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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.

Keywords: 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.

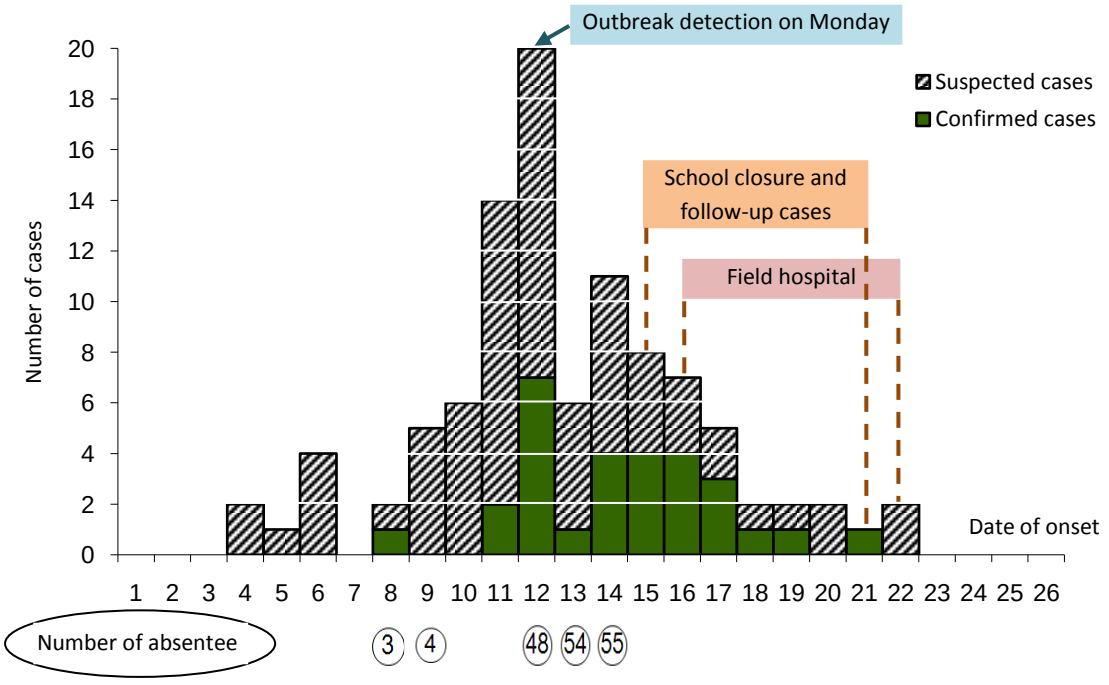

Figure 1. Influenza cases by date of onset in School M, Li District, Lamphun Province, November 2007 (n=109)

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).

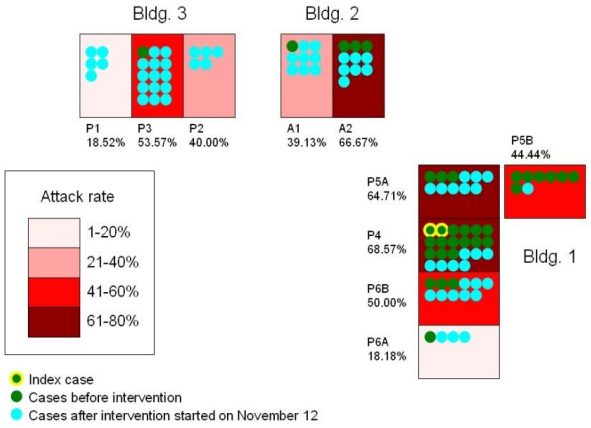

Figure 2. Classroom-specific attack rate and spatio-temporal distribution of influenza cases in School M, Li District, Lamphun Province, November 2007

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).

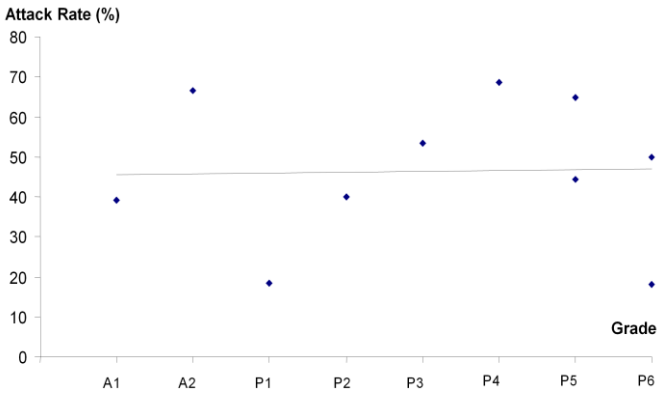

Figure 3. Attack rate of influenza cases by grade with trend line in School M, Li District, Lamphun Province, November 2007

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).

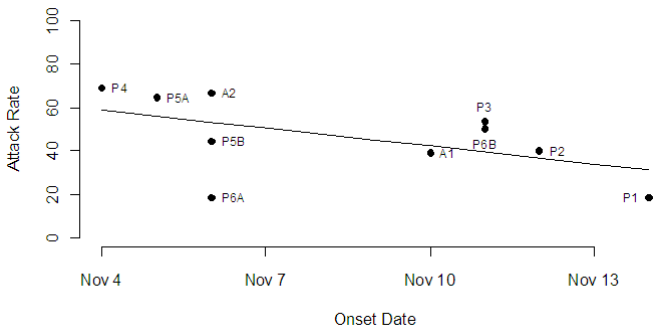

Figure 4. Attack rate by onset date of first influenza case in a classroom in School M, Li District, Lamphun Province, November 2007

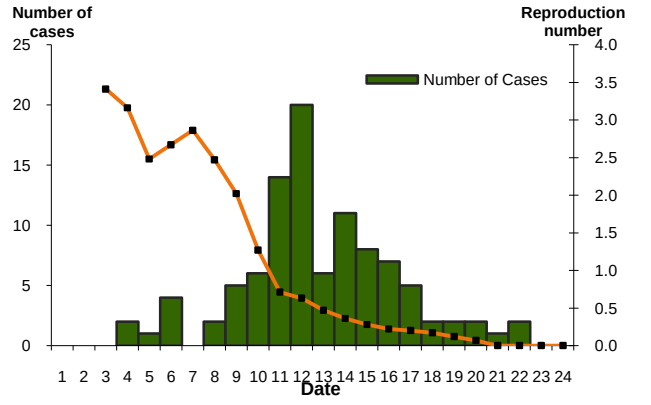

Figure 5. Epidemic curve and estimated reproductive number of influenza outbreak in School M, Li District, Lamphun Province, November 2007

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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