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An Outbreak of Respiratory Syncytial Virus in a Nursery, Tainan City, 2009

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Abstract

An outbreak of respiratory tract infection in a nursery was reported by Hospital A in Tainan City on October 5, 2009. The Fourth Branch of Taiwan Centers for Diseases Control (Taiwan CDC) and the local health bureau initiated an outbreak investigation on October 6. Among the 36 children and 26 staff members, 35 children and 3 adults were symptomatic, 12 children were hospitalized, and one infant died on October 2. The onset of the first two symptomatic children was September 22, and the number of patients peaked on October 5. Most of the patients aged below two years. Respiratory specimens collected from 8 patients with more severe symptoms were sent to Research and Diagnostic Center of Taiwan CDC, and respiratory syncytial virus (RSV) was isolated from seven specimens, while none of them was positive for influenza virus or enterovirus. Therefore, the local health bureau helped that institute to implement infection control measures, including disinfection, adequate ventilation, patients isolation, hand hygiene, and daily check-up for health status and body temperature. Staff members were required to report any suspicious outbreak and take care of the same children to avoid cross-transmission of RSV. By October 19, the epidemic had slowed down and no more severe complications or mortality was found. Lack of infection control measures, no patient isolation, and failing to notify the local health bureau in time all contributed to the outbreak.

Keywords：respiratory syncytial virus, outbreak, infant

Introduction

Respiratory syncytial virus (RSV), mumps virus and rubella virus are RNA viruses of the Paramyxoviridae family. RSV growing in many different cell cultures can produce characteristic syncytial cytopathology.

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After entering the respiratory tract, the virus can induce necrosis of bronchial epithelium, hypersecretion of mucus, inflammation cells infiltration, and submucosal edema [1, 2]. RSV is one of the most important respiratory tract pathogens of early childhood, especially among children between 6 weeks to 2 years of age (rarely seen in infants less then one month old). The incubation period is about 4 to 6 days. Patients present with symptoms for about 7 days, while most of them shed viruses for 3 to 7 days or even longer [2-4]. Initial symptoms can mimic common cold, including cough, rhinorrhea and fever. But the illness progress, wheezing and respiratory distress ensue and patients may have bronchiolitis and pneumonia [2, 5]. Spread of infection occurs when infectious droplets, either airborne or conveyed on hands, are inoculated in a susceptible subject [2]. The epidemics occur in fall and winter while most cases in the tropics are found in rainy seasons. Epidemics usually start in late fall and peak between November and the next March [3, 10]. During the first 5 years of life, 90% of children have been contracted with RSV, but the protection of neutralization antibodies derived from previous infection is short and not strong enough. Although reinfection takes place often, the severity of illness is usually lower; complications such as bronchiolitis and pneumonia are less [6]. Prematurity, children with congenital heart diseases, bronchopulmonary dysplasia, immune deficiency, cystic fibrosis, neurologic diseases, metabolic diseases, or family history of asthma, residents of child care centers, and hospitalized patients have higher risk of severe complications [6, 7]. Infection in premature infants may result in suffocation and death. Infections in children with congenital heart disease or immune deficiency also usually require more intensive care, and the mortality resulting from bronchiolitis and pneumonia is higher [7, 9].

On October 5, 2009, the Fourth Branch of Taiwan CDC was notified by the local health bureau of Tainan City that three young children from a nursery were hospitalized at Hospital A because of respiratory infection. Their influenza rapid antigen tests were negative and the RSV rapid antigen tests were positive. Hospital A had reported a 6-month-old fatal infant on October 2. To investigate the intensity of this outbreak, to clarify the cause of the widespread within this institute, and to give recommendations on how to control RSV outbreak, Taiwan CDC and the local health bureau initiated an outbreak investigation on October 6. This article described the results for future reference.

Outbreak Investigation

This facility provides shelters for young children less than 2-years of age, whose

parents are unmarried, abused in domestic violence, mentally retarded, or financially distressed, or those are deserted. Among the 36 young children stayed in this institute when the outbreak occurred, 25 were boys and 11 were girls. The shelter was divided into three sections. Children between 4 months and 2 years of age were settled in Section A and B, and less then 4 months of age in Section C, respectively. Section A and Section B were interlinked and children always played together. Section C was a separate room, two infants shared a bed. Twenty-six female staff members worked in this institute. Among them, 14 were full-time staff, 2 were part-time workers, 5 were volunteers, 3 were students from schools of childhood care and education, and 2 were administrators. Except the administrative personnel, all other 24 staff participated in taking care of the kids and worked on an eight-hour shift. Two to four staff worked in each shift; they took care of the children, cleaned up the environment, and mutually supported each other. Three contract physicians came to the institute for routine health check-ups on Tuesdays. Regular environmental disinfection were also arranged, visitors were required to have health status evaluation before entering, and staff were asked to wear masks or stay home if they were ill.

A case was defined as a child or staff member presenting with at least two of the following symptoms, including fever, cough, rhinorrhea, sore throat, headache, and dizziness, since September 22, 2009. Among the 38 cases found in this outbreak, 3 were staff member and 35 were infants or young children, including 25 boys and 10 girls. Section distribution of cases and attack rates were listed in Table The most common symptoms were fever, cough and rhinorrhea in infants and young children (Figure1), while staff members presented with headache, dizziness, nasal congestion, and sputum production more often. As shown in Figure 2, children of Section A and Section B became ill since September 22, infants of Section C had a later onset starting from September 27, and staff's symptoms began on October 5. By October 30, 12 patients had been hospitalized, 3 of them had been treated in intensive care units (ICU), and one boy died. The mortality case used to stay in Section B had symptoms since September 24, had been hospitalized between September 25 and October 1 in Hospital A. During hospitalization, influenza rapid antigen test was negative but RSV antigen test was positive. He had resurging fever after discharge and was admitted again on October 2. After transferring to ICU, he died because of septic shock associated with cardiopulmonary failure.

In this outbreak, specimens collected from 28 infants or young children were sent for RSV rapid antigen test in Hospital A and 8 specimens were sent to Research and Diagnostic Center of Taiwan CDC for virus isolation. As a result, 7 specimens were positive for RSV rapid antigen test and 4 of them came from hospitalized patients, including the fatal case. RSV was isolated from 7 specimens and 5 of them were obtained from the same patients who had positive results of RSV rapid antigen test. All the specimens were negative for influenza viruses and enteroviruses.

Table. Characteristics, dates of onset, and attack rates of a RSV outbreak in a nursery, Tainan City, 2009

		Number of people	Number of cases	Onset date of the first case	Median age of cases (range)	Attack rate (%)	Positive RSV test (viral isolation / rapid antigen test)	Patient characteristics
Infants and young Children	Section A	11	11	September 22	9 months-old (5-19 months)	100.0	0/0	1 with cerebral palsy, 2 with G6PD deficiency
	Section B	12	12	September 22	7 months-old (5-11 months)	100.0	1/2	3 prematurity
	Section C	13	12	September 27	3 months-old (1-4 months)	92.3	6/5	1 with congenital heart disease
Staff members	Nursing staff	24	3	October 5	25 years-old (22-29 years)	11.5	no specimen available	
	Administrators	2	0					
	Total	62	38			59.7	7/7	

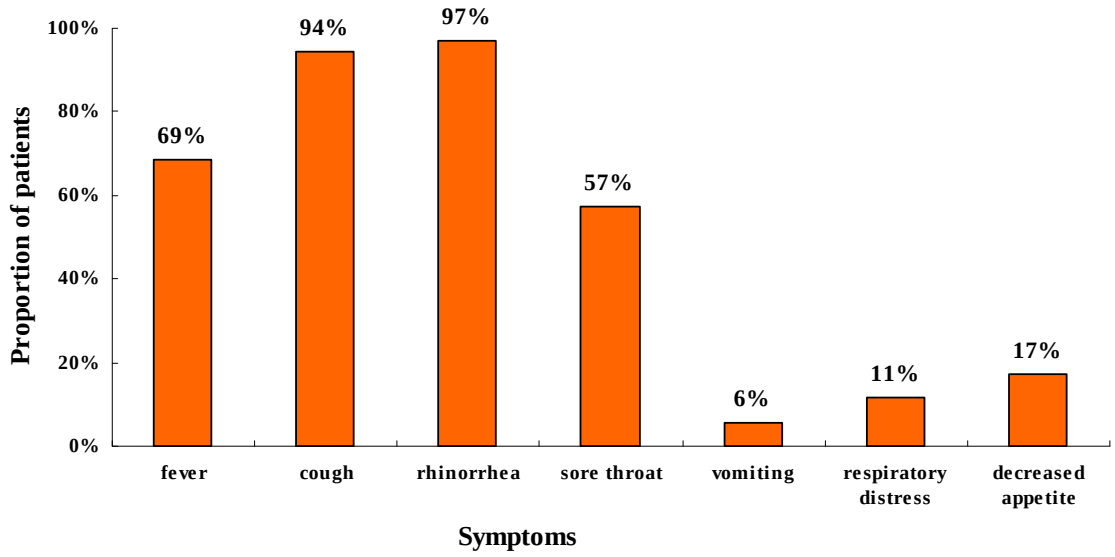

Figure 1. Symptoms of 35 children cases of a RSV outbreak in a nursery, Tainan City, 2009

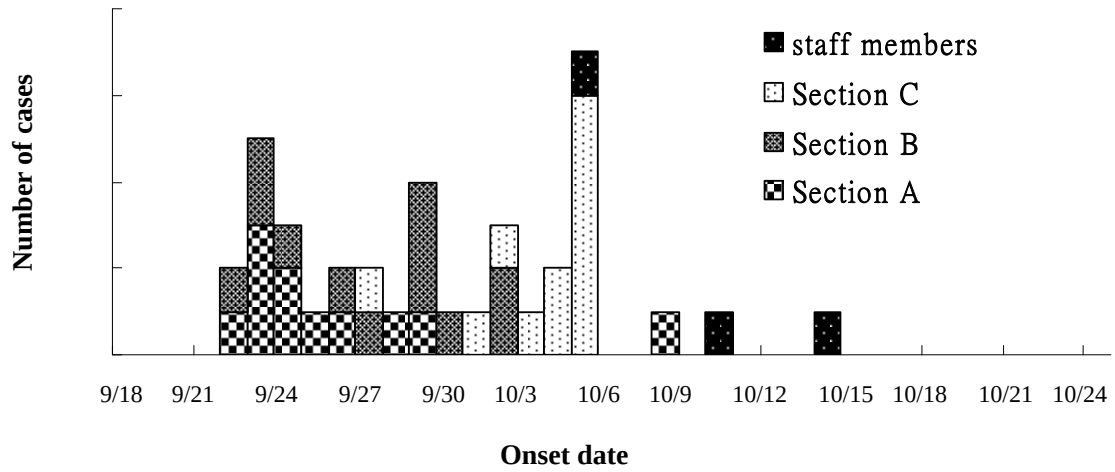

Figure 2. Number of RSV cases in a nursery, by date of onset－Tainan County, 2009

Control Measures

Taiwan CDC and local health bureau have provided recommendations on infection control measures. Ventilation system should be improved; windows should be opened for 3 hours twice daily. Disinfection of the environment and clothes and hand hygiene should be executed. Staff members should take care of the same children. Sick patients should be isolated and reported to local health bureau. Daily check-up for health status and body temperature should be arranged. In addition, this nursery should set up standard infection control measures, standard operating procedures, and instructions on environmental disinfection. The local health bureau should well educate the staff members to follow the infection control measures and emphasize the importance of notification. On the other hand, what Hospital A has done, including prompt notification based on clinical diagnosis and laboratory examinations and assist the nursery collecting specimens and performing further studies, have greatly help on control this outbreak.

Discussion

The source of infection could be one of the staff members or a visitor who has contracted infection, and further spread to children of Section A and Section B via infectious droplets or close contacts. The expansion of the outbreak of RSV, involving almost every child in Section A and Section B, could be contributed to improper isolation of patients and the intimacy between these young children because of the proximity of their beds and sharing the living surroundings. Because the nursery was short-handed, staff members must mutually support each other or the children must be gathered up to be taken care. Besides, the staffs were not well-educated and infection control measures, such as hand hygiene and clothes disinfection, were not properly implemented. Consequently, infants of Section C also got infection. Furthermore, the administrators were not able to stop the transmission in the nursery and did not report the outbreak, because they did not understand the importance of infection control and could not implement the control measures. In response, the local health bureau informed the importance of reporting, educated the staff, imposed sanctions according to Communicable Disease Control Act, and requested the administrators to establish infection control measures, and standard operating procedures. RSV infection is not a notifiable disease in Taiwan, but clusters in any populous institute should be reported to the local health bureaus. The purpose of this regulation is to early detect outbreaks and to give adequate management and control [11].

Worldwide, respiratory syncytial virus is one of the most common pathogen that leads to respiratory tract infection among infants and young children, especially children aged less than 2 years. In the literature, one out of every 100 or 200 infected children would be hospitalized due to complications such as bronchiolitis, which results in overloading of the pediatric wards in fall and winter. Hospital acquired infections could ensue if the infection control measures were not implemented [12]. Outbreaks in child care centers have been reported. An article reported that 60% of the infected infants or

young children aged between 6- 50 months had pneumonia [13]. In this study, the attack rate in this nursery was up to 92.3 to 100%. All the patients were infants or young children less than 2 years-old; four of them were hospitalized because of respiratory distress and one died. According to previous studies, implementation of control measures such as hand hygiene, disinfection of environments and clothes, reinforcement of care to those with underlying diseases, patient isolation, and regular education to staff and caregivers, could help to decrease the number of patients [12-15].

RSV infection is not a vaccine-preventable disease so far. To prevent the similar outbreaks, child care centers and nurseries should have proper ventilation, regular environmental disinfection, and adequate distance between baby cribs; staff should have good hand hygiene, wear gloves as needed and change frequently, wear masks when ill. Knowledge about respiratory syncytial virus should be passed to physicians, nurses and caregivers. The importance of notification should be strengthened. Once a suspected case is found, he should be sent to hospitals for medical consultations and reported to local health bureau. Symptomatic patients should be isolated and take care by specific caregivers. Staff should wash hands before and after touching kids. Ill staff should stay home or wear surgical masks to prevent cross-transmission. Ventilation system should be re-checked; environmental disinfection and daily check-up for health status and body temperature should be implemented. The results of daily check-up should report to the local health bureau so that they can know the intensity of outbreaks and prevent further transmission. Risk of getting infection is higher in premature babies and children with congenital heart diseases and other underlying diseases. The populations at risk without sufficient treatment could become fatal. Therefore, infection control measures are even more important.

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Hospital Outbreak of Mixed Infection of Influenza Virus and*Mycoplasma pneumoniae* in Hualien, 2009

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Abstract

Some residents and health care workers (HCWs) of a long-term psychiatric care facility in Hualien presented with upper respiratory tract symptoms continuously since December 30, 2008. Investigation found that 62.2% of the residents (114/183) and 68.9% (11/16) of the HCWs were symptomatic. From the 104 samples obtained from symptomatic patients, 27 were H3 subtype of influenza A virus (Flu A H3) confirmed by reverse transcription-polymerase chain reaction (RT-PCR), 12 were serologically positive for *Mycoplasma pneumoniae*. Among the 27 specimens positive for influenza A virus, 11 of them were culture positive. Sequence analysis of the genome showed a 95% similarity in nucleotide identity. Based on these laboratory evidences, we attributed this respiratory

outbreak to mixed infection of Flu A H3 and *Mycoplasma pneumoniae*. The outbreak was controlled after sick staffs were asked to stay home, sick residents were isolated, access and visitors were controlled, HCWs were asked to adhere to standard precautions. Although with higher coverage rate of seasonal influenza vaccines in long-term psychiatric facilities, influenza outbreaks still could occur because of the high population density and lack of self-care ability of residents. Therefore, infection control, cold chains of vaccines transportation, and vaccination rate among HCWs should be improved in facilities with high population density, especially in facing this episode of pandemic H1N1.

Keywords：long-term psychiatric facilities; influenza virus; *Mycoplasma pneumoniae*

Introduction

The genome of influenza A virus, which contains 8 pieces of single-stranded, negative-sense RNA, is the key to it's highly variable antigenic diversity. Antigenic shift results in the generation of a new subtype, which could lead to pandemic in 3 to 6 months. Instead, antigenic drift always cause outbreaks in limited areas [1]. Hemagglutinin (HA) and Neuraminidase (NA), two glycoproteins on the surface of the viral particles, are the main antigens to which antibodies can be raised. Influenza A viruses are classified into subtypes based on antibody responses to HA and NA. Among the known subtypes, H1, H2, H3 and N1, N2 are commonly found in humans. In closed and crowded environments, influenza A virus could be transmitted via inhalation of aerosols produced by infected persons. Because influenza virus could survive in airborne droplets for hours in places with lower humidity and lower temperature, it can also be transmitted by contact to contaminated surfaces [2].

Mycoplasma pneumoniae could be transmitted via inhalation of airborne droplets in close personal contacts. The usual incubation period between exposure and onset of symptoms is up to 3 weeks. With prodromes including headache, fatigue, and mild fever, the subsequent disease progression is slow [3]. Among those who get infection, 75 to 100% have dry cough and 3 to 10% may progress to pneumonia [4]. Outbreaks of *Mycoplasma pneumoniae* have been reported from hospitals [5], rehabilitation facilities for the disabled, and other populous institutions [6].

Residents of long-term psychiatric facilities are high risk population in outbreaks of infectious diseases. Upper respiratory tract infections, skin or soft tissue infections, and urinary tract infections are most common, accounting for 94% of all the outbreaks [7] and carrying an attack rate up to 70% for influenza outbreaks [8]. In Taiwan, outbreaks of gastrointestinal infections with Norovirus, *Shigella spp*, or *Entamoeba histolytica* also have been reported [9-11]. In this article, we addressed a large respiratory outbreak in a long-term psychiatric facility in Hualien County occurred on December 30, 2008. We not only described the suspected pathogens, but also analyzed the epidemic curve, limited transport and movement of the residents, isolation and control measures and coverage rates of influenza vaccines among HCWs and patients.

Materials and Methods

A. Background

The referring hospital in Hualien County with 3 separate districts is a long-term psychiatric facility. There are 6 buildings in the main district and all are three-story. Public activities for residents in the same building take place in the restaurant and basketball court at the ground floor; dormitories locate at the second and third floors. There are few contacts between residents and HCWs of different buildings. The respiratory outbreak described in this article occurred in Building B of the main district. All of the 183 residents of Building B are relatively younger and with better mental status; they could participate in occupational therapy and recreational activities and are allowed to meet visitors in the reception room. There are 16 staff members serving in Building B. In flu season 2008, the coverage rates of influenza vaccines in this hospital, in residents of Building B, and in staff members of Building B are 92%, 96%, and 25% respectively.

B. Definitions and Terms

As stipulated in Symptom Surveillance System of Centers for Disease Control, Taiwan (Taiwan CDC), facilities are mandatory to notify the local health bureaus if more than two associated persons in the same facility present with upper respiratory tract symptoms such as cough, rhinorrhea, and fever. The local health bureaus must notify a cluster to Symptom Surveillance System after initial investigation and risk assessment. In this study, residents and staff members of Building B who ever presented with cough, sore throat, rhinorrhea, muscle ache, nausea, vomiting, or fever between January to March, 2009 were included. Their chest radiographs were reviewed to see if there was evidence of severe complicated influenza infection, such as pneumonia, bronchiectasis, and pleural effusion. Two episodes were identified in the outbreak because the duration between the last case of the first episode and the first case of the second episode was up to 7 days, and different pathogens have been identified. One of the HCWs had been hospitalized due to pneumonia since December 16, 2008, but since he had fully recovered by the time we started to investigate and we could hardly get his specimens for further examination, he was excluded in this study. Mixed infection is defined by confirmation of more than two pathogens identified from specimens of the same outbreak, either by culture or paired serum tests.

C. Case information

Field investigation questionnaire were not performed because of the residents' poor cognitive function and inability to express themselves. The information about who had symptoms, what symptoms they had, and the onset of symptoms was obtained from personnel of infection control in that hospital.

D. Sampling and laboratory examination

Throat swabs and serum from patients with upper respiratory symptoms were obtained to test for influenza virus, adenovirus, respiratory syncitial virus, human metapneumovirus, and *Mycoplasma pneumoniae*. Virus culture was used to test for adenovirus, respiratory syncitial virus, and human metapneumovirus. Both RT-PCR and viral isolation were used to identify influenza viruses; virus isolates were sequenced to see if the genotypes were identical. Serological tests for specific antibodies including IgM, IgG, and IgA were performed with commercial kit SeroMP ELISA Kit

(Savyon, Israel) to identify the infection status of *Mycoplasma pneumoniae* [12]. A positive IgM, positive IgA, or a significant rise in IgG titer in the second sample was defined as current infection. Positive IgG in the first sample but without significant rise in IgG titer in the second sample was defined as past infection. Those with past infection were not included in this study.

E. Investigation and infection control measures

After notifying the outbreak of upper respiratory tract infection on January 14, 2009, Area B of the 3rd floor (Area 3B) of Building B was designated as isolation ward in order to isolate afebrile but symptomatic patients. Once the patient became febrile, he would be sent to the 1st floor for isolation. If isolated residents in Area 3B became asymptomatic, they were relocated to Buffering area at the 3rd floor. After observation for 3 days, a resident remaining asymptomatic would be released from isolation. Infection control measures for HCWs, including hand-washing before entering the wards, putting on surgical masks, and reminding residents about personal hygiene, were implemented. Febrile staff members, but not those with only mild symptoms, were prohibited from coming to work. Symptomatic visitors were asked to put on surgical masks and were allowed to meet the residents only in specialized reception areas. Bleach water (500 ppm) was used daily to sterilize the floors, bathrooms, ward beds, and end tables. Symptomatic patients were sampled for further examinations. Body temperatures and presence of upper respiratory symptoms of the residents and the staffs were monitored. Public health workers were in charge of field investigation and assessment of the infection control measures.

Results

A. The scale of the outbreak

There were 125 symptomatic patients found in Building B between December 30, 2008 to March 8, 2009, including 114 residents and 11 staff members. The epidemic curve showed that there were two episodes in this epidemic (Figure 1). The onset dates of

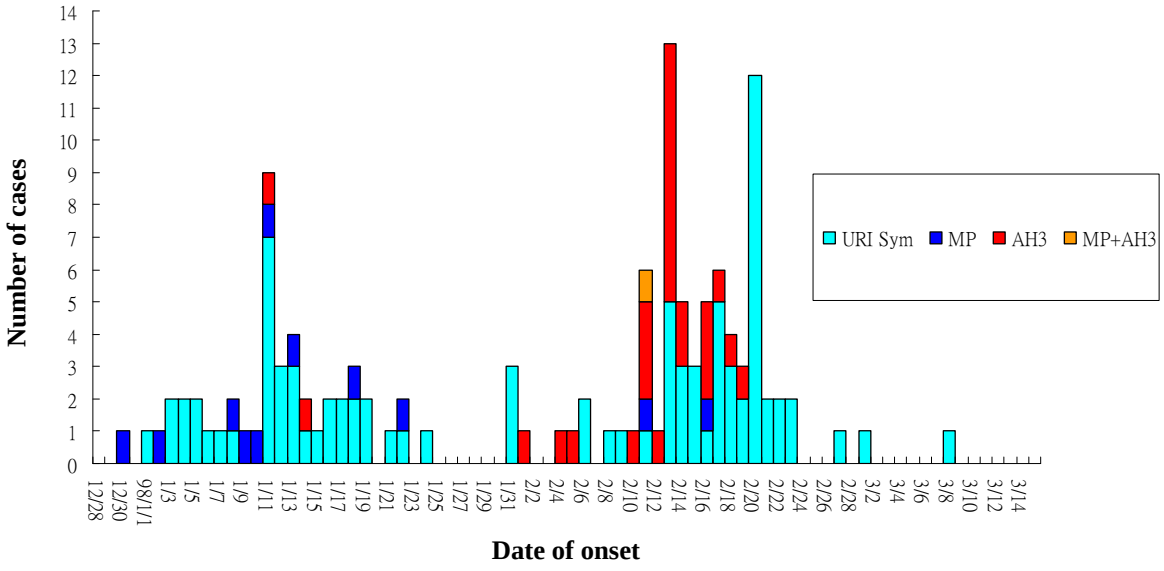

Figure 1. A respiratory outbreak occurred in a hospital in Hualien County, 2009

(N=125) AH3: Influenza A virus H3 subtype, MP: *Mycoplasma pneumoniae*

the first episode were between December 30, 2008 and January 24, 2009 while the second episode began on January 31, 2009 and ended on March 8, 2009. Between these two episodes, 28 residents went home because of Chinese New Year and 6 of them became symptomatic 7 days after coming back to the institution. Among the 6 symptomatic residents, 2 turned out to be confirmed cases of Flu A H3. The total number of patients of these two episodes were 47 (including 40 residents and 7 staff members) and 78 (including 74 residents and 4 staff members) respectively. The overall attack rate in residents was 62.3% while the attack rate in staff members was 68.8%.

B. Clinical presentations

Common symptoms in this outbreak included cough (76.8%), rhinorrhea (36.8%), fever (28.8%), sore throat (18.4%), muscle ache (4.8%), and vomiting (1.6%). Four residents had pulmonary infiltrates on chest radiographs that were compatible with pneumonia; 3 of them were serology positive for *Mycoplasma pneumoniae* and the specimen from last pneumonic patient was tested positive for Flu A H3 by RT-PCR. Two patients had pleural effusion on chest radiographs, including one staff member who had been admitted for pneumonia on December 16, 2008 and one resident whose specimen was positive for Flu A. None of the symptomatic patients met the criteria of severe complicated influenza infection set up by Taiwan CDC.

C.Laboratory examinations

A total number of 104 specimens were sampled during field investigation, including 47 specimens from the first episode and 57 specimens from the second episode. As listed in Table 1, 27 specimens were tested positive for Flu A H3 by RT-PCR and 12 serum samples were positive for *Mycoplasma pneumoniae*. One resident was positive for both Flu A H3 and *Mycoplasma pneumoniae*. The results of *Mycoplasma pneumoniae* serology tests were listed in Table 2, including one positive for IgM, 3 positive for IgG, two positive for IgA, one positive for both IgM and IgG, and 5 positive for both IgA and IgG. Nine of 12 specimens were obtained from the first episode and the remaining three were from the second episode. Only 3 specimens were sampled from staff members during the first episode, the other 9 specimens came from the residents. As for the 27 positive specimens for Flu A H3, 2 were from the first episode and 25 were from the second episode. Most of the specimens were obtained from the residents except one was sampled from a staff member during the second episode. Two of the nine patients who were serological positive for *Mycoplasma pneumonia* in the first episode had pulmonary infiltrates on chest radiographs, which were compatible with pneumonia. One of the three patients who were serological positive for *Mycoplasma pneumonia* in the second episode had pleural effusion on chest radiograph. In addition, 11 viral isolates were cultured from the 27 specimens which tested positive for Flu A H3 by RT-PCR. Sequence analysis of the genome showed a 95% nucleotide identity (Figure 2). All specimens were negative for adenovirus, respiratory syncitial virus, or human metapneumovirus.

D. The effects of control measures

After all the 35 symptomatic residents were sampled for further examinations on

Table 1. Laboratory results of all specimens obtained from the respiratory infection outbreak of a long-term psychiatric care facility in Hualien, 2009

	Flu AH3[*1] RT-PCR positive (positive rate)	MP[*1] seropositive (positive rate)	Number of specimens
1st episode[*2]	2 (4.3%)	9 (19.1%)	47
Residents	2 (5.0%)	6 (15.0%)	40
HCWs	0 (0%)	3 (42.9%)	7
2nd episode[*3]	25 (43.9%)	3 (5.3%)	57
Residents	24 (45.3%)	3 (5.7%)	53
HCWs	1 (25.0%)	0 (0%)	4
Total	27 (26.0%)	12 (11.5%)	104

*1: Flu AH3：Influenza A virus H3 subtype, MP：*Mycoplasma pneumoniae*

*2:1st episode: December 30, 2008 to January 24, 2009.

*3: 2nd episode: January 31, 2009 to March 8, 2009.

Table 2. Number of patients who were serologically positive for *Mycoplasma pneumoniae* from the respiratory infection outbreak of a long-term psychiatric care facility in Hualien, 2009

	Ig M positive (positive rate)	Ig G positive (positive rate)	Ig A positive (positive rate)	both IgM and IgG were positive (positive rate)	both IgA and IgG were positive (positive rate)	total
1st episode (n=47)	1 (2.1%)	2 (4.3%)	2 (4.3%)	1 (2.1%)	3 (6.4%)	9 (19.2%)
2nd episode (n=57)	0(0%)	1(1.8%)	0(0%)	0(0%)	2(3.5%)	3 (5.3%)
total (n=104)	1 (1.0%)	3 (2.9%)	2 (1.9%)	1 (1.0%)	5 (4.8%)	12 (11.5%)

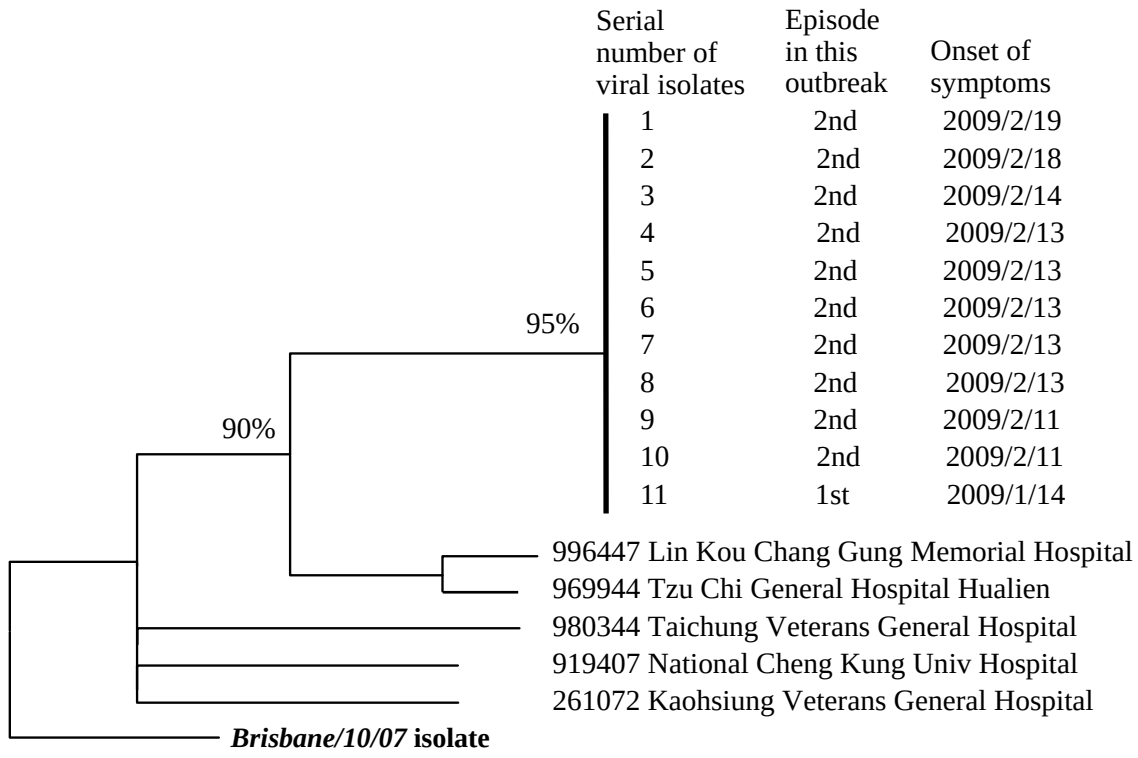

Figure 2. Phylogenetic tree of Flu A H3 viruses from the respiratory infection outbreak of a long-term psychiatric care facility in Hualien, 2009

Eleven viral isolates were cultured from the 27 patients who tested positive for Flu A H3 by RT-PCR. The 11th viral isolate came from the 1st episode, and the other 10 viral isolates came from the 2nd episode.

January 13, the hospital started monitoring the presence of symptoms among residents and staff members and also implemented infection control measures. The number of cases decreased gradually and there was no new case found during Chinese New Year (from January 25 to January 30). However, one nurse was found at work with symptoms and fever. The hospital had once lifted isolation in the morning on January 31, after Chinese New Year, but soon resumed it because of 5 new cases found in the afternoon. Public health workers visited the hospital on February 12 to initiate an investigation and offered some recommendations. First of all, because only 25% of the staff members had received influenza vaccination in 2008, most caregivers in this hospital were still vulnerable to influenza infection and influenza virus could subsequently be transmitted to residents. So it is suggested for them to catch-up immunization. Second, ill and febrile staff members did not stop working and might have resulted in spreading and transmission of the pathogens. So symptomatic staff should stay home or work on administrative jobs instead of taking care of residents directly and febrile staff should only stay at home. Third, there was no regulations regarding personal contacts between different areas or different floors even after the outbreak occurred. Residents also continued receiving occupation therapy and were free to go out. Cross infection between symptomatic residents and susceptible people might have happened. So all physical contacts and communication activities should be suspended until 7 days after the onset of the last patient. Last but not least, visitors could meet the residents without restrictions, so it was possible that residents might get the infection from visitors with respiratory symptoms. We suggested that both parties should wear surgical masks and the reception area should be away from the wards.

In this outbreak, thirteen patients were found by February 13, 2009. Therefore, regulations regarding personal contacts between different areas or different floors were set up and occupation therapies as well as other activities outside this hospital were suspended. The number of cases decreased initially but resurged on February 17, 2009, probably because asymptomatic residents at the first floors could have contacts with isolated febrile patients in the bathrooms. Time for using the bathroom was then scheduled and controlled. The number of patients surged again on February 20, which could be contributed to mobilizations of isolated febrile patients and residents in Buffering Area on February 19. Mobilizations of residents between different areas were strictly forbidden and isolation rules were stringently enforced. The number of cases decreased and the last case occurred on March 8. The hospital deregulated all the infection control measures on March 15.

Discussion

A. Influenza A virus and *Mycoplasma pneumoniae* both attributed to this outbreak.

Combined the clinical presentations and the results of laboratory examinations, this outbreak could be attributed to the mixed infection of Flu A H3 and *Mycoplasma pneumoniae*. Because *Mycoplasma pneumoniae* was identified by serology studies,

we were unable to distinguish the subtypes and to confirm the identity by using molecular typing. As for the 11 isolates of Flu A H3, sequence analysis of the genome showed a 95% similarity in nucleotide identity. The probable transmission routes were close personal contacts and inhalation of infectious droplets. Because not only residents, but also staff members contracted both pathogens, close contacts between residents, occurring at meals, exercise, talks, in the bathrooms, and during occupational therapy, and failure in practice of standard precautions when staff gave injections and medications to residents and when staff tried to check the residents' body temperatures might have resulted in cross infections. In addition, we should keep an eye on the risk of long-term transmissions of *Mycoplasma pneumoniae* in this hospital because of the 12 cases found in this outbreak.

B. Failing to implement infection control measures resulted in further spreading of the diseases.

We focused on the HCWs first. Before this outbreak, one of the HCWs with upper respiratory tract symptoms kept going to work before this outbreak. Since February 5, 2009, another HCW who did not receive influenza vaccination in 2008 also suffered from fever, muscle ache during this outbreak. He also kept working when he was ill and turned out to be a confirmed case of Flu A H3. Tracing back to the vaccination history of the HCW, the coverage rate in 2008 was 25%. The attack rate in HCWs was 75% which was higher than that in the residents (62.3%). Combined these facts, there is still room for improvement in infection control among the HCWs.

As for the residents, the infection control center of the hospital has placed restrictions on symptomatic patients, but not on the contacts early in this outbreak. Because residents from different floors could contact with each other, there should be additional rules set up to prevent spreading of the disease. Going out for occupational therapy and other activities should be suspended. Relocation of the residents should be avoided and all other infection control measures established in response to this outbreak should be strictly implemented.

C. More aggressive infection control measures should be considered.

1. Implementation of active surveillance and reporting systems in psychological wards: According to the guidelines for seasonal influenza in adults and children set up by Infectious Disease Society of America in 2009 [13], influenza viruses could more easily be transmitted in facilities with high population density, and the residents are more prone to develop complications if they do contract influenza. Facilities such as hospitals, day care centers for adults and children, and prisons should cooperate with local health bureaus and have to abide by Communicable Disease Control Act and provisions for surveillance of the infectious diseases.
2. Set up indicators for symptom screening: Although 75-100% patients with *Mycoplasma pneumoniae* infection presented with dry cough, but it could not be taken as an indicator for screening because many residents were heavy smokers. Fever could be a better indicator since 16 of the 27 patients positive for Flu A H3 were febrile.

3. Set up warning thresholds for influenza infection to help the hospital initiating mandatory control measures: If influenza virus is found in the community with laboratory confirmed cases, facilities must put an eye on residents presenting with influenza-like illness and see if there is influenza outbreak. For example, if two residents are found to have influenza-like illness within 72 hours and one of them is confirmed by laboratory tests, this event should be managed as a flu outbreak [14].
4. Make the laboratory examinations on time: The first episode of this respiratory outbreak was reported on January 14. Because the onset dates in 15 of the 35 symptomatic patients were earlier than January 10, the positive rate for influenza virus was only 4.2%. If specimens could be sampled within three days, the positive rate for influenza of the first episode could be more close to that of the second episode (43.9%). According to the IDSA guideline, respiratory specimens should be collected for detection of influenza virus if more then two residents in a facility present with influenza-like illness within 72 hours in flu season[13] Since the sensitivity of influenza rapid antigen test is not good enough to rule out influenza in patients with negative results, patients in a flu cluster should have their samples sent for RT-PCR and viral isolation to see if influenza virus is the pathogen. Although influenza infection without complication is not a notifiable disease in Taiwan, facilities can report the cases via Viral Surveillance System and send specimens for laboratory examinations. The hospital is one of the sentinels of the Viral Surveillance System, but only one respiratory specimen was sent to the contract laboratory in previous flu season (between November, 2008 and February, 2009). The hospital did not make the best use of the Viral Surveillance System and therefore overlooked the flu trends inside this facility. Concerning the tools for laboratory diagnosis of *Mycoplasma pneumonia*, culturing from sputum or throat swab of patients at early stage of the disease is the best method. But due to the slow growth of the pathogen, culture has limited value in clinical diagnosis and serology test has been accepted as the gold standard. Because both influenza and *Mycoplasma pneumonia* are common in autumn, differential diagnosis is of great importance.
5. Reenforce check-ups of the vaccine storage: Some of the HCWs declined flu vaccines because of concerns about safety issues due to a service interruption in electricity power supply during vaccination campaign. Uninterrupted Power System (UPS) should be maintained and regularly checked up and the vaccine coverage rate should be improved.

The first confirmed case of 2009 pandemic H1N1 influenza in Taiwan was found on May 20, 2009 and the first community case was then found on July 2, 2009. Because mitigation has replaced quarantine as the mainstay of the control measures, schools and facilities with high population density have become the most important source of transmission. The first

case of severe complicated influenza infection due to 2009 pandemic H1N1 influenza was confirmed on July 17,2009 and the public health authorities have tried every means of control measures to decrease the number of severe complicated cases and the number of death. To identify susceptible hosts and populations at higher risk in developing complications, Taiwan CDC analyze the first 100 cases of severe complicated influenza infection [15]. Thirty-eight of the 100 patients had pre-existing medical conditions; both neurocognitive dysfunction (12 patients, 31.6%) and chronic obstructive pulmonary diseases or asthma were the most common underlying diseases. Similar results were documented in an analysis targeted infected children conducted by Centers for Disease Control and Prevention, US, which reported that neurodevelopmental disorders were seen in 92% of mortality cases [16] and another epidemiological study in seasonal influenza in children [17]. Therefore, public health authorities should spend more time on how to implement control measures against communicable respiratory diseases, especially in nursing homes for psychological diseases and facilities with high population density.

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