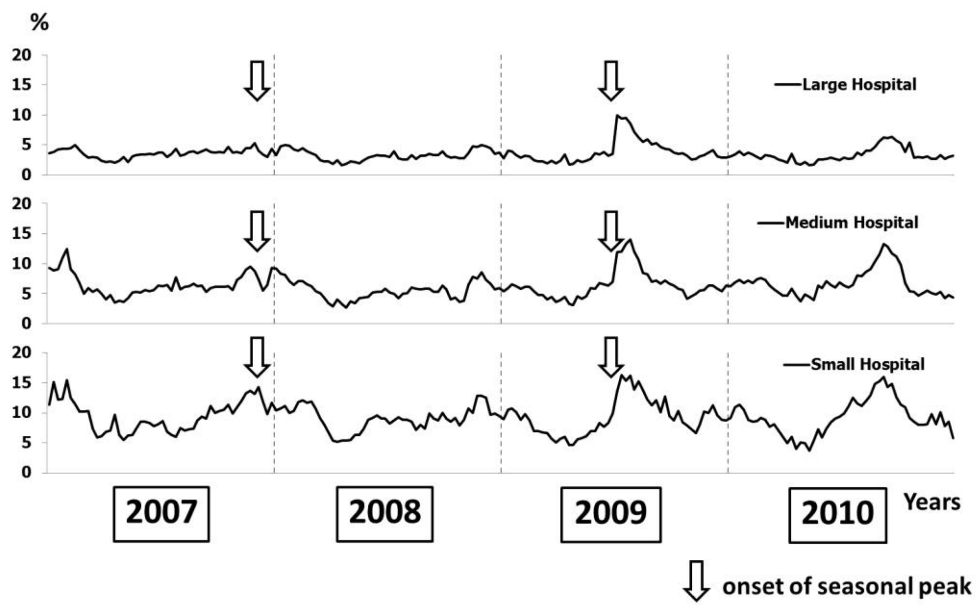
The results showed that large hospitals had baseline ILI proportion lower than medium hospitals and baseline ILI proportion of medium hospitals was lower than that of small hospitals. Mean and median ILI proportions before the pandemic were lower than those of after the pandemic in all hospital sizes (Table 1).

We used median + 2 SD for epidemic alert thresholds in small, medium and large hospital categories and compared total number of signals per hospital in each category during 2007-2010 (Table 2). The median was chosen over the mean because there was less variability in the median values before and after the pandemic. This reduced the number of signals per year in each hospital category.

In addition, we also found that seasonality of peak ILI proportions in 2009-2010 (September to October) was different from pre-pandemic years of 2007-2008 (December to January) (Figure 3).

Table 2. Number of signal over median + 2 SD in each hospital category, Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand, 2007-2010

Hospital size	Number of signal over median + 2 SD				
	2007	2008	2009	2010	Total
Large	2	0	6	2	10
Medium	2	0	6	4	12
Small	3	0	5	3	11



Note: Data not available for one medium hospital in 2007-2008 and one small hospital for two months in 2007

Figure 3. Trend of weekly ILI proportions in each hospital category, Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand, 2007-2010

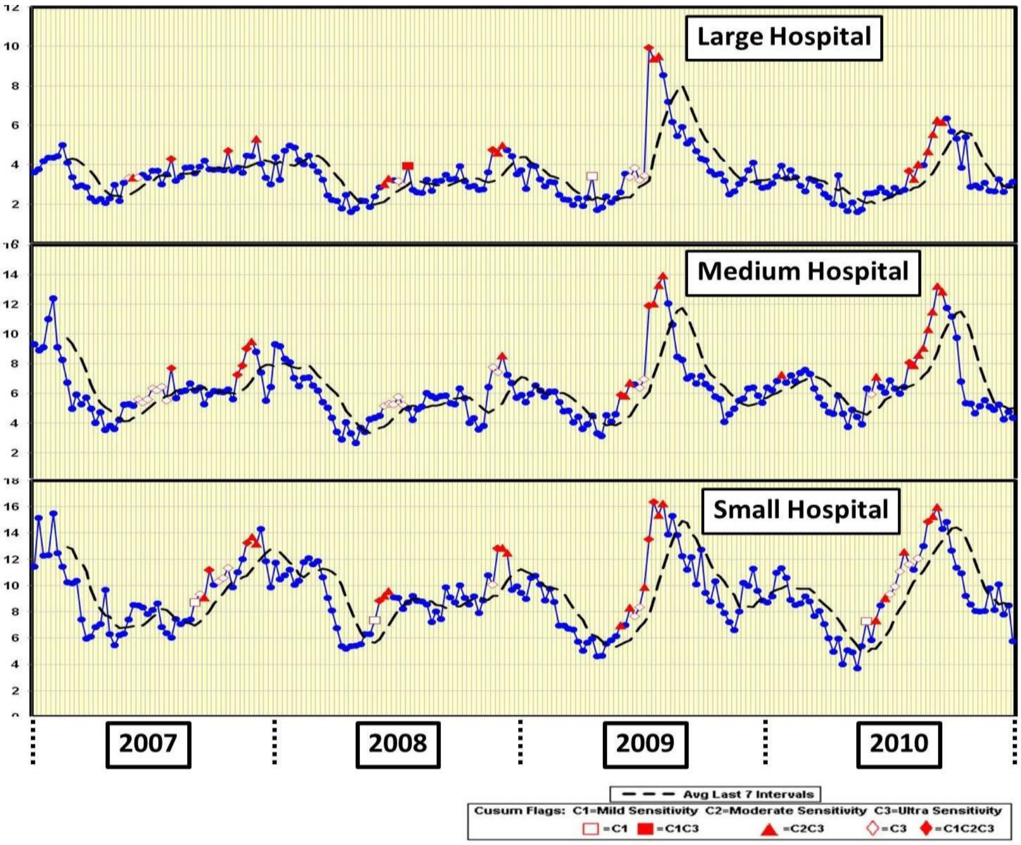


Figure 4. Aberration from baseline ILI proportions in each hospital category by EARS-X v2.8, Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand, 2007-2010

Table 3. Number of single and combination signal in each hospital category in Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand, 2007-2010

Hospital size	Number of signal				
	C1	C3	C1C3	C2C3	C1C2C3
Large	1	8	1	14	5
Medium	0	17	0	16	7
Small	3	12	0	17	7

Table 4. Number of C1C2C3 signal in each hospital category in Nakhon Ratchasima Province and Nakhon Si Thammarat Province, Thailand, 2007-2010

Hospital size	Number of C1C2C3 signal			
	2007	2008	2009	2010
Large	2	1	1	1
Medium	4	0	2	1
Small	2	2	2	1

Using EARS-X v2.8 software, we determined aberrations from baseline ILI proportions in each hospital size category (Figure 4). The results showed there were many C1, C2 and C3 alert signals, making any single CUSUM technique challenging to implement. However, combinations of signals (C2C3 or C1C2C3) appeared to signal the start of flu season and there were not many alerts in non-peak periods over the four years studied (Tables 3 and 4).

Discussion

We used two methods to determine epidemic thresholds among different sized hospitals in Thailand: median + 2 SD and the cumulative sum aberration detection method, using data from nine hospitals in two provinces.[6,8] There were fewer alert signals when we used the C1C2C3 combined cumulative sum aberration detection method in each hospital category compared with median + 2 SD in each category. There were only 1-2 signals per year using the C1C2C3 combined CUSUM technique and these tended to correspond to the onset of seasonal peaks in ILI proportions. Mean and median ILI proportions were varied substantially by hospital sizes, indicating that a single standard might not be appropriate for all hospitals. The difference in ILI proportions by hospital sizes might be attributed to the fact that large hospitals in Thailand have more patients and serve as referral centers, receiving severely ill patients from all district hospitals in the province.[9] Therefore, they have higher in-patient to out-patient ratios than medium and small hospitals. However, adjusting the differences of in-patient and out-patient volume did not completely eliminate the difference noted between hospitals of different sizes. This suggested that there might be inherent care-seeking differences in communities served by small versus larger hospitals and also reflected the fact that larger hospitals might have more non-respiratory admissions due to sub-specialty services.

When ILI proportion increased more than the epidemic alert threshold determined by either method, it did not mean that there was an influenza epidemic in the area because this system was only syndromic surveillance.[10] Combining laboratory data from sentinel sites to this syndromic surveillance would improve influenza epidemic detection and help to reduce non-influenza alerts.[10] Non-influenza alerts are still useful to individual hospitals to institute infection control practices. However, oseltamivir should be administrated to the outbreaks with significant alerts in the areas where influenza viruses are known to be circulating.[5] However, the simple method of epidemic threshold for alert system with SMS (3% of ILI proportion in large hospitals, 6% for medium and 10% for small) might reflect hospital size than the selected 5% and 10% alert threshold at the national level.

The second method using the EARS-X program for aberration detection could be applied to all different sized hospitals uniformly since aberrations were determined from historical data. However, week-to-week biases in consistency and quality of reporting at the level of the individual hospital may produce signals frequently that are of little clinical significance. Therefore, this method appeared to be more suitable for aggregate reporting at the regional or national level.

Public Health Actions and Recommendations

We suggested choosing a method of epidemic threshold detection by level of health system. The EARS-X v2.8 program using the CUSUM technique (C2C3 or C1C2C3 signals) to determine the aberration of ILI baseline would be a potentially useful tool at the sub-national level, especially if combined with laboratory data confirming influenza circulation. For each hospital, we suggested the simple methods such as median + 2 SD to determine epidemic threshold.[6,11] However, inconsistent reporting may reduce the utility of any method and alerts may not be useful if there are substantial issues with reporting and data quality.

Limitations

Our study had several limitations. First, we selected a small number of health facilities because data had to be collected at the level of the health facility before the ILI surveillance system was initiated in 2009. In addition, some hospitals did not use computerized record systems until 2009. Thus, data were limited for two hospitals as mentioned previously. Finally, the current system did not incorporate laboratory confirmation of influenza virus circulation in the province. Adding this information would be useful to help clinicians rationally use oseltamivir in hospitalized patients with severe respiratory illnesses.[5]

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References

1. Centers for Disease Control and Prevention. 2009 pandemic influenza A (H1N1) virus infections - Chicago, Illinois, April-July 2009. MMWR Morb Mortal Wkly Rep. 2009 Aug 28;58(33):913-8.
2. World Health Organization. World now at the start of 2009 influenza pandemic. 2009. [cited 20 Feb 2013]. <http://www.who.int/mediacentre/news/statements/2009/h1n1_pandemic_phase6_20090611/en/>.
3. Iamsirithaworn S, Akarasewi P, Yingyong T, Suthachana S, Pittayawonganon C, Ungchusak K. Three waves of the 2009 H1N1 influenza pandemic in Thailand. Siriraj Med J. 2011;63:64-67.
4. Thailand. Bureau of Epidemiology, Department of Disease Control. Influenza like illness (ILI) surveillance system. [cited 10 Feb 2013]. <http://164.115.5.58/ili/>.

5. Heymann DL. Control of communicable diseases manual. 19th ed. Washington DC: American Public Health Association, 2008.
6. World Health Organization. WHO interim global epidemiological surveillance standards for influenza. 2012 July. [cited 10 Feb 2013]. <http://www.who.int/influenza/resources/documents/INFSURVMANUAL.pdf >.
7. Centers for Disease Control and Prevention. Emergency preparedness and response. Early Aberration Reporting System. 2012 Sep 19. [cited 10 Feb 2013]. <http://www.bt.cdc.gov/surveillance/ears/>.
8. Hutwagner LC, Thompson WW, Seeman GM, Treadwell T. A simulation model for assessing aberration detection methods used in public health surveillance for systems with limited baselines. Stat Med. 2005 Feb 28;24(4):543-50.
9. ASEAN Institute for Health Development. Management challenges: urban primary care network. Thai. [cited 10 Feb 2013]. <http://www.aihd.mahidol.ac.th/rcenter/content/การจัดการความท้าทาย-เครือข่ายบริการปฐมภูมิเขตเมือง.>.
10. Henning KJ. Overview of syndrome surveillance. What is syndrome surveillance? MMWR Morb Mortal Wkly Rep. 2004 Sep 24;53(Suppl):5-11.
11. World Health Organization. Systems for the early detection of malaria epidemics in Africa. An analysis of current practices and future priorities. 2006. [cited 10 Feb 2013]. <http://www.who.int/malaria/publications/atoz/9789241594882/en/index.html>.

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