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Dengue Hemorrhagic Fever in West Sumatera, Indonesia, 2009

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Abstract

In December 2009, 23 people were diagnosed with dengue fever in a village in Western Sumatera, Indonesia. This was unusual because in Indonesia, dengue fever usually occurs in the rainy season and December is in the dry season; dengue usually occurs in low elevations and these villages are in the highlands; and the area was dengue free for the past five years. We conducted a case-control study to determine the risk factors, with cases matched by age, village and gender. Eighteen cases (78.3%) were hospitalized and there were deaths. Most cases lived in Tigo Balai and Matur Hilir Villages, and had an incidence of 2.1/1,000 population. Fever (≥38°C), nausea, vomiting and intense headache were the most common signs and symptoms. All cases had thrombocytopenia and a 20% drop in hematocrit. The strongest risk factor was no activity to eliminate mosquito breeding sites, with adjusted OR 4.8, 95% CI 3.3-7.8 and p-value 0.04.

Key words: dengue, fever, risk factor, Indonesia

Introduction

Dengue fever begins with a sudden onset of high fever, intense headache and muscle pain. About five percent develop a hemorrhagic form because of severe bleeding. A single bite from an *Aedes aegypti* mosquito contains enough virus to cause dengue.[1,2] Dengue Hemorrhagic Fever (DHF) is a major public health issue in Indonesia. The national incidence rate was 27 cases per 100,000 population with case fatality rate of 1.5%.[2,3] DHF is endemic in the Agam District. In 2005-2009, more than 143 cases were reported and five outbreaks occurred in five Sub-districts with no deaths (Figure 1).[3,4] In October-December 2009, after 5 years of no reports of DHF, 23 people who lived in the Matur Sub-district contracted DHF. The Matur Sub-district had a population of 18,685. The most common occupations were farmers and workers at sugarcane plantation.

Occurrence of dengue in the Agam District is unusual because the area is at a high elevation (1,250m above sea level) and the date of onset occurred after the rainy season (April to July). In addition, the last report of dengue in the area was five years ago. To understand the etiology of this outbreak, we conducted a case-control study to describe distribution of cases[5], to identify risk factors and to recommend control measures.

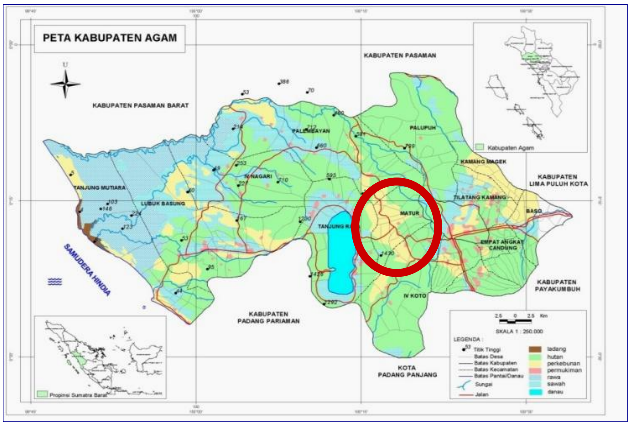

Figure 1. Location of Matur Sub-district, Agam District, West Sumatera, Indonesia

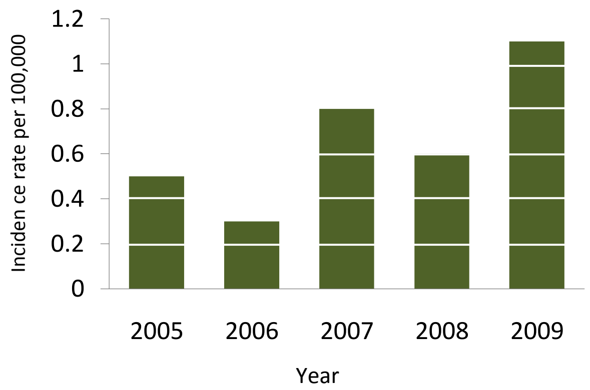

Figure 2. Incidence rate of Dengue Hemorrhagic Fever in Agam District, West Sumatera, Indonesia, 2005-2009

Methods

We conducted a case-control study to determine whether occupations, breeding places of mosquito and selected environment conditions were risk factors for DHF in Matur Sub-district. A case was defined as a person who lived in Matur Sub-district and had the following clinical symptoms: temperature more than or equal to 38°C that lasted 2-7 days, intense headache, myalgia, arthalgia, retro-orbital pain, anorexia, nausea, vomiting, or rash, and at least one of the following hemorrhagic manifestations: positive tourniquet test, petechiae, ecchymoses, purpura, hematemesis, melena or other overt bleeding. Because the Agam District had limited laboratory capacity, the supporting tests available were platelet counts for thrombocytopenia (less than 100,000/mm^3) and hematocrit for blood loss (20% rise from average for age and sex, or 20% drop in hematocrit).[6] A control was a person who did not have any signs or symptoms of DHF and lived in one of the five villages in Matur Sub-district. Cases and controls were matched for age (within 3 years difference), village and gender. Cases and controls were interviewed at their homes and information on signs and symptoms and risk factors were collected by a standardized questionnaire. Home visits also allowed observation of study participants' living environment.[7] We used SPSS 15.0 to calculate crude Odds Ratio (OR). To identify risk factors for DHF, we used multivariate analysis (logistic regression).[8,9]

Results

We identified 23 people with DHF and recruited 23 matched controls in five villages in Matur Sub-district (Table 1). Cases were mostly female (57%), had a median age of 52 years old (range 5-60 years), and the age group with the most cases was more than 50 years (26%). Eighteen cases (78%) hospitalized and there were no patient had Dengue Shock Syndrome (DSS) or died of DHF. Tigo Balai and Matur Hilir villages had seven cases each (30.4%) and Matur Mudik had five cases (21.7%). No case lived in Kelok-Kelok village. Tigo Balai and Parit Panjang villages had the highest attack rate (Table 2). All cases had a temperature ≥38.0°C, intense headache and GI symptoms such as nausea and vomiting. No case had overt bleeding and diarrhea because all cases were immediately treated in health centers.

Table 1. Univariate analysis of Dengue Hemorrhagic Fever in Matur Sub-district, Agam District, West Sumatera, Indonesia, 2009

Characteristic	Cases (%) n=23	Controls (%) n=23	Total (%)
Gender:			
Male	10 (43)	10 (43)	20 (43)
Female	13 (57)	13 (57)	26 (57)
Age (years):			
0-10	2 (9)	2 (9)	4 (9)
11-20	5 (22)	5 (22)	10 (22)
21-30	2 (9)	2 (9)	4 (9)
31-40	3 (13)	3 (13)	6 (13)
41-50	5 (22)	5 (22)	10 (22)
>50	6 (26)	6 (26)	12 (26)
Villages:			
Tigo Balai	7 (30)	7 (30)	14 (30)
Matur Mudik	5 (22)	5 (22)	10 (22)
Parit Panjang	1 (43)	1 (43)	2 (43)
Matur Hilir	7 (30)	7 (30)	14 (30)
Panta Pauh	3 (13)	3 (13)	6 (13)
Kelok-Kelok	0 (0)	0 (0)	0 (0)
Signs and self-reported symptoms:			
Fever (≥38°C)	23 (100)	0 (0)	23 (100)
Tourniquet test (+)	20 (87)	0 (0)	20 (87)
GI symptoms (nausea and vomiting)	23(100)	0 (0)	23(100)
Retro-orbital pain	13 (56)	0 (0)	19 (83)
Myalgia	19 (83)	0 (0)	0 (0)
Arthralgia	10 (44)	0 (0)	10 (44)
Intense headache	23 (100)	0 (0)	23 (100)
Other overt bleeding	0 (0)	0 (0)	0 (0)
Diarrhea	0 (0)	0 (0)	0 (0)
Laboratory tests:			
Thrombocytopenia	23 (100)	Not done	23 (100)
More than 20% decrease in hematocrit	23 (100)	Not done	23 (100)

Table 2. Attack rate of Dengue Hemorrhagic Fever per 1,000 population in Matur Sub-district, Agam District, West Sumatera, Indonesia, 2009

Village	Population	Cases (%)	Attack rate
Tigo Balai	3,266	7 (30.4)	2.1
Parit Panjang	477	1 (4.3)	2.1
Matur Hilir	4,428	7 (30.4)	1.6
Panta Pauh	1,954	3 (13.0)	1.5
Matur Mudik	5,164	5 (21.7)	1.0
Total	15,289	23 (100)	1.5

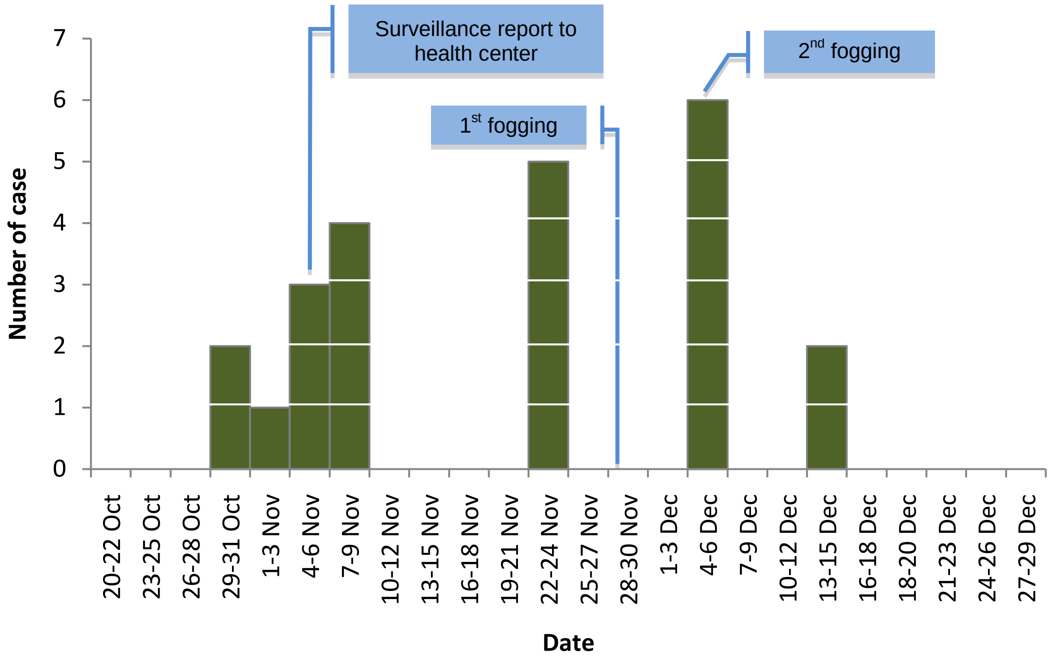

Figure 3. Epidemic curve of Dengue Hemorrhagic Fever in Agam District, West Sumatera, Indonesia, October to December 2009

The index case was a 42-year-old male farmer who lived in Matur Sub-district. According to his medical record, his first visit to the health service occurred at Matur Sub-district health center on 29 Oct 2009; he was diagnosed with typhoid fever. On 1 Nov 2009, the man was hospitalized at the Public Bukittinggi Hospital. On the third day of hospitalization, doctor diagnosed him with DHF and the hospital reported this case to the Agam District Health Office. The peak of the outbreak occurred on 4 Dec 2009 and the last case occurred on 16 Dec 2009. Fogging was done for two times on 28 Nov 2009 and 5 Dec 2009.

Table 3. Multivariate analysis of outbreak surveillance and response of DHF in Matur Sub-district, Agam District, West Sumatera, Indonesia, October to December 2009

Variable	Adjusted OR	95% CI	P-value
No activity to remove, destroy or manage habitats of mosquitoes larva	4.8*	3.3 – 7.8	0.03*
Work as a farmer and employee in sugarcane plantation	1.9*	1.0 – 3.2	0.04*
Breeding site or place less than 150m from home	1.2	0.1 – 2.5	0.12
Environmental risk (sugarcane plantation) 150m from house	1.1	0.5 – 2.1	0.33
Live near wet rice field	0.1	0.3 – 0.8	0.45

* *Statistically significant*

To calculate adjusted odds ratio, we used multivariate analysis (logistic regression) and included variables with p-value ≤0.25 from the bivariate analysis. All variables in the model had a normal distribution. The regression used a forward stepwise approach. No behaviors to eliminate mosquito breeding sites had the highest OR and thus, it was the strongest risk factor for DHF outbreak in Matur Sub-district.

Discussion

From October to December 2009, 23 people living in Matur Sub-district, Indonesia, were diagnosed with DHF. The diagnosis was based upon their clinical symptoms and presence of hemorrhagic symptoms. Confirmatory laboratory tests for dengue fever were not done because of limited funds and lack of laboratory capacity; platelet counts and tourniquet tests were done to confirm the hemorrhagic component of DHF.

While the outbreak lasted for three months, the epidemic curve showed an absence of cases between 7 and 23 Nov 2009. This 16-day period is more than three times the average incubation period of two to seven days. We suspect that transmission was occurring and the absence of reports may be due to people not seeking health care or under-reporting to the surveillance system.

This outbreak was unusual because it occurred in the dry season while DHF in Indonesia usually occurs in the wet season, the cases lived at high altitudes while DHF usually occurs below 12,500m in Indonesia, and absence of DHF in the past five years in the area.[10] Unfortunately, no viral cultures were done to identify whether a novel dengue virus caused this unusual outbreak.

Although the location, time and appearance of the outbreak were unusual, the symptoms reported were characteristics of DHF -- a sudden onset of fever with intense headache, myalgia and retro-orbital pain followed by rash and overt bleeding.[10] Most hospitalized persons were treated at government hospitals following the Standard Operating Procedure for DHF. This included supportive therapy of crystalloid and colloid fluid, intensive care, antipyretic and analgesic.[11,12] The government covered all costs for hospitalized DHF patients. The Standard Operating Procedure for DHF also covered public health activities such as case finding, surveillance and health promotion. In this outbreak, more adults had DHF than children. This was not similar to other outbreaks in Indonesia.[13]

The factors most associated with the DHF outbreak in Matur Sub-district were working on a plantation or farm and presence of mosquito breeding sites. Both factors are related to increased contact with the *A. aegypti* mosquito. Many people who live in Matur Sub-district are farmers and sugarcane plantation employees. These occupations spend much of their time outdoors during the biting times (daytime) of the mosquito.

Public Health Actions and Recommendations

A community survey determined the presence of large water containers and an abundance of *A. aegypti*. This prompted public health officials and villagers to eliminate the breeding places. Larvicides were placed in potential *A. aegypti* habitats and community water containers. Fogging was done on 30 Nov and 5 Dec 2009. Other preventive actions included educating the public about sources of dengue and promoting behaviors to remove, destroy or manage mosquito larva habitats. This reflected national regulation dealing with removal of water-holding containers close to or inside human habitation (e.g. flower pots, discarded containers for food or water storage and old tires).

Recommendations to reduce the dengue burden in these villages include identifying areas of high mosquito density and prompt launching of appropriate prevention and control activities.[14] Intensified surveillance and control of mosquitoes during periods with high temperature and high humidity are recommended. Good hygiene and sanitation should be maintained, and there should be a regulation to eliminate of *A. aegypti* breeding sites. Adult and larva indices should be calculated and manage containers that contain water.[2,14] Villagers should be advised to protect windows adjacent to nursery with nets and rub skin lotion, and spray insecticides to decrease contact with mosquitoes in Matur Mudik, Tigo Balai and Matur Hilir villages.

Active and passive surveillance should be conducted for dengue fever. A new system to comprehensively review and investigate every fatality from DHF as well as analyze surveillance data for trends of an outbreak should be established. When an outbreak occurs, an investigation should be conducted to identify etiological agents and risk factors and to guide control and prevention measures. Finally, villagers must take an active role in eliminating breeding places for mosquitoes.

Limitations

One major challenge faced by health care workers in this outbreak was social panic among villagers. They were afraid of being infected with dengue and thus, public health officials conducted a health promotion campaign about dengue.

This investigation was limited by the small number of DHF cases that limited the analytic analysis, few human resources for investigating the outbreak and the lack of confirmatory laboratory tests for dengue.

DHF still represents the global society health problem, especially in developing countries inclusive of Indonesia.[9,15] DHF may occur in an area that had no reported cases and in a geographic area and season that do not support dengue transmission.

Acknowledgments

We would like to thank staff in Agan District Health Office, Agam District Disease Control Health Office, and Matur Sub-district Health Center; Drs. Indra and Bakhrizal, Mr. Halim Wajdi and Mrs. Hesfiyanti for helpful reviewing this study.

Suggested Citation

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Effectiveness of Non-pharmaceutical Interventions in Controlling an Influenza A Outbreak in a School, Thailand, November 2007

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Abstract

Non-pharmaceutical interventions are often recommended as a component of integrated control measures for pandemic influenza, but the effectiveness needs to be evaluated. An outbreak of influenza A (H1N1) in northern Thailand in November 2007 offered opportunity to evaluate these interventions. An investigation was conducted to describe the outbreak, evaluate effectiveness of non-pharmaceutical interventions and assess surge capacity of health agencies. A descriptive study was conducted by interviewing students and personnel in a school. We characterized transmission of the virus in this outbreak and explored effects of control measures. We identified that 44% of the students and teachers developed influenza during the 19-day outbreak. Non-pharmaceutical interventions including school closure, setting up a field hospital and community health education were implemented. These measures possibly limited the outbreak spreading to other schools nearby. Surveillance and preparedness plans could be strengthened to respond to pandemic and inter-pandemic influenza by using non-pharmaceutical interventions.

Key words: influenza, school, Thailand

Introduction

Influenza is an acute viral infection of the respiratory tract caused by influenza virus types A, B and C. Transmission is usually human to human, yet sometimes humans could be infected by other mammals or avian species. It is transmitted by droplet spread or direct contact with secretion of infected cases. It is characterized by fever, headache, myalgia, prostration, coryza, sore throat and cough. The median incubation period for influenza A is 1.4 days (range 1-3 days).[1] The period of communicability is around 3-5 days from clinical onset in adults and up to seven days in children. The disease is self-limiting in most patients; recovery takes about 2-7 days.[2] An influenza outbreak is usually recognized by a cluster of people with flu-like symptoms while sporadic cases are usually identified by laboratory tests. Non-pharmaceutical interventions are often recommended as a component of integrated control measures for pandemic influenza, but the effectiveness needs to be evaluated.

On 12 Nov 2007 (Monday), 48 students of Primary School M in Li District, Lamphun Province, northern Thailand were absent from the school, with high attack rate. An influenza outbreak was suspected as a cause of absenteeism.[3] The local rapid response team initiated non-pharmaceutical control measures, including closure of the school, establishing a field hospital and providing intensive health education in the community. Following a notification from Lamphun Provincial Health Office, a team from the Bureau of Epidemiology, Ministry of Public Health arrived at the school and conducted an investigation from 29 Nov to 11 Dec 2007.

The objectives of the study were to describe the epidemiological characteristics of the outbreak, evaluate the effectiveness of non-pharmaceutical interventions and assess surge capacity of local health agencies in response to a school-based influenza outbreak in terms of materials, equipments, and human and financial resources.

Methods

Case Finding and Laboratory Confirmation

Using a descriptive study approach, we reviewed in-patient and out-patient records of influenza patients who sought care at Li District Hospital during 1-30 Nov 2007. A structured questionnaire was administered to all students and personnel in the school to identify additional cases. Variables included age, sex, classroom, clinical symptoms, date of onset and number of family members with any respiratory symptoms.

Blood or nasopharyngeal (NP) swabs were collected from 48 students who either went to the hospital or attended the school during symptomatic period after sampling by the outbreak response team, and tested for influenza A by influenza A specific immunoglobulin (IgM) antibodies for blood samples, or antigen rapid test or reverse transcriptase polymerase chain reaction (RT-PCR) for NP swabs at Thai National Institute of Health.[4]

Influenza cases were classified as either suspected or confirmed. A suspected case was defined as a student or an employee in School M who developed fever (body temperature more than 38.5°C) and at least one of the following symptoms: sore throat, cough, runny nose, headache, myalgia or arthralgia during 1-30 Nov 2007. A confirmed case was a suspected case with any positive influenza laboratory test.

Public Health Response

We interviewed the local rapid response team members regarding public health interventions delivered and resources used in response to the outbreak. The effectiveness of interventions was assessed by comparing class-specific attack rates with date of the first influenza case in that classroom. Active surveillance for early detection of influenza transmission was established in three adjacent primary schools within a radius of 11 km.

Transmission Dynamics

The household secondary attack rate was calculated by dividing number of people with acute respiratory illness in a student's household (as reported by the student) by total number of household members excluding the student. We estimated the basic reproductive number (R_0)[5] and effective reproductive numbers (R_t) using R programming language version 2.6.2 with methods developed by Wallinga and Teunis.[6]

Results

Outbreak Detection

The influenza A (H1N1) outbreak occurred in a School M in Li District, which was a rural district with a population of 70,000, Lamphun Province, Thailand. The average temperature in the province is 20-30°C in the winter season (November to February) and the main occupation is agriculture.

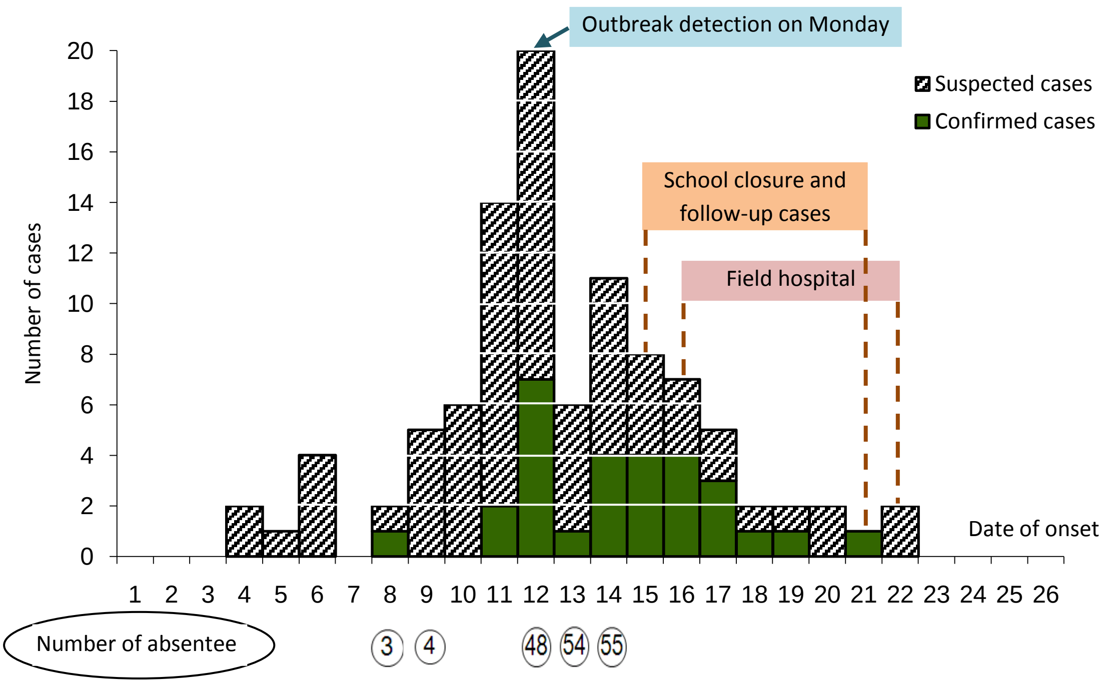

Figure 1. Influenza cases by date of onset in School M, Li District, Lamphun Province, November 2007 (n=109)

A nurse reported that 15 students with influenza-like illness sought care at the clinic on a single day. On that day, 48 (20.8%) of the students in School M were absent from the school, and the number increased to 54 (23.3%) and 55 (23.8%) on the following two days (Figure 1). The number of absentees was abnormally high, compared with a range of 1-4 absentees per day in the school records. Of the 48 absentees on 12 Nov 2007, there were 45 absent due to flu-like symptoms and three were absent for reasons other than illness. Of the 45 students with respiratory symptoms, seven were laboratory-confirmed to be influenza cases (Figure 1).

Descriptive Study

Of the 231 students and 17 staff interviewed, 105 students and four staff met the suspected case definition. The attack rate was 47.3% in students and 40.0% in staff. Of the 48 suspected cases tested for influenza A infection, 32 (67%) were laboratory-confirmed. Fifty-one percent of cases were females. The median age of the student cases was 10 years (range five to 12 years).

All laboratory positive results were H1 strain of influenza A. Eighteen out of 36 (50%) samples were tested positive by antigen rapid test, 31 of 34 (91%) by RT-PCR and two of three by specific IgM testing.

Of the 109 suspected cases, the most common symptom accompanying fever was cough (89%), followed by coryza (79%), sore throat (66%), sputum production (55%), headache (45%), vomiting (22%), myalgia (16%) and arthralgia (9%). The median duration of illness was five days (range 1-20 days). Twenty-one cases were hospitalized for treatment. No deaths were reported. The latest case had onset on 22 Nov 2007. This influenza A outbreak lasted for 19 days.

Outbreak Response

On 13 Nov 2007, the local investigation team arrived at the school 18 hours after detection of the outbreak and started screening for suspected influenza cases. The health authorities, the school principal and community leaders decided to implement extensive control measures immediately. The 60-bed district hospital was overloaded by the patients within a few days. One ward with a capacity of 30 in-patients was devoted to influenza alone. Meanwhile, masks were distributed in the school since 13 Nov 2007. Neither flu vaccine nor anti-viral drugs were given in this outbreak. School closure started on Thursday, 15 Nov 2007, followed by the establishment of a field hospital in the affected community on the next day. The field hospital was established so that suspected influenza cases could be kept separated from other patients in the general hospital and also for more accessible location for health care.

The local rapid response team visited students' homes to identify additional cases soon after detection of the outbreak. Suspected cases were sent to the field hospital for further management. Non-severe cases were sent back to home, and follow-up visits were conducted to monitor their conditions. Public health education campaigns, including education on mask usage, hand washing and isolation of individuals with respiratory symptoms, were conducted in the community by the rapid response team and health volunteers.

Following careful consideration by personnel from the school, local administrators and public health staff, School M was closed for seven days from 15 to 21 Nov 2011. This was the first time in Thailand that a school was purposively closed to control an influenza outbreak. This intervention was intended to isolate cases and reduce transmission among students. While School M remained closed, three investigation and control teams were deployed to the villages to monitor the sick students at their homes until recovery or 14 days after onset of symptoms on a daily basis. When additional cases were identified, they were screened for influenza and brought to the field hospital. During home visit, students and their families were provided with masks and information on prevention of influenza infection.

The 30-bed field hospital was set up in a Buddhist temple, and provided early symptomatic treatments and effective isolation of symptomatic cases until they improved clinically. Doctors and nurses were on duty at the field hospital. Seventeen students were admitted to the field hospital while cases with severe symptoms were referred to the district hospital, which was approximately 34 km away, for intensive medical care, laboratory testing and chest X-ray. The field hospital operated for seven days from 16 to 22 Nov 2007. A doctor, 24 nursing staff from the district hospital and 18 trained health volunteers were assigned to work in the field hospital daily. The cost to maintain the field hospital for seven days was USD 4,335, approximately the monthly expense of the district hospital. The budget was covered by the district hospital, District Health Office and local administration office.

Transmission Dynamics

The two presumed index cases had onset of illness on 4 Nov 2007. Both were students in grade 4 with epidemiologic linkage to the subsequent cases in the same classroom. Classroom-specific attack rates varied from 18% in grade 6A to 68% in grade 4 (Figure 2).

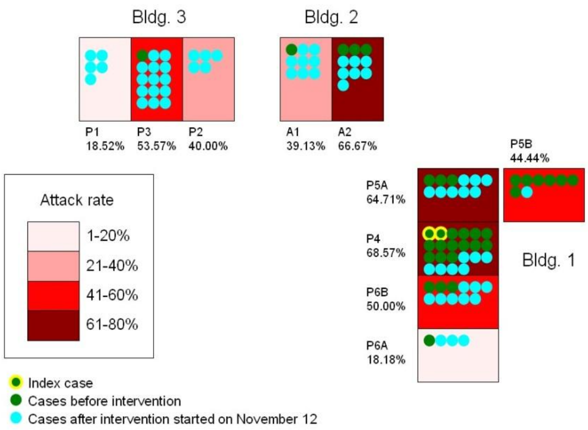

Figure 2. Classroom-specific attack rate and spatio-temporal distribution of influenza cases in School M, Li District, Lamphun Province, November 2007

The highest attack rate was in Building 1 where the index cases were located. The classrooms with early onset cases and those located in Building 1 had higher attack rates compared to the classrooms in other buildings or those with a later onset date of illness. No trend in attack rates by grade was visually apparent (Figure 3). However, there was a non-statistically significant trend (p-value 0.11), indicating a decrease in attack rate by onset date of first case in a classroom (Figure 4).

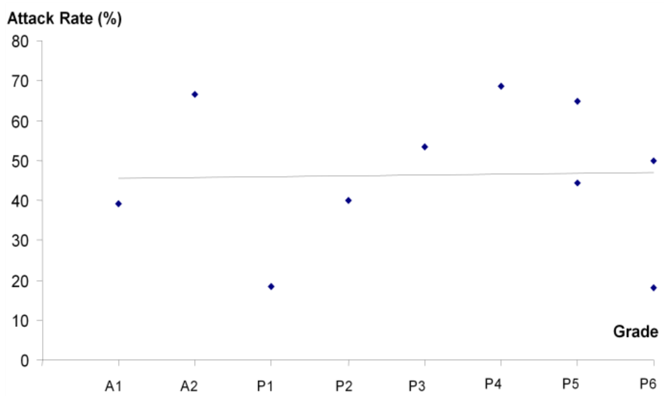

Figure 3. Attack rate of influenza cases by grade with trend line in School M, Li District, Lamphun Province, November 2007

The secondary attack rate among household members of student cases was 12% (49% among children under 15 years and 6% among adults). Using the method of Wallinga and Teunis,[7] we estimated basic reproductive number in the school to be 3.4 (Figure 5).

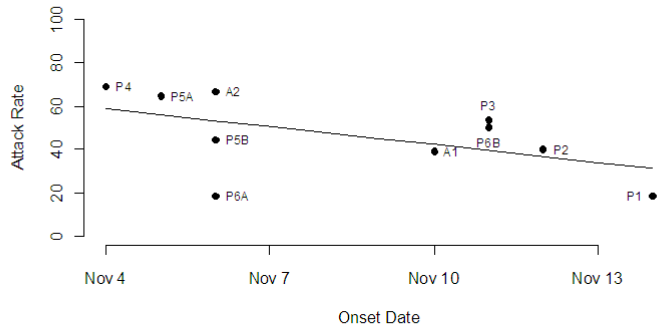

Figure 4. Attack rate by onset date of first influenza case in a classroom in School M, Li District, Lamphun Province, November 2007

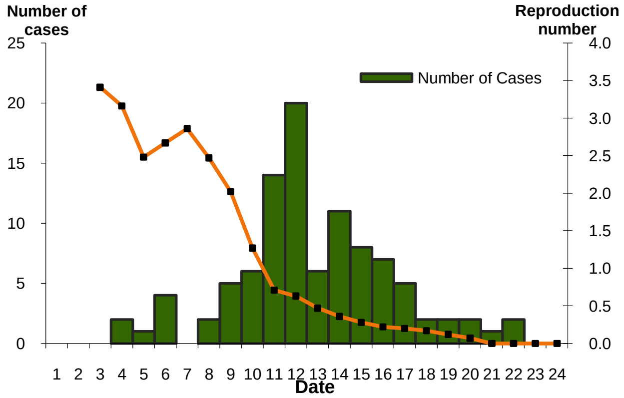

Figure 5. Epidemic curve and estimated reproductive number of influenza outbreak in School M, Li District, Lamphun Province, November 2007

Active Surveillance

In three other primary schools where active surveillance was implemented, two laboratory-confirmed influenza cases with mild symptoms were detected; both were in a school seven kilometers away. They were promptly isolated at home. Additional 48 suspected cases were identified among the residents of the affected communities; incidence rate was 6 per 1,000 population, excluding students in the School M.

Discussion

This influenza outbreak had a high attack rate among the students, presumably due to close contact between infectious cases and susceptible students. Previous investigations in Thailand showed that influenza outbreaks in primary schools could spread quickly to other nearby schools.[7] In this outbreak, the epidemic appeared to be receding before interventions were launched. However, the interventions could help prevent further spread to other schools in the area and a wide-scale outbreak. It was not economically measured that the reduction in transmission was worth the costs of the field hospital and the disruption from school closure. However, both were justified by the high number of cases that could not seek care in local hospitals and would have disrupted normal school activities.

In order to control influenza outbreak in schools, school closure is recommended in some countries, but its effect has not been shown to be significant.[8] However, one modeling study estimated that school closure could lower number of cases by 90%,[9] depending on timeliness of the interventions. In this outbreak, school closure was initiated one week after the start of the outbreak, which was perhaps too late to significantly reduce transmission. The intensive public health interventions, including active surveillance and immediate isolation of new cases, possibly limited disease transmission to nearby schools because of increased awareness of teachers and students, and proactive surveillance in those schools.

Classroom-specific attack rates suggested that the interventions had some effects. Although attack rates of influenza are normally higher in younger students due to lower level of protective immunity and differences in contact patterns, no age-specific trend was observed in this outbreak. However, there were lower attack rates in classrooms with the first case appeared later. This suggested that the non-pharmaceutical interventions reduced the influenza A transmission.

Additional 48 cases were identified in the community; many of them were sick students' family members. The secondary attack rate among children in student households was high. However, the overall incidence in the community was low.

This influenza outbreak response using integrated non-pharmaceutical interventions demonstrated the feasibility of controlling source of pandemic influenza in rural Thailand. Strong community partnership and co-operation between public health agencies were major key factors. The resources used for establishing a field hospital and screening cases in the community could be implemented in the rural area within 24 hours.

This outbreak investigation had some limitations. First, symptoms were self-reported and subjected to recall bias, especially recalling onset date of illness. Case ascertainment bias might exist in the study because only a small proportion of the cases were laboratory-confirmed and cases with mild symptoms might have been missed. Moreover, infections of other respiratory viruses could mimic the influenza infection and result in overestimation of incidence.

We recommend that containment of an influenza outbreak in primary schools should include a clear response plan that includes intervention strategy, strong community participation, timely school closure and possible establishment of a field hospital if the hospital is overcrowded. The location, procedures and management guidelines for operating a field hospital or overloaded wards must be determined during development of pandemic preparedness plan. Mobilization of additional health resources, which includes health providers and budget to support the local team, and influenza outbreak response drills are critical for the containment of influenza outbreak.

Motivated by the delayed detection of this school outbreak using the passive surveillance system in public health services, we recommend an enhanced flu-like detection in schools, private clinics and communities for early detection. School teachers should notify surveillance officers when over 10% of students are absent with respiratory symptoms.[10]

Conclusion

It was unclear whether masks distribution and school closure had a significant effect on influenza A transmission in School M. The effectiveness of the control measures implemented in the school had been limited by the delayed detection and implementation of interventions. Public health professionals and rapid response teams in this rural district demonstrated their capacity to rapidly respond to a school-based outbreak of seasonal influenza, possibly preventing a widespread outbreak in nearby schools.

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Control of a Pandemic Influenza A (H1N1) 2009 Outbreak in a Prison, Saraburi Province, Thailand, August 2009

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Abstract

The influenza A (H1N1) 2009 viruses reached Thailand in May 2009. On 11 Aug 2009, an outbreak of influenza-like illness among 200 prisoners in Prison S was notified. We conducted active case finding, environmental survey and laboratory investigation. Patients' medical records in the provincial hospital and in the treatment units of the prison were reviewed. Prisoners and officers were interviewed. A total of 421 case-patients (attack rate 19%) were identified. Of 34 throat swab specimens collected, 10 (29%) were positive for influenza A (H1N1) 2009 virus by RT-PCR, including nine male prisoners and a female prisoner. The median age was 29 years (range 18-69 years). The prisoners lived in overcrowded condition. The importation of the pandemic virus was from the surrounding community with ongoing influenza transmission. A mobile clinic from the provincial hospital was deployed into the prison to provide early diagnosis and oseltamivir was given to 17% of cases. Multiple intensive control measures probably resulted in declining number of new cases within a short period of time. Allocation of seven rooms, one per day from Monday through Sunday, was feasible for isolation of cases in the prison setting.

Key words: influenza A (H1N1) 2009, outbreak, prison, control, Thailand

Background

In the spring of 2009, an outbreak of severe pneumonia in Mexico was caused by a novel swine-origin influenza A (H1N1) virus. The number of cases increased such that the influenza A (H1N1) 2009 subtype viruses became the primary circulating virus. This had not happened since the 1957 pandemic.[1] As of 11 May 2009, the influenza A (H1N1) 2009 virus spread quickly to 30 countries by human-to-human transmission, thus the World Health Organization (WHO) raised its pandemic alert to phase five (sustained community level transmission in two or more countries in one WHO region) out of total six phases.[2] As human-to-human transmission became widespread in at least one region of the world, the WHO rapidly announced the outbreak as an imminent pandemic.[3] Later, WHO declared a phase six pandemic on 11 Jun 2009, when community level transmission occurred in another country in another WHO region.[4]

The pandemic virus arrived in Thailand in early May 2009 with Thai students who returned from epidemic countries.[5] The local outbreaks of influenza A (H1N1) 2009 were reported in many schools in early June 2009.[6]

On 11 Aug 2009, the Saraburi Provincial Health Office notified the Bureau of Epidemiology (BOE), Thailand Ministry of Public Health that over 200 prisoners in Prison S had developed fever and upper respiratory tract infection; six people were admitted to Saraburi Provincial Hospital. The outbreak was detected by prison officers on 8 Aug 2009. Initially, five out of 10 throat swabs were tested positive by Reverse Transcription Polymerase Chain Reaction (RT-PCR) for influenza A (H1N1) 2009. This result prompted a BOE team to investigate the outbreak. On 13 Aug 2009, the team traveled to the prison to confirm the diagnosis, to determine the extent of the outbreak, to identify the source of infection and risk factors, and to recommend appropriate prevention and control measures.

Methods

To determine the extent of the outbreak, our team went to the prison and collected demographic information and signs and symptoms of ill people from the log books in the out-patient department (OPD) and medical charts in in-patient department (IPD) in the Provincial Hospital where patients were admitted. In addition, we conducted active case finding in Prison S by inquiring prisoners and officers about their illnesses from 1 Jul through 31 Aug 2009. The BOE and local Surveillance Rapid Response Team (SRRT) conducted face-to-face interviews with prisoners and collected information by employing a structured questionnaire. A suspected case was defined as a prisoner or a prison officer who developed at least two of the following symptoms: fever, cough, sore throat or running nose from 1 Jul to 31 Aug 2009. A confirmed case was a suspected case that had a throat or nasopharyngeal swab that was positive for influenza A (H1N1) 2009 by RT-PCR.

An environmental study was conducted by inspecting facilities and activities in the prison. For statistical analysis, the basic reproductive number (R_0) was estimated by R software to evaluate the effectiveness of all the measures taken.

Results

In Prison S, 2,097 inmates were imprisoned in three zones (male zone 1 and 2, and female zone). There were a total of 1,778 male and 319 female prisoners with 65 officers. All prisoners were over 18 years old. Some prisoners were waiting for trial and some were serving less than 15-year jail term.

Table 1. Number of total influenza cases with attack rate and confirmed influenza A (H1N1) 2009 cases by zones in Prison S, Saraburi Province, Thailand, 1 Jul - 31 Aug 2009

Zone	Number of prisoners	Total cases (AR %)*	Confirmed cases
Male zone 1	1,295	269 (21)	7
Male zone 2	483	70 (14)	2
Female zone	319	79 (25)	1
Officer	65	3 (5)	0
Total	2,162	421 (19)	10

** No death or severe complications*

The total number of case-patients reached 421, with attack rate (AR) of 19%. Ten (29%) out of 34 samples collected from case-patients of every zone were positive for the influenza A (H1N1) 2009 virus, including nine male prisoners and a female prisoner. There was no confirmed case among the officers. No death or severe complications occurred during this outbreak (Table 1).

There were 398 patients who could recall the first date of their illnesses between 1 Jul and 30 Aug 2009. The first suspected case started symptoms on 3 Jul 2009 and additional suspected cases were identified in the same week. The number of cases started to climb up at the beginning of August 2009. The outbreak reached an alarming scale on 8 Aug 2009, followed by a peak on 10 Aug 2009. In the next few days, it decreased gradually (Figure 1). The illness onset of the first confirmed case was on 22 Jul 2009. He was treated by a physician in Saraburi Provincial Hospital. The first cluster appeared in the male zone 1 and followed by the male zone 2. Then, the last zone was the female zone. The time lag between each zone was about a week (Figure 2).

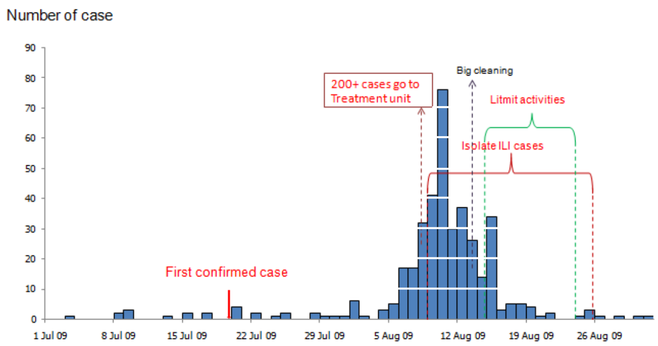

Figure 1. Number of influenza cases by date of onset in Prison S, Saraburi Province, Thailand, Jul-Aug 2009 (n=398)

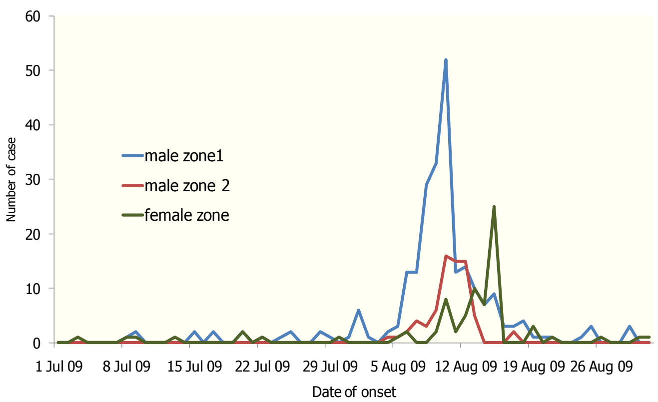

Figure 2. Number of total influenza cases by zones in Prison S, Saraburi Province, Thailand, Jul-Aug 2009 (n=389)

The median age of influenza cases was 29 years (range 18-69 years) and the highest number of cases (45%) was in the age group of 20-29 years. However, the number of prisoners in each age group was not available to estimate age-specific attack rates. Most cases presented with cough (87%), sore throat (67%), fever (50%) and rhinorrhea (45%).

In the Prison S, prisoners could have very close contact with each other through activities in some areas even though concrete walls with iron bars separated each zone. The work places and the kitchen were located near the male zone 2. There were separate treatment units for males and females. The prison office was outside the restriction area. The work places and prisoners' buildings were overcrowded (1 square meter per prisoner) when compared with the standard capacity (2.25 square meters per prisoner).[7] The visitors' room was located close to the prisoners' building, and had a glass partition that provided 2-meter separation between the prisoners and their visitors. They used telephones to communicate. About 300 relatives came to the prison's visiting room every day. In the attorney's visiting room, there were iron bars without any physical barriers in between, and thus, they could come to contact with each other easily (Figure 3). About 15 new prisoners arrived at the prison, and nine were released every day during the past year. Before this outbreak occurred, one or two prisoners visited Saraburi Provincial Hospital and 20-50 prisoners worked daily in the community.

Figure 3. Attorney visiting room in Prison S, Saraburi Province, Thailand

In order to prevent further transmission at the beginning of the outbreak, the local health officers isolated suspected cases in a single room, provided health education to the prisoners and officers, assigned prisoners to disinfect their wards, conducted hand washing campaign with installation of additional water tanks at new locations with soaps and provided masks. A mobile clinic from the Provincial Hospital was deployed into the prison to provide early diagnosis and treatment. Seventeen percent of patients who had influenza-like illness were treated with oseltamivir. Prison officers directly observed that the ill prisoners swallowed the antibiotics to assure the treatment compliance.

Intensive measures for outbreak containment were implemented after the joint investigation on 15 Aug 2009. Each of seven rooms in the male zone 1 was sequentially allocated for the new cases, starting from Monday through Sunday, with a purpose of strict isolation for a week. The mass gathering and working activities were prohibited. Frequency of relative visits was decreased from twice to once a day, and the processes of food and supplies distribution were also changed to reduce cross contamination.

A respiratory illness surveillance system was established in the prison for daily screening of new cases in the morning meetings and at the treatment unit. Additionally, every new inmate was screened for respiratory symptoms before entering the prison. Prevention and clinical detection were promoted particularly among high risk groups of developing severe illness.

Discussion

The moderate attack rate (19%) of influenza cases in this prison outbreak was likely attributable to overcrowded condition in cafeteria, work places and wards as doubled the standard capacity (1 square meter per prisoner),[7] and sharing of telephones, utensils and glasses. Previous studies identified high attack rates of influenza infections in prisons, ranging from 19-40%.[8,9,10]

Compared with the male zones, the higher attack rate in the female zone (25%) could be explained by more sensitive surveillance in the female zone at the late phase of the outbreak than that of the male zone. Female prisoners were working, having meals and sleeping in the same quarter (Figure 4), and there was only one isolation room that might increase risk of influenza transmission.

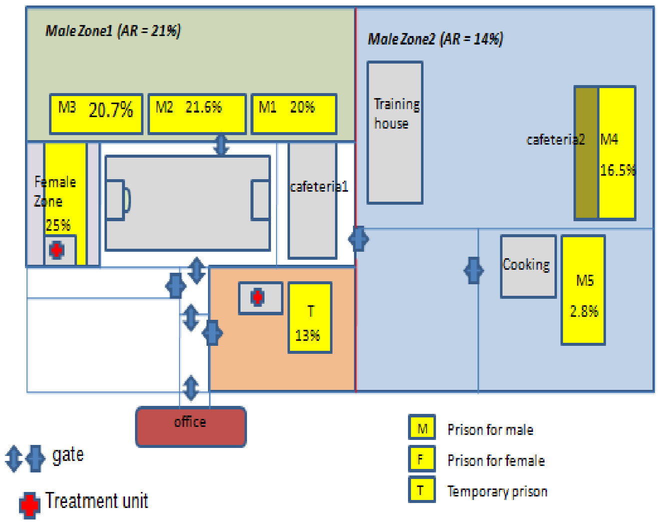

Figure 4. Map of Prison S and influenza attack rate by zones in Saraburi Province, Thailand, Jul-Aug 2009

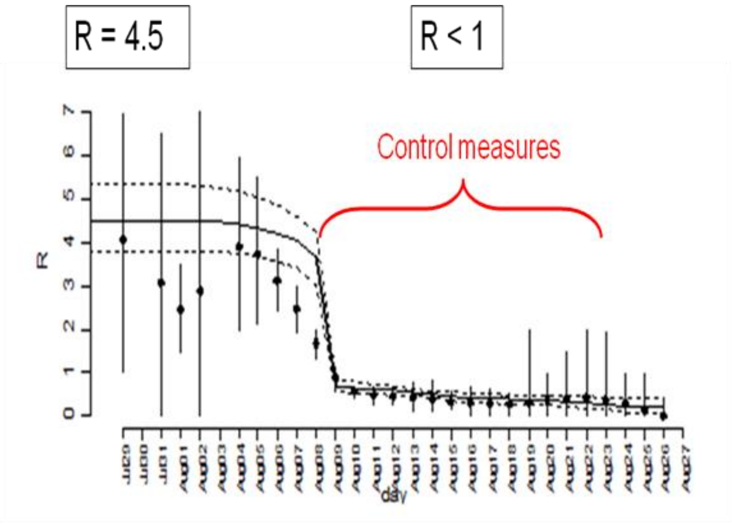

Figure 5. Reproductive number of influenza outbreak in Prison S, Saraburi Province, Thailand, Jul-Aug 2009

The R_0 of influenza in this outbreak was about 4.5 at the beginning and then, decreased rapidly to below one after 8-9 Aug 2009 while the outbreak was detected and the control measures were first implemented (Figure 5). Compared to average basic reproductive numbers of 1.3-1.7 in influenza outbreaks from any other community,[11] the R_0 of 4.5 in this outbreak suggests the higher transmission rate of influenza in overcrowded institutional setting like prison.

Possible sources of influenza A (H1N1) 2009 infection at the beginning were new prisoners, or prisoners who were infected during their visits to local hospitals, or prisoners who were working outside the prison during day-time, or officers who were infected by close contacts in the communities, or attorneys who visited prisoners. The outbreak of influenza A (H1N1) 2009 in Saraburi Province was first reported in June 2009.

The influenza outbreak in the female zone began after the male zones with a delay of one week. It showed that the virus spread easily probably via officers or male prisoners or assistant prisoners of officers from the epidemic zone.

The local SRRT responded to the outbreak rapidly with good multi-disciplinary cooperation from several organizations. Although the outbreak occurred among criminals, good cooperation was witnessed during the investigation. However, the limitations emerged in the restriction areas where the team was barred from direct investigation. In that connection, self-reporting and interviews were performed by prison nurses and assisting prisoners. Other limitation was inadequate information in log books at the treatment units as onset dates of illness were missing. The attack rate of influenza was estimated by using the number of suspected cases and a few of confirmed cases, it was subject to bias in overestimation of influenza incidence. However, under-reporting of mild cases was possible, especially in the early epidemic.

Conclusion

Laboratory-confirmed influenza A (H1N1) 2009 outbreak occurred in Prison S from July to August 2009 with a moderate attack rate, yet without any severe complications or deaths. The source of infection was importation of the pandemic virus from the surrounding communities with ongoing transmission.

Rapid virus transmission among prisoners was probably attributable to overcrowded condition in close institution and sharing objects. Multiple intensive control measures that were simultaneously implemented to control the influenza outbreak probably resulted in declining number of new cases within a short period of time. Allocation of seven rooms for strict isolation of cases was feasible in the prison setting. However, the measure requires thorough assessment of its effectiveness in the future outbreaks.

Recommendations

Control of influenza outbreak requires multiple intensive control measures with interdisciplinary cooperation from several organizations. To prevent importation of influenza virus into prison, the interventions include screening respiratory symptoms of new prisoners, prison officers, and attorneys and relatives visiting prison.

Improvement of medical records such as adding information on onset dates in log books was recommended. Delay detection and report of influenza outbreak should be improved by training of prison nurses and officers to increase their knowledge and awareness.

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