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An Outbreak of Leptospirosis in Davao City of Philippines, 2013: An Investigation of the Risky Behaviors that Led to the Resurgence

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Abstract

On 7 Feb 2013, the National Epidemiology Center in the Philippines Department of Health received a report on increasing number of leptospirosis cases in Davao City after the monsoon flooding. Leptospirosis has been endemic in Davao City and a leptospirosis outbreak occurred in 2011 after a flashflood in the city. Objectives of our investigation were to determine existence of the outbreak, identify source and mode of transmission, and find out risk factors. We reviewed medical records of local hospitals and conducted active case finding in the affected communities. A suspect leptospirosis case was a resident in one of nine flooded districts of Davao City who had fever for two days or more and any of the following: myalgia, conjunctival suffusion, jaundice, anuria/oliguria, hematuria or calf pain from 6 Jan to 15 Feb 2013. Serum samples were collected for laboratory confirmation by microscopic agglutination test and polymerase chain reaction. Key informants were also interviewed. Total 64 suspect leptospirosis cases with six deaths (CFR = 9.4%) were identified. Ages ranged from 14-73 years (median = 33 years), with 86% as males. Among 42 cases, 64% were positive for *leptospira spp*. Majority of the cases (82%) waded in the flood without any post-exposure prophylaxis and 63% had open wounds on lower extremities when exposed to floodwater. The most affected age group was 21-30 years old (33%). The case-control study showed that wading in floodwater (OR = 11, 95% CI = 1.45-458.37), swimming in floodwater (OR = 3, 95% CI = 1.31-8.00), having contact with moist soil (OR = 3, 95% CI = 1.13-6.49) and having open wounds (OR = 11, 95% CI = 3.61-36.63) were risk factors. Therefore, it was confirmed that there was a resurgence of leptospirosis in Davao City. Intensive health education activities, emphasizing protective clothing and prophylactic treatment might reduce risk for leptospirosis and future outbreaks.

Key words: leptospirosis, case-control, risk factors, flooding, Philippines

Introduction

Leptospirosis is a zoonotic disease that affects both humans and animals, and a re-emerging public health problem.[1] Early-phase illness is characterized by abrupt onset of high fever, muscle pain in calves and lumbar region, and retro-orbital and frontal headaches. Other manifestations such as nausea, vomiting, abdominal pain, diarrhea, cough, photophobia and rash may present in the early phase as well. Conjunctival suffusion, redness of conjunctiva, is a pathognomonic finding of leptospirosis.[2]

Feral and domestic animals are reservoirs of pathogenic leptospires. Infected animals may shed spirochete in urine or amniotic fluid. People become infected when their mucous membrane or broken skin comes in contact with water (swimming or immersion), moist soil or vegetation that is contaminated with urine of infected animals. Incidence is significantly higher in countries with warm climate than those in temperate regions, which is mainly due to longer survival of leptospires in warm and humid environment.[3]

With the estimated 350,000-500,000 cases reported annually around the world, leptospirosis is an emerging important public health problem in many developing countries.[4] In the Philippines, it is an endemic zoonotic disease, with average 680 cases and 40 deaths reported every year and prevalence of 10 per 100,000 population.[5] Risk of infection can be increased by poor sanitation and growing number of urban slums, along with frequent typhoons and expansion of flood areas. Health education campaigns directed at household occupants as well as promotion on social determinants of health and concrete actions to decrease health inequity are several approaches to reduce risk of acquiring leptospirosis in these situations.[6]

On 28 Jun 2011, heavy rainfall caused flash floods in Davao City, Mindanao, Philippines. Matina Pangi, Matina Crossing, Matina Aplaya and Talomo Villages were greatly affected. The flash flood contributed to upsurge of leptospirosis cases during 26-27th weeks of 2011, with two reported deaths. On 7 Feb 2013, the Event-based Surveillance and Response (ESR) Unit of

the National Epidemiology Center (NEC) observed an increase of leptospirosis cases in Davao City. Thus, we conducted an outbreak investigation to determine existence of an outbreak, identify source and mode of transmission, find out risk factors, and recommend control and prevention measures.

Method

To construct a line-list of leptospirosis cases, we reviewed medical records of admitted cases in Southern Philippines Medical Center, Brokenshire Hospital, Community Health and Development Cooperative Hospital, and the City Health Office (CHO). In addition, the investigation team travelled to the flooded communities in order to conduct active and retrospective case finding. The team also reviewed data from NEC-Philippine Integrated Disease Surveillance and Response (NEC-PIDSR), Regional Epidemiology Surveillance Unit and City Epidemiology Surveillance Unit.

A suspect leptospirosis case was defined as a previously well individual who lived in one of nine flooded districts of Davao City (Talomo North, Talomo South, District A, District B, District C, Agdao, Buhangin, Toril and Calinan) and had fever for two days or more and one of the following: myalgia, conjunctival suffusion, jaundice, anuria or oliguria, hematuria, or calf pain, with onset of symptoms between 6 Jan to 15 Feb 2013. A confirmed case was a suspect case or any individual who was a resident in one of the nine flooded districts of Davao City and tested positive for *Leptospira spp.* by microscopic agglutination test (MAT) or polymerase chain reaction (PCR) during the same time period.

A case-control study was conducted to determine risk factors associated with leptospirosis. A standard questionnaire was used in the interviews. Controls were healthy and symptom-free individuals randomly selected from neighborhood of the cases and tested negative for *Leptospira spp.* by MAT or PCR. Odds ratios with 95% confidence interval (CI) and chi-square test were calculated by Epi Info version 3.5.1.[7]

Blood samples from cases and controls were collected, sent to the Research Institute for Tropical Medicine and tested for leptospira antibodies by MAT and for leptospira DNA by PCR. MAT was considered as the "gold standard" of serodiagnosis and interpreted as positive when there was 4-fold rise in titer from acute to convalescent sera. The serogroups that could be identified by MAT were Andaman, Australis, Autumnalis, Ballum, Bataviae, Canicola, Cellidoni, Cynopteri, Djasiman, Grippotyphosa, Hebdomadis, Icterohaemorrhagiae, Javanica, Louisiana, Manhao, Mini, Pomona, Pyrogenes, Ranarum, Sarmin, Sejroe, Shermani, Tarassovi and serogroup Semaranga serovar patoc. PCR has an advantage for early confirmation of diagnosis, especially during acute leptospiremic phase (first week of illness) before appearance of antibodies.[5]

We also interviewed key informants from CHO and district health office and village health workers. An environmental survey of the affected villages was also conducted during investigation from 20-26 Feb 2013.

Results

We identified 64 cases (Figure 1) and of which, six died (Table 1), with case fatality rate (CFR) of 9.4%. Majority (86%) were males. Age of the cases ranged from 14-73 years, with median 33 years and highest proportion in age group was 21-30 years (33%) (Figure 2). Aside from fever, other common clinical manifestations were myalgia (82%), conjunctival suffusion (62%), hematuria (49%) and oliguria (40%).

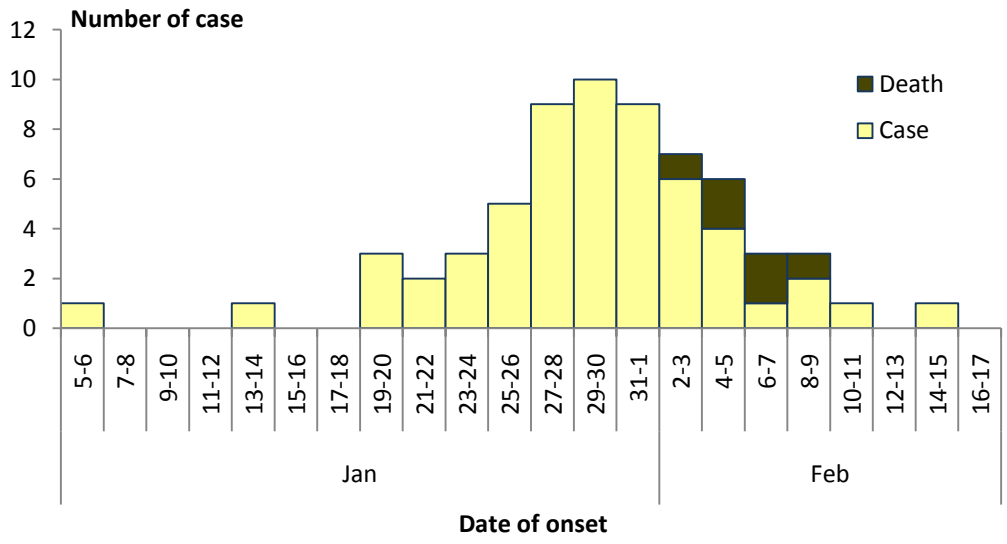

Figure 1. Leptospirosis cases (n=58) and deaths (n=6) by onset of illness in Davao City, Philippines, Jan to 15 Feb 2013

Table 1. Epidemiological characteristics and clinical course of fatal leptospirosis cases (n=6) in Davao City, Philippines, 6 Jan to 15 Feb 2013

No.	Age (year)	Gender	District	Date of onset	Date of admission	Date of death	Exposed to floodwater or mud	Cause of death
1	34	Male	District A	24 Jan 2013	5 Feb 2013	6 Feb 2013	Yes	Acute respiratory distress syndrome
2	35	Male	District A	27 Jan 2013	4 Feb 2013	4 Feb 2013	Yes	Sepsis
3	52	Male	Talomo North	29 Jan 2013	31 Jan 2013	2 Feb 2013	Yes	Acute kidney injury secondary to sepsis
4	28	Male	Talomo North	31 Jan 2013	4 Feb 2013	5 Feb 2013	Yes	Acute renal failure
5	68	Female	District A	3 Feb 2013	6 Feb 2013	6 Feb 2013	Yes	Sepsis
6	70	Male	District A	4 Feb 2013	Missing	8 Feb 2013	Yes	Weil's Syndrome

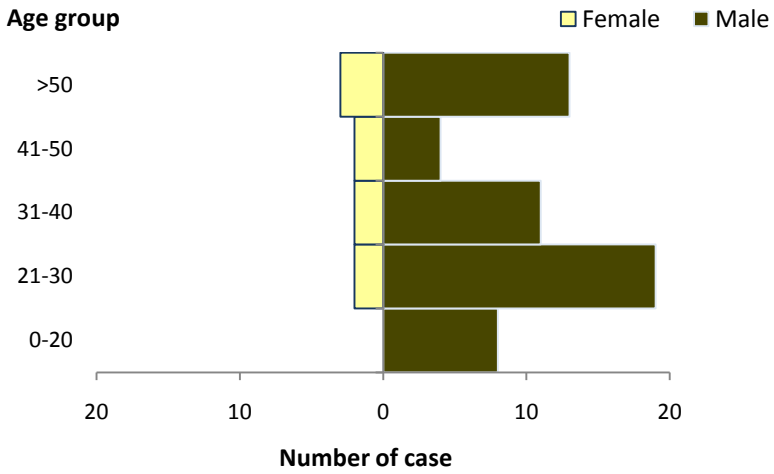

Figure 2. Leptospirosis cases by age groups and gender in Davao City, Philippines, 6 Jan to 15 Feb 2013 (n=64)

Among total 64 cases, 56 (87.5%) were exposed to floodwater, including 46 cases (82.1%) who had history of wading without any post-exposure prophylaxis and four cases (7.1%) who had post-exposure prophylaxis (Doxycycline) but not able to complete the treatment. Total 35 cases (62.5%) had history of open wounds on lower extremities at the time of exposure to floodwater, including three cases (8.6%) who received the prophylaxis.

For analytic study, 44 cases and 66 controls were interviewed using a standard questionnaire. On bivariate analysis, results showed that cases were 11 times more likely to have open wounds, 11 times more likely to wade, three times more likely to have contact with moist soil and three times more likely to swim in floodwater than controls, and these were all statistically. Moreover, wearing boots was a strong protective factor for leptospirosis.

A total of 42 serum samples were collected from the cases. Of these, 27 (64.3%) and 16 (38.1%) specimens were positive for *Leptospira spp.* and L*eptospira biflexa* serovar Patoc by MAT respectively, and 11 (26.2%) were positive for pathogenic *Leptospira spp.* by PCR.

During interviews with the key informants, the village health workers mentioned that for the period of flooding, the local people had to wade in floodwater for evacuation without protective clothing and were not able to take prophylaxis. In addition, the CHO staff mentioned that there was a leptospirosis outbreak in 2011 after a flashflood.

On environmental survey, we observed mud, moist soil and pools in the communities. Several rodents were seen, especially in open canals. Many households owned dogs and some had pigs and goats. Poor sanitation and improperly maintained sewage system were detected in the affected villages. Submerged pipes in open canals and muddy roads were also noticed.

Table 2. Bivariate analysis of factors associated with leptospirosis in Davao City, Philippines, 6 Jan to 15 Feb 2013

Factor	Case (n=44)		Control (n=66)		Crude odds ratio (95% CI)
	Number	Percent	Number	Percent	
Gender (male)	40	90.9	56	84.8	1.78 (0.47-8.32)
Age group (year)					
<21	9	20.5	17	25.8	Reference
21-30	12	27.3	17	25.8	1.33 (0.39-4.61)
31-40	9	20.5	11	16.7	1.55 (0.40-6.00)
41-50	4	9.1	8	12.1	0.94 (0.16-4.85)
>50	10	22.7	13	19.7	1.45 (0.39-5.29)
Waded in floodwater	43	97.7	53	80.3	10.55 (1.45-458.37)
Swam in floodwater	32	72.7	30	45.5	3.20 (1.31-8.00)
Contacted with moist soil	23	52.3	19	28.8	2.71 (1.13-6.49)
Walked barefoot	24	54.5	27	40.9	1.73 (0.75-4.02)
Had open wounds	23	52.3	6	9.1	10.95 (3.61-36.63)
Wore boots	0	0	22	33.3	0 (0-0.18)*
Took prophylaxis	2	4.5	11	16.7	0.24 (0.02-1.19)

*P-value < 0.001

Discussion

There was a leptospirosis outbreak in Davao City, Philippines from 13 Jan to 9 Feb 2013. Majority of the cases were males and the most affected age group was 21-30 years. There were a significant number of deaths (CFR = 9.4%) and causes of death were acute renal failure and sepsis. This was consistent with a previous study in the Philippines which stated that mortality rates of patients admitted to hospitals were high (12-14%) in Philippine General Hospital and San Lazaro Hospital, with major cause of death as renal failure.[4]

Poor sanitation, muddy roads and improper sewage system were observed in the flooded villages. Thus, health teaching on usage of protective clothing and prophylactic treatment were helpful in controlling for this outbreak. As leptospirosis is a preventable disease, control measures at household level and in community are critical for success of prevention and control of leptospirosis. Poverty, environmental sources of transmission such as open refuse deposits, animal reservoirs, open sewers, and flooding in and around the household had shown to be associated with exposure to and infection of leptospirosis.[6] In the Philippines, leptospirosis is endemic and number of cases peak during the rainy months from June to August.[5] While the occurrence of serovars among humans in the country dated back to the late 1960s and 1970s, the first leptospirosis outbreaks in the country were reported from Sablayan Prison and penal farms in Mindoro in 1976, followed by outbreaks in Manila City Jail from September to October 1999.[4]

In October 2009, two weeks after heavy rainfall from the typhoon Ketsana, the Department of Health declared a leptospirosis outbreak in Metro Manila.[5] In 2011, there was a leptospirosis outbreak in Davao City due to flooding caused by heavy rainfall. Therefore, leptospirosis was likely to continue to re-emerge in the Philippines as a result of rapid urbanization, deforestation, poor sanitation and increase incidence of typhoons brought about by the climate change.[5] The Philippines is directly hit by typhoons and cyclones at an average of 20 times a year. It was also observed that since 1960s, the flooded areas in the Philippines have been expanding. Yanagihara et al. demonstrated that leptospirosis cases occurred when rainfall level exceeded 50-100 mm per month.[4]

In our case-control study, cases were randomly selected from the obtained line list of suspect cases rather than choosing only confirmed cases, given that laboratory results were not available at the time of study. This was likely to reduce the power of our study. Nevertheless, the measurement of association remained significant. In spite of this limitation, our study demonstrated that majority of the patients' clinical features were fever, myalgia and conjunctiva suffusion, which was consistent with other studies where majority of patients presented with non-specific clinical signs such as fever (98.5%), myalgia (78.1%), malaise (74.9%) and conjunctiva suffusion (59.3%).[8] Another limitation of our investigation was that due to delayed notification, the investigation team arrived at the end of the outbreak and missed an opportunity to institute control measures in a timely manner.

Majority of the residents did not use any protective clothing such as boots and walked barefoot when they waded in floodwater and had contact with moist soil. Most of the residents were also not aware of the need for post-exposure prophylaxis or availability of prophylaxis distributed by the CHO. Although some cases took post-exposure prophylaxis, they were not able to follow the recommended duration and timing of prophylaxis treatment. The World Health Organization recommended antimicrobial therapy to start before the fifth day of disease onset.[1] Intensive and well-directed health education activities on prevention and control of leptospirosis, emphasizing on usage of protective clothing, prophylactic treatment and advocacy of seeking early consultation, decrease garbage and rodent population, for long term plan, the government should plan for a fast floodwater irrigation that might reduce risk factors for leptospirosis.

In conclusion, Davao City had experienced another outbreak of leptospiroris after flooding. Our study highlighted the challenges in improving community awareness and practice in prevention of future outbreaks.

Suggested Citation

Zapanta MJ, De Guzman A, Ching PK, de los Reyes VC, Sucaldito MN, Tayag E. An outbreak of leptospirosis in Davao City of Philippines, 2013: an investigation of the risky behaviors that led to the resurgence. OSIR. 2014 Dec; 7(4):1-5. <http://www.osirjournal.net/issue.php?id=72>.

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Ferry Boat Injuries and Deaths in Pattaya, November 2013: Its' Time for Thailand to Reclaim its Safe Hospitality

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Abstract

On 3 Nov 2013, the Bureau of Epidemiology was notified of a ferry boat accident in Pattaya, Chon Buri Province. At least six deaths and 16 severe injuries were reported. The investigation team conducted a descriptive study to describe potential risk factors associated with injury and death, and determine the effectiveness of interventions on injury prevention after the accident. All medical records related to injuries and deaths from four hospitals were reviewed and interviews were held with patients, crew, heath volunteers, rescuers and local authorities. The team also observed ferry boat transportation services. Medical records of 37 hospitalized injuries, including seven deaths, were reviewed. Of these, 59% were males, with median age of 32 years. Major causes of injury were muscle strain (35%), aspiration pneumonia (19%) and submersion (14%). Five out of seven fatalities used a buoyancy aid, with one victim's buoyancy aid reported to be "riding up", which led to drowning. Overcapacity of the boat and inappropriate wearing of buoyancy aids accounted for the injuries and deaths. A multi-sectorial approach, including collaboration with National Institute of Emergency Medicine, Marine Department and, Department of Disaster Prevention and Mitigation, was essential to resolve safety issues resulting from resource constrained public transportation services.

Key words: buoyancy aid, injury, boat, Chon Buri, Thailand

Introduction

Boat journeys were the second most common mode of travel in Thailand, accounting for 9.5% of Thailand's transportation in 2009.[1] In 2013, 30 boat accidents, which resulted in 34 injuries and six deaths, were reported to the Marine Department, Ministry of Transport, Thailand. Four of these accidents occurred in Pattaya, Chon Buri Province, causing 13 injuries and three deaths, the highest number of injuries and deaths compared to other provinces. Of the four accidents in Pattaya, speed boats accounted for three. The other incident involved a ferry boat, which was the first accident of this type of boat in Pattaya.[2]

Pattaya is a popular tourist area for both domestic and international visits. Each year approximately two million tourists or 45% of tourists who visit Pattaya,[3] travel between Pattaya and the island of Koh Larn which are located approximately seven kilometers apart. There were two types of boat service: speed boats (Figure 1) and ferry boats (Figure 2).

Figure 1. Speed boats parking along the beach to board more passengers in Pattaya, Thailand, November 2013

Figure 2. Ferry boat transporting between Koh Larn to Pattaya, Thailand, November 2013, showing passengers without buoyancy aids and no size fit for children

Speed boats are smaller and faster, with a capacity for 20-80 passengers. It takes approximately 20 minutes for each trip between Koh Larn and Pattaya. Ferry boats are larger with capacity of 150-200 passengers and take approximately 30-45 minutes to travel between Bali Hai Port in Pattaya to Na Baan or Ta Waen Port in Koh Larn. The cost of traveling by a ferry boat was cheaper than a speed boat, costing 30 Baht (0.9 USD) compared to 100-200 Baht (3-6 USD) for a speed boat.

The Bureau of Epidemiology (BOE), Ministry of Public Health (MOPH) was notified by the Provincial Health Office (PHO) of a fatal boat accident in Pattaya, Chon Buri Province (Figure 3) which occurred at approximately 17:00 on 3 Nov 2013. The BOE team, including members from PHO, 3rd Office of Disease Prevention and Control (ODPC) investigated the incident to describe potential risk factors associated with injury and death from the boating accident, and determine the effectiveness of interventions on injury prevention after the accident.

Methods

Descriptive Study

Medical records related to the ferry boat injuries and deaths from four hospitals in Chon Buri Province, including Bangkok Pattaya, Samitivej Sriracha, Banglamung and Paolo Memorial Hospitals, were reviewed for demographic characteristics of the injured persons, fatalities and injury-related information.

Hospitalized injured passengers, boat crews in other nearby boats and rescuers that witnessed the accident were interviewed using a structured questionnaire to record a description of the accident, confirm the safety equipment on board and describe the rescue procedures during the accident.

Additionally, we interviewed health volunteers and staff from Department of Disease Prevention and Mitigation in Marine Department, and Director of the Pattaya Business and Tourism Association to obtain information on current prevention and control procedures of boating accidents using structured questionnaires.

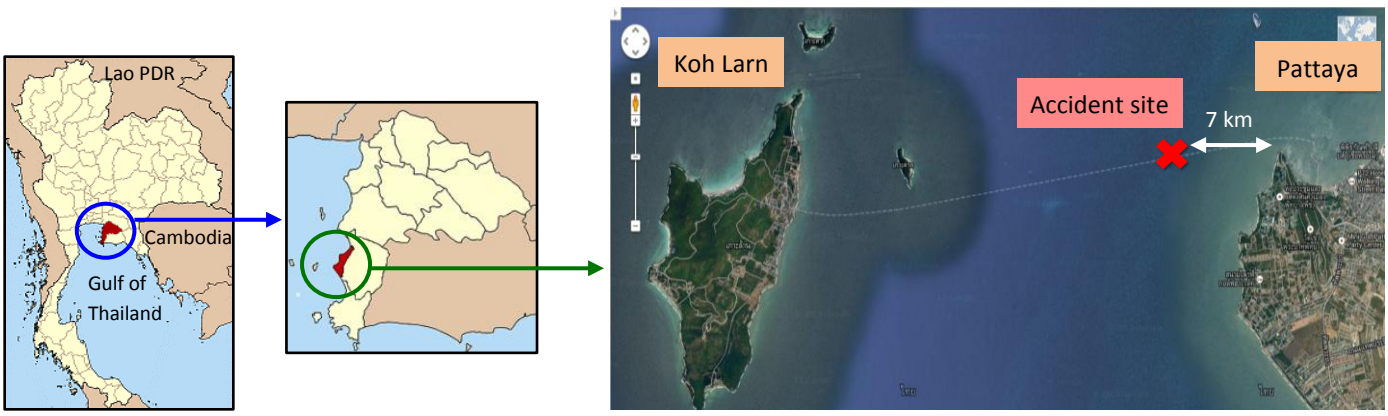
Environmental Observation of Other Boat Services

On two occasions the investigation team also observed other ferry boat transportation services between Pattaya and Koh Larn at approximately 17:00.

The team used a checklist to observe type and number of available buoyancy aids, monitoring systems for overcapacity loading, information available onboard regarding emergency procedures in case of an accident, and crews' ability to inform and encourage passengers to wear their buoyancy aids.

Data Analysis

The Haddon Matrix framework[4,5] was used to analyze data by describing accident-related factors (pre-event, event and post-event), interviews with captain, crew members and passengers, and observing ferry boat safety equipment and socio-economic environment.



(a) Thailand (b) Chon Buri Province (c) Accident site between Koh Larn and Pattaya

Figure 3. Map of accident site between Koh Larn and Pattaya, Chon Buri Province, Thailand

Results

Descriptive Study

Reviewing medical records of four hospitals identified 18 mild injuries, 12 severe injuries and seven deaths. Of the injuries and deaths, 59% were males, with median age of 32 years (Interquartile range 21-48). The victims included 28 (76%) Thai, four (11%) Russians, three (8%) Chinese and two (5%) persons with unknown ethnic background (5%).

Among the injured passengers, common diagnoses were muscle strain (35%), aspiration pneumonia (19%) and submersion injuries (14%). Of the seven deaths identified, which included four males and three females, three were from Thailand, two were Russians and two were Chinese. Six persons were dead on arrival at hospital while one was in coma and died during the period of investigation (Table 1).

Table 1. Physicians' principal diagnosis of injured people from a boat accident in Pattaya, Thailand, 3 Nov 2013 (n=37)

Diagnosis	Number of case	Percent
Muscle strain	13	35.1
Aspiration pneumonia	7	18.9
Submersion injury	5	13.5
Bronchitis	2	5.4
Head injury	1	2.7
Middle ear barotrauma	1	2.7
Open maxillary fracture	1	2.7
Coma	1	2.7
Dead on arrival	6	16.2

Event Description

According to 10 passengers, three boat crew from other companies who witnessed the accident, two rescuers, three health volunteers and the Director of Pattaya Business and Tourism Association, at 17:00 on 3 Nov 2013, engines of the ferry boat suddenly stopped on the way from Koh Larn to Pattaya for no apparent reason. Then, although the ferry began to sink, no announcement was made by the captain. Passengers reported that there were insufficient buoyancy aids available for all passengers and there were no buoyancy aids that could fit children.

Rescue efforts were limited as other speed boats and ferries nearby were already overloaded with passengers on board and could not pull victims out of the water. A rescue boat arrived at the accident site only after 30 minutes later due to lack of communication and rescued some of the passengers. The emergency response usually took 20-30 minutes from notification to arrival at the scene and approximately 20 minutes to reach the nearest hospital. Thus, for some of the victims, the rescue efforts were too late to save lives.

Factors linked to the loss of life included selling and drinking of alcohol on board, and lack of information about total number of the onboard passengers (Table 2). The rescue team estimated that approximately 230 passengers were on board, travelling from Koh Larn to Pattaya at the time of the accident. However, there was no official record of the actual number of people on board or their identities. Since this boat was the last one leaving from Koh Larn on that day, more people boarded it. Thus, this boat was probably carrying more passengers than the registered maximum capacity.

Information obtained from rescuers stated that five out of seven dead victims had their buoyancy aids on. This knowledge was also confirmed by some survivors seeing one passenger who was wearing a buoyancy aid had died.

Environmental Observation of Other Boat Services

The average capacity of ferry boats varies from 150-200 passengers, according to size of boat and registered maximum capacity printed on the hull. Daily random inspection on maximum capacity of boats was conducted by marine officers at the port. However, boats could pick up more passengers along the beach during the trip (Figure 1).

During our observation, although we saw a few buoyancy aids, no instructions were provided on board (Figure 4).

Figure 4. Buoyancy aid on a ferry boat without leg strap (left) compared to the standard buoyancy aid used by the rescue team (right), Pattaya, Thailand, November 2013

Discussion

The BOE team identified a number of risk factors associated with injury and death resulting from this ferry boat accident. Categorizing them according to the Haddon Matrix framework, there were specific

Table 2. Information obtained from boat crew and passengers, boat safety equipment and environment from a boat accident in Pattaya, Thailand, November 2013, using the Haddon Matrix framework

	Boat crew	Passenger	Boat safety equipment	Environment
Pre-event	- Alcohol drinking and selling on board - No regular check on wearing buoyancy aids by passengers - Did not tell passengers to wear buoyancy aid - No warning announcement of the boat sinking - Did not aware of maximum capacity of the boat	- Some did not wear their buoyancy aids - Language barrier - Different swimming skill	- Only few buoyancy aids available - Inappropriate design of buoyancy aids and size - No media instruction (e.g. poster) for wearing buoyancy aids and emergency evacuation	- Too many passengers on board - Shortage of staff from the Marine Department to inspect and monitor ferry and speed boats - Picking more passengers up along the beach outside the port - No regulation for passengers to put on their buoyancy aids
Event	- Did not contact the rescue team	- Panic among passengers - Did not get out of the boat	- Fighting over buoyancy aids	- No assistance from other ships that passed nearby due to overloading with passengers
Post-event	- Limited rescue effort from the surrounding boats - Delayed rescue, no triage and CPR at scene - Long time to transport the victims to hospitals - No official records of the actual number and identities of the passengers from the rescuers - No compensation for victims from the company			

pre-event, event and post event factors that could be highlighted for future prevention interventions.

Boating played an important role in tourist attractions[6,7] and accounted for 6% of the country's total GDP in 2011[8]. Although the tourism industry in Pattaya had been growing cumulatively at 15% annually during 2010-2012,[2] budget for the Pattaya Local Marine Department had remained the same, resulting in insufficient staff to achieve effective safety management and prevent boat accidents.

Koh Larn is one of the most famous attractions in Pattaya for tourists from various countries, including non-English speakers such as Chinese and Russians. According to the Tourism Authority of Thailand, tourists from these countries were rapidly increasing.[9] This also highlighted language barrier problem. Even though most of officers and workers in Pattaya could speak English, very few could speak Russian and Chinese. This might have obstructed communication about safety procedures such as giving instruction on buoyancy aid or emergency procedures, as most of the communication materials and the media were presented only in Thai and English. The language barrier between tourists and lack of enforcement on policies related to mandatory use of buoyancy aids made it difficult to maintain adequate safety levels.

When the accident occurred, both the ferry boat crew and the passengers panicked. There were no instructions in locating the buoyancy aids, putting them on or using them in the water. No evacuation procedures were instructed by the crew. More panic ensured when there was not enough buoyancy aids for all passengers and crew. Additionally, from the team's observation on boat safety equipment from other companies covering the same route, we found that buoyancy aids were not appropriately designed. The design defect of buoyancy aids and inappropriate method of wearing them might have resulted in 'riding up', i.e., the buoyancy aid floating up over head and pushing the person's head under the water, resulting in drowning. According to the documents of the Marine Department, Ministry of Transport, there were specifications only for the life vest and appropriate specifications for buoyancy aids were still under revision.[10-13]

Rescue teams arrived at the scene only after 30 minutes, which was too long as the drowning victims must be resuscitated within 30 minutes[14]. Therefore, survival for drowning victims must not only depend

on rescue teams alone, but boat crews must be trained in use of safety equipment and cardiopulmonary resuscitation (CPR). Although these training sessions should be coordinated by district health center and the Marine Department, it had not been provided as regular training for boat captains and crew or mandated by laws.

Limitations

There were not any official records from the rescue team or details regarding total number of person rescued and victims' identities. In addition, some boats that had passed by might have picked some victims up. Thus, the total number of survivors might not be accurate. The medical record of the deaths did not describe any of victim's general appearance and there were no physical examinations. We could not obtain the final diagnosis of drowning victims from the Institute of Forensic Medicine at the Police Hospital.

In addition, we were not able to interview the company's staff including the crew and the captain, take photos of the boat, or inspect the buoyancy aids and other safety equipment of the boat that was involved in the accident on 3 Nov 2013. This was due to the ongoing police investigation. Thus, the information we obtained from the survivors might not be sufficient to explain why or how the boat sank.

Conclusion

This boating accident, along with others, has had an negative impact on Pattaya's tourism industry[15-16] and have forced the government to take action. On 12 Sep 2013, the Ministry of Tourism and Sports initiated a travel safety plan to reduce the number of all boating related accidents in Pattaya.[17]

On 29 Nov 2013, we presented our investigation report to all responsible authorities: Deputy Permanent Secretary of MOPH, National Institute of Emergency Medicine, Marine Department, Chon Buri PHO, 1st and 3rd Offices of Disease Prevention and Control, Department of Disaster Prevention and Mitigation, and Director of Pattaya Tourism Association; and held discussions about prevention and control measures.

Right after the discussion, local authorities in Pattaya ordered all registered ferry boats to cancel their services until safety requirements were met. In collaboration among multi-sectorial organizations, MOPH and Pattaya Tourism Association developed a plan for annual rescue simulation exercises to reduce number of casualties and save more lives.

With limited resources, the rapid growing of tourism industry in Pattaya inhibited the local officers from effectively and efficiently carrying out their mandate. Being unable to monitor and enforce the law has resulted in increased injuries and deaths. A multi-sectorial approach is needed in order to overcome this problem in this constrained resource setting to achieve positive outcomes related to all boat travel.

Recommendations

The following recommendations should be implemented in a timely manner. First of all, before departure, the captain must report the total number of passengers, destination, crew contact list, and departure and returning schedule to the local marine officer. As selling of alcohol on ferry boats, according to regulations of the Marine Department, is strictly prohibited, this should be enforced with multi-sectorial approach as the MOPH lacks the appropriate authority.

The Marine Department should also ensure that all boat companies provide all passengers with brochures on safety in multiple languages before the boat leaves the port. The brochures should include information on what to do in case of an emergency, including how to correctly put on buoyancy aid. The crew should also provide onboard demonstrations of putting the buoyancy aid on and make sure all passengers are wearing them. Compliance with these safety precautions should be randomly checked by local marine officers at least once a week. Boats found to be overcapacity or with passengers not wearing a buoyancy aid, should not be allowed to operate.

The provision of a boat license and safety regulations should be tightened, particularly on ferry and speed boats. All boat services should have reliable and up-to-date insurance for their passengers. In addition, the Marine Department should be responsible for inspecting tourist boats to assure regular maintenance and safety.

Ferry and speed boats should carry passengers only from official ports so that local marine officers could effectively check for safety issues. The number of coast guards and patrol boats should be increased. Patrol boats should provide service daily and cover more areas around Koh Larn beaches. Above all, regular monitoring and policy enforcement will be an ongoing requirement to prevent future events.

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Methicillin-susceptible *Staphylococcus aureus* Outbreak of Skin Infection among Neonates in a Private Hospital in Bangkok, 2013

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Abstract

On 27 Jul 2013, the Bureau of Epidemiology, Thailand was notified by a private hospital in Bangkok of abnormally increasing number of neonates with *Staphylococcus aureus* skin infection. An investigation was conducted to determine source of infection and risk factors. Medical records of 101 neonates born during 29 Jun to 31 Aug 2013 were reviewed. The workplaces, including a delivery room, an operating room, a nursery ward and a washing area, were inspected. Clinical and environmental samples were obtained and examined for bacterial culture. Total 40 neonates had clinical features that met the case definition, giving an attack rate of 39.6%. Methicillin susceptible *S. aureus* was isolated from seven (87.5%) out of eight specimens from skin lesions and three (10.7%) out of 28 nasal swab samples from health care personnel. The infection rate was significantly higher in male neonates (50.0%) than females (27.7%). The outbreak rapidly curtailed after massive control measures, including strengthening contact precaution among health care personnel, provision of health education to mothers and improving the hospital environment.

Key words: *Staphylococcus aureus*, neonate, Bangkok

Introduction

Staphylococcus aureus is the most common cause for pyogenic infection of skin and soft tissues, with humans and mammals as the natural reservoirs. About 30% of normal population has *S. aureus* colonization in their nares which may result in hand carriage and nosocomial spread. Even neonates, they can be colonized within the first few weeks of life.[1] The organism usually spreads by direct contact with the lesion or asymptomatic carrier. Although the incubation period is around 4-10 days, the disease may occur several months after colonization as well.[2] Not only the incubation period, but also the survival time of *S. aureus* outside hosts vary in different environment.[3]

There are many types of disease presentation when humans are infected with *S. aureus* such as skin infection, pneumonia, osteomyelitis, toxic shock syndrome, food poisoning and staphylococcal scalded skin syndrome (SSSS).[1,4] *S. aureus* skin infection may result in abscess, carbuncle, furuncle, folliculitis, impetigo and bullous impetigo. Neonates are prone to have skin infection because of their immature skin formation and relative immunodeficiency status.[4]

On 27 Jul 2013, the Bureau of Epidemiology, Ministry of Public Health, Thailand was notified by an infection control nurse from a private hospital in Hospital A of an abnormal increase in suspected *S. aureus* skin infection among neonates during follow-up visits after birth. The Bureau of Epidemiology, the responsible Bangkok Health Center and Hospital A jointly conducted an investigation from 30 Jul to 31 Aug 2013. Objectives were to confirm the outbreak, identify source of infection and risk factors, and provide appropriate measures to control the outbreak.

Methods

Descriptive Epidemiology

Medical records of the neonates born in Hospital A from January to August 2013 were reviewed. Physicians and nurses were interviewed about clinical features and diagnosis of the cases. Active case findings were conducted among the neonates in August 2013. A suspected case was defined as a neonate who was born in the hospital between 29 Jun and 7 Aug 2013, and had skin lesions of pustules, vesicles, abscess or exfoliation on any part of body, or had diagnosis of pyoderma, bullous impetigo, furunculosis, SSSS or bacterial skin infection. A

confirmed case was defined as a suspected case with laboratory-confirmed *S. aureus* from skin lesion by bacterial culture.

Environmental Study

The workplaces, including a delivery room, an operating room, a nursery ward and a washing area, were inspected. In each place, working process of health care personnel was observed and hygiene survey among the staff was conducted using questionnaires modified from the infection prevention checklist of United States Centers for Disease Control and Prevention (US CDC).[5]

Laboratory Study

Clinical and environmental samples were obtained and examined for bacterial culture. Specimens were collected from skin lesions of suspected cases to confirm the diagnosis. Hand and nasal swabs were obtained from health care personnel, including physicians, nurses and patient assistants working in the delivery room, the operating room and the nursery ward during June to July 2013. Equipment and devices in the workplaces such as incubators, radiant warmers, cribs, stethoscopes, weight scales, bath tubs, clothes, closets and air conditioners were swabbed and examined for bacterial contamination. The specimens were collected by swab with Stuart's media and sent to National Institute of Health within 48 hours for bacterial culture and drug susceptibility testing. All *S. aureus* isolates were examined for genetic patterns by pulsed field gel electrophoresis (PFGE) testing.

Analytic Study

A retrospective cohort study was conducted to determine risk factors of the infection. There were total 107 neonates born in the Hospital A during 29 Jun to 7 Aug 2013. Study variables included gender, birth weight, gestational age, maternal age, number of pregnancy, number of childbirth, type of labor and presence of premature rupture of membrane, length of stay at birth episode. Attack rate, infection rate and relative risk were also calculated by univariate analysis, and 95% confidence interval (CI) was calculated to determine the strength of association. Epi Info version 7 was used for statistical analysis.[6]

Results

Descriptive Epidemiology

Hospital A was a 30-bed private hospital in Bangkok, with two pediatricians and one obstetrician. They provided delivery service for mothers with normal pregnancy. From January to May 2013, median number of childbirth per month in the hospital was 32, with range of 26-37. Most of the mothers who gave birth in this hospital were foreign workers. The monthly number of birth increased to 82 in June 2013 and 85 in July 2013. Proportion of neonates with skin infection increased to 44.7% in July 2013 (Table 1).

Table 1. Skin infection by month among neonates born in Hospital A, Bangkok, Thailand, January to July 2013

Month	Number of neonate	Number of infected neonate	Attack rate (%)
January	37	2	5.4
February	36	4	11.1
March	26	2	7.7
April	28	1	3.6
May	32	3	9.4
June	82	4	4.9
July	85	38	44.7

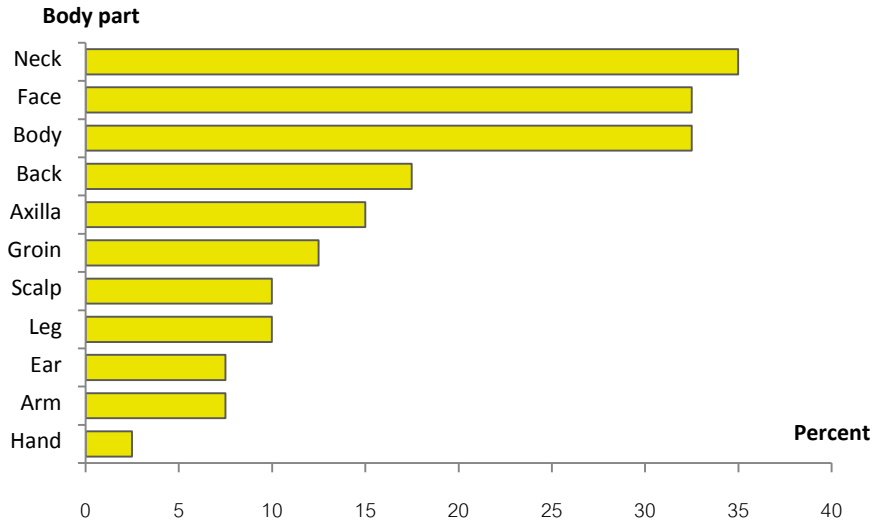

Figure 1. Infected body parts of neonates with skin lesion in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013 (n = 40)

Table 2. Characteristics and infected neonates and their mothers in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Characteristic	Total	Number of case	Infection rate (%)	Relative risk	95% CI
Sex					
Male	54	27	50.0	1.8	1.06-3.08
Female	47	13	27.7	Reference	
Birth weight (gram)¶					
< 2,500	2	0	0	Undefined	-
≥ 2,500	99	40	40.4	Reference	
Gestational age (week)*,¶					
< 37	4	0	0	Undefined	-
≥ 37	95	40	42.1	Reference	
Maternal age (year) *					
≥ 35	84	32	38.1	0.8	0.46-1.43
< 35	17	8	47.1	Reference	
Number of pregnancy					
1st	59	26	44.1	1.3	0.79-2.31
2nd or more	42	14	33.3	Reference	
Number of delivery					
1st	66	29	43.9	1.4	0.80-2.45
2nd or more	35	11	31.4	Reference	
Type of delivery					
Abnormal**	57	20	35.1	0.8	0.48-1.25
Normal	44	20	45.5	Reference	
Present	20	9	45.0	1.2	0.66-2.00
Absent	79	31	39.2	Reference	
Length of stay (day)					
> 3	10	3	30.0	0.74	0.28-1.98
≤ 3	91	37	40.7	Reference	
Maternal race					
Lao	7	2	28.6	0.7	0.21-2.30
Cambodia	2	1	50.0	1.2	0.30-5.00
Thai	2	0	0.0	0	
Myanmar	90	37	41.1	Reference	

* *Excluding those with no information*
** *Including caesarean section and vacuum extraction*
¶ *p > 0.1*

Normally, those normal neonates would stay in the hospital for two days after birth, and then, were discharged. The doctor would make a follow-up appointment on the 7th day after discharge.

In June 2013, only four neonates with skin infection were detected during the early week and no cases were found until the end of the month. During the study period from 29 Jun to 7 Aug 2013, there were total 107 neonates in the nursery ward, including 105 neonates born in the hospital and two born before admission. Six neonates lost follow-up after birth. Of total 101 neonates included in this study, 96 (95.0%) were full term. Only two (2.0%) had low birth weight (less than 2,500 gm) and one (1.0%) had birth weight more than 4,000 gm.

Total 40 neonates had clinical features which met the case definition, giving an attack rate of 39.6%. The first case born on 29 Jun 2013 developed onset of skin infection on 1 Jul 2013, with subsequent 37 cases clustered in the same month and the other two in August 2013. All cases were full term and healthy neonates who lived in different communities. Majority of them were detected during the first week follow-up.

For the skin presentation, neck was the most affected part (35.0%), followed by face (32.5%) and body (32.5%) (Figure 1).

The most common diagnosis of the cases was pyoderma (52.5%), followed by bullous impetigo (20.0%) and furunculosis (12.5%) (Figure 2). One patient with skin lesion was not recorded for any diagnosis.

Total 31 (77.5%) cases were treated as out-patients, eight (20.0%) were admitted, and one (2.5%) was referred to an ophthalmologist due to skin lesion close to eyes.

The infection rate was significantly higher in male neonates (50.0%) than females (27.7%). Neonates born to mothers with first pregnancy or first delivery had a slightly higher rate of infection than those of mothers with second or more (Table 2). There were no other variables significantly associated with the infection.

Laboratory Results

Among eight specimens of skin lesion examined, seven were positive for *S. aureus* (Table 3). Nasal and hand swabs from 28 health care personnel were collected.

Table 3. *Staphylococcus aureus* isolated from infected neonates, health care personnel and environment samples in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Type of sample	Number of sample tested	Number of sample tested positive	Percent
Infected neonate (n = 8)			
Skin lesion	8	7	87.5
Conjunctiva	1	1	100.0
Health care personnel (n = 28)			
Nasal	28	3	10.7
Hand	28	0	0
Skin lesion	1	0	0
Environment			
Delivery room	3	0	0
Nursery room	28	0	0

S. aureus was found in nasal swabs of three (10.7%) health care personnel. All the swabs from equipment and devices in the delivery room, the operating room and the nursery ward were negative for *S. aureus*. All the *S. aureus* isolates from the cases and three nurses with nasal colonization were methicillin susceptible. PFGE showed that one health care person and two cases shared the 100% compatible phage type pattern. However, they had different drug susceptibility. From the two cases, the organism was susceptible to clindamycin and erythromycin whereas the organism isolated from the health care person was resistant to both drugs. For other cases and health care persons, genetic patterns of the organisms were different at 50-75% compatibility.

Environmental Study

The delivery room, the operating room and the nursery ward all were on the second floor of the building, approximately 20 meters from each other. The delivery room was connected to the operating room. There was limited space in the delivery room with one delivery bed, one waiting bed and one radiant warmer. The radiant warmer was shared with the operating room in case of cesarean section. No one in the delivery room had skin infection during the previous two months. The neonates born in the delivery room were tagged and umbilical cord tied. This process lasted for about 15-20 minutes before they were taken to the nursery ward. Wearing a gown, a cap, a mask and shoes was required before entering the delivery room and the nursery ward.

Floor and equipment in both rooms were cleaned twice daily with phenol-derivative solution. Cribs were cleaned every time after a neonate was discharged. The nursery ward, if unfurnished, was approximately 30-35 sq m. But there were equipment placed inside such as table, procedure bed, incubators, etc. Then, the baby cribs were placed together. Maximum capacity of the nursery ward was 20. There were usually 2-10 babies admitted in the ward every day. The space between each cribs were less than one meter. Before the outbreak, mothers were allowed to enter the nursery ward for breastfeeding after hand washing. Lastly, we visited the laundry area. There was one staff operating a washing machine. Clothes were washed every day separately from other wards. After drying and ironing, the staff returned clothes to the ward in the afternoon.

Hygiene survey among health care personnel showed that they did not perform hand washing or use personnel protective equipment regularly such as gloves, goggles and gowns (Table 4). There was no difference between male and female neonates in term of caring in the nursery. Moreover, no male neonates were circumcised during that period.

Analytic Study

Being a male neonate was found associated with *S. aureus* infection while the other variables were not statistically associated with the infection as shown in table 2.

Control Measures

Surveillance and reporting systems were set up in the pediatric out-patient unit to detect new cases. The hospital strengthened contact precaution among

Table 4. Universal precaution practices of health care personnel in the delivery room and the nursery ward in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Type of practice	Delivery room (n = 5)	Nursery ward (n = 18)
Washing hands before contact with patient	100.0	61.1
Washing hands after contact with patient	100.0	77.8
Washing hands before procedure	60.0	83.3
Washing hands after procedure	80.0	88.9
Washing hands after contact with blood/secretion	80.0	83.3
Washing hands before moving from contaminated site to other area	80.0	66.7
Taking off a cap, gloves and a mask before leaving from patients' areas	60.0	72.2
Washing hands after taking off a cap, gloves and a mask	20.0	61.1
Wearing gloves when having chance to contact with blood, secretion or soft tissue	60.0	72.2
Changing gloves before contact with another patient	80.0	72.2
Wearing a gown before doing procedure	60.0	33.3
Changing a gown before contact with another patient	40.0	22.2
Wearing goggles and a mask when working with possible blood or fluid splash	60.0	33.3

health care personnel and gave health education to mothers during admission. For environmental control, the nursery room, the delivery room and the operating room were adequately cleaned. A new room for breast-feeding and a cohort ward for sick neonates were set up. The carriers were treated with mupirocin ointment for one week and allowed to stop working with neonates for three weeks. Repeated nasal swabs from those carriers were all negative. The latest case was the case born on 7 Aug 2013, and no further case was found until 31 Aug 2013.

Discussion

This outbreak of *S. aureus* skin infection in neonates was likely to be nosocomial spread on account of four reasons. First, the dates of onset were early (within seven days of life). Hence, time of exposure was likely to be during the time when the neonates were admitted to the nursery ward. Another reason was that as the cases came from different communities, the epidemiological linkage in the aspect of place was only in the nursery ward. In addition, the laboratory testing also showed the evidence that one nurse and two cases had the same phage type patterns of the organism. Lastly, the outbreak curtailed after control measures were implemented in the hospital. Despite the facts mentioned above, since the laboratory study showed various strains of *S. aureus* both in cases and carriers, some cases might also acquire infection in the communities.

In a previously published outbreak in Nan Province of Thailand, equipment in the environment was implicated in the transmission of infection.[7] Therefore, we implied that equipment could contribute to this outbreak as the two cases stayed in the nursery ward might have direct contact with the equipment after the nurse left the ward. However, negative results from the environmental swabs might result from interventions in place before the specimen collection. Allowing mothers coming into the nursery ward might also increase the number of carrier to spread the organism. Carrier-case pairs which had the same PFGE patterns with different drug susceptibility could be explained by the pattern of drug susceptibility that might be lately developed in the carriers after spreading the organism to the cases. In addition, the gene responsible for these drug susceptibility patterns might be too small to be differentiated by PFGE study. This interesting finding suggested more attention to multi-drug resistant nosocomial infection in the future.

Due to the newly launched campaign of health insurance for foreigners, the number of pregnant women giving birth in the hospital started to increase in June 2013, a month before the outbreak. A standard nursery ward should have at least 2.32 square meters for each crib and distance between edges of each crib should not be less than one meter.[8,9] However, the remaining limited space in the nursery ward did not allow as such. Then, the baby cribs were placed closely. In the hygiene survey, some health care personnel did not maintain standard hygienic practice. High workload of health care worker rendering inappropriate hand washing and crowding in the nursery ward might increase risk of infection spread and contribute to nosocomial spread. However,

after this outbreak, the hospital restricted the number of neonate admitted in the nursery ward.

Univariate analyses showed that male gender was associated with the infection. This finding was consistent with previous studies[10,11]. Despite that, mechanism of infection for gender of neonates and immunity difference should be studied further. Since most of the study population in this outbreak were full term and healthy neonates, our investigation indicated that outbreak of *S. aureus* skin infection could occur even among full term and healthy neonates. Therefore, all measures of universal precaution should adequately be in place for all neonates.

Limitations

We could not obtain the exact onset date of each case due to lack of information in medical records and thus, could not determine the association between health care personnel and cases. We also faced language problem because most of the mothers were foreigners. In context of the private hospital, some staff were part-time and not always available for data collection. Information bias might occur in the hygiene survey among health personnel as we used the self-administered questionnaire. In this study, since only univariate analysis was used due to statistical non-significance of other variables, confounding factors could not be adjusted.

Recommendations

The issue of *S. aureus* infection should be added into the routine infection surveillance and control program among neonates in the hospital, including strengthening contact precaution, health education to health care personnel and mothers, close monitoring of neonates during follow-up and surveillance for drug resistant *S. aureus*.

Conclusion

The methicillin susceptible *S. aureus* skin infection outbreak occurred among neonates in Hospital A was caused by different strains of *S. aureus*. The sources of infection might be the hospital and the communities. In the hospital, the investigation identified nasal carriers who could transmit the organism through equipment in the set-up. The number of case markedly decreased after implementing strong contact precaution, isolation of cases, treating carriers and providing education to mothers before returning to communities.

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