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Epidemiology of Multiple Casualty Incidents from Road Accidents in Thailand, 2006-2011

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Abstract

Investigations that focus on multiple casualty incidents (MCIs) can identify factors which can determine a very high burden of injury and death. Five MCI investigations were carried out in Thailand using surveillance data, physical investigation data from the scenes and vehicles, in-depth interviews with survivors and witnesses, and extraction of medical information from hospital records. Haddon's matrix was utilized to structure results in three phases (pre-event, event and post-event) which were stratified into four agents (human, vehicle, physical and socio-economic environment). The five MCIs involved 113 people, nine pickup trucks, four sidecar motorcycles and one each of a car, bus, prime mover truck and prime mover truck with a flatbed semi-trailer. Ten (8.8%) people died and 81 (71.7%) people were injured. Many amenable risk factors were human-related (inexperience, falling sleep, dangerous driving, non-use of seat belts, riding in the cargo area or on the rear platform). Vehicle-related factors were also present (poor tire treads and lack of safety devices), and environmental factors were prominent (wet and slippery roads, poor signage and lighting). Other notable facts included delay in contacting emergency services, lack of cutting equipment and limited first aid support. Many modifiable risk factors were identified, highlighting the need to reform roads and vehicles, and educate passengers and drivers.

Keywords: Multiple casualty incidents, road accident, investigation, Haddon matrix

Introduction

The World Health Organization (WHO) predicted that road traffic accidents would increase from the ninth leading cause of death in 2004 to the fifth leading cause of death by 2030.[1] As road traffic accidents happen in all regions of the world, there have been efforts to find solutions to prevent injuries, disability and mortality. Road traffic accidents can involve pedestrians, cyclists, and drivers and passengers of motor vehicles.

In Thailand, statistics from the Royal Thai Police from 2007 to 2014 showed that the annual number of road traffic accidents as 17,779 to 20,973 motorcycles, 14,790 to 16,923 cars, 6,775 to 9,587 pickup trucks, and 7,124 to 9,332 other types of vehicles.[2] Of all road traffic accidents occurring in 2014, the vehicles contributed most were motorcycles (35.6%), cars (34.3%) and pickup trucks (17.0%).[3]

In order to prevent road traffic accidents in the future, it is important to investigate the cause and severity of past incidents. Multiple casualty incident (MCI) contributes significantly to the burden of disease from injuries and deaths due to road traffic accidents.[4,5] When MCI involves with a large number of victims and severe injuries, it creates curiosity and instill fear in the public. In a setting of economic and transportation development, MCI may occur more frequent, yet limited resources prevent in-depth investigations to identify the causes.

Recently in Thailand, the Bureau of Epidemiology under Department of Disease Control, Ministry of Public Health placed an emphasis on MCI. The criteria for triggering an investigation on MCI is mainly based on the number of victims involved. However, there had been no public health research studies which focused on identifying the causes, and documenting the number and severity of injuries and death toll resulted from MCIs in Thailand.

This study concentrated on an analysis of five major MCIs in Thailand that occurred between 2006 and 2011, aiming to assess the information which would lead to improve policies and strategies for better prevention and control of such incidents in the future. In addition, this study demonstrated the utility of MCI investigations for revealing potential preventable causes of injury and death, focusing particularly on victim behavior and medical response.

Methods

The public health approach to problem solving consists of four steps: identify the problem (surveillance), identify risk factors, develop interventions and implement interventions.[4,5] The epidemiologic model of injury investigation guides further analysis of the host (pedestrian, passenger, rider or driver), the agent (mechanical force, energy), the vector (vehicles) and the environment (weather, road and traffic conditions).[6,7]

The Haddon matrix helps to organize the data into three crucial stages of MCI (pre-crash, crash and post-crash).[2,3,5,6] This staging system is important when preparing investigation forms, collecting and analyzing data, identifying risk factors, and preventing further MCIs. During an investigation, an epidemiological model was used together with the Haddon matrix to divide the determinants of MCI into three aforementioned stages. These features of investigation on MCI in Thailand consisted of five components: behavioral factors of pedestrians, passengers, riders and drivers; nature of accident; scene and environment; vehicle(s); and crash simulation analysis (Table 1).[8] Adapting the public health approach and the national guideline for MCI investigations, a protocol was developed for MCI investigations in this study (Figure 1).

An epidemiologic approach was used to describe five MCI investigations in Thailand. From this information, conclusions were drawn in terms of

Table 1. Haddon matrix employed for investigations on multiple casualty incidents in Thailand, 2006–2011[3,7]

Phase	Factors potentially related to event			
	Human	Vehicle	Environment	
			Physical	Socio-economic
Pre-event	**Human Risk** - Driver's license/ health/behavior/ experience - Speeding - Distracting activity - Alcohol/drugs - Seat belt/helmet use - Wrong attitude	**Dangerous Vehicle** - Brake/light/tire - Modified vehicle - Vehicle visibility - Inspection of vehicle - Overloading - Seat belt/helmet availability and quality - Airbag	**Hazardous Environment** - Road/road surface - Street light - Hierarchy of road - Traffic light/traffic line/traffic direction - Tree - Weather **Safer Environment** - Motorcycle lane - Overpass - Crosswalk - Zebra crossing	**Environmental Obstacle** - Traffic sign - Shop on sidewalk - Community along the way
Event	**Human Tolerance of Energy Transfer** - Seat belt/helmet use - Child seat use - Passenger behavior - Driver decision - Road use	**Protection Device** - Seat belt - Airbag - Restraint system - Helmet - Vehicle structure	**Environment** - Safety zone - Roadside hazard	**Environment** - Rush hour - School zone - Community zone
Post-event	**Injuries Contribute to Disability or Death** - First aid - Rescue skill - Medical treatment	**Vehicle Contributes to Disability or Death** - Fire risk - Fuel leakage - Trapped in a car - Submerged car	**Environment Contributes to Disability or Death** - Ease of access - Ease of evacuation	**Environment Contributes to Disability or Death** - Emergency team - Rescue work - Rescue tools

prevention in each event. Key features of each MCI occurrence were also described to determine the overall causes of injuries and deaths for each person. A mixed approach was used to collect data, identify risk factors and determine preventions. This included review of surveillance data, physical investigation of scene, environment and vehicles, in-depth interviews of victims and eye-witnesses, and extraction of medical information from the responding health services (medical records from ambulance, clinic and hospital, and interviews with health staff).

Figure 1. Protocol developed for investigations of multiple casualty incidents (MCI) in this study, Thailand, 2006-2011

The MCI in this study was defined as an accident resulted in five or more deaths, or 15 or more injuries in the same event[8] from 2006 to 2011. The investigations were conducted by epidemiologists who gathered data from physicians, nurses, hospital records, public health officers, civil engineers and police. Cooperation with various agencies was carried out in conducting the investigations.

Ethics

The information was collected for official purposes, and data and events were anonymized in this report with no references to the provinces where the accidents occurred. No names, dates or identifying information were used. Permission to submit for publication was granted by the regional Office of Disease Prevention and Control 12, Department of Disease Control, Ministry of Public Health, Thailand.

Results

In Thailand, drivers are required, by law, to drive on the left side of the road. When driving on two or more traffic lanes in the same direction, the driver should drive on the outermost left-hand side lane or close to the bus lane, if there is one present. The vehicles traveling at low speed should keep to the curbside of the roadway as close as possible.[6]

Five MCIs in southern Thailand were investigated due to high number of injured persons and severity of the incidents. The events involved 113 persons in total, including 10 deaths.

Incident 1. An overturned bus crashing into trees

Upon seeing an elderly female pedestrian suddenly showing up in front of a bus on the traffic lane, the bus driver swerved to the left, yet side of the bus hit the pedestrian and the out-of-control bus then ran into a house on the roadside. Despite the bus driver's attempt to avoid the collision, the bus overturned and landed on its side. The rear of the bus crashed against a tree and then the roof of the bus slammed into a second tree, with four passengers trapped inside (Figure 2).

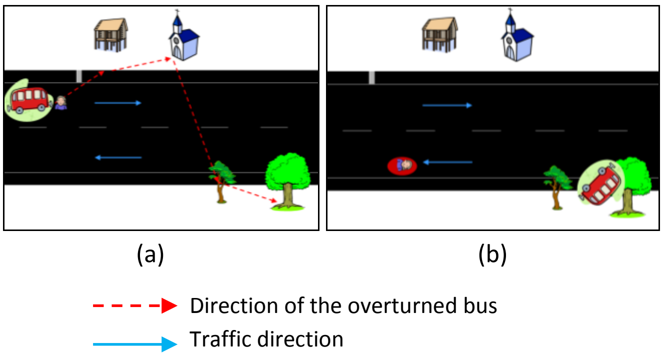
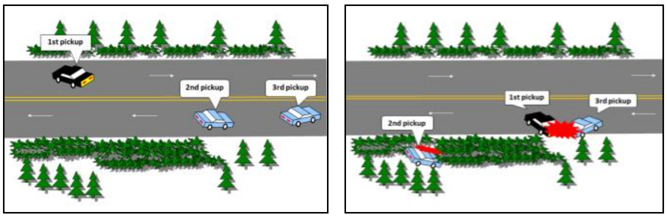


Figure 2. An overturned bus crashing into trees (a) before and (b) after the event in Thailand, 2006

This incident involved 26 persons. Two people were killed at the scene, including the elderly pedestrian, and a female passenger who was caught in between the tree and the bus. In addition, 16 others were injured. One passenger fastening the seat belt was not injured.

Incident 2. A pickup crashing into two other pickups

As the driver of a 4-door pickup truck fell asleep while driving, the vehicle crossed into the opposite lane and hit the extended cab of the second (2-door) pickup truck. Then, the first vehicle collided head-on with the third (2-door) pickup truck. As a result, the second vehicle drove into the margin of the road, rolled, and finally came to a halt on its side. A female passenger was trapped inside the vehicle (Figure 3).



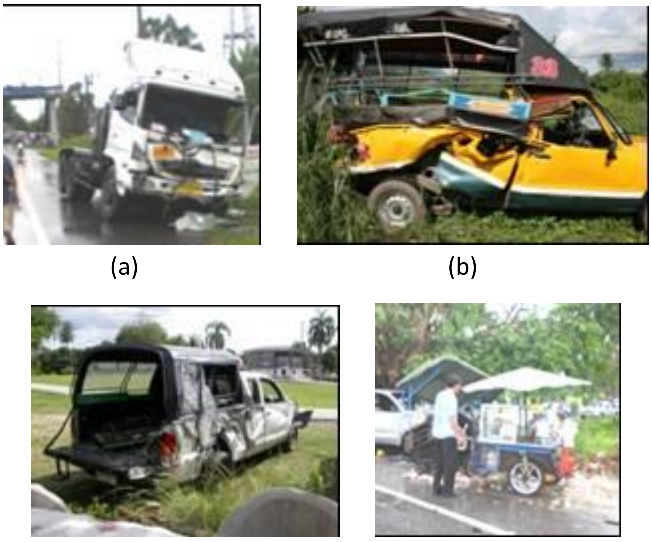
(a) (b)

Figure 3. A pickup truck crashing into two others (a) before and (b) after the event in Thailand, 2007

A total of 18 injured persons were involved: one in the first vehicle, 11 in the second, and six in the third. No pedestrians were involved. Two females riding in the cargo area of the second vehicle died: one at the scene and one in a hospital one day after the incident.

Incident 3. A multi-vehicle crash in front of a school zone

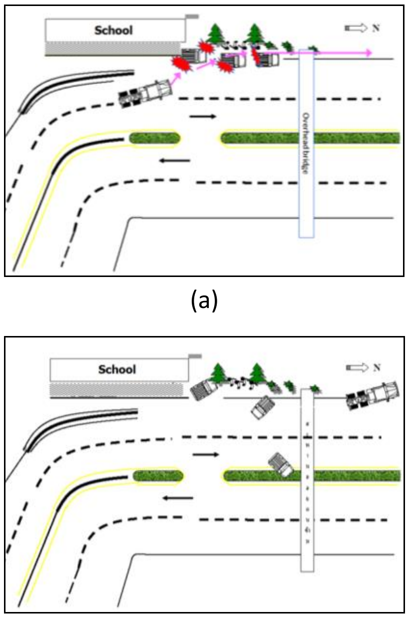
While the heavy rain changed to a shower, a person was driving a prime mover at a speed of about 45 km/hr on the drenched road. The vehicle had just rounded a curve in front of a school during the school dismissal time, yet the driver could not keep the vehicle within the lane and braked suddenly on the slippery road, causing the vehicle to skid uncontrollably. The vehicle then struck three public passenger vehicles (modified pickup trucks) and four motorcycles with sidecar, which were all parked on the edge of the road. Two of three public passenger vehicles was carrying students (Figure 4).



(a) (b) (c) (d)

Figure 4. (a) A prime mover, (b) a public passenger vehicle, (c) a passenger vehicle for students, and (d) a sidecar motorcycle selling food, involved in a multi-vehicles crash in front of a school, Thailand, 2008

The prime mover (Figure 4a) first collided with a songthaew (2-row) public passenger vehicle (Figure 4c), hit a tree and collided with two motorcycles with sidecar. The prime mover then crashed into the second songthaew public transport vehicle (Figure 4b) which, due to force of the collision, hit a motorcycle with sidecar and two pedestrians before it came to rest on the pedestrian refuge area in the centre of the road. The prime mover continued crashing into a motorcycle with sidecar (Figure 4d) and the sidecar motorcycles then flipped over a pedestrian, and hit the third public passenger vehicle which again struck one pedestrian (Figure 5).



(a)

(b)

Point of impact

Direction of the prime mover

Sidecar motorcycle

Figure 5. A multi-vehicles crash (a) before and (b) after the event in front of a school, Thailand, 2008

This incident involved 40 persons. Table 2 described about those involved, injured and admitted to hospital. There were four pedestrians with sustained injuries: three on four sidecar motorcycles, 17 people from the first songthaew vehicle, 10 people from the second songthaew, four people from the third vehicle, and two people from the prime mover. Although there were no fatalities, 33 people were injured, including 31 students. One of the students had her leg amputated due to severe injuries sustained during the incident.

Incident 4. A school pickup crashing into a tree

In drizzling rain, a pickup truck carrying 17 school students (one in the passenger seat, five in the cab and 11 in the cargo area) ran off a curved section of a 4-lane highway, crashed into a tree and overturned in the depressed median strip. There was no roof or seat in the cargo area of the truck. Meanwhile, another pickup truck, travelling at a speed of 90 km/hr, was driving behind the first vehicle on the same road also ran off the road and ended up in the depressed

Table 2. Number of injured and admitted persons by usage of safety device and vehicles in a multi-vehicle crash in front of a school, Thailand, 2008

Vehicle	Type of person	Safety device	Number total	Number injured (%)	Number admitted (%)
One prime mover	Diver	No seat belt	1	0	0
	Passenger	No seat belt	1	0	0
3 public passenger vehicles	Driver	Seat belt	1	0	0
		No seat belt	2	1 (50.0)	1 (50.0)
	Passenger in cargo area	No safety device	25	23 (92.0)	11 (44.0)
	Passenger on rear platform	No safety device	3	3 (100.0)	3 (100.0)
4 sidecar motocycles	Diver	No safety device	2	1 (50.0)	0
	Passenger	No safety device	1	1 (100.0)	0
Pedestrian			4	4 (100.0)	2 (50.0)
Total			40	33 (82.5)	17 (42.5)

median strip, following the first vehicle. One child from the first vehicle was trapped underneath and killed at the scene. All 17 people (16 children and the driver) in the first vehicle were injured, yet no one in the second vehicle was injured (Figure 6).

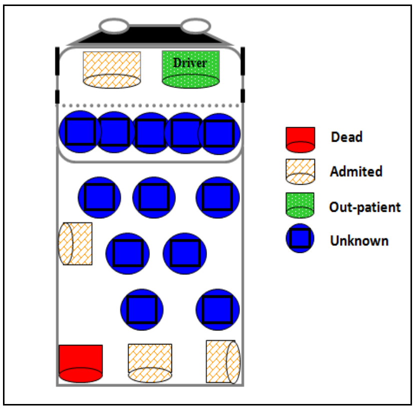


Figure 6. People affected in a school pickup truck after crashing into a tree in Thailand, 2009

Incident 5. A car running off the road and colliding with a prime mover truck

While the driver of one car tried to overtake a pickup truck which was travelling at 70-80 km/hr, the car made contact with the side of the truck, veered off the road, ran into the depressed median strip and tossed in the air. It then hit the ground and collided head-on with another prime mover truck which was a heavily loaded flatbed semi-trailer (Figure 7) traveling in the right-hand lane from the opposite direction. The car spun around, hit a tree and came to a stop. Smoke from the car engine was witnessed by a passerby who sprayed the car engine with a fire retardant. The accident involved eight people, including six in the car, one in the pickup truck and one in the prime mover truck. Five people in the car were killed, including two children and one pregnant female who died at the scene, and the car driver who died on the way to a hospital.

(a) (b)

Figure 7. (a) The car (front) and the prime mover truck pulling a semi-trailer loaded with lumber (back), (b) damaged head of the prime mover after an accident in Thailand, 2011

Discussion

Five investigations from this study revealed multiple risk factors in various phases of the events, which could be intervened to prevent severe injuries, disability and deaths. We identified modifiable factors related to risk-outcome relationship in each Haddon time period (pre-event, event and post-event).[7,9,10]

Our analysis revealed a variety of human factors: driver-vehicle inexperience, falling asleep while driving, overtaking and cornering with speed, driving too fast on wet and slippery roads, not wearing seat belts, and sitting or standing in the cargo area or rear platform of pickup trucks and songthaews. Some other pre-event factors were documented as overloading, poor tire treads, lack of safety devices (seat belts and rollover bars), use of bench seats and platforms in songthaew public passenger vehicles, trees growing near the road, and broken glass on the road. Furthermore, dim lighting, obstructed sidewalks, lack of traffic signs, lack of clear-school-community zones and lack of sidewalks were also noted.

Table 3. Meta-matrix analysis of interventions related to five multiple casualty accidents using Haddon matrix in Thailand, 2006-2011

Phase	Factors related to event			
	Human	Vehicle	Environment	
			Physical	Socio-economic
Pre-event	**National & Local Agencies** - Train drivers about speed limit, safety, rest, community and school zones, seat belt use and student drop off-pick up parking areas *(Incident 1, 2, 3, 4, 5)* - Train drivers about decisions and problems (swerve, slippery road) *(Incident 1, 3, 5)* - Educate people about road use, pickup-truck transport and seat belt use) *(Incident 1, 2, 3, 4, 5)* - Research transport safety in public passenger vehicles and standing on rear platforms *(Incident 2, 3, 4)* **Schools** - Educate students on dangers of standing on rear platforms or inside the vehicle and playing inside the vehicle *(Incident 3, 4)* - Educate passengers to use seat belt properly *(Incident 3, 4)* - Prohibit students from buying food from vendors setting up outside school boundaries *(Incident 3)*	**National Agencies** - Develop guidelines on appropriate vehicles for school transport, overload, third bench and platform of pickup trucks *(Incident 3,4)* **Local Agencies** - Enforce law on safety devices used, speed limits, overload and no occupants in cargo area *(Incident 1, 2, 3, 4, 5)* **Private Vehicles** - Checkup vehicle *(Incident 2, 3, 5)* - Install occupant restraints or other safety devices *(Incident 2, 3, 4, 5)* - Provide child restraint *(Incident 2, 5)*	**Local Agencies** - Construct pedestrian fencing and footpath *(Incident 1, 3)* - Set up traffic signs (community, school, school speed limits, flashing lights, road markings, parking) *(Incident 1, 3)* - Provide clear zone for road user *(Incident 1, 2, 4)* - Clear items obscuring or obstructing traffic signs (tree, heavy-vehicle, close-following traffic, building) *(Incident 1, 3)* - Ensure appropriate road and traffic systems in school zone *(Incident 3)* - Use pavement marking for parking in school zone *(Incident 3)* - Design safe drop off/pick up areas for students *(Incident 3)*	**National Agencies** - Develop guidelines and policies for community and school zone safety (speed limit, parking) *(Incident 1, 3)* **Local Agencies (Police, school)** - Ensure traffic safety in areas nearby schools *(Incident 3)* - Law enforcement on traffic safety of community and school zone (food vendor, parking, traffic sign) *(Incident 1, 3)*
Event	**Local Agencies** - Train drivers to solve problems when an accident occurs (driving skill) *(Incident 1, 3, 5)* - Educate people to protect themselves when an accident happens (use of restraints) *(Incident 1, 2, 3, 4, 5)* **Schools** - Educate students to protect themselves when an accident occurs (use of restraints) *(Incident 3, 4)*			
Post-event	**National & Local Agencies** - Educate and train the concerned people (witnesses, victims, students, teachers, parents) *(Incident 2, 3, 5)* - Improve access to ambulance hotline call (1669) when emergencies happen *(Incident 2, 3, 5)* - Train the concerned people about first aid *(Incident 2, 4, 5)* - Provide the manual on emergency response to rescue units and emergency teams *(Incident 2, 3, 4, 5)*			**National & Local Agencies** - Cutting equipment for rescue units *(Incident 1, 5)* - Communication tools for emergency teams and rescue units *(Incident 4)*

During the incidents, people were pinned inside or dislodged from seats and cargo areas out of the vehicles. Most casualties had multiple injuries. After the incidents, confusion often reigned for communication with emergency rescue units, limited skills on first aid measures, and frequent unmet need for cutting equipment. This caused delays in treatment beyond the "Golden Hour", substantially reducing chances of survival.[11]

The Thai experiences with MCI in this study were similar to other internal reports, publications, and observations in other countries.[12-16] Sleeping and inattention were important risks for drivers in Thailand as well as the United States of America. Approximately 4% of US drivers had an accident or near accident from dozing off behind the wheel.[17] Drowsy driving was a contributing factor in 3.9% of all accidents in the USA, with the most frequent consequence (8.3%) being running off the road.[18] People who worked long hours at night were at a 6-fold greater risk.[19]

The MCIs investigated in this study identified preventable injuries, disability and death. The Haddon matrix is a useful tool for structuring MCI investigations as it leads to the discovery of modifiable risk factors which may serve to reduce the burden of illness from MCI. The use of the Haddon matrix in five MCIs in this study suggested that there was much to be done in order to create a safer and modern road transportation system in Thailand.

Recommendations

The preceding meta-matrix analysis of five MCIs due to road traffic accidents identified possible interventions to prevent injuries or reduce the severity of injuries in the future (Table 3).

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An Investigation of a Cluster of Echovirus 6 Infection with an Encephalitis Death in Samut Prakan Province, Thailand, 2015

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Abstract

On 16 Dec 2015, the Bureau of Epidemiology in the Ministry of Public Health, Thailand, was notified of a suspected echovirus 6 encephalitis death in Samut Prakan Province. An investigation was launched for active case detection and confirmation of causative agent. Out of 32 people identified, two (6.3%) were confirmed for echovirus 6, including the index case, and there were 30 suspected cases. The index case was a 5-year-old Thai boy and kindergarten student. On 8 Dec 2015, he developed encephalitis. Echovirus 6 was detected in his cerebrospinal fluid, nasal and rectal swab samples. Chest x-ray revealed pulmonary edema and elevated cardiac enzyme as signs of rhombencephalitis. There were also five (2.9%) out of 173 asymptomatic contacts tested positive for echovirus 6 infection. Potential risks for infection were sharing of utensils and toys, and playing together. Lack of intensive health screening in the school and inadequate hand washing facilities were also observed. We recommended households and the school to improve sanitation, and health education was provided in the communities and schools. Physician's knowledge and awareness of echovirus infection among children should be raised to provide proper treatment and early referral if needed.

Keywords: Human, echovirus 6, enterovirus, encephalitis, investigation, Thailand

Introduction

There have been outbreaks of echovirus infection reported in many countries such as Brazil, China, France, Greece, Japan and Korea, where the majority of the cases had resulted with severe neurological diseases.[1-6] The data from the national event-based surveillance system in the Bureau of Epidemiology revealed that about 3% of unspecified encephalitis reported in Thailand during 2005-2015 were caused by echovirus and the case fatality rate for echovirus encephalitis was 100%. However, the echovirus encephalitis cluster had never been reported to date in Thailand.[7]

Echovirus belongs to the species *Enterovirus B*, genus *Enterovirus* of the *Picornaviridae* family. Echoviruses and other enteroviruses are found in human gastrointestinal tract, and can cause opportunistic infections and diseases. While it can be transmitted from person to person, the fecal-oral route is the predominant mode and sometimes occurs via droplets from respiration or oral secretion. Contaminated swimming and wading pools can also transmit the virus. The common incubation period ranges from 3-6 days.[8,9]

Although about 50-80% of enteroviruses infections are asymptomatic, the infections may result in a wide variety of presentations, including rash, herpangina, respiratory illness (cough, coryza, croup) or hand, foot and mouth disease (HFMD). Severe myocardial, pericardial or neurological complications can also occur with acute aseptic meningitis or encephalitis such as rhombencephalitis.[10] It can involve autonomic nervous system, resulting in autonomic dysfunction, and particularly, sympathetic overstimulation that causes high blood pressure, tachycardia, sweating, hyperglycemia as well as pulmonary edema.[11]

On 16 Dec 2015, the Bureau of Epidemiology received a notification from the Office of Disease Prevention and Control 13 of a suspected death from echovirus encephalitis in Samut Prakan Province. The surveillance and rapid response teams (SRRT) from Bureau of Epidemiology, and local provincial health office, district health office and health promoting hospital jointly conducted a field investigation from 17 to 18 Dec 2015 to determine the cause of death, confirm the diagnosis, describe the extent of the outbreak, explore risk behaviors and provide preventive measures to the local authorities.

Methods

A descriptive study was performed to outline the index case and an investigation was carried out in the area where the case lived (Wat Si Wari Noi Sub-district, Bang Sao Thong District, Samut Prakan Province) from 29 Nov to 22 Dec 2015.

Description of the Index Case

The available clinical information and laboratory investigation of the index case died from suspected echovirus encephalitis were collected from medical records of all hospitals where the case visited. The doctors and parents were interviewed about demographic factors, clinical manifestations and management, risk behavior and activities. In the school where the case attended, the teachers and caretakers were questioned about risk behaviors and activities as well as number of students with HFMD and encephalitis cases identified in the school during the previous five years.

Active Case Finding

The situation of HFMD and encephalitis in Wat Si Wari Noi Health Promoting Hospital from 29 Nov to 22 Dec 2015 was reviewed. In addition, the laboratory findings in the National Institute of Health (NIH) for enterovirus infection during 2014-2015 were retrieved as well.

Target population of the active case finding in the communities included people in the index case's house, the neighboring houses located within 500 meter-radius, and the case's school. The active case finding was carried out to identify cases and contacts during 29 Nov to 22 Dec 2015 (two times of maximum incubation period of echovirus infection before and after the onset of the index case) using the door-to-door survey method.

A contact was a person or neighbor who lived, played or studied together with the index case. A suspected case was a contact with any symptoms of: vesicles or ulcers in oral cavity; vesicular or maculopapular rash on palm, foot or buttock; upper respiratory infection (URI); and severe manifestations (neurological deficit, cardiovascular symptoms) from 29 Nov to 22 Dec 2015. A confirmed case was a suspected case who was tested positive for echovirus 6 from fresh stool or throat swab specimen by polymerase chain reaction (PCR) or viral isolation. Asymptomatic infection included contacts without any symptoms, yet found to have echovirus 6 by laboratory testing of fresh stool or throat swab by PCR or viral isolation.

Clinical specimens from contacts and symptomatic cases were collected during 17-18 Dec 2015 for testing echovirus 6 and other enterovirus infections. All specimens in viral transport media were kept at 4°C and transported with ice packs to the NIH, the Neuroscience Centre for Research and Development under Faculty of Medicine in Chulalongkorn University, and the Faculty of Medicine in Ramathibodi Hospital. The specimens were tested for 12 species of enterovirus, including *Enterovirus A*, *B* (including echovirus), *C*, *D*, *E*, *F*, *G*, *H* and *J*, and *Rhinovirus A*, *B*, *C* by PCR and viral isolation.

Contact Tracing

Fresh stool specimens were collected from the index case's household members, neighborhood contacts and all students studying in the same class with the index case. Throat swabs were obtained from the symptomatic contacts, including household members, neighborhood contacts and students in the same school, with URI symptoms, or vesicles/ulcers in oral cavity, or vesicular/maculopapular rash at palm, sole or buttock within seven days before specimen collection.

Phylogenetic Analysis

Furthermore, a phylogenic study was also conducted using 500 bootstrap method/maximum composite likelihood approach to find the epidemiological linkage of the virus.

Environmental Study

An environmental study was also performed at the index case's house, the neighborhood area and the school via a walk-through survey, and findings were recorded using an environmental checklist. General sanitation, drinking water, water for washing, toilet and waste container were observed. The residual chlorine level in the water was tested as well. Moreover, personal behaviors such as daily activity, eating, playing and hand washing were inspected.

Results

Description of Index Case

The index case was a Thai boy aged four years and 11 months, without any underlying disease. He studied in the kindergarten and lived in Wat Si Wari Noi

Sub-district, Bang Sao Thong District, Samut Prakan Province. On 8 Dec 2015, he had high fever, poor appetite and occasional myoclonic jerk. However, he had no URI symptoms, nausea, vomiting, skin lesion or oral ulcer. Although he was treated at home with symptomatic treatment, his illness did not improve. Hence, his mother brought him to a private hospital (Hospital A) where he received out-patient treatments on 10 Dec 2015. Despite that, he continued to have fever, had poor oral intake, went to another private hospital (Hospital B) on 11 Dec 2015 and was admitted.

At Hospital B, he had fever, tachycardia and mild tachypnea. No abnormal neurological finding was detected at the time of admission. He received intravenous antibiotic as well as intravenous acyclovir, yet the fever was still persistent and later, he developed nausea and vomiting. At 4 am on 12 Dec 2015, as he developed high grade fever and seizures, he was referred to another private hospital (Hospital C) and admitted in the intensive care unit. Due to seizures and cardiac arrest, endotracheal intubation and cardiopulmonary resuscitation were performed. Despite the efforts, he died at 9:15 am on 13 Dec 2015.

The laboratory investigation revealed leucocytosis, hyperglycemia and elevated cardiac enzymes, with creatinine phosphokinase (CPK) of 462 U/L (normal range = 22-198 U/L) and the cardiac marker (CK-MB) of 56 IU/L (normal range = 5-25 IU/L). Peribronchial thickening was found in the chest X-ray.

No influenza and respiratory syncytial virus was identified from his nasal swabs. Samples of cerebrospinal fluid (CSF) were tested negative for herpes and rabies, yet positive for Japanese encephalitis (JE) immunoglobulin G. Echovirus type 6 (E6) was identified from throat and rectal swabs, and CSF samples by PCR only after he died.

The index case had received complete vaccination as recommended in the immunization schedule, including JE vaccine. He had no travel history two weeks prior to his illness. Furthermore, he did not go to school or go to play outside after he developed the symptoms. There were other nine persons in the same household and 16 persons in the neighboring houses within 500 meter radius. For the exposure history, his cousin had herpangina about two weeks before he developed symptoms. However, his cousin was not included in this study as the onset of illness was beyond the study period.

Active Case Finding

For active case finding in the hospitals, none were diagnosed with HFMD or encephalitis in Wat Si Wari Noi Health Promoting Hospital. In addition, there was no previous outbreak of echovirus infection or HFMD in Wat Si Wari Noi Sub-district during the study period.

As there were two houses within 500 meter-radius from the index case's house, active case finding was conducted in these two houses and the index case’s school. Among total 211 persons identified, 204 (96.7%) persons were interviewed. Total 31 people were detected from the active case finding, including 30 suspected cases and one confirmed case who was the index case’s sister confirmed as echovirus 6 infection by viral isolation. Hence, total two (6.3%) cases were confirmed, including the index case. The overall attack rate was 15.6% (Table 1).

The most common symptoms were nasal discharge (81.3%), cough (75.0%) and sore throat (15.6%). The first suspected case had onset on 1 Dec 2015 and the peak of an epidemic occurred during 10-17 Dec 2015, followed by a downward trend (Figure 1).

There were two suspected cases reported clinical URI symptoms earlier than the index case. The first suspected case (suspected case A) who developed URI symptoms on 1 Dec 2015 was a 6-year-old Thai female. She studied in the kindergarten together with the index case. She still went to school even after she got sick and shared some activities with the index

Table 1. Number of villagers and echovirus cases identified in Wat Si Wari Noi Sub-district, Bang Sao Thong District, Samut Prakan Province, Thailand, 29 Nov - 30 Dec 2015

Finding		Household & neighborhood	School		Total
			Kindergarten	Others	
Found/Total		25/25	45/45	135/142	205/212
Case	Suspected	3	6	21	30
	Confirmed	2	0	0	2
Attack rate (%)		20.0	13.3	15.6	15.6
Asymptomatic		1	4	0	5

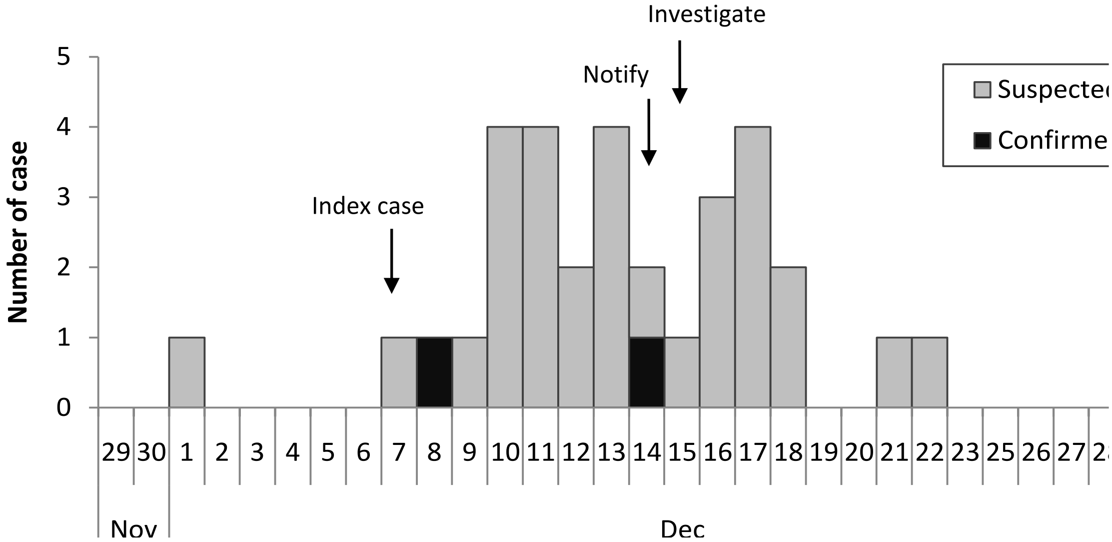

Figure 1. Number of echovirus cases in Wat Si Wari Noi Sub-district, Bang Sao Thong District, Samut Prakan Province, Thailand, 29 Nov - 30 Dec 2015 (n= 32)

case, including having lunch. Her symptoms lasted for three days and however, laboratory testing did not find enterovirus from her throat swab and fresh stool specimens.

Another suspected case (suspected case B) was an 8-year-old Thai female and reported clinical URI symptoms on 7 Dec 2015. She studied at the primary level in the same school. However, she did not go to school after she got sick or share any activities with the index case. Her symptoms lasted for four days. Her throat swab specimen also showed negative results for enterovirus.

Contact Tracing

Regarding to asymptomatic household and neighbor contacts, one household contact out of 21 fresh stool specimens collected was positive for echovirus 6. In addition, five out of 22 specimens from asymptomatic contacts in the kindergarten were tested to have enterovirus, including four for echovirus 6 and one for coxsackie virus A16. In addition, one out of 21 throat swab specimens from symptomatic contacts in the primary level was positive for coxsackie A16 (Table 2).

Phylogenetic Analysis

Six positive specimens for echovirus 6 (2 confirmed and 4 asymptomatic cases) were undergone the phylogenetic analysis and found that all had the same nucleic base sequencing. The VP1 gene 635 bp from 719 bp were sequenced and the viral isolate showed 96% identity to the E6 strain prevalent in Shandong, China during 2011-2012 (E6SD11CHN HFMD, accession number: JX976771.1)[12] (Figure 2).

Information from National Institute of Health

The data obtained from NIH between 2014 and 2015

Table 2. Laboratory results for enterovirus infection in Wat Si Wari Noi Sub-district, Bang Sao Thong District, Samut Prakan Province, Thailand, 29 Nov-30 Dec 2015

Specimen	Contact	Specimen collected			Positive for enterovirus		Type
		Total	Symptomatic	Asymptomatic	Symptomatic	Asymptomatic	
Throat swab (n=31)	Household & neighborhood	4	4	0	1 (index case)	0	Echovirus 6
	School						
	- Kindergarten	6	6	0	0	0	-
	- Others	21	21	0	1	0	Coxsackie A16
Fresh stool (n=52)	Household & neighborhood	25	4	21	1 (index case's sister)	1	Echovirus 6 (2)
	School						
	- Kindergarten	27	5	22	0	5	Echovirus 6 (4) Coxsackie A16 (1)

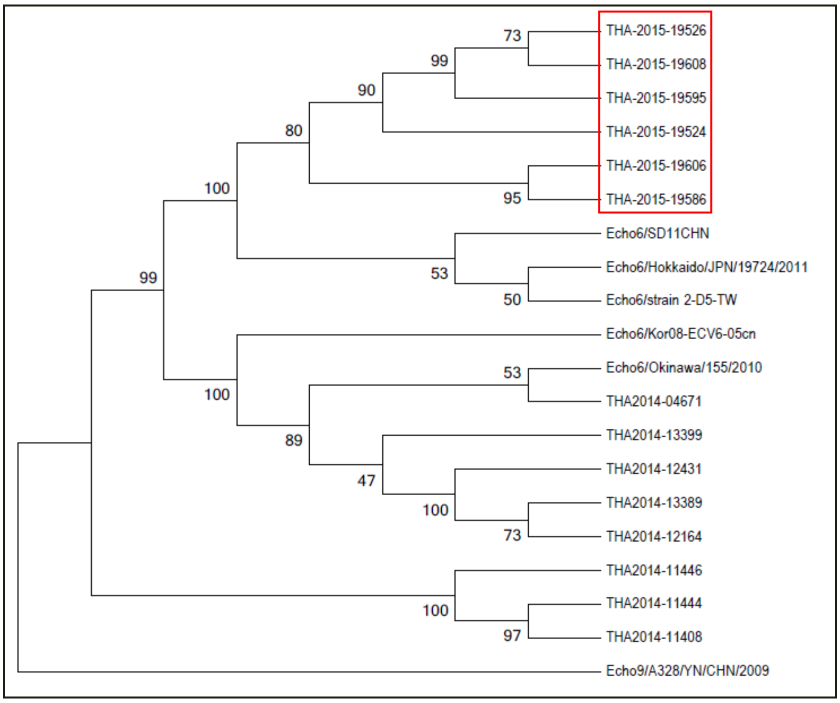

Figure 2. Phylogram of partial VP1 sequences of human echovirus 6 isolates from Wat Si Wari Noi Sub-district, Bang Sao Thong District, Samut Prakan Province, Thailand, 29 Nov - 30 Dec 2015

showed that 1,909 samples were sent for enterovirus detection, 349 samples (18.3%) were tested positive. The most common serotype was enterovirus 71 (39.0%), followed by coxsackie A16 (25.2%). During 2014 to 2015, echovirus was identified from 4% of the total samples (Table 3).

Table 3. Distribution of enterovirus serotypes isolated in the National Institute of Health, Thailand, 2014-2015

Serotype	Number	Percent
Enterovirus 71	136	39.0
Coxsackie A16	88	25.2
Unidentified	47	13.5
Coxsackie A6	35	10.0
Echovirus 6	14	4.0
Coxsackie A10	6	1.7
Coxsackie A2	5	1.4
Echovirus 3	4	1.2
Poliovirus	3	0.9
Coxsackie A24	2	0.6
Echovirus 11	2	0.6
Human Rhinovirus	2	0.6
Coxsackie A8	1	0.3
Coxsackie A14	1	0.3
Echovirus 9	1	0.3
Echovirus 14	1	0.3
Coxsackie B4	1	0.3

Environmental Study

The index case lived in a 3-generation extended family, with total 26 people. The index case and his sister were confirmed to have echovirus 6 infection, and were the grandchildren in the family.

Two (50.0%) out of four symptomatic and one (4.5%) out of 21 asymptomatic family members and neighbors were tested to have positive for echovirus 6 infection. They occasionally ate dinner together, shared glasses, dining utensils and toys, watched TV, and played together. They shared toilets and kitchen, and usually washed their hands with soap before meal and after using the toilet. The index case slept in the same bedroom with his younger sister and mother.

They consumed bottled water as drinking water and used tap water for washing. The residual chlorine level was adequate (⩾0.5 ppm) on the investigation day, 17 Dec 2015. They used water privy toilets with good sanitation. There were adequate trash bins with cover as waste containers around their houses.

In the index case's school, there were kindergarten and primary levels 1-4. The index case studied in the kindergarten in a single-story building while the primary students studied in another building. One playground was shared for all students. There were total 45 students in the kindergarten and had lunch together in their classroom. They did not usually wash their hands before meal and after using the toilet. Daily health screening was done roughly by teachers in the mornings. There was no isolation room for sick students.

The school provided bottled drinking water for students and tap water for washing. The residual chlorine level was also adequate (⩾0.5 ppm). The toilets for the kindergarten students and primary students were separated. Two water toilets with good sanitation were provided for the kindergarten students. There were only two washing sinks, yet one was broken. There were waste containers with cover in the school.

Discussion

A cluster of echovirus 6 infection with an encephalitis death was confirmed. The cause of death was likely to be brainstem infection. Although the source of the outbreak was inconclusive, it was most probably from a school contact.

The clinical manifestations of hyperglycemia, tachycardia, leucocytosis, pulmonary edema, and myocarditis suggested reticular formation involvement and autonomic dysfunction, which implied the potential brainstem involvement resulted from echovirus 6 infection. The brainstem infection that could cause cardiopulmonary failure was also corresponded with the previous report in Malaysia[13]. However, the pathological confirmation was not available as the brain imaging, autopsy or necropsy was not performed. WHO has recommended using intravenous immunoglobulin in enterovirus infection. One public health critique relating to the index case's death was the awareness of echovirus infection, which could led to proper diagnosis and treatment such as intravenous immunoglobulin[14,15]. Hence, this was a cluster of echovirus 6 infection that caused URI as well as severe manifestations such as encephalitis and myocarditis.

Although the index case's cousin had herpangina two weeks before his onset, the direct infection from his cousin was less likely as the incubation period for echovirus infection is commonly reported as 3-6 days[8,9]. Out of two suspected cases (suspected cases A and B) with earlier date of onset than the index case, the suspected case A might be the source of the cluster as she still went to the school during the infectious period. Nonetheless, the epidemiological linkage could not be confirmed as the laboratory results for echovirus infection revealed negative for the suspected case A. Despite that, as the specimens for this study were collected only on 17 Dec 2015, laboratory testing might fail to detect etiologic agent.

Two confirmed cases of echovirus 6 were identified in the same household, highlighting the risk behavior of sharing glasses, utensils and toys. Most enteroviruses are resistant to acid pH, ether, alcohol and deoxycholate. Appropriate means of disinfection include using sodium hypochlorite, chlorine, glutaldehyde, formaldehyde, boiling at 50-60 °C for 30 minutes, sterilization[16] and ultraviolet.[10] Therefore, the disease could spread easily in the community if control measures such as disinfection are not applied properly.

The predisposing factor of this cluster could be the overcrowding condition in the kindergarten with total 45 students, which is the common risk factor of enterovirus outbreak.[17] Furthermore, a higher rate of infection was normally found in children due to exposure, hygiene and immunity status.[18] Sharing of glasses, dinning utensils and toys, and lack of appropriate hand washing and proper health screening were also observed as the potential risks of transmitting infection in the school. Thus, provision of spacious classrooms, avoid sharing of materials, conducting intensive health screening and managing an isolation room for sick children at the school as well as frequent hand washing could help limiting the outbreaks.[19]

The phylogram for partial VP1 sequences of human echovirus 6 isolates was the first of its kind developed in NIH, which identified a viral isolate similar to the echovirus 6 strain prevalent in Shandong, China. Although the linkage to China was not revealed from this study, the phylogram would be useful as a reference for the future investigations and studies in Thailand.

Limitations

Specimens could not be collected from some close contacts, which might have failed to detect some epidemiologically linked cases or asymptomatic infections. Long working period for laboratory process might result in delayed case detection and affect the control measures.

Lack of official health care network between public and private sectors caused challenges in referral and consulting systems. Reluctance among some local staff, teachers and parents adversely affected the cooperation for disease control as well as delay in specimen collection for laboratory confirmation within the appropriated time period.

Public Health Recommendations

Communities

Regular cleaning of glasses, dining utensils and toys should be performed with prohibiting sharing of materials among students. Hand washing behavior should be promoted in the school under supervision of the teacher before meals and after using toilet.

Close monitoring of cases, especially among under five children, should be carried out in schools and day-care centers to prevent further transmission. Health education highlighting the importance of the disease should be performed among local staff, teachers and parents. The disease surveillance should be strengthened in schools, in terms of conducting daily intensive health screening, isolating sick children and giving advice to keep infected children at home.

Health Sectors

Physician's awareness should be raised for echovirus among children who come with neurological symptoms as well as URI symptoms. The guideline for clinical case management of severe enterovirus infection should be developed and distributed to all health services. Importance of echovirus infection and consultation of atypical clinical infection to infectious disease experts in specialized areas should be accessible among medical personnel in both public and private medical centers to achieve correct diagnosis. Availability of intravenous immunoglobulin treatment for echovirus infection should be informed to pediatricians.

Surveillance in the communities should be improved for disease detection, prevention and referral by establishing a network between epidemiologists and pediatricians. Public education about echovirus infection through various media should be implemented as well.

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Plant Poisoning Outbreak in a Primary School in the northern Thailand, October 2015

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Abstract

On 6 Oct 2015, the Thailand Bureau of Epidemiology was notified of a food poisoning outbreak among students in a primary school. An investigation was performed to verify the diagnosis and outbreak, describe epidemiological characteristics, identify the source, and provide proper recommendations in order to prevent further outbreaks. Descriptive and retrospective cohort studies were conducted. Medical records at the hospital were reviewed, and teachers, students, cooks and janitors from the school were interviewed. A suspected case was a person in the school with at least two of the followings: nausea, vomiting, abdominal pain or diarrhea during 5-9 Oct 2015. The water samples were sent to the National Institute of Health for bacterial culture. The suspected plant was examined at the Plant Varieties Protection Division for species identification. Bivariate analysis was used to determine the food items associated with illness. The attack rate was 28.8% with 19 suspected cases out of total 66. Most common symptoms included nausea (85.0%), vomiting (85.0%) and abdominal pain (60.0%). All of the suspected cases consumed the coral plant (*Jatropha multifida*), which was also the only significant risk for the illness (P value <0.001). Therefore, this event was a coral plant poisoning outbreak. To prevent future outbreaks, a fence around the herb garden with a warning sign should be set up in the school, along with adequate warning of herb toxicity.

Keywords: plant, poisoning, *Jatropha*, coral plant, outbreak, Thailand

Introduction

Coral plant (*Jatropha multifida* L.) is a shrub or small tree with a single trunk. All parts are toxic, particularly the seeds.[1] It belongs to genus *Jatropha* L. (nettlespurge) and species *Jatropha multifida* L. (coralbush).[2] The symptoms of coral plant poisoning include vomiting, constricted pupils, leukocytosis and lethargy, that can be treated by decontamination and supportive therapy.[3] The severity of ingesting coral plant seeds is uncertain. As few as one seed could cause toxic symptoms, while in other cases, 50 seeds resulted in relatively mild symptoms. Diagnosis can be made through case history and presenting manifestations.[1]

Poisonous plant intoxicated cases accounted for 3% of all reported poisoning cases, and coral plant was identified in 3% of plant poisoning, with no fatalities.[4] Although the magnitude and severity of coral plant poisoning was relatively low, most of affected population were children who accidentally ingested the plants. Moreover, some poisoning outbreaks in Thailand reported coral plant (*Jatropha multifida*) as the source of outbreak in two (22%) out of nine seed poisoning outbreaks during 1981-1987.[5] Therefore, plant poisoning outbreak investigation is important to understand the nature and circumstances of coral plant toxicity.

In October 2015, the Bureau of Epidemiology (BOE) received a notification from the Office of Disease Prevention and Control 10 of a food poisoning outbreak in a primary school from the northern Thailand. The BOE and the local teams jointly conducted a field investigation to verify the outbreak, confirm diagnosis, describe epidemiological characteristics, determine the etiology, and make appropriate recommendations to prevent further outbreaks.

Methods

Descriptive Study

On 7-9 Oct 2015, the investigation team visited the outbreak site and conducted a descriptive study in the primary school, including active case finding among students, teachers, cooks and janitors, face-to-face interviewing, and reviewing medical records in the school. A structured questionnaire was developed for collecting information on demographic (age, gender and grade), signs and symptoms, hospitalization, onset time and foods consumed prior to onset of illness.

A suspected case was a person in the school who had at least two of the following symptoms: nausea, vomiting, abdominal pain and diarrhea from 5-9 Oct 2015.

Environmental Study

An environmental survey was conducted in the school to investigate food production and processing. In addition, a walk-through examination was performed in kitchen, cafeteria, classrooms and garden. Students were also observed to assess health behaviors, especially hand washing before eating and sharing utensils when eating.

Laboratory Study

Samples of tap and ground water were collected on 5 Oct 2017 and sent for enteropathogenic bacteria culture at the National Institute of Health, Thailand. Samples of the suspected poisonous plant that students reported of eating before onset of symptoms were also collected and sent to the Plant Varieties Protection Division under the Department of Agriculture for identification. Nonetheless, clinical samples and leftover foods were not available for testing.

Analytical Study

A retrospective cohort study was undertaken to identify the source of outbreak. The cohort included students, teachers, cooks and janitors who were in the primary school during 5-9 October 2015.

Data were collected by interviewing and reviewing medical records. The focused variables were demographic data (age, gender and school grade), onset time, clinical symptoms and history of food consumption. The exposure such as foods and items that people in the primary school ate or put in mouth on 5 Oct 2015 were collected and analyzed by using Epi Info version 3.5.4.[6] Bivariate analysis was conducted and presented in risk ratio with 95% confidence interval. If risk ratio could not be identified, the result was shown as p-value instead.

Results

Descriptive Study

The school is a public primary school (kindergarten to primary grade 6) and located in the rural area of the northern Thailand. There were 66 people (36 males and 30 females) identified in the school, including 59 students, five teachers, one cook and one janitor.

Total 19 suspected cases were identified, with the overall attack rate of 28.8% (19/66). While all the cases were found in primary grades 1-4, the highest attack rate was observed in grade 1 (87.5%) (Table 1). There were two grades in each classroom for the primary level. Specific attack rates by classroom showed 72.7% (8/11) in room 2 (primary 1-2) and 64.7% (11/17) in room 3 (primary 3-4) (Table 2).

Table 1. Attack rate of food poisoning cases among staff and students from a primary school in the northern Thailand, 5 Oct 2015 (n=66)

Educational level	Number of case	Total number	Attack rate (percent)
Kindergarten	0	14	0
Primary grade			
1	7	8	87.5
2	1	3	33.3
3	7	10	70.0
4	4	7	57.1
5	0	2	0
6	0	15	0
Teacher, cook, janitor	0	7	0
Total	19	66	28.8

Table 2. Attack rates of food poisoning cases by classrooms from a primary school in the northern Thailand, 5 Oct 2015 (n=59)

Classroom	Number of case	Total number	Attack rate (percent)
1 (Kindergarten)	0	14	0
2 (Primary grades 1-2)	8	11	72.7
3 (Primary grades 3-4)	11	17	64.7
4 (Primary grades 5-6)	0	17	0

Cases were evenly distributed by gender with male to female ratio of 1:1. The median age was nine years (inter-quartile range 7-9 years, range 6-10 years). Among all cases, 89.5% (17/19) received treatment and 52.6% (10/19) were admitted to the hospital for observation and rehydration. Two cases were diagnosed with anaphylaxis and no one died. Clinical symptoms included nausea (85.0%), vomiting (85.0%) and abdominal pain (60.0%) (Figure 1).

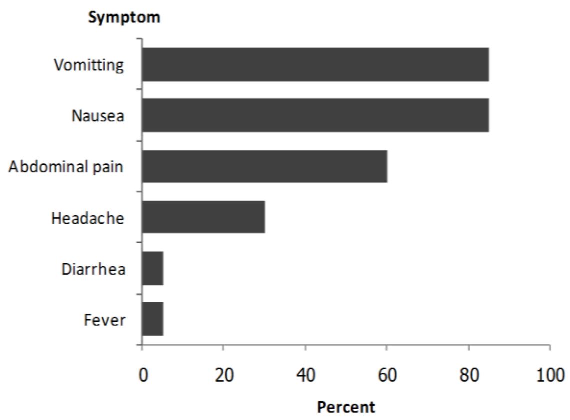

Figure 1. Clinical manifestations of food poisoning cases from a primary school in the northern Thailand, 5 Oct 2015 (n=19)

On 5 Oct 2015, the school lunch served at 10:45 to 11:30 while all cases developed symptoms around 15:00. Interview of the cases indicated that two students brought *Jatropha* to their classrooms: one in classroom 2 (grades 1-2) and one in classroom 3 (grades 3-4), and distributed the fruits to their classmates while the teachers were not around as they assumed that the plants were herbs. The students from grades 1-4 ingested around 13:00 and all of them developed symptoms within one hour after ingesting the poisonous plant. The epidemic curve was compatible with a common source outbreak (Figure 2).

Environmental Study

A *Jatropha* tree was growing in the herb garden of the school, with no fence around or a warning sign. It was located near toilets and playground, where students usually passed by. Many other coral plants were also observed outside the school compound.

No rodent or other animals were observed in the kitchen and cafeteria. The lunch items were cooked in the kitchen at 09:00 and completed around 10:30 every day as well as on the day that food poisoning occurred. The cooked foods were covered and kept warm until the serving time. The foods were served to kindergarten students at 10:45, and then served to primary students at 11:30 on that day as usual.

The team identified two water sources: groundwater and tap water. The groundwater was used for gardening and in restrooms. The tap water was used for daily cooking, washing as well as drinking in the cafeteria and playground after filtered in the tank.

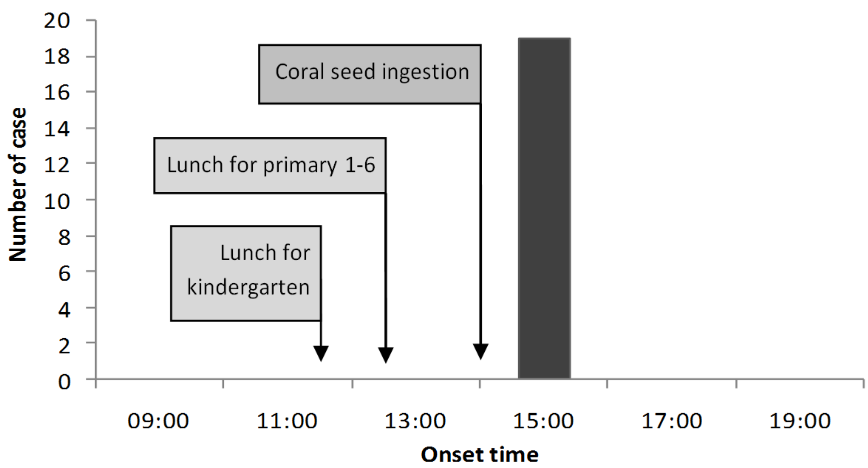

Figure 2. Number of plant poisoning (*Jatropha multicida*) cases by time of onset from a primary school in the northern Thailand, 5 Oct 2015 (n=59)

Figure 3. A *Jatropha* tree (left) (source: Wikipedia) and its seeds (right) from the herb garden of a primary school in the northern Thailand, October 2015

Laboratory Study

Water sample from the cafeteria showed growth of *Aeromanas hydrophila* and *Bacillus cereus* while only *Bacillus cereus* was found in the groundwater. There was no evidence of enteropathogenic bacteria in the water from the kitchen and restrooms. The photo and sample of the ingested herb were identified as *Jatropha multifida* L. by botanical specialists (Figure 3).

Retrospective Cohort Study

Retrospective cohort study was conducted among 59 subjects in the school. Of these, 19 cases met the case definition. The univariate results suggested that the coral plant fruit or *Jatropha multifida* was the risk factor (P-value <0.001) (Table 3).

Discussion

This outbreak was caused by the ingestion of coral plant (ฝิ่นต้น), *Jatropha multifida* L, since the cases were identified only in classrooms 2 and 3, and the implicated plant was also confirmed to be coral plant (*Jatropha multifida* L.). The clinico-epidemiological characteristics were also compatible with its etiology[1]. The majority of cases (85%) developed nausea and vomiting shortly after ingestion. The characteristics of this outbreak was consistent with the previous outbreaks that most cases had upper gastrointestinal symptoms within an hour or more after consumption of the plant.[5] Moreover, the coral plant was also identified as the risk factor (P-value <0.001) by the analytical study.

Even though laboratory results found *Bacillus* spp. and *Aeromonas* spp. in the groundwater and a water tank in the cafeteria, this could not be the source of outbreak as these enteropathogenic bacteria are often detected in drinking water[7] and clinical symptoms were not consistent with these bacteria either. Moreover, the cases were not distributed evenly among the primary students even though they shared the same water source. Statistical analysis also presented the insignificant results.

Food poisoning outbreaks are frequently occurred in children and schools.[8,9] As in the previous outbreaks of poisoning caused by coral plants, most of the cases involved children. The risk behaviors were lack of knowledge about the plant and easy access to it.[10,11] Accidental food poisoning by another species of *Jatropha curcas* L. (Physic nut) is also common in children from Thailand[12], as well as in other countries such as India[13,14] and French[15]. *Jatropha* species can contain toxalbumin ricin, which could be fatally toxic and can cause severe vomiting and diarrhea, leading to dehydration, shock as well as renal and hepatic impairments.[9]

In this event, the students believed that the coral plant was an edible herb as it was planted in the herb garden. Moreover, no warning sign was placed near the plant and supervision by teachers was not feasible around the clock. Although the investigators recommended cutting the coral plant tree, the school principal did not agree on it as it remarked the anniversary of school inauguration.

Table 3. Univariate analysis of a retrospective cohort study for food items associated with a food poisoning outbreak in a primary school of the northern Thailand, 5 Oct 2015 (n=64)

Exposure	Eating			Not Eating			Risk ratio	P-value
	Ill	Total	Percent	Ill	Total	Percent		
Stir-fried basil with minced pork	19	61	28.8	0	3	0	UD	0.34
Coral plant seed	19	19	100.0	0	45	0	UD	<0.001
Drinking tank water	19	63	30.2	0	1	0	UD	0.70
Milk	19	58	32.8	0	6	0	UD	0.11

Hence, we advised them to post a warning sign near the tree in the herb garden. Additional supervision of all students by teachers should be strengthened. Information about the coral plant (*Jatropha multifida*) and consequences of ingestion should be given to all students occasionally.

Limitations

Although residual foods, vomitus and stool samples were planned to collect for testing, the samples were not available on the day of investigation.

Acknowledgements

We would like to thank all students and staff in the primary school and officers from the Office of Disease Prevention and Control 10 for cooperation and support. We are grateful to the Plant Varieties Protection Division and the Department of Agriculture for their technical advice on plant identification.

Suggested Citation

Nittayasoot N, Lekcharoen P, Tantiworrawit P. Plant poisoning outbreak in a primary school from the northern Thailand, October 2015. OSIR. 2017 Dec;10(4):17-21.

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Excerption from the Crucial Instructive Talks, 2017:

In Remembrance of His Majesty King Bhumibol Adulyadej (1927-2016), His Public Health Contributions and Sustainable Development

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This article is excerpted from the keynote speech of High Excellency Clinical Professor Emeritus Dr. Piyasakol Sakolsatayadorn, Minister of Public Health, Thailand, in the 9th Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) Global Scientific Conference which was held on 7-11 Aug 2017 in Chiang Mai, Thailand.

Throughout years and years of His Majesty the King's work with and for the people, His Majesty convinced that self-reliance and sustainable development was the only way for the country to achieve stability, even through the unbelievable economic growth in the early 1990s.

Historical photographs today often show the monarch making his way over rough terrain by car, boat and even on foot to visit his people, gain a first-hand experience about their woes and find a way to help them, even to the remote corners of the Kingdom.

We are Thais and prompt to follow the guidance of the late great King who dedicated his life for his people. His public health contributions and sustainable development on health was particularly beneficial to well-being of the country. Today, it is confirmed that the sustainable development gradually formulated with his remedies would improve the people's well-being and livelihood.

Four main parts of this speech include sustainable development, the thought leader, the King contributions to public health and disease control, and the following of the late King Bhumibol's footsteps.

Sustainable development is an organized principle. It is defined as the development that meets the needs of present, without compromising the ability of future generation to meet their needs. There are three main elements, including economic growth, social inclusion and environment protection. The three main elements have to be interconnected, and all are crucial for the well-being of individuals and societies.

In 2015, the world leaders expressed their solidarity for global sustainability and enshrined in the Sustainable Development Goals (SDGs) as key development milestones. It is comprised of 17 goals and 69 targets, which all nations should attain by the year 2030. The next 15 years will be crucial to global development and human security.

In this regard, Thailand as a global citizen embodiment, our King Bhumibol "Sufficiency Economy" philosophy guided us toward the sustainability. The concept of self-sufficiency had been touched upon in His Majesty's speeches for the past 20 years, but it was only after the great economic meltdown in 1997 that the concept was properly formulated and promoted.

In His Majesty the King's birthday address given on 4 Dec 1974, he said: "I ask all of you to aim for moderation and peace, and work to achieve this goal. We do not have to be extremely prosperous … If we can maintain this moderation, then we can be excellent".

The 1997 economic crisis gave Thailand the first-hand experience of how fragile unsustainable growth was. The economic pain prompted a nationwide question for balanced development. Since then, the Sufficiency Economy Philosophy has become Thailand's development compass.

Moderation is the guiding spirit of the country. When the globe is over consumption and greed-driven development, moderation is the principle. When globalization brought economic uncertainties and risks, we have to be prudence and built-in selfimmunity. And when things get tough, we will strive on.

The Philosophy of Sufficiency Economy and its Three Pillars

Moderation is sufficiency at a level of not doing something too little or too much at the expense of oneself or others, for example, producing and consuming at a moderate level.

Reasonableness is the decision concerning the level of sufficiency must be made rationally with consideration of the factors involved and careful anticipation of the outcomes that may be expected from such action.

Risk management is the preparation to cope with the likely impact and changes in various aspects by considering the probability of future situations.

To secure the country well-being, the King discovered that many counties and remote areas had faced the problem of drought. Over 82% of Thai agricultural land relied on rainfall. Thai farmers were not able to grow crops for lack of water. The research was started since 1955 and the first attempt was made in July 1969 at Kha Yai National Park. In 2009, Jordan received permission from Thailand to use the technique.

Vetiger grass is a domestic grass that easily grow, needs less water and survives longer. The International Union of Soil Science announced in 2002 that 5 December is recognized as the World Soil Day. Doi Kham is a business under the Royal Project Foundation. The Doi Kham Food Products Company buys organic farm products at fair prices from the hill tribe people in northern Thailand. The project helps prevent the hill tribes from being exploited, and restores highland ecology and the farmers' quality of life. It was also recognized worldwide for success in eradication of opium cultivation through crop substitution programs.

Although only few people observed His Majesty's royal duties in health and disease control, his contributions to the public health were enormous. At the age of 24, he spent his money to build a building name Mahidol Vongsanusorn for the Bacillus Calmette–Guérin (BCG) production (Figure 1). He spent his own money, raised fund by radio advertisement, organized piano performance for purchasing "Iron Lung" (Figure 2), hydrotherapy equipment, and built two wards for polio treatment: one in Pramongkut and another one in Siriraj Hospital.

Figure 1. The "Mahidol Vongsanusorn" built for Bacillus Calmette–Guérin (BCG) vaccine production in 1951

Figure 2. His Majesty King Bhumibol Adulyadej donated "Iron Lung" for polio treatment in 1955

In 1958, there were cholera outbreaks in 35 provinces. The need of normal saline was unmet due to the limited saline bottles and autoclave for sterilization. The King again did raise fund for cholera control by performing saxophone, according to the request. The donation amount came up to 883,738.82 Baht. The royal medical unit was established as an accompany service for his visit to the remote area.

Following in the footsteps of His Royal Highness, Prince Mahidol of Songkla, the King's father, noted, "True success is not in the learning, but in its application to the benefit of mankind" (Figure 3).

The King Bhumibol and his enlightened approach teach Thais, especially personnel in health sector. An excerpt from His Majesty the King's speech in several occasions, learning to build up and enhance the core values for personnel in the Ministry of Public Health was implemented as "MOPH".

When everyone sees the logo of health care, the shadow of coin or money is behind. So Sufficient economy for health care and value-based health care does not only considered the financial profits, but also its cost has to be considered.

The philosophy of the late King, sufficient economy does not mean that do less without development. It can make profit. However, non-profitable organization is not to make the income benefit for partners, but for sustainable development.

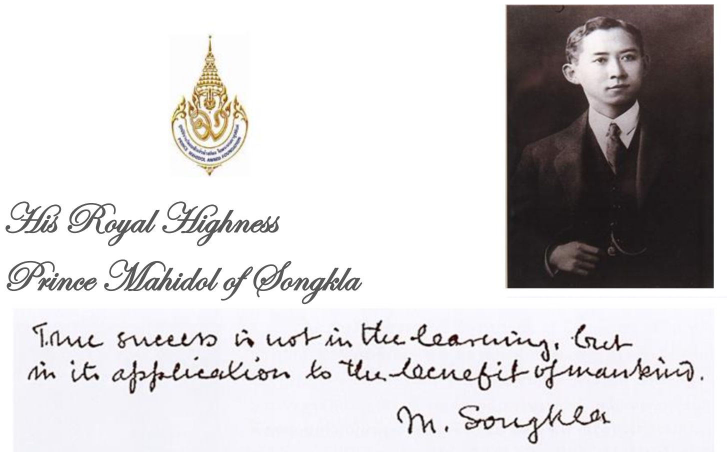

Figure 3. The script of His Royal Highness, Prince Mahidol of Songkla

In change of Thai health care system by universal coverage on health care, lots of families were saved from bankruptcy. After the medical care support by the government was initiated, the proportion of family expenditure costs for health was presented in reverse direction.

To target stability, prosperity and sustainability among Thais, Thailand 4.0 has been branded and implemented for value-based economy. In the same direction, Thai health system is focused on value-based health care through the brands of health care 4.0 and the MOPH 4.0.

Currently, three main growth engines of health care 4.0, including inclusive, productive and green growth engines, are implemented nationally and locally. Thus, following in the footsteps of the Great King, together we can be stronger, smarter and make our Thai society, our country and the world better.

Suggested Citation

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A Chronological Outbreak of Influenza in Thailand, 1918-2010

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This article is excerpted from the panel talk of Emeritus Prof. Dr. Prasert Thongcharoen in the 9th Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) Global Scientific Conference which was held on 7-11 Aug 2017 in Chiang Mai, Thailand.

The term of influenza is derived from the Latin influentia, to word meaning “influence” which the disease could be implied from the influence of the stars. Influenza had been officially recorded since 1918 of Spanish flu as a pandemic in Europe and spread to Asia and Africa. Spanish flu was a global epidemic and infected a large proportion of the world population, including Thailand. The five important influenza outbreaks were related to Thailand as in table 1.

However, the putative pandemic in Thailand before 1918 is difficult to obtain its record. The first report was written by Prof. Dr. Samran Wongspa, an ophthalmologist at Siriraj Hospital. He described influenza outbreak during the reign of King Rama VI (1910-1925) in a local journal named Siriraj Hospital Gazette[1]. The outbreak of influenza in Thailand was brought by troops after the World War I (WWI) as Thailand sent the Royal Thai Army Forces to join the Allied Forces in France and returned later when the WWI ended. The troops arrived back with the influenza virus, which was spreading over the frontline. In October 1918, influenza was therefore being spreading from the harbor city in the southern of Thailand. By November 1918, the infection had been spread throughout the whole country and it was afterwards subsided in March 1919.

The impact of Spanish flu in Thailand during 1918-1919, as that time the population was estimated at 8,478,566, had affected to 2,317,633 individuals infected by influenza virus (36.6% the infected rate), with 80,263 deaths (1.0% mortality rate) and the affected rate/fatality rate was 3.6%. The number of infected individuals was found in 17 administrative regions called as Monthol of Siam in 1918 as shown in table 2 and could not characterized the viral subtypes. Currently, new technologies have allowed several researchers to characterize the 1918 influenza virus that was found to be influenza A subtype H1N1 and assumed the recorded outbreaks in Thailand during 1918-1919 was the same subtype due to it caused from the returned troops from France after the WWI.

The second influenza outbreak was emerged in 1957-1958 and it called Asian flu which started in the southern part of mainland China or in Vladivostok, the Union of Soviet Socialist Republic. There was an evidence of outbreak from China that then spread to Japan, Taiwan, the Philippines and other countries in Asia Pacific. Asian flu impacted approximately 10-15% of the world population, with the mortality rate estimated at 0.3%. The first officially documented was reported when the virus spread to Singapore in early 1957. The first viral isolation was obtained from a sample in Singapore that could characterize and designated as A/Singapore/1/57 (H2N2).

Asian flu in Thailand came in after the outbreak in Singapore. It originated in the southern part of country during the late of April to the beginning of May 1957 and disseminated to the whole country. The infected population was 1,081,677 (4.8%) of the total population at 22,811,701, with the highest infected rate in Kalasin Province while Suphanburi Province was the lowest infected rate. The viral characterization was isolated and identified by Dr. Samarn Vardhanabhuti[2] who found that it was the same strain of virus in the Singapore outbreak[3].

Table 1: The global influenza outbreak

Year	Common name	Considered area of emergence	Subtype	Estimated case fatality rate	Estimated deaths worldwide	Estimated people infected
1918-1919	**Spanish flu**	Unclear	H1N1	2-3%	50-100 million	500 million
1957-1958	**Asian Flu**	Southern China	H2N2	<0.2%	1-4 million	ND
1968-1969	**Hong Kong Flu**	Southern China	H3N2	<0.2%	1-4 million	ND
2003-now	**Avian Flu**	Southern China	H5N1	52%	452	856
2009-2010	**Pandemic 2009**	Mexico	H1N1	0.03%	18,500	10-200 million

Table 2. Spanish flu cases in 17 Monthols of Siam, 1918

Regions (Monthol)	Total number of people	Percent of infected patient	Percent of death
Phayap	805,787	18.3	1.5
MahaRachsdon	546,944	16.4	1.1
Nakhon Chai Si	343,963	37.3	0.3
Ratchaburi	465,080	24.3	0.5
Nakhon Si Thammarat	525,394	23.9	0.8
Nakhon Ratchasima	590,612	25.7	1.0
Nakhon Sawan	359,978	28.6	0.7
Prachinburi	401,972	42.3	0.5
Phitsanulok	395,723	16.8	0.5
Pattani	302,870	37.5	1.2
Surat Thani	185,106	34.9	1.1
Ayutthaya	681,533	37.8	0.5
Chanthaburi	149,377	23.9	0.7
Phuket	244,919	19.3	0.8

The third outbreak was Hong Kong flu in 1968-1969[4] and was caused from influenza A virus subtype H3N2. Hong Kong flu was firstly notified from six medical students who had been admitted to the medical service of Siriraj Hospital with a provisional diagnosis of influenza-like illnesses on 26 Aug 1968. In Bangkok, the prevalence rate was estimated 47 per 100,000 populations, with Bangkok population at that time approximately 150,000. All age groups developed mild symptoms, without any serious complications and no deaths related to influenza. Later, the infection spread further in the whole country.

The fourth outbreak was avian flu on 11 May 1997[2] when there was a report of avian influenza virus transmitted to human by direct contact with infected poultry for the first time in Hong Kong SAR. Avian influenza virus A (H5N1) was isolated from clinical specimens and mainly caused an epidemic among poultry. Later, World Health Organization (WHO) reported the probable human-to-human H5N1 transmission in Vietnam on 2 Feb 2004. In Thailand, there was an outbreak report of fowl in November 2003 in Nong Bua and Nakhon Sawan Provinces. The Thai government confirmed the outbreaks of avian influenza with two human cases in children on 23 Jan 2004. The avian flu from the first reported case in January 2004 to December 2006 resulted 25 confirmed cases of avian influenza A (H5N1), with 17 deaths and complete recovery in eight cases. As the epidemic in poultry and wild birds was strengthened through the surveillance program, the last report was in January 2008. Thailand had been free of avian influenza virus in animals since January 2008.

The last pandemic influenza of H1N1 or Pandemic 2009 was detected in Thailand on 12 May 2009. Two cases were the exchanged students returned from Mexico where influenza A (H1N1) first emerged. They were quarantined and treated at Bamrasnaradura Infectious Diseases Institute in Nonthaburi, Thailand. The occurrence of viral transmission to Thai people could be assumed its infection from the travelers. However, as the infection caused mild symptoms, the endemic was not obviously noticed. However, the first pandemic began in May 2009, with peaked in July. By the end of July 2009, cases were reported from all 76 provinces, with 65 fatalities. The serological surveillance based on the hemagglutination inhibition assay revealed that approximately 8-12% of Thai people were infected with the pandemic influenza A (H1N1) 2009 virus infection. The WHO declared the initial pandemic phase of influenza A (H1N1) 2009 on 11 Jun 2009 and the post-pandemic phase on 10 Aug 2009. The second wave of influenza A (H1N1) occurred during December 2009 to April 2010 and peaked in February 2010. The third wave was observed from June to October, with a peak in August 2010. After the third wave, the pandemic of influenza A (H1N1) virus infection was only occasionally observed in Thailand.

Thailand had mostly been affected with influenza since one century ago. The spreading of influenza or called "Spanish flu" was firstly reported in October 1918 through March 1919. The second outbreak of Asian flu was recorded after the Singapore outbreak in 1957 while the third outbreak of Hong Kong flu was notified in 1968. The fourth outbreak of Avian flu was initially appeared in January 2004. The last pandemic influenza of H1N1 was reported in May 2009. After August 2010, the pandemic of influenza A (H1N1) virus infection was only occasionally seen in Thailand. The global outbreak of influenza has been beaten Thailand almost century and it will continue to challenge to Thai health officers and Thai scientists as the viral influenza is developing to surviving in the environment. Therefore, we must improve our knowledge to understand the viral development and develop the diagnosing method to handle immediately which is included the effective viral treatment.

Suggested Citation

Thongcharoen P. Excerption from the crucial instructive talks, 2017: a chronological outbreak of influenza in Thailand, 1918-2010. OSIR. 2017 Dec;10(4):24-26.

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